Bibliography on Hot Isostatic Pressing (HIP) Technology

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**Abstract:**

This report contains an annotated bibliography of 950 documents on the Hot Isostatic Pressing (HIP) Technology dealing with metals, alloys, and intermetallic compounds and covers over 450 materials. Documents published from 1966 to early 1992 are covered. Bibliographic information reported here are divided into three broad categories. The first category includes an annotated bibliography dealing with HIP technology as applied to powder metallurgy. The second category deals with casting and the third deals with miscellaneous materials which either are not properly identified or have a limited number of bibliographic citations. Within each category, bibliographic information is organized according to major alloy groups, e.g., aluminum alloys, beryllium alloys, cobalt alloys, etc., followed by bibliographies for miscellaneous alloys which are alloys either not properly identified or not having enough data to warrant a separate category. Each alloy group is further subdivided into individual commercial alloys, e.g., aluminum alloys AA 2024, AA 7075, AA 7090, etc., followed by miscellaneous aluminum alloys.

**Subject Terms:**

Bibliography, hot isostatic pressing (HIP), powder metallurgy, castings, metals, alloys, intermetallics, mechanical properties, processing, beryllium alloys, titanium alloys, aluminum alloys, cobalt alloys, refractory alloys, steels.

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Hot isostatic pressing (HIP) uses a combination of elevated temperature and an inert gas pressure and is carried out in pressure vessels containing internal furnaces. HIP was invented by Sailer et al. 37 years ago at Battelle Columbus Laboratories. An early Battelle report on Hot Isostatic Pressing, by Hanes et al. [1], was first issued in 1977. This report covered the history of HIPping, manufacturing systems, and studies of HIPping applications in the areas of castings, powder consolidation, and rejuvenation of used components. A more recent report in 1982 by Clauer et al. [2] reviewed more recent research dealing with the same subjects covered in the first report. Such studies confirmed the positive benefits of HIPping in a wide range of material compositions. The period of 1972-1982 in the field of HIPping may be considered as the decade of experimentation and confirmation of HIPping as a viable process to be used in the production of material components.

An important short coming of the report was the lack of information on the understanding of the metallurgical reactions which take place during the HIP process. The majority of research results focused on the closure of porosity as it affected mainly LCF and ductility. Many possible structural responses can occur when complex cast superalloys are heated in a temperature range of 1875°F to 2400°F for periods of two to four hours.

It is well known that superalloys have a wide solidification temperature range, i.e. the temperature difference between the liquidus and solidus. As the molten metal slowly solidifies, large grains and primary carbides nucleate and grow while at the same time the larger alloying elements diffuse slowly and segregate in the interdendritic regions. External and internal porosity results when the last liquid cannot fill the intertices.

The presence of surface connected porosity in the large castings prohibits internal porosity closure. Various methods of bridging over the surface porosity prior to HIPping have been tried, but a good coating method is still being sought. Perhaps, new coatings such as new boron nitride lubricant paints may provide a solution to this problem.

The HIP process can close internal casting porosity provided the proper temperature, pressure, and time conditions are selected. At the same time porosity closure is taking place, a certain degree of chemical homogenization is also taking place. However, there are undesirable reactions which can occur depending on the alloy composition. When the HIP temperature is too high, segregated areas are prone to incipient melting which cannot be rectified by thermal treatments. Another detrimental reaction is the breakdown of primary carbides and possible subsequent formation of continuous grain boundary carbide films and resultant embrittlement. In high boron content alloys, borides can also be solutioned and re-precipitated at grain boundaries. In Hf modified superalloys, the Hf can lose its beneficial effect by the formation of HfC.

It has been the authors' observation that when the as-cast gamma prime (γ') phase (the main strengthener in superalloys) is solutioned by high temperatures such as in a HIP process, the reprecipitated γ' phase due to post HIP heat treatments does not have the same composition as the as-cast γ'. The effects on mechanical properties due to the changes in such γ' are overshadowed by the positive improvements in mechanical properties with porosity closure. γ' effects on mechanical properties may be more evident in second generation HIP processing, i.e., first HIP of castings to close porosity and second HIP to rejuvenate properties.
One summation of HIP temperatures, pressures, and times for various superalloys is given by Bouse and Mihalisin [3]. They, too, caution the use of one blanket set of HIP parameters for different alloys without preliminary studies.

The uses of powders in components for high temperature service are mainly for disks and in dual alloy configurations. Powder materials are consolidated by either HIP, extrusion, and/or HIP plus forging/extrusion. Powder compacts exhibit fine grain structures and are more homogeneous in composition than cast/wrought products. The fine grain nature of consolidated powder components makes them suitable for low temperature applications like turbine disks.

Two disadvantages of the powder components are higher costs associated with powder production and the possibility of oxide inclusions being present which act as crack initiation sites for LCF failures. To overcome the problem with oxide inclusions, powder atomization processes are being developed which eliminate or replace the use of ceramic nozzles.

In the field of high temperature materials, HIP rejuvenation is now accepted as a viable method for reclaiming components which otherwise would be scrapped. Engine run components suffer from varying degrees of creep voids, internal cracking, and structural degradation. Used components which still meet all design specifications can be HIP rejuvenated by proper selection of HIP parameters and proper post HIP heat treatments to regenerate mechanical properties. Those blades which suffer from only long time structural degradation can be easily rejuvenated by thermal treatments. Successful use of HIP rejuvenation saves critical elements, reduces cycle replacement time, reduces costs, and saves on energy.

References


ASSESSMENT AND FUTURE TRENDS OF HIP TECHNOLOGY

HIP technology is currently a very mature technology and is being used to consolidate powders of all types, close casting porosity, promote weld integrity, rejuvenate used turbine blades and vanes, etc. After the high cost of HIP equipment, the greatest consideration or deterrent for use of HIPping of materials is the high cost of the cycle time. As the number of parts per HIP run is increased, the cost per unit decreases, but with the need to HIP large castings, the cost per unit remains very high.

A summary of the research activities in the HIP technology for powder and cast components is presented in the following table.

Summary of Research Activities in HIP Technology for Powder and Cast Components

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>6 (0)</td>
<td>6 (0)</td>
<td>4 (0)</td>
<td>21 (2)</td>
<td>8 (7)</td>
<td>3 (3)</td>
<td>54</td>
</tr>
<tr>
<td>Beryllium</td>
<td>3 (0)</td>
<td>23 (0)</td>
<td>26 (0)</td>
<td>8 (0)</td>
<td>3 (0)</td>
<td>0 (0)</td>
<td>63</td>
</tr>
<tr>
<td>Cobalt</td>
<td>0 (0)</td>
<td>11 (2)</td>
<td>4 (2)</td>
<td>7 (2)</td>
<td>3 (3)</td>
<td>2 (0)</td>
<td>36</td>
</tr>
<tr>
<td>Iron</td>
<td>0 (0)</td>
<td>11 (5)</td>
<td>26 (5)</td>
<td>37 (13)</td>
<td>15 (7)</td>
<td>10 (1)</td>
<td>130</td>
</tr>
<tr>
<td>Nickel</td>
<td>0 (0)</td>
<td>25 (4)</td>
<td>72 (37)</td>
<td>84 (61)</td>
<td>41 (53)</td>
<td>5 (7)</td>
<td>389</td>
</tr>
<tr>
<td>Refractories</td>
<td>0 (0)</td>
<td>3 (2)</td>
<td>1 (0)</td>
<td>4 (1)</td>
<td>5 (0)</td>
<td>3 (0)</td>
<td>19</td>
</tr>
<tr>
<td>Titanium</td>
<td>0 (0)</td>
<td>11 (1)</td>
<td>34 (27)</td>
<td>84 (35)</td>
<td>47 (21)</td>
<td>5 (0)</td>
<td>265</td>
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<tr>
<td>Intermetallics</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (0)</td>
<td>5 (2)</td>
<td>17 (4)</td>
<td>42 (3)</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>3 (0)</td>
<td>90 (14)</td>
<td>168 (71)</td>
<td>250 (116)</td>
<td>139 (95)</td>
<td>70 (14)</td>
<td>1,030</td>
</tr>
</tbody>
</table>

* Number in parentheses are for cast components.
The major thrust of the research in the early to mid-Seventies was to use beryllium to fabricate structural materials by HIPing. Attempts to develop cast and wrought beryllium products resulted in limited commercial success. Powder metallurgy techniques have been used to fabricate components for structural applications. Since beryllium is a relatively expensive material, most of the efforts were on the other cost cutting measures such as machining costs, scrap losses, and development of net shape components. However, interest in using HIPing technology for commercial fabrication of structural components slowly diminished which is evident from the number of documents published in the Eighties. Research activities in this decade were concentrated on nickel (and to a lesser extent, iron) superalloys and titanium alloys. The relative ease to produce near net shape components was the driving force behind acceptance of superalloys. Interests in the intermetallic alloys have increased significantly in the late Eighties and early Nineties.

**Superalloys**

**Large Structural Castings**

The development of new aircraft engines requires larger and more complex structural castings. It is estimated that the use of castings will increase by a factor of four before 1994 and the use of castings greater than 40 inches will increase even more substantially.

Currently, large structural components, such as engine cases, rings, frames, and supports, are made of various cast and wrought pieces joined together by welding and/or brazing. If extensive welding is required, distortion, increased costs, and long cycle times result.

An example of one such structural component is the CF6-80A turbine frame made of alloy 718 and weighing over 150 Kg (330 lb.) and 135 cm (53.15 in.) diameter with 61 separate pieces of varying wall thicknesses which must be joined by welding. By producing this component as a single casting, cycle time and distortion is greatly reduced and a $20,000 cost reduction is realized.

Large structural castings are also being made of newer cast alloys such as René-220C, GTD-222, René-108 and IN-939. The trend is to go to Ni base superalloys for higher temperature applications and greater oxidation/sulphidation resistance. However, the structural responses to high temperature thermal treatments like welding repair, HIP, and longtime service needs to be characterized.

In order to successfully HIP fine grain components without grain growth, the HIP temperatures must be lower and the pressures higher. The HIP parameters selected must close porosity, minimize grain growth, and partially homogenize segregation. Generally, fine grain castings are given preHIP thermal treatments to help reduce segregation so as to minimize potential incipient melting.

At this same time, casting vendors have developed new casting techniques to produce fine grains and incorporating a HIP step to close porosity. Advances in wax and mold technologies coupled with the use of robotics for dipping large molds made possible production of large structural castings. Two fine grain casting processes, Grainex and Microcast-X have been developed by the Howmet Corporation, as well as a fine grain process by Precision Castparts.

Two main problems exist in the HIPing of large castings. The first problem is that larger HIP furnaces are required to accommodate the larger structural castings of the future. Currently, HIP furnace manufacturers are developing or have developed furnaces with hot zones up to 60 inches in diameter.

The second critical problem in HIPing is that the cycle time for a HIP run is too long. Because the long cool down in the HIP furnace produces undesirable structures, a post HIP solution heat treatment is necessary before final aging can take place to develop the mechanical properties. Two procedures are currently being explored to reduce cycle time. One method involves the cooling of the pressurizing gas by
external heat exchangers. A process to do this has been developed by ABB Autoclave Systems, Inc. which is called "HIP Quenching." The other method is to cool the pressurizing gas by introduction of cool gas. Both methods are promising but the critical factor is whether the material can be cooled uniformly.

**Quick HIP**

A recent development to reduce cycle time is a process called Quick HIP. In this process the material is first heated externally to the HIP furnace and then given a quick HIP at high pressures in a pressurized furnace. This technology would reduce the heating and cooling part of the conventional HIP cycle. This is still in the experimental stages for this technology.

**Cast Turbine Blades**

During the decade of 1982-1992, equiaxed and D. S. turbine blades were being routinely HIPped to close casting porosity. Since most of the blade components are large grain structures, grain growth during HIPping is not a problem. However, in the case of single crystal blades, closure of casting porosity at high temperatures may be accompanied by the formation of areas of small recrystallized grains which are unacceptable for high temperare operation. Opinions are divided over whether to HIP single crystals due to the possibility of producing recrystallized grains; however, more single crystal blades are being HIPped without encountering the recrystallization effect. Since the HIP temperature controls the tendency for the recrystallization process, HIPping of single crystal blades should be done at the lowest possible HIP temperature for porosity closure.

**Turbine Disks**

Currently some turbine disks are made of powder but the majority of disks are small grain wrought products. Materials being considered for disk applications are conventional alloys but subsolvus (gamma prime) processed to retain fine grain structures. However, when these materials are subsolvus processed, the yield of the final component is so low that the resultant high material cost makes powder disks of the same composition very competitive.

HIP rejuvenation studies of used wrought turbine disks have been unsuccessful since the high temperatures involved in the HIP process produces large grain growth. This would make such disks unacceptable for low temperature applications. However, used powder turbine disks might be amenable to HIP rejuvenation since fine grains in powder components resist grain growth to a much higher temperature than their wrought counterparts.

**Titanium Alloys**

The strength to density ratio of titanium alloys coupled with their fracture toughness and fatigue properties make them attractive for aeronautical and space applications. First Ti-6Al-4V and later Ti-6Al-2Sn-4Zr-2Mo were used in early gas turbine engines but as the operating temperature increased these were replaced with nickel superalloys. In advanced gas turbine engines, titanium alloys are used mainly as compressor discs and fan blades. Today titanium alloys are more important as structural materials for modern warplanes and spacecraft.

Research on HIPping of titanium alloys focused mainly on fabrication of powder components and near net shape forming. These processes make titanium alloys more economical by increasing low temperature strength and while limiting scrap material and machining cost. This was demonstrated by using P/M near net shaped Ti-6Al-6V-2Sn for fuselage braces on the navy F-14A. Also investigated was increasing the performance of titanium castings as well as repair and rejuvenation of used titanium castings. HIPping of
titanium castings can close cracks and remove the porosity thus increasing the strength and fatigue life. HIPing is essential for castings that are to be machined or welded.

**Intermetallics**

The main advantages of intermetallic alloys over conventional alloys for high temperature structural applications are high melting points, low density, good high temperature strength and oxidation resistance. While the major disadvantages have been room temperature ductility and fabrication, pursued mainly as aircraft turbine engine materials, the aluminides and silicides have shown the most promise. Particularly, monolithic as well as composites of TiAl, Ti₃Al, Ti₂AlNb, NiAl and MoSi₂ have been considered for both compressor blades, vanes, discs and shafts and turbine blades, discs and nozzles.

Other intermetallic alloys, most noticeably Fe₃Al and Ni₃Al, are already in use as or are being tested for applications such as dies for Fe-B-Nd automotive magnets, automotive turbocharger rotors, roller bearings, hydroturbines and feed water pumps with improved cavitation erosion resistance, heating elements for toasters and clothes dryers, hot gas filters for coal gassification systems and coatings for oxidation and sulfidation resistance.

**Recommendations**

It is an accepted fact that porosity closure of castings reduces the amount of materials scrapped, but care should be exercised to reject any trend to lower the initial high quality of materials on the premise that HIPing will make poor quality materials good.

In the future more emphasis should be placed on the re-use of engine run components by application of the HIP rejuvenation technologies. In addition, ongoing structural studies coupled with HIP cycles need to be carried out on newer and more complicated cast alloys which are being considered for long time operation at increasingly higher temperatures.
ORGANIZATION

The Bibliography on Hot Isostatic Pressing (HIP) Technology presented here is concerned with HIP of unalloyed metals, metal alloys, and intermetallic compounds. Most of the literature cited deals with structural materials and/or materials designed to perform at high temperatures. The emphasis is placed on HIP techniques, microstructural changes, and effects on creep, fatigue, corrosion, and mechanical properties.

This bibliography contains 950 individual citations published from 1966 to mid-1992 and covers over 450 different materials organized on three hierarchical levels. The first level is the material processing (powder metallurgy, casting, or miscellaneous); the second is material class (nickel alloys, aluminum alloys, intermetallic compounds, and so forth); and the third is the specific alloy (Udimet 700, NiAl, Ti-6Al-4V, and so forth). Within each level, a miscellaneous category contains either undefined materials or specific materials for which there were insufficient entries to warrant a separate category.

The miscellaneous category in the first level contains all materials that could not be properly identified either as powder metallurgy or cast materials. This section also includes citations on HIP equipment, computer simulations, or theoretical models. In the second level, the miscellaneous category includes citations on material classes that do not warrant separate sections and citations that specify the processing condition but not the material class. For example, the "Powder Metallurgy/Miscellaneous" section may include a citation with information on ball milled material without detailing material class as well as a citation for powder metallurgy Mg-5Li-5Si alloy. At the innermost or third level, the miscellaneous category contains those specific materials with only a few citations and materials referred to by material class only. A citation, for example, on cast aluminum alloys which does not specify alloy type would be found in the section for "Cast Materials/Aluminum Alloys/Miscellaneous Materials," along with a citation on cast AA 6061 which has only a few citations. A complete alphabetical list of materials covered in this report, with the pages on which they appear, is included at the end of the report under "MATERIALS LIST." An alphabetical list of the most common keywords is also included in the "INDEX TERMS."

This report is organized so that each section is complete and self-contained. This means that a given citation is listed more than once whenever the cited work covers more than one material. An entry for a journal article on the "Microstructure and Property Improvements in 7075 and 8090 Aluminum Alloys by Spray Forming" will be cited in the section for AA7075 and also will be repeated in the section for AA8090. An entry for a report on the "Mechanical Property Difference Between HIP Powder Metallurgy and HIP Cast Ti-6Al-4V" will be cited in the "Powder Metallurgy" section as well as in the "Castings" section for that material. By organizing the report in this fashion, cross referencing is eliminated: all pertinent entries are listed under every area of coverage, and only the area or areas of interest need to be searched to find the needed information. Citations in each section are listed in reverse chronological order. This should make searches quicker and more efficient.

For alloys that have different commercial designations but the same/similar composition, and are therefore considered the same material, a list of those encountered in the report appears below:

1. Udimet 700, Astroloy, APK1, Nimonic AP1, Rene' 77
2. MA753, IN-853
3. C-103, WC-103
4. Alloy 454, PWA 1480
5. Mar-M250, Maraging (250)
6. Rene 150, PA 101 (low C)
7. Inconel 718, IN-718, Pyromet 718
8. X-40, X-45 (low C)
9. Maraging 300, Vascomax 300
10. HP 9-4-20 steel, 9Ni-4Co
11. A-286, JBK-75
12. IN-100, Rene' 100

To facilitate document acquisition, the appropriate identification numbers are provided: the Defense Technical Information Center (DTIC) AD- number; Department of Defense (DoD) or NASA report number, for government sponsored reports; corporate report number, for items that do not have a government report number; the contract number, when a report number is not available. For reports produced outside of North America, an NTIS number, if available, is cited instead of a report or contract number.
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AA 7075

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Key Words: beryllium, grain size, grain refinement, microstructure morphology, particle size, tensile properties, hardness, fracture surface, density
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**Key Words:** beryllium, applications, tensile properties, compressive properties, plasma deposition, cost

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   Hashiguchi, D.H., Clement, T.P., Marder, J.M.
   J Mater Shaping Technol 7 (1), 23-31, 1989 (AD-D 143 267)
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   Charles Stark Draper Lab Inc., Cambridge, MA
   Technical Research Report Number Five
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   **Key Words:** beryllium alloys, grain refinement, thermomechanical treatment, tensile properties

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   **Key Words:** HIP 50, beryllium alloys, tensile properties, compressive properties, grain size

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    **Key Words:** beryllium alloys, grain size, deformation, plasma deposition, tensile properties

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    **Key Words:** beryllium alloys, microstructure, grain size, ductility, tensile properties, hardness, stress relieving

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    **Key Words:** RENE' 95, MPDC, turbine components, microstructure, grain size, tensile properties, machining, creep rupture
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Key Words: MPDC, beryllium, nose cones, tensile properties, fracture surface, machining, fabrication

16. Establishment of a Manufacturing Process for Thin Walled Conical Beryllium Structures Involving Hot Isostatic Pressing
Mueller, J. J., Hanes, H. D.
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Final Technical Report Dec 69-Jul 72
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Key Words: beryllium, MPDC, GB-2, re-entry vehicles, microstructure, tensile properties, outgassing, fabrication, cost, heat treatment

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Mueller, J. J., Hanes, H. D.
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Key Words: S-200, beryllium alloys, tensile properties
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   Lawley, A.
   J Met 38 (8), 15-25, 1986 ( AD-D136 435 )
   Key Words: NiAl, IN-100, MAR-M509, RENE‘ 95, AA 2024-T6, consolidation, REP, tensile properties, impact toughness

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   Hellner, L., Johansson, H.
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   Key Words: X-40, MAR-M509, superplasticity, hot working microstructure, cracking, tensile properties, temperature effect

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   Hellner, L., Johansson, H.
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   Meyer, G. E., Harth, G. H., Houck, J. A., Byrer, T. G.
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   Key Words: MAR-M509, IN-100, Ti-6Al-4V, turbine components, microstructure, thermomechanics, die forging, cold drawing, extrusion

5. Structure and Property Control through Rapid Quenching of Liquid Metals
   Grant, N. J., Pelloux, R. M., Flemings, M. C., Argon, A. S.
   Massachusetts Institute of Technology, Center for Materials Science and Engineering, Cambridge, MA
   Final Technical Report
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   Key Words: AA 7075, AA 2024, AISI 1045, IN-100, MAR-M509, Maraging 300, tensile properties

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   **Key Words:** T-15, M-4, M-50, AISI 304, AISI 316, AISI 321, AISI 410, AISI 440, Udimet 700, MERL 76, IN-100, Stellite 6, Stellite 12, Stellite 21, atomization, particle size, density, creep, metal injection molding

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   Grant, N. J., Pelloux, R. M., Flemings, M. C., Argon, A. S.

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   Grant, N. J., Pelloux, R. M.

   Massachusetts Institute of Technology, Department of Metallurgy and Materials Science, Cambridge, MA


   **Key Words:** AA 2024-T4, IN-100, MAR-M509, atomization, silicon addition, hafnium addition, tensile properties, fatigue, segregation

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   Widmer, R.

   Industrial Materials Technology Inc., Woburn, MA

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   **Key Words:** IN-100, Maraging 300, X-45, MAR-M509, Hastelloy X, Udimet 710, Alloy 713, Ti-6Al-6V-2Sn, microstructure, creep rupture, tensile properties

6. **Structure and Property Control Through Rapid Quenching of Liquid Metals**

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   Contract No: DAHC15-70-C-0283, 191 pp., 1971 (AD-728 053)

   **Key Words:** IN-100, Vascomax 300, X-45, MAR-M509, extrusion, tensile properties, creep rupture, quenching

7. **Structure and Property Control Through Rapid Quenching of Liquid Metals**

   Grant, N. J., Pelloux, R. M., Flemings, M. C., Argon, A. S.

   Massachusetts Institute of Technology, Center for Materials Science and Engineering, Cambridge, MA

   Semi-Annual Technical Report Number Four, Jan-Jul 1972

   Contract No: DAHC15-70-C-0283, 140 pp., 1972 (AD-749 679)

   **Key Words:** AA 7075, IN-100, MAR-M509, AISI 1045, Maraging 300, microstructure, fractography, tensile properties

8. **Structure and Property Control Through Rapid Quenching of Liquid Metals**

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   Contract No: DAHC15-70-C-0283, 128 pp., 1972 (AD-757 677)

   **Key Words:** IN-100, MAR-M509, 18Ni steel, microstructure, hot working, creep properties, strain rate, tensile properties

9. **Liquid-Metal Atomization for Hot Working Preforms**

   Grant, N. J., Pelloux, R. M.

   Massachusetts Institute of Technology, Department of Metallurgy and Materials Science, Cambridge, MA


   **Key Words:** AA 2024-T4, IN-100, MAR-M509, atomization, silicon addition, hafnium addition, tensile properties, fatigue, segregation

10. **Coarse Powder Techniques**

    Widmer, R.

    Industrial Materials Technology Inc., Woburn, MA

    Proc 18th Sagamore Army Materials Research Conf, Sagamore Conference Center, Raquette Lake, NY, Aug-Sept 71, 16 pp., 1971 (AD-181 534)

    **Key Words:** IN-100, Maraging 300, X-45, MAR-M509, Hastelloy X, Udimet 710, Alloy 713, Ti-6Al-6V-2Sn, microstructure, creep rupture, tensile properties

11. **Structure and Property Control Through Rapid Quenching of Liquid Metals**

    Grant, N. J., Pelloux, R. M., Regis, M. N., Flemings, M. C., Merton, C.

    Argon, A. S.

    Massachusetts Institute of Technology, Center for Materials Science and Engineering, Cambridge, MA


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    **Key Words:** IN-100, Vascomax 300, X-45, MAR-M509, extrusion, tensile properties, creep rupture, quenching

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**Stellite 6**
2. HIP-Tool Materials
Bayer, E.
Powder Metall Int 16 (3), 117-20, 1984 ( AD-D130 130)
Key Words: Haynes 21, Stellite 6, tool steel, stainless steel, microstructure, impact toughness, tensile properties, net shape forming

3. Metallography of Hot Isostatically Pressed Materials (Part 2)
Piske, D., Wittner, I.
Pract Metall 21 (3), 107-17, 1984 ( AD-D130 404)
Key Words: Ti-6Al-4V, Stellite 6, WC coating, diffusion welding, diffusion bonding

4. Application Fields of the HIP-Technology
Selistorfer, H.
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Key Words: Waspaloy, Udimet 700, Stellite 6, turbine components, net shape forming, mechanical properties, hardness

5. Containerless HIPping of PM Parts: Technology Economics and Equipment Productivity
Nyce, A. C.
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Key Words: AISI 4650, M-2, AISI 316L, Ti-6Al-4V, Monel 400, Stellite 6, Stellite 21, applications, cost, density, tensile properties

6. New Approach Widens the Use of HIP P/M
Precis Met 40 (10), 32-4, 1982 ( AD-D128 141)
Key Words: AISI 4650, Stellite 6, AISI 316, Ti-6Al-4V, porosity, cost, tensile properties

7. Trends in Powder Metallurgy Technology
Chandler, H. E., Baxter, D. F.
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Key Words: RENE' 95, AISI 316, M-2, Stellite 6, Ti-6Al-4V, AISI 410, jet engines, net shape forming

X-40

1. Superalloys from Powder: Production and Properties
Author Anon
National Materials Advisory Board (NAS-NAE), Washington DC
Final Report
Rept No: NMAB-369, 102 pp., 1981 ( AD-B058 349L)
Key Words: RENE' 95, X-40, Maraging 300, turbine components, fatigue, rapid solidification, mechanical properties, atomization

2. Grain Size Control in PM Superalloys
Dahlen, M.
NTIS, N79-18021, Springfield, VA
Final Report
Rept No: N79-18021, 31 pp., 1977 ( AD-D115 659)
Key Words: Udimet 700, IN-738, X-40, grain size, tensile properties, creep properties, hardness, fatigue, recrystallization, annealing
3. **Hot Workability of Cobalt-Base Superalloys Produced via Powder Metallurgy**
   Hellner, L., Johansson, H.
   Powder Metall Int 8 (2), 82-6, 1976 (AD-D107 172)
   **Key Words:** X-40, MAR-M509, superplasticity, hot working microstructure, cracking, tensile properties, temperature effect

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   Hellner, L., Johansson, H.
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   **Key Words:** X-40, MAR-M509, IN-738, dispersion hardening, cracking, microstructure, temperature effect, deformation, stress intensity, tensile properties

5. **Modern Methods of Powder Metallurgical Processing of Superalloys**
   Gessinger, G. H., Bomford, M. J.
   Brown, Boveri & Co. Ltd., Baden, Switzerland
   Proc Symp High Temperature Materials in Gas Turbines 35 pp., 1973 (AD-D102 997)
   **Key Words:** Udimet 500, Hastelloy X, X-45, Udimet 710, IN-100, IN-853 Udimet 700, RENE' 95, Inconel 718, D-979, Nimonic 80A, TD-nickel, turbine components, creep rupture, tensile properties, fatigue, atomization, REP, thermomechanical treatment

6. **Specialty Methods of Powder Atomization**
   Grant, N. J.
   Massachusetts Institute of Technology, Cambridge, MA
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   **Key Words:** IN-100, Maraging 300, 18/8 stainless, AA 2024, X-45, AISI 316, REP, microstructure, ultrasonic testing, fatigue, tensile properties

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   Hiroshi, K., Toda, K., Yuine, T., Elsevier, London, UK
   Proc 3rd Int Conf Hot Isostatic Pressing: Theory Appl. 223-8, 1992
   **Key Words:** Co(79.5)Nb(15)Zr(5.5), compaction, density, viscous flow, porosity

2. **The Production and Processing of High-Quality Powder Metallurgy Materials**
   Graf, W., Kraemer, H. J., Poestschke, J., Weiglin, W.
   Powder Metall Int 23 (4), 246-52, 1991
   **Key Words:** T-15, M-4, M-50, AISI 304, AISI 316, AISI 321, AISI 410, AISI 440, Udimet 700, MERL 76, IN-100, Stellite 6, Stellite 1, Stellite 12, Stellite 21, atomization, particle size, density, creep, metal injection molding
3. Properties of 'Stellite' (R) Alloy No. 21 Made Via Pliable Powder Technology
Aizaz, A., Kumar, P.
Metal Powder Industries Federation, Princeton, NJ
Proc Int Powder Metallurgy Conf, Modern Developments in Powder Metallurgy
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Key Words: Stellite 21, microstructure, Ceracon processing, fatigue, tensile properties

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Prosthetic Alloys
Runkle, J. C., Nicholson, J., Rice, J.
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16, 705-25, 1985 (AD-D136 356)
Key Words: PREP, F-75, tensile properties, fatigue stress

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Bayer, F.
Powder Metall Int 16 (3), 117-20, 1984 (AD-D130 130)
Key Words: Haynes 21, Stellite 6, tool steel, stainless steel, microstructure, impact toughness, tensile properties, net shape forming

6. Containerless HIPing of PM Parts: Technology Economics and Equipment Productivity
Nyce, A. C.
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Key Words: AISI 4650, M-2, AISI 316L, Ti-6Al-4V, Monel 400, Stellite 6, Stellite 21, applications, cost, density, tensile properties

7. Application of Rapidly Solidified Superalloys
Patterson, R. J.
United Technologies Corp., West Palm Beach, FL
Quarterly Report
Rept No: FR-8062, 22 pp., 1976 (AD-D108 171)
Key Words: MAR-M200, IN-100 Co-20Cr, airfoils, tantalum addition, microstructure, particle size, atomization

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Freche, J. C., Ashbrook, R. L.
National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH
Technical Note
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Key Words: HS-31, microstructure, heat treatment, creep rupture, tensile properties
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Smugeresky, J. E.
Metall Trans 13A (9), 1535-46, 1982 ( AD-D 125 578 )
Key Words: A-286, JBK-75, Fe-30Ni, microstructure, tensile properties, morphology

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Muzyka, D. R.
ASTM, Philadelphia, PA
Proc Symp MiCon 78, 526-46, 1979 ( AD-D 126 409 )
Key Words: A-286, Inconel 901, Inconel 718, Waspaloy, RENE’ 95, Pyromet CTX-1, Pyromet 31, tensile properties, creep rupture, microstructure

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Key Words: A-286, microstructure, tensile properties, brittle fracture, intergranular fracture, carbide precipitation, titanium carbides

4. Fracture Path in Hot Isostatically Pressed Superalloy A286
German, R. M., Smugeresky, J. E., Karfs, C. W.
Powder Metall Int 9 (4), 178-9, 1977 ( AD-D 11 621 )
Key Words: A-286, intergranular fracture, fracture surface, titanium carbides, grain boundaries

5. The Consolidation and Properties of Hot Isostatically Pressed A286 Stainless Steel
German, R. M., Smugeresky, J. E.
Key Words: A-286, tensile properties, fracture surface, aging

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1. HIP of Bi-modal Powder Mixtures: Modeling and Experiment
Funkenbusch, P. D., Li, E. K. H.
Key Words: AISI 316L, powder metallurgy, particle size optimization

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Key Words: T-15, M-4, M-50, AISI 304, AISI 316, AISI 321, AISI 410, AISI 440, Udiment 700, MERIT 76, IN-100, Stellite 6, Stellite 1, Stellite 12, Stellite 21, atomization, particle size, density, creep, metal injection molding
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Stover, D., Buchkremer, H.P., Diehl, W., Kaiser, H., Laakmann, J.  
MPR Publishing Services Ltd., Bellstone, Shrewsbury, UK  
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**Key Words:** Udimet 700, AISI 316L, Hastelloy X, SEM, microscopy, porosity

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Koss, D. A.  
Department of Metallurgical Engineering, Michigan Tech University, Houghton  
Technical Report Number Four  
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19 pp., 1986 (AD-A167 404)  
**Key Words:** Ti-6Al-4V, AA 7075-T6, AA 1100, AISI 316, fabrication, rapid solidification

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Roll, K.H., Johnson, P.K.  
**Key Words:** copper, iron, Inconel 625, AISI 316L, M-2, NiFe, rapid solidification, injection molding

6. **Containerless HIPing of PM Parts: Technology Economics and Equipment Productivity**  
Nyce, A. C.  
**Key Words:** AISI 4650, M-2, AISI 316L, Ti-6Al-4V, Monel 400, Stellite 6, Stellite 21, applications, cost, density, tensile properties

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McIntyre, R. D.  
Mater Eng 95 (1), 36-43, 1982 (AD-D124 025)  
**Key Words:** RENE' 95, IN-100, AISI 316, microstructure, recrystallization, creep rupture, oxidation, tensile properties

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**Key Words:** AISI 4650, Stellite 6, AISI 316, Ti-6Al-4V, porosity, cost, tensile properties

9. **Trends in Powder Metallurgy Technology**  
Chandler, H. E., Baxter, D. F.  
Metal Prog 117 (1), 100-3, 1980 (AD-D117 225)  
**Key Words:** RENE' 95, AISI 316, M-2, Stellite 6, Ti-6Al-4V, AISI 410, jet engines, net shape forming

10. **Corrosion Behavior of P/M and Conventionally made 316-L Stainless Steel**  
Nazmy, M. Y., Karner, W., Al-Gwaiz, A. A.  
J Met 30 (6). 14-9, 1978 (AD-D112 730)  
**Key Words:** AISI 316L, corrosion, pitting, microstructure

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Jaffee, R. I.  
**Key Words:** AISI 316, Ti-6Al-4V, titanium, zirconium, hafnium, embrittlement, fracture mechanics
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Grant, N. J.
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13 pp., 1971 (AD-181 533)
Key Words: IN-100, Maraging 300, 18/8 stainless, AA 2024, X-45, AISI 316, REP, microstructure, ultrasonic testing, fatigue, tensile properties

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Sheinker, A. A.
TRW Inc., Materials Technology, Cleveland, OH
Rept No: TRW-ER-8097-2, 68 pp., 1980 (AD-A094 185)
Key Words: AISI 4340, rare earth addition, tensile properties, Charpy impact

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Slaughter, E. R., Boardea, R. G.
Pratt and Whitney Aircraft Group, West Palm Beach, FL
Rept No: FR-10233, 20 pp., 1978 (AD-D108 306)
Key Words: AISI 4340, airfoils, aluminum addition, titanium addition, boron addition, tensile properties, superplasticity, thermomechanical treatment

3. Hot Isostatic Pressing: An Economic Route to Powder Components
James, P. J.
Metals and Materials 27-31, 1977 (AD-D111 600)
Key Words: AISI 4340, beryllium, Ti-6Al-4V, pressure vessels

Bryant, W. A.
Weld J 54 (12), 433-S-435-S, 1975 (AD-D102 316)
Key Words: AISI 4340, MAR-M250, AISI 1020, 9Ni-4Co steel, Inconel 718, diffusion welding, dissimilar joining, temperature effect, modulus of elasticity, melting point

M-2

1. Mechanical Properties of PH-IHIPed M2 high speed steel (HSS)
Kothari, N. C.
Diffus Defect Data, Pt B 25-26, 471-8, 1992
Key Words: M-2, vanadium addition, austenitizing, tempering, mechanical properties, impact strength, bend strength, hardness

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Roll, K.H., Johnson, P.K.
Key Words: copper, iron, Inconel 625, AISI 316L, M-2, NiFe, rapid solidification, injection molding

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3. Containerless HIPping of PM Parts: Technology Economics and Equipment Productivity
Nyce, A. C.
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Key Words: AISI 4650, M-2, AISI 316L, Ti-6Al-4V, Monel 400, Stellite 6, Stellite 21, applications, cost, density, tensile properties

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Clauer, A. H., Meiners, K. E., Boyer, C. B.
Metals Information Analysis Center, West Lafayette, IN
Rept No: MIIC-82-46, 228 pp., 1982 (AD-A132 232)
Key Words: Ti-6Al-4V, IN-738, RENE' 95, Udimet 700, IN-797 Inconel 718, M-1, M-2, In-1900, MAR-M250, welding, fatigue, tensile properties, heat treatment

5. Properties of High-Speed Steels Produced by Powder Metallurgy
Takigawa, H., Manto, H., Kawai, N., Homma, K.
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Key Words: M-2, M-3, M-35, M-36, AISI 1050, AISI 1040, AISI 321, AMS 6512, cutting tools, density, bend strength, toughness, cost

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Key Words: RENE’ 95, AISI 316, M-2, Stellite 6, Ti-6Al-4V, AISI 410, jet engines, net shape forming

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Dunkley, J. J., Causton, R. J.
Key Words: HSS, M-2, alloying, microstructure, hardness, impact properties, grinding, drilling, milling, cost, annealing, extrusion

8. Toughness and Toughness Behavior of Two High-Speed Steels
Berry, G., Kadhim AI-Tomachi, M. J.
Met Technol 4 (6), 289-95, 1977 (AD-D110 293)
Key Words: M-2, M-3, fracture toughness, fatigue, crack growth fracture mechanics, hardness, milling, tool life

9. Crucible CPM Rex-High Speed Steel for Superior Cutting Tools
Colt Industries Inc., N.Y., 5 pp., 1974 (AD-D104 321)
Key Words: M-1, M-2, M-7, M-10, M-42, M-3, T-15, H41, cutting tools, tool life, Charpy impact, impact toughness, wear, grain size

MA 956

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Evans, D. J., Sheffler, K. D., Freedrich, L. A.
Pratt and Whitney Aircraft Group, East Hartford, CT
Quarterly Technical Progress Report Number Twenty Four, Dec 81-Feb.82
Contract No: NAS 3-20072
44 pp., 1982 (AD-D124 466)
Key Words: MERL 76, Hastelloy X, Incoloy 901, AMS 5616, AMS 4928, MA956, JT-9D, JT-8D, turbine components, coatings, erosion, fatigue
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Evans, D. J., Shefler, K. D., Friedrich, L. A.
Pratt and Whitney Aircraft Group, East Hartford, CT
Contract No: NAS 3-20072
36 pp., 1981 (AD-D122 325)
Key Words: Hastelloy X, MA956, Udimet 700, MERL 76, turbine components,
combustor liners, airfoils, coatings, fatigue, erosion resistance

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Evans, D. J., Henricks, R. J., Friedrich, L. A., Blecherman, S. S.
Pratt and Whitney Aircraft Group, Commercial Products Div, East Hartford, CT
Quarterly Technical Progress Report Number Sixteen, Dec 79-Feb-80
Contract No: NAS3-20072
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Key Words: MERL 76, Haynes 8077, MA956, turbine components, combustor liners,
tensile properties, creep rupture, coatings, plasma deposition, dispersion hardening

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Key Words: MERL 76, Haynes 8077, MA956, turbine components, combustor liners,
compressor components, airfoils, fatigue, creep properties,
coatings, mechanical properties

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Key Words: MERL 76, MA956, Hastelloy X, turbine components, tensile properties,
fatigue, coatings

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Contract No: NAS 3-20072
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Key Words: MERL 76, Haynes 8077, MA956, aircraft engines, turbine components,
combustor liners, compressor components, airfoils, fatigue,
net shape forming, coatings

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Quarterly Progress Report Number Thirteen
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Key Words: Haynes 8077, MA956, MERL 76, turbine components, combustor liners,
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Benjamin, J. S., Larson, J. M.
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Key Words: Udimet 700, RENE' 95, MA956E, MA754 turbine components, creep rupture, hot corrosion, oxidation, grain size, thermomechanical treatment

MAR-M250

1. Microstructures and Mechanical Properties of HIP Consolidated 18% Ni Maraging Steel
Komatsubara, N., Hayzelden, C., Cantor, B.
Powder Metall 30 (2), 119-24, 1987 (AD-D137 558)
Key Words: MAR-M250, microstructure, fracture, atomization, tensile properties

2. Hot Isostatic Processing
Clauer, A. H., Meiners, K. E., Boyer, C. B.
Metals Information Analysis Center, West Lafayette, IN
Rept No: MCIC-82-46, 228 pp., 1982 (AD-A132 232)
Key Words: Ti-6Al-4V, IN-738, RENE' 95, Udimet 700, IN-792, Inconel 718, M-1, M-2, B-1900, MAR-M250, welding, fatigue, tensile properties, heat treatment

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German, R. M., Smugeresky, J. E.
Metall Trans A 9A (3), 405-12, 1978 (AD-D112 162)
Key Words: MAR-M250, tensile properties, microstructure fracture surface, fabrication

4. Effect of Hot Isostatic Pressing Temperature on the Properties of Inert Gas Atomized Maraging Steel
German, R. M., Smugeresky, J. E.
Key Words: Maraging(250), microstructure, particle size, tensile properties, temperature effect

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Bryant, W. A.
Weld J 54 (12), 433-S-435-S, 1975 (AD-D102 316)
Key Words: AISI 4340, MAR-M250, AISI 1020, 9Ni-4Co steel, Inconel 718, diffusion welding, dissimilar joining, temperature effect, modulus of elasticity, melting point

Maraging 300

1. Superalloys from Powder: Production and Properties
Author Anon
National Materials Advisory Board (NAS-NAE), Washington DC
Rept No: NMB-369, 102 pp., 1981 (AD-B058 349L)
Key Words: RENE' 95, X-40, Maraging 300, turbine components, fatigue, rapid solidification, mechanical properties, atomization
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Marley, W. F., Jr.
Metal Powder Industries Federation, Princeton, NJ
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Key Words: Maraging 300, titanium alloys, shock loading, dispersion hardening, thermomechanical treatment

3. Properties of Maraging Steel 300 Produced by Powder Metallurgy
Van Swam, L. F., Pelloux, R. M., Grant, N. J.
Powder Metall 17 (33), 33-45, 1974 ( AD-D100 184 )
Key Words: Maraging 300, tensile properties, fatigue, aging, annealing

4. Structure and Property Control through Rapid Quenching of Liquid Metals
Grant, N. J., Pelloux, R. M., Flemings, M. C., Argon, A. S.
Massachusetts Institute of Technology, Center for Materials Science and Engineering, Cambridge, MA
Final Technical Report
Contract No: DAHC15-70-C-0283
411 pp., 1973 ( AD-775 225 )
Key Words: AA 7075, AA 2024, AISI 1045, IN-100, MAR-M509, Maraging 300, tensile properties

5. Structure and Property Control Through Rapid Quenching of Liquid Metals
Grant, N. J., Pelloux, R. M., Regis, M. N., Flemings, M. C., Merton, C.
Argon, A. S.
Massachusetts Institute of Technology, Center for Materials Science and Engineering, Cambridge, MA
Contract No: DAHC15-70-C-0283
130 pp., 1972 ( AD-739 340 )
Key Words: IN-100, MAR-M509, Maraging 300, microstructure, tensile properties, fatigue, hardness, creep rupture, fracture toughness

6. Structure and Property Control Through Rapid Quenching of Liquid Metals
Grant, N. J., Pelloux, R. M., Flemings, M. C., Argon, A. S.
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140 pp., 1972 ( AD-749 679 )
Key Words: AA 7075, IN-100, MAR-M509, AISI 1045, Maraging 300, microstructure, fractography, tensile properties

7. Specialty Methods of Powder Atomization
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Massachusetts Institute of Technology, Cambridge, MA
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T-15

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**Key Words:** T-15, M-4, M-50, AISI 304, AISI 316, AISI 321, AISI 410, AISI 440, Udimet 700, MERL 76, IN-100, Stellite 6, Stellite 1, Stellite 12, Stellite 21, atomization, particle size, density, creep, metal injection molding

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4. **Processing Variables and Failure Properties of Water Atomised Sintered T15 High-Speed Steels**  
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**Key Words:** T-15, HSS, water atomization, sintering, transverse rupture strength, grain boundaries, brittle fracture, fracture toughness, microstructure
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Martinez, V., Palma, R.H., Urcola, J.J.
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**Key Words:** T-6, T-15, microscopy, high speed steel, sintering, fracture toughness, hardness

6. **A Fundamental Study of Tool Steels Processed from Rapidly Solidified Powders**
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**Key Words:** T-15, Rex 25, tool steel, microstructure, hardness, size distribution

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Lasday, S. B.
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**Key Words:** M-1, M-2, M-7, M-10, M-42, M-3, T-15, H41, cutting tools, tool life, Charpy impact, impact toughness, wear, grain size
Miscellaneous Stainless Steel

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2. **Influence of Powder Surface Oxidation on Some Properties of HIPed Martensitic Chromium Steel**
   Arnberg, L., Karlsson, A.
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   **Key Words:** 12Cr-1Mo steel, microstructure, fracture, impact, hardening, atomization, tensile properties

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   **Key Words:** Haynes 21, Stellite 6, tool steel, stainless steel, microstructure, impact toughness, tensile properties, net shape forming

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Key Words: M-2, M-3, M-35, M-36, AISI 1050, AISI 1040, AISI 321, AMS 6512, cutting tools, density, bend strength, toughness, cost

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Key Words: RENE' 95, AISI 316, M-2, Stellite 6, Ti-6Al-4V, AISI 410, jet engines, net shape forming

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Key Words: AISI 4600, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Waspaloy, IN-100, AISI 329, 12Cr steel, injection molding, cost, applications

14. Medium and High Alloy P.M. Steel Products by Hot Isostatic Pressing
Garvare, T., Benning, C.
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Key Words: 3Cr steel, 3.5Ni steel, 12Cr steel, impact properties creep rupture, tensile properties, hardness, net shape forming

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Walther, H. H.
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Key Words: IMn steel, atomization, fracture toughness, bend strength, sliding friction, wear rate

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Bayer, E.
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Key Words: Haynes 21, Stellite 6, tool steel, stainless steel, microstructure, impact toughness, tensile properties, net shape forming

16. A Fundamental Study of Tool Steels Processed from Rapidly Solidified Powders
Lawley, A., Koczak, M. J.
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Key Words: T-15, Rex 25, tool steel, microstructure, hardness, size distribution

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35. Medium and High Alloy P.M. Steel Products by Hot Isostatic Pressing
Garvare, T., Benning, C.
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**Key Words:** 3Cr steel, 3.5Ni steel, 12Cr steel, impact properties, creep rupture, tensile properties, hardness, net shape forming
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Walther, H. H.
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Dunkley, J. J., Causton, R. J.
Key Words: HSS, M-2, alloying, microstructure, hardness, impact properties, grinding, drilling, milling, cost, annealing, extrusion

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**Key Words:** M-1, M-2, M-7, M-10, M-42, M-3, T-15, H41, cutting tools, tool life, Charpy impact, impact toughness, wear, grain size

49. **Structure and Property Control through Rapid Quenching of Liquid Metals**  
Grant, N. J., Pelloux, R. M., Flemings, M. C., Argon, A. S.  
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**Key Words:** AA 7075, AA 2024, AISI 1045, IN-100, MAR-M509, Maraging 300, tensile properties

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**Key Words:** MERL 76, Hastelloy X, Incoloy 901, AMS 5616, AMS 4928, MA956, JT-9D, JT-8D, turbine components, coatings, erosion, fatigue

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   **Key Words:** NiAl, IN-100, MAR-M509, RENE’ 95, AA 2024-T6, consolidation, REP, tensile properties, impact toughness
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Key Words: Nimonic 90, Udimet 520, Udimet 700, Inconel 718, IN-738, IN-100, turbine components, microstructure, creep properties, tensile properties, fatigue, precipitation, thermomechanical treatment

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Key Words: Incoloy 901, Waspaloy, Udimet 700, IN-100, turbine components, tensile properties, creep rupture, metallography

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Key Words: IN-100, IN-738, Alloy 713, Inconel 718, RENÉ’ 95, Ti-6Al-4V, Waspaloy, precipitation hardening

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Key Words: MAR-M200, IN-100, Co-20Cr, airfoils, tantalum addition, microstructure, particle size, atomization

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   Kaido, Y.
   Key Words: IN-738, MA6000, MA753, turbine components, creep rupture

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   Author Anon
   Foreign Technology Division, Wright-Patterson AFB, OH
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   Key Words: Ti-6Al-4V, B-1900, IN-738, RENE' 77, IN-792, RENE' 80, AA C355, AA
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   Key Words: Ti-6Al-4V, IN-738, RENE' 95, Udimet 700, IN-792, Inconel 718, M-1,
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    **Key Words:** Ti-111, Ti-6Al-4V, AA A356-T61, IN-738, RENE’ 80, Udimet 700, IN-792, welding, tensile properties, pressure bonding

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    **Key Words:** IN-100, IN-738, Alloy 713, Inconel 718, RENE’ 95, Ti-6Al-4V, Waspaloy, precipitation hardening
14. Atomised Powder-The Key to New Alloys
Wallis, P. B.
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Key Words: Nimonic 75, Nimonic 80A, Nimonic 81, Nimonic 90, Nimonic 105,
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Key Words: Ti-6Al-4V, IN-738, RENE’ 77, IN-792, defects, diffusion bonding,
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IN-792

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Author Anon
Foreign Technology Division, Wright-Patterson AFB, OH
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tensile properties, creep rupture, fatigue

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Deel, Omar  
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5. Exploratory Development of Die Materials for Isothermal Forging of Titanium Alloys  
Kortovich, C. S., Marder, J. M.  
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Hanes, H. D., Seifert, D. A., Watts, C. R.  
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Key Words: IN-792, turbine components, hafnium addition, microstructure, tensile properties, creep rupture, temperature effect, cost

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Key Words: IN-100, AA 7075-T6, IN-792, Ti-6Al-4V, turbine components, nondestructive testing

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SAMPE Qtrly 5 (2), 1-9, 1974 (AD-D133 138)  
Key Words: Ti-6Al-4V, IN-738, RENE’ 77, IN-792, defects, diffusion bonding, elongation
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   Harf, F. H.
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   **Key Words:** Incoloy 901, RENE' 95, MERL 76, Udimet 700, turbine components, microstructure, tensile properties, creep rupture, joining

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   Evans, D. J., Sheffler, K. D., Friedrich, L. A.
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   Schafrik, R. E.
   Air Force Inst of Tech, Wright-Patterson AFB, OH
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   **Key Words:** A-286, Incoloy 901, Inconel 718, Waspaloy, RENE' 95, Pyromet CTX-1, Pyromet 31, tensile properties, creep rupture, microstructure

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   Blackburn, M. J., Sprague, R. A.
   Met Technol 4 (8), 388-95, 1977 (AD-D110 796)
   **Key Words:** Incoloy 901, Waspaloy, Udimet 700, IN-100, turbine components, tensile properties, creep rupture, metallography

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   Wallis, P. B.
   Powder Metall Int 8 (4), 167-9, 1976 (AD-D108 681)
   **Key Words:** Nimonic 75, Nimonic 80A, Nimonic 81, Nimonic 90, Nimonic 105, Nimonic 115, Incoloy 901, Nimonic PE11, Nimonic PE16, Nimonic 263, Inconel 718, Inconel X-750, Nimocast 80, Nimocast 242, Nimocast 263, Alloy 713C, Alloy 713LC, Nimocast PD21, Nimocast PE10, Nimocast PK24, IN-738, turbine components
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   Sisak, W. J., Ayer, R., Mueller, R. R., Leta, D. P., MS, Warrendale, PA
   **Key Words:** Inconel 625, AISI 4130, 2.25Cr-1Mo steel, cladding, welding, corrosive medium, mechanical properties, microstructure, carbides

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   Proc Int Conf PM Aerospace Materials-87, 2.1-2.9, 1988 (AD-D143 657)
   **Key Words:** Udimet 700, Inconel 625, RENEP 95, H-13 tool steel, precipitation hardening, tensile properties, thermal expansion, hardness, creep

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   David W. Taylor Naval Ship Research and Development Center, Ship Materials Engineering Department, Annapolis, MD
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   **Key Words:** AA 7090, AA 7091, IN9052, Ti-6Al-4V, Monel 400, Inconel 600, RENEP 95, Ch291. Udimet 700, IN-100, AF-115, Inconel 625, net shape forming, injection molding, applications, forging

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   Acta Metall 37 (3), 897-908, 1989 (AD-D140 991)
   **Key Words:** Pyromet 718, shock wave processing, impact tests, tensile properties, consolidation, rapid solidification
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   **Key Words**: AF-115, Waspaloy, Inconel 718, turbine components, tensile properties, fatigue, cracking

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   Kawai, N., Honma, K., Takigawa, H., Iwai, K., Hirano, M.
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   **Key Words**: 300M, Waspaloy, Inconel 718, AA 2218, AA 2219, AA 2618, AISI 52100, atomization, rapid solidification, tensile properties, net shape forming

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Key Words: NASA IIB-11, turbine components, thermal stability, microstructure, creep rupture, tensile properties, grain size, heat treatment
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Miner, R. V., Kent, W. B.
Key Words: NASA IIB-11, turbine components, tensile properties, grain growth, Larsen-Miller curves, creep rupture, long term tests, gamma prime

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Key Words: IN-738, Udimet 700, Nimonic 80A, dispersion hardening yttrium addition, mechanical alloying, grain size, grain structure, creep rupture, recrystallization

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Key Words: Nimonic 75, Nimonic 80A, Nimonic 81, Nimonic 90, Nimonic 105, Nimonic 115, Incoloy 901, Nimonic PE11, Nimonic PE16, Nimonic 263, Inconel 718, Inconel X-750, Nimocast 80, Nimocast 242, Nimocast 263, Alloy 713C, Alloy 713LC, Nimocast PD21, Nimocast PE10, Nimocast PK24, IN-738, turbine components

3. Production of Superalloys from Powders
Key Words: IN-100, Nimonic 105, Nimonic 90, Nimonic 80A, TD-nickel, turbine components, creep rupture, dispersion hardening, cost

4. Modern Methods of Powder Metallurgical Processing of Superalloys
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Key Words: Udime 500, Hastelloy X, X-45, Udimet 710, IN-100, IN-853 Udimet 700, RENE' 95, Inconel 718, D-979, Nimonic 80A, TD-nickel, turbine components, creep rupture, tensile properties, fatigue, atomization, REP, thermomechanical treatment

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Author Anon., Foreign Technology Division, Wright-Patterson AFB, OH
Rept No: FTD-ID(R5)T-1406-84, 65 pp., 1985 (AD-B093 100L)
Key Words: Ti-6Al-4V, B-1900, IN-738, RENE' 77, IN-792, RENE' 80, AA C355, AA A356, 142-T4
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Peterson, L. G., Hrencecin, D. E., Schilling, W. F., Ostergren, W. J.
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Key Words: RENE’ 80, RENE’ 150, Udimet 700, MAR-M200, IN-939, RENE’ 125.
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Key Words: T-l 11, Ti-6Al-4V, AA A356-T61, IN-738, RENE’ 80, Udimet 700.
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Semchyshen, M.
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Key Words: TMP-1, TMP-9, TMP-2, RENE’ 95, TMP-3, TMP-4, TMP-10, TMP-11
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Mao, J., Yu, K., Zhou, R.
Foreign Technology Division, Wright-Patterson AFB, OH
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Key Words: RENE’ 95, heat treatment, grain boundaries, carbides, gamma prime phase, grain size

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Morra, J.M., Biederman, R.R., Tuler, F.R.
The Metallurgical Society of AIME, Warrendale, PA
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Key Words: RENE’ 95, microscopy, deformation, isothermal forging, flow stress, stability
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MPR Publishing Services Ltd., Bellstone, Shrewsbury, UK  
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**Key Words**: Udiment 700, Inconel 625, RENE’ 95, H-13 tool steel, precipitation hardening, tensile properties, thermal expansion, hardness, creep

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**Key Words**: RENE’ 95, tensile properties, elongation, superplasticity

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Center for Strategic Materials, Henry Krumb School of Mines, NY  
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Fiedler, H. C., Sawyer, T. F., Kopp, R. W., Leatham, A. G.  
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**Key Words**: RENE’ 95, Inconel 718, near net forming, tensile properties, fatigue, creep rupture

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Lawley, A.  
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Key Words: Nimonic AP1, Udimet 700, RENE’95, turbine components, grain size, tensile properties, creep rupture, fatigue

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Shamblen, C. E., Chang, D. R.
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Wigotsky, V.
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19. **Superalloy Powder Processing, Properties and Turbine Disk Applications**  
Chang, D. R., Krueger, D. D., Sprague, R. A.  
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Proc 5th Int Symp Superalloys 1984, 245-73, 1984 (AD-D132 841)  
**Key Words:** RENE’ 95, microstructure, tensile properties, fatigue crack

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**Key Words:** RENE’ 95, particle size, deformation, plastic strain

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Bashir, S., Antolovich, S. D.  
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**Key Words:** RENE’ 95, turbine components, microstructure, deformation, oxidation, fatigue strain, plastic strain

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**Key Words:** RENE’ 95, microstructure, fracture surface, oxidation, creep test, fatigue

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Bain, K. R., Pelloux, R. M.  
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**Key Words:** Udiment 700, MERL 76, IN-100, RENE’ 95, grain boundaries, notch properties, aging, embrittlement

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Jeandin, M., Bienvenu, Y., Kouty, J. L.  
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**Key Words:** Nimonic AP1, Udiment 700, RENE’ 95, molybdenum addition, chromium addition, microstructure, tensile strength, creep rupture

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Wilhelm, H.  
NTIS, N85-16191, Springfield, VA  
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**Key Words:** Udiment 700, IN-100, RENE’ 95, MERL 76, weld and post weld, tensile properties, fatigue
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Shamblen, C. E.
General Electric Co., Aircraft Engine Group, Evendale, OH
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Key Words: C-103, PA 101, MAR-M247, RENE' 95, turbine components, joining, unidirectional solidification

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Key Words: RENE' 95, rapid solidification, fatigue crack growth, creep rupture, tensile properties
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McIntyre, R. D.
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Thompson, E. R.
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Author Anon
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Final Report
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Van Stone, R. H., Henry, M. F.
General Electric Co., Aircraft Engine Group, Evendale, OH
Progress Report Number 2, Nov 80-Feb 81
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59 pp., 1981 (AD-D121 677L)
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Redden, T. K., Wilbers, L. G.
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Harf, F. H.
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Moll, J. H.
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Key Words: RENE' 95, titanium alloys, tool steel, Udimet 700, IN-100, MERL 76, Waspaloy, turbine components, microstructure, tensile properties, stress intensity

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Marder, J. M., Kortovich, C. S.
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Key Words: RENE' 95, AF-115, tensile properties, fatigue, creep rupture

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Key Words: RENE' 95, hardness, tensile properties, creep rupture

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Key Words: RENE' 95, AF-115, rapid solidification, fatigue, cracking, tensile properties
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Contract No: N00019-79-C-0659
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Key Words: RENE' 95, fatigue tests, fabrication, heat treatment

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48 pp., 1980 (AD-D119 708L)
Key Words: RENE' 95, turbine components, microstructure, microscopy, aging, tensile properties, fatigue, cracking

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Key Words: RENE' 95, tensile strength, fatigue, cracking, replica technique

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Bernstein, H. L.
Systems Research Labs Inc., Research Applications Div, Dayton, OH
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Key Words: RENE' 95, AF-115, AF 2-1DA, forging, tensile properties, hardening, fatigue

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Contract No: F33615-76-C-5245 and F33615-76-C-5191
119 pp., 1980 (AD-A097 430)
Key Words: RENE' 95, AF-115, AF 2-1DA, microstructure, aging. tensile properties, defects, creep rate, fatigue

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Key Words: RENE' 95, AISI 316, M-2, Stellite 6, Ti-6Al-4V, AISI 410, jet engines, net shape forming
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Pratt and Whitney Aircraft Group, West Palm Beach, FL  
Rept No: PWA-FR-13153, 191 pp., 1980 (AD-D119 421)  
**Key Words:** MERL 76, RENE' 95, IN-100, Waspaloy, Udimet 700, NASA IIB-7  
fatigue cracking, creep-fatigue, tensile properties, microstructure

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Dreshfield, R. L., Miner, R. V., Jr.  
National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH  
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**Key Words:** RENE' 95, Udimet 700, MERL 76, turbine components, tensile properties, creep properties, fatigue

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Domingue, J. A., Beosch, W. J., Radavich, J. F.  
ASM International, Metals Park, OH  
Proc 4th Int Symp Superalloys, Superalloys 1980 335-344, 1980 (AD-D120 663)  
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**Key Words:** RENE' 95, crack growth, tensile properties, fatigue

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Rept No: AFML-TR-79-4171, 192 pp., 1979 (AD-B056 840L)  
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General Electric Co., Aircraft Engine Group, Evendale, OH  
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Key Words: RENE' 95, fatigue, crack growth, tensile properties, grain size, dislocation density, microstructure

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General Electric Co., Aircraft Engine Group, Evendale, OH
Final Report, Volume 1 of 2
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Key Words: RENE' 95, turbine components, T700 engine, tensile properties, machining

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Muzyka, D. R.
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   Key Words: titanium, plasma deposition, REP, porosity, density, microstructure

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Highberger, W. T., Chanani, G. R.  
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Key Words: Ti-6Al-4V, Corona-5, aircraft structures, F-14 aircraft, fatigue, crack growth, tensile properties, superplastic forming, cost

3. Relationship of Mechanical Properties to Microstructure and Fractographic Features in a Welded High-Toughness Titanium Alloy  
Baeslack III, W. A., Mullins, F. D.  
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**Ti-5Al-2.5Sn**

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Jackson, A. G., Moteff, J., Froes, F. H.
Metall Trans 15A (1), 248-9, 1984 ( AD-D129 167 )
Key Words: Ti-5Al-2.5Sn, porosity, microstructure

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Patterson, B. R., Bates, C. E.
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Key Words: Ti-5Al-2.5Sn, Ti-6Al-6V-2Sn, density, sintering, net shape forming.

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Key Words: Ti-5Al-2.5Sn, microstructure, porosity, dispersion hardening, aging

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Key Words: Ti-6Al-4V, Ti-5Al-2.5Sn, silicon and germanium, porosity, dispersions

**Ti-6Al-2Sn-4Zr-2Mo**

1. **Fatigue property Enhancement of Alpha-Beta Titanium Alloys by Blended Elemental P/M Approach**
Hagiwara, M., Kaieda, Y., Kawabe, Y., Miura, S.
Iron Steel Inst Jpn Inter 31 (8), 922-30, 1991
Key Words: IMI 829, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-4V, Corona-5 Ti-5Al-2Cr-1Fe, Ti-5Al-2.5Fe, microstructure, fatigue life crack initiation, tensile properties

2. **P/M Processing of Titanium Aluminides**
Moll, John H., Yolton, C. F., McTiernan, B. J.
Key Words: Ti3Al, Ti-25Al-10Nb-3V-1Mo, Ti-6Al-2Sn-4Zr-2Mo, Ti-48 at pct Al-1 at pct V, microstructure, particle size, tensile properties, stress rupture, plasma spraying
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Moll, J. H., Yotlon, C. F., Chandholk, V. K.
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**Key Words:** Ti-6Al-4V, Ti-6Al-2Sn-4Zr-2Mo, near net forming, REP, atomization, tensile properties, creep rupture

4. **High Temperature Rapidly Solidified Titanium Alloy Evaluation**
Anderson, R. E.
Pratt and Whitney, Engineering Div, West Palm Beach, FL
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Rept No: P&W/ED/FR-19120-7, 19 pp., 1987 (AD-D138 557L)
**Key Words:** Ti-6Al-2Sn-4Zr-6Mo, Ti-8Al-1Mo-1V, Ti-6Al-2Sn-4Zr-2Mo, microscopy, porosity, tensile properties

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Birla, N. C., Krishnaswamy, W.
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**Key Words:** Ti-6Al-2Sn-4Zr-2Mo, microstructure, tensile properties, consolidation, explosive compaction

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Roberson, J. A., Adair, A. M., Lipsitt, H. A.
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**Key Words:** Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-6V-2Sn, microstructure, hot working

Ti-6Al-2Sn-4Zr-6Mo

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Martin, R. L., Tamacki, G.
TMS, Warrendale, PA
**Key Words:** Ti-6Al-2Sn-4Zr-6Mo, erbium addition, turbine components, airframes, rapid solidification, gas atomization, production, extrusion, forging, tensile properties, fracture toughness, creep

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**Key Words:** Ti-6Al-2Sn-4Zr-6Mo, microstructure, alloy development, machining, forging, rapid solidification

3. **High Temperature Rapidly Solidified Titanium Alloy Evaluation**
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Rept No: P&W/ED/FR-19120-7, 19 pp., 1987 (AD-D138 557L)
**Key Words:** Ti-6Al-2Sn-4Zr-6Mo, Ti-8Al-1Mo-1V, Ti-6Al-2Sn-4Zr-2Mo, microscopy, porosity, tensile properties
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Irving, R. R.
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**Key Words:** AISI 4600, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Waspaloy, IN-100, AISI 329, 12Cr steel, injection molding, cost, applications

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**Key Words:** Ti-6Al-25n-4Zr-6Mo, microstructure, tensile properties, fracture toughness

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**Key Words:** Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, aircraft structures, engine components, tensile properties, net shape forming

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**Key Words:** Ti-6Al-25n-4Zr-6Mo, turbine components, microstructure, forging, fracture, gatorizing, tensile properties, creep rupture

**Ti-6Al-4V**

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Hagiwara, M., Kaieda, Y., Kawabe, Y., Miura, S.
Iron Steel Inst Jpn Inter 31 (8), 922-30, 1991
**Key Words:** IMI 829, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-4V, Corona-5 Ti-5Al-2Cr-1Fe, Ti-5Al-2.5Fe, microstructure, fatigue life crack initiation, tensile properties

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Froes, F. H., Eylon, D.
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**Key Words:** Ti-6Al-4V, Ti-10V-2Fe-3Al, microstructure, crack growth, fatigue, fracture toughness, tensile properties, porosity, near net shape
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Lee, Y.T., Schurmann, H., Grundhoff, K.J., Peters, M.  
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**Key Words:** Ti-6Al-4V, microstructure, tensile properties, fatigue, fracture toughness

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**Key Words:** Ti-6Al-4V, consolidation, damping, hot working

5. **P/M Titanium Technology for High Performance Uses**  
Moll, J. H., Yolton, C. F., Chandhok, V. K.  
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**Key Words:** Ti-6Al-4V, Ti-6Al-2Sn-4Zr-2Mo, near net forming, REP, atomization, tensile properties, creep rupture

6. **Production of Powder Ti-Alloy Rings by Means of Compaction and Radial-Rolling**  
Szczepanik, S., Kopp, R., Wiegels, H.  
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**Key Words:** Ti-6Al-4V, microstructure, deformation, fracture surface, rolling, forging

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**Key Words:** Ti-6Al-4V, microstructure, fracture surface, REP, plastic deformation

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MPR Publishing Services Ltd., Bellstone, Shrewsbury, UK  
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**Key Words:** Ti-6Al-4V, ingot metallurgy, near net shape, REP, plasma deposition, fatigue stress

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**Key Words:** Ti-6Al-4V, REP, fatigue stress, fracture

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Lee, Y.T., Grundhoff, K. J., Wirth, G.  
Z Metallk 78 (1), 49-57, 1987 (AD-D136 922)  
**Key Words:** Ti-6Al-4V, microstructure, fatigue crack, PREP, aging, tensile properties

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Majima, K., Hirata, T., Yamamoto, M., Shoji, K.  
**Key Words:** Ti-6Al-4V, microstructure, fractography, REP, tensile properties
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Sheinker, A. A., Chanani, G. R., Bohien, J. W.
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Key Words: Ti-6Al-4V, F-18A aircraft, corrosion, REP, tensile properties, shear, fracture toughness

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Koss, D. A.
Department of Metallurgical Engineering, Michigan Tech University, Houghton
Technical Report Number Four
Contract No: N00014-85-K-0427
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Key Words: Ti-6Al-4V, AA 7075-T6, AA 1100, AISI 316, fabrication, rapid solidification

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Wirth, G., Grundhoff, K. J., Smarsly, W.
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Key Words: Ti-6Al-4V, microstructure, TEM, tensile properties, fatigue stress

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Schwenker, S. W., Eylon, D., Froes, F. H.
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Key Words: Ti-6Al-4V, alumina addition, silica addition, crack propagation, tensile properties, fatigue stress

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Haziwara, M., Kaieda, Y., Kawabe, Y.
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Key Words: Ti-6Al-4V, tensile properties, fracture toughness, fatigue stress

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Friedman, G. I., Moxson, V. S.
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Key Words: Ti-6Al-4V, turbine components, microstructure, aging, beta processing, tensile properties, fatigue crack

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Key Words: Ti-6Al-4V, turbine components, microstructure, net shape forming, tensile properties, fatigue

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Key Words: Ti-6Al-4V, Ti-10V-2Fe-3Al, rapid solidification, REP, tensile properties, fatigue
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Author Anon  
Foreign Technology Division, Wright-Patterson AFB, OH  
Rept No.: FTD-IDRS/T-1406-84, 65 pp., 1985 (AD-B1093 100L)  
**Key Words:** Ti-6Al-4V, B-1900, IN-738, RE/NI: 77, IN-792, RE/NI: 80, AA C355, AA A356, 142-T4

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Williams, B.  
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**Key Words:** Ti-6Al-4V, TiN coatings, sputtering

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Eylon, D., Schwenker, S. W., Froes, F. H.  
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**Key Words:** Ti-6Al-4V, microstructure, REP, thermally induced porosity

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Smarsly, W., Lee, Y. T., Welsch, G.  
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**Key Words:** Ti-6Al-4V, microstructure, oxide addition

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Devillard, J.  
Deutsche Gesellschaft Metallk, Germany  
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**Key Words:** Ti-6Al-4V, microstructure, fracture surface, crack propagation, tensile properties, fatigue

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Wirth, G., Grundhoff, K. J.  
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**Key Words:** Ti-6Al-4V, microstructure, fracture, fatigue crack, tensile properties

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Smarsly, W., Bunk, W., Kopp, R.  
Deutsche Gesellschaft Metallk, Germany  
Proc 5th Int Conf Titanium, Titanium--Science and Technology 1, 367-73, 1985 (AD-D135 675)  
**Key Words:** Ti-6Al-4V, microstructure, near shape forming, forging

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Grundhoff, K. J., Wirth, G.  
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Proc 5th Int Conf Titanium, Titanium--Science and Technology 1, 405-10, 1985 (AD-D135 681)  
**Key Words:** Ti-6Al-4V, crack propagation, tensile properties, fatigue
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Wirth, G., Grundhoff, K. J., Smarsly, W., Froes, F. H., Eylon, D.
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Key Words: Ti-6Al-4V, fracture, tensile properties, fatigue, REP

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Keinath. W., Engels, J.
Deutsche Gesellschaft Metallk, Germany
Proc 5th Int Conf Titanium, Titanium--Science and Technology
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Key Words: Ti-6Al-4V, tensile properties, shot peening, heat treatment

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Buhl, H.
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Key Words: Ti-6Al-4V, fracture, stress, corrosion

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Metal Powder Industries Federation, Princeton, NJ
Proc Int Powder Metallurgy Con., Modern Developments in Powder Metallurgy
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Key Words: Ti-6Al-4V, fatigue improvement, tensile properties, fatigue, REP

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Broomfield, R. W., Turner, N. G., Leat, B. J.
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Key Words: Ti-6Al-4V, turbine components, microstructure, consolidation, tensile properties, fatigue, impact properties

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Froes, F. H., Pickens, J. R.
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Key Words: AA 7090, AA 7091, Ti-6Al-4V, rapid solidification, mechanical attritioning, tensile properties

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Koss, D. A.
Department of Metallurgical Engineering, Michigan Tech University, Houghton
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Contract No : N00014-76-C-0937
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Key Words: Ti-6Al-4V, AA 7075-T6, porosity, hydrogen embrittlement, tensile properties, fracture
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36 pp., 1984 (AD-A148 766)
Key Words: Ti-6Al-4V, microscopy, tensile properties, deformation

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Wigotsky, V.
Aerospa Amer 22 (3), 90-4, 1984 (AD-D129 541)
Key Words: Ti-6Al-4V, RENE’ 95, AA 7090, AA 7091, Al-8Fe, turbine components, shear properties, compressive properties, net shape forming

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Key Words: Ti-6Al-4V, inclusions, nondestructive testing

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Thummler, F., Oberacker, R.
Key Words: Ti-6Al-4V, net shape forming

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Key Words: Ti-6Al-4V, Stellite 6, WC coating, diffusion welding and bonding

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Hagiwara, M., Kaieda, Y., Kawabe, Y.
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Key Words: Ti-6Al-4V, microstructure, REP, aging, tensile properties

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Key Words: Ti-6Al-4V, turbine components, fracture toughness, fatigue, plasma arc melting

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Key Words: Ti-6Al-4V, rare earth addition, microstructure, grain size, bending, tensile properties, fatigue stress

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Peebles, R. E., Parsons, L. D.
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Key Words: Ti-6Al-4V, microstructure, fracture toughness, tensile properties, fatigue stress
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Mahajan, Y. R., Eylon, D., Kelto, C. A., Egerer, T., Froes, F. H.
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Proc Symp Titanium--Net Shape Technologies, 38-51, 1984 (AD-D134 591)
**Key Words:** Ti-6Al-4V, microstructure, rapid solidification, tensile properties, fatigue stress

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Abkowitz, S., Kardys, G. J., Fujihiro, S., Froes, F. H., Eylon, D.
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Proc Symp Titanium--Net Shape Technologies, 107-20, 1984 (AD-D134 596)
**Key Words:** Ti-6Al-4V, net shape forming, tensile properties, gas tungsten arc welding, fatigue stress

46. Suiting Blended Elemental Powder Metallurgy Material/Processing to Parts
Friedman, G. I.
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Proc Symp Titanium--Net Shape Technologies, 121-9, 1984 (AD-D134 597)
**Key Words:** Ti-6Al-4V, manufacturing, hydrostatic compaction

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Renpo, T., Tao, L., Changchun, L.
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**Key Words:** Ti-6Al-4V, microstructure, fracture, tensile properties, impact toughness, fatigue stress

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**Key Words:** Ti-6Al-4V, microstructure, REP, flow stress, stress-strain

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Eylon, D., Kim, Y. W.
Metcut Research Associates Inc., Materials Research Group, Wright-Patterson AFB, OH
Rept No: AFWAL-TR-83-4131, 54 pp., 1983 (AD-A135 612)
**Key Words:** Ti-6Al-4V, AA 7091, IN9051, AA 7075, turbine components, tensile properties, fatigue, bending

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Koss, D. A.
Department of Metallurgical Engineering, Michigan Tech University, Houghton
Annual Report Number Twenty Three 18 pp., 1983 (AD-A135 612)
**Key Words:** Ti-6Al-4V, porosity, ductile fracture, fracture strain

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Froes, F. H., Eylon, D., Wirth, G., Grundhoff, K. J., Smarsly, W.
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**Key Words:** Ti-6Al-4V, fatigue, crack growth, tensile properties
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Key Words: AA 7090, AA 7091, IN9052, Ti-6Al-4V, Monel 400, Inconel 600, RENI, 95, Cr291, Udimet 700, IN-100, AF-115, Inconel 625, net shape forming, injection molding, applications, forging

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Schwenker, S. W., Sommer, A. W., Eylon, D., Froes, F. H.
Metall Trans 14A (7), 1524-8, 1983 (AD-D127 927)
Key Words: Ti-6Al-4V, stress intensity factor, fracture surface, fatigue, crack growth

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Nyce, A. C.
Met Powder Rept 38 (7), 387-92, 1983 (AD-D128 150)
Key Words: AISI 4650, M-2, AISI 316L, Ti-6Al-4V, Monel 400, Stellite 6, Stellite 21, applications, cost, density, tensile properties

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Ti-10V-2Fe-3Al

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Moody, N.R., Garrison, W.M., Costa, J.E., Smugeresky, J.E.
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Koss, D. A.
Department of Materials Science and Engineering, Pennsylvania State University,
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    Department of Metallurgical Engineering, Michigan Tech University, Houghton
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    Key Words: Ti-10V-2Fe-3Al, Ti-15V-3Cr-3Al-3Sn, steel, aircraft, net shape
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    Author Anon
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14. **Treatment Processes of Light and Heat Resistant Alloys**
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Foreign Technology Division, Wright-Patterson AFB, OH
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**Key Words:** aluminum alloys, titanium alloys, mechanical properties, fatigue, cracking

15. **Effects of Manufacturing Processes on Structural Allowables**
Jones, Dana J., Ford, S. C.
 Battelle Memorial Institute, Columbus, OH
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Rept No: AFWAL-TR-82-4136, 168 pp., 1982 (AD-A122 963)
**Key Words:** Ti-6Al-4V, 10V2Fe3Al-Ti alloy, CT-91-TTE69 aluminum alloy, AF-1410 steel, extrusion, fracture toughness, creep rupture, stress corrosion, fatigue crack, tensile properties, compressive properties, thermal expansion, bearing strength

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**Key Words:** Ti-6Al-4V, Ti-5Al-2Sn-2Zr-4Cr-4Mo, REP, tensile properties, fracture toughness

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Smugeresky, J. E., Dawson, D. B.
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**Key Words:** Ti-6Al-4V, Ti-10V-2Fe-3Al, Ti-6Al-6Zr-6Mo, Ti-6Al-6V-2Zr, tensile properties, microstructure, density

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Moll, J. H.
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**Key Words:** RENE’ 95, titanium alloys, tool steel, Udimet 700, IN-100, MERL 76, Waspaloy, turbine components, microstructure, tensile properties, stress intensity

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Peebles, R. E., Kelto, C. A.
The Metallurgical Society of AIME, Warrendale, PA
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Grumman Aerospace Corp., Bethpage, NY
Third Quarterly Program Report Apr-Jul 78
Contract No: F33615-77-C-3109
61 pp., 1978 (AD-D113 509L)
**Key Words:** Ti-6Al-4V, Ti-15V-3Cr-3Al-3Sn, diffusion welding, superplastic forming, lap shear strength
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   Peebles, R. E.
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    Schwertz, J. H., Chandhok, V. K., Peterson, V. C., Thompson, V. R.
    Colt Industries Inc., Crucible Materials Research Center, Pittsburgh, PA
    Final Report
    Rept No: AFML-TR-78-41, 333 pp., 1978 (AD-A078 039)
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    Contract No: F33615-77-C-3109
    9 pp., 1978 (AD-D113 232)
    **Key Words:** Ti-6Al-4V, Ti-6Al-2Zn-2Sn-2Mo-2Cr

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    Grumman Aerospace Corp., Bethpage, NY
    Contract No: F33615-77-C-3109
    9 pp., 1978 (AD-D113 510)
    **Key Words:** Ti-6Al-4V, Ti-6Al-2Zn-2Sn-2Mo-2Cr, welding, superplastic forming

25. **Powder Forging**
    Huppmann, W. J., Hirschvogel, M.
    **Key Words:** titanium alloys, aluminum alloys, nickel alloys, beryllium, porosity, plasticity, impact strength, tensile properties, fatigue, sintering, cost, preheating

26. **Soviet Activities in Iron and Titanium Powder Metallurgy**
    Marley, W. F., Jr.
    Metal Powder Industries Federation, Princeton, NJ
    P/M Ordnance Seminar, Powder Metallurgy in Defense Technology
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    **Key Words:** Maraging 300, titanium alloys, shock loading, dispersion hardening, thermomechanical treatment
INTERMETALLIC COMPOUNDS

Ni(3)Al

1. **Powder Processing of Intermetallic Alloys and Intermetallic Matrix Composites**  
   Stoloff, N. S., Alman, D. E.  
   **Key Words:** Al(3)Ta, NiAl, Ni(3)Al, NbAl(3), TiAl, phase diagram, reactive sintering, densification, injection molding, reaction milling, mechanical alloying, Charpy impact, tensile properties

2. **High Temperature Deformation Behavior of the Ni(3)Al Compacts Produced by Hot Pressing of Mechanically Alloyed Powder**  
   Esaki, H., Tokizane, M.  
   **Key Words:** Ni(3)Al, mechanical alloying, ball milling, compressive properties, strain rate sensitivity, dynamic recrystallization

3. **Modelling of Hipping Consolidation Applied to Ni(3)Al Powders**  
   Wright, R. N., Williamson, R. L., Knibloe, J. R.  
   Powder Metall 33 (3), 253-9, 1990  
   **Key Words:** Ni(3)Al, Ni-19 at pct Al-8.5 at pct Cr, grain boundary diffusion, creep, tensile properties, atomization

4. **Intermetallic Compounds and Their Powder Metallurgy Materials**  
   Ni, R., Sun, Yuan  
   Foreign Technology Division, Wright-Patterson AFB, OH  
   P/M Technology (Fenmo Ycjin Jishu)  
   Rept No : FTD-ID(RS)-T-1058-90, 7 (4), 253-61, 1989 ( AD-A237176 )  
   **Key Words:** Ni(3)Al, turbine components, corrosion resistance, tensile properties, rapid solidification, grain growth, coatings

5. **Ni(3)Al-Base Alloys Processed by Rapid Solidification**  
   Huang, S. C., Chang, K. M., Taub, A. I.  
   Met Powder Rept 43 (2), 92-5 1988 ( AD-D138 292 )  
   **Key Words:** Ni(3)Al, boron addition, atomization, tensile properties

6. **Hot Isostatic Pressing of Nickel Aluminide Powders**  
   Wright, R. N., Flinn, J. E.  
   EG & G Idaho Inc., Idaho Falls, ID  
   Technical Report  
   Rept No : EGG-MG-7986, DE88 009677, 31 pp., 1988 ( AD-D141 721 )  
   **Key Words:** Ni(3)Al, microscopy, grain size, densification, flow stress, tensile properties

7. **High-Temperature Fatigue Crack Propagation in P/M Ni3Al-B Alloys**  
   Chang, K. M., Huang, S. C., Taub, A. I.  
   Materials Research Society, Pittsburgh, PA  
   **Key Words:** Ni(3)Al, Ni-12Al-12Co, T144, grain size, fatigue, crack growth, oxidation, tensile properties, fracture surface

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Fuchs, G. E., Stoloff, N. S.
Scr Metall 21 (6), 863-8, 1987 (AD-D137 117)
Key Words: Ni(3)Al, fracture, crack propagation, fatigue, tensile properties

9. Effects of Processing and Impurities on the Elevated Temperature Ductility Loss in Rapidly Solidified Ni (3)Al-B
Iaub, A. I., Chang, K. W., Huang, S. C.
ASM International, Metals Park, OH
Proc Conf Rapidly Solidified Mater, 297-302, 1986 (AD-D139 047)
Key Words: Ni(3)Al, plasma deposition, melt spinning, tensile properties

NiAl

1. HIP and Sinter-HIP of Ternary Nickel Aluminide (NiAl)-X alloys
Kaysser, W. A., Laag, R., Murray, J. C., Petzow, G.
Elsevier, London, UK
Key Words: NiAl, gas atomization, sintering, microstructure, density, grain size, tensile properties, fracture path, fracture toughness, hardness, titanium additions, niobium additions

2. Consolidation of Nickel Aluminide Powders Using Hot Isostatic Pressing
Wright, R. N., Knibloe, J. R., Noebe, R. D.
Key Words: NiAl, density, HIP maps, diffusion

3. Fabrication of Dense Nickel Aluminide Monolithic and Composite Bodies by Combined Self Propagating High Temperature Synthesis and In Situ Containerless Hot Isostatic Pressing
Concannon, M., Hodge, E. S., Nyce, A. C., Turmel, C. P.
Materials Research Society, Pittsburgh, PA
Key Words: NiAl, boron addition, density, tensile properties, hardness

4. A Comparative Study on the Influence of Nb and Ti Additions to Different Processed Atomized NiAl Powders
Laag, R., Kaysser, W. A., Petzow, G.
Materials Research Society, Pittsburgh, PA
Key Words: NiAl, niobium addition, titanium addition, microstructure, grain size, impurities, fracture surface, intergranular fracture, transgranular fracture, fracture toughness, creep, hardness, elastic modulus, tensile properties, melting point, Poisson’s ratio

5. Powder Processing of Intermetallic Alloys and Intermetallic Matrix Composites
Stoloff, N. S., Alman, D. E.
Key Words: Al(3)Ta, NiAl, Ni(3)Al, NbAl(3), TiAl, phase diagram, reactive sintering, densification, injection molding, reaction milling, mechanical alloying, Charpy impact, tensile properties
6. **Powder Processing of High Temperature Aluminides**

German, R.M., Bose, A., Stoloff, N.S.
Materials Research Society, Pittsburgh, PA
Proc Symp High-Temperature Ordered Intermetallic Alloys III
133, 403-14, 1989 (AD-D143 438)
**Key Words:** NiAl, TiAl, NbAl(3), Ta(2)Al(4), TaAl(3), microstructure, tensile properties

7. **Microstructures and Mechanical Behavior of Mechanically Alloyed Nickel Aluminide**

Wang, J. S. C., Donnelly, S. G., Godavarti, P., Koch, C. C.
**Key Words:** NiAl, microstructure, grain refinement, consolidation, mechanical alloying, tensile properties, fracture, creep

8. **High Temperature Intermetallics by Powder Processing**

Bose, A., Moore, B., Stoloff, N.S., German, R.M.
MPR Publishing Services Ltd., Bellstone, Shrewsbury, UK
**Key Words:** NiAl, Nb(3)Al, phase diagram, elongation, tensile properties

9. **Modern Powder Metallurgy Science and Technology**

Lawley, A., J Met 38 (8), 15-25, 1986 (AD-D136 435)
**Key Words:** NiAl, IN-100, MAR-M509, RENE' 95, AA 2024-T6, consolidation, REP, tensile properties, impact toughness

10. **P/M Processing of Intermetallic Compounds of CsCl Type for High Temperature Applications**

Vedula, K., Anderson, G., Pathare, V., Aslandis, I.
Metal Powder Industries Federation, Princeton, NJ
Proc Int Powder Metallurgy Conf, Modern Developments in Powder Metallurgy
16, 717-44, 1985 (AD-D138 357)
**Key Words:** FeAl, NiAl, hot extrusion, creep, compressive properties

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**Ti(3)Al**

1. **Microstructure and Mechanical Properties of HIPed compacts of Mechanically Alloyed Titanium-Aluminum Powder**

Park, Y. H., Hashimoto, H., Watanabe, R., Ahn, J. H., Chung, H. S.
**Key Words:** TiAl, Ti(3)Al, Al(3)Ti, mechanical alloying, ball milling, microstructure, mechanical properties, microhardness

2. **Synthesis of Titanium Aluminide (TiAl) Intermetallic Compounds by HIP-Reaction Sintering**

Kakitsuji, A., Miyamoto, H., Elsevier, London, UK
**Key Words:** TiAl, Ti(3)Al, reaction sintering, microstructure, grain size

3. **P/M Processing of Titanium Aluminides**

**Key Words:** Ti(3)Al, Ti-25Al-10Nb-3V-1Mo, Ti-6Al-2Sn-4Zr-2Mo, Ti-48 at pct Al-1 at pct V, microstructure, particle size, tensile properties, stress rupture, plasma spraying

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4. Influence of Metallurgical Methods on the Properties of Ti(3)Al

Proc Int Conf Titanium 1990, Products and Applications, 1, 170-9, 1990 (AD-D144 273)

Key Words: Ti(3)Al, microstructure, porosity, corrosion, oxidation, grain growth, compressive properties, tensile properties, creep, elastic modulus

5. Improved Toughness Alloys Based on Titanium Aluminides

Blackburn, M. J., Smith, M. P.
Pratt and Whitney Aircraft Group, West Palm Beach, FL
Final Report
Rept No: PW-FR-20760, 222 pp., 1989 (AD-A218 149)

Key Words: Ti(3)Al, turbine components, niobium addition, molybdenum addition, lanthanum addition, erbium addition, cerium addition, rapid solidification, thermomechanical treatment, fracture toughness, impact strength, tensile properties, creep rupture, fatigue

TiAl

1. Microstructure and Mechanical Properties of HIPed compacts of Mechanically Alloyed Titanium-Aluminum Powder

Park, Y. H., Hashimoto, H., Watanabe, R., Ahn, J. H., Chung, H. S.

Key Words: TiAl, Ti(3)Al, Al(3)Ti, mechanical alloying, ball milling, microstructure, mechanical properties, microhardness

2. Phase Transformation Effects During HIP of Titanium Aluminide (TiAl).

Schaefer, R. J., Janowski, G. M.
Acta Metall Mater 40 (7), 1645-51, 1992

Key Words: TiAl, phase transformation, densification

3. Synthesis of Titanium Aluminide (TiAl) Intermetallic Compounds by HIP-Reaction Sintering

Kakitsuji, A., Miyamoto, H.
Elsevier, London, UK
Proc 3rd Int Conf Hot Isostatic Pressing: Theory Appl 295-300, 1992

Key Words: TiAl, Ti(3)Al, reaction sintering, microstructure, grain size

4. Powder Processing of Intermetallic Alloys and Intermetallic Matrix Composites

Stoloff, N. S., Alman, D. E.

Key Words: Al(3)Ta, NiAl, Ni(3)Al, NbAl(3), TiAl, phase diagram, reactive sintering, densification, injection molding, reaction milling, mechanical alloying, Charpy impact, tensile properties

5. Novel P/M Processing of Intermetallic Compound Using Amorphous TiAl

Kimura, H., Kobayashi, S.
The Japan Institute of Metals, Sendai, Japan
Proc Intermetallic Compounds-Structure and Mechanical Properties (JIMIS-6) 985-9, 1991

Key Words: TiAl, amorphous alloy, hardness, processing, microstructure
6. **Formability of Hiped TiAl at Elevated Temperatures**  
Bolt, P. J., Horihata, M., Ohuchi, K., Sano, T., Matsuno, K.  
The Japan Institute of Metals, Sendai, Japan  
Proc Intermetallic Compounds-Structure and Mechanical Properties (JIMIS-6)  
953-7, 1991  
**Key Words**: TiAl, compressive properties, three point bend, self-propagating high-temperature synthesis

7. **Microstructure and Mechanical Properties of Reactive Hot Isostatic Pressed TiAl Powder Material**  
Smarsly, W. G., Dahms, M.  
The Japan Institute of Metals, Sendai, Japan  
Proc Intermetallic Compounds-Structure and Mechanical Properties (JIMIS-6)  
947-52, 1991  
**Key Words**: TiAl, aerospace applications, microstructure, hardness, tensile properties, bend test

8. **Processing and Properties of Gamma Titanium Aluminide Sheet Produced from Prep Powder**  
Ohls, M. A., Nachtrab, W. T., Roberts, P. R.  
Metal Powder Industries Federation, Princeton, NJ  
**Key Words**: TiAl, materials comparison, PREP, microstructure, tensile properties

Tokizane, M., Isonishi, K., Kido, S.  
PM Into the 1990's 2, 53-6, 1990  
**Key Words**: TiAl, ball milling compressive properties, microstructure

10. **Processing of TiAl Structural Parts by Reaction HIP of Precompacted Elemental Powders**  
**Key Words**: TiAl, structural parts, airframes, turbine components, extrusion, reactive hipping

11. **Mechanical Properties of Sintered TiAl Prepared by Canning Hipping**  
**Key Words**: TiAl, grain size, impurities, crack growth, fracture surface, compressive properties, three point bend, bend strength, work hardening

12. **Powder Processing of High Temperature Aluminides**  
German, R.M., Bose, A., Stoloff, N.S.  
Materials Research Society, Pittsburgh, PA  
Proc Symp High-Temperature Ordered Intermetallic Alloys III  
133, 403-14, 1989 (AD-D143 438)  
**Key Words**: NiAl, TiAl, NbAl(3), Ta(2)Al(4),TaAl(3), microstructure, tensile properties

13. **Powder Metallurgy of Titanium Aluminides**  
Moxson, V. S., Friedman, G. I.  
Met Powder Rept 43 (2), 88-91, 1988 (AD-D138 291)  
**Key Words**: TiAl, microstructure, fracture, tensile properties, REP, bimetal joining
14. Microstructure and Mechanical Properties of Sintered TiAl
Nakamura, M., Kaieda, Y.
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Key Words: TiAl, microstructure, compressive properties, hardness, sintering, atomization, bend properties

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Key Words: TiAl, microstructure, phase diagram, consolidation, REP, rapid solidification

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Yolton, C. F., Lizzi, T., Chandhok, V. K., Moll, J. H.
The Metallurgical Society of AIME, Warrendale, PA
Proc Symp Titanium, Rapid Solidification Technology 263-71, 1986 (AD-D138 900)
Key Words: TiAl, turbine components, creep rupture, tensile properties, plastic deformation

17. Alloys Based on NiAl for High Temperature Applications
Vedula, K., Pathare, V., Aslandis, L., Titran, R. H.
National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH
Technical Memorandum
Rept No: NASA-TM-86976, 13 pp., 1984 (AD-D134 342)
Key Words: TiAl, grain size, strengthening, flow stress, compressive properties, hot extrusion

18. Intermetallic Phases in the Copper/Titanium-6-6-2 Alloy System for the XM-785 Rotating Band
Shappirio, J. R., Calella, P. C., Eckart, D. W.
Army Electronics Technology and Devices Lab., Fort Monmouth, NJ
Research and Development Technical Report
Rept No: DELET-TR-83-1, 16 pp., 1983 (AD-B074 322L)
Key Words: TiAl, Ti-6Al-6V-2Sn, dissimilar joining, diffusion bonding

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1. Microstructure and Mechanical Properties of HIPed compacts of Mechanically Alloyed Titanium-Aluminum Powder
Park, Y. H., Hashimoto, H., Watanabe, R., Ahn, J. H., Chung, H. S.
Key Words: TiAl, Ti(3)Al, Al(3)Ti, mechanical alloying, ball milling, microstructure, mechanical properties, microhardness

2. HIP Consolidation of Aluminum-Rich Intermetallic Alloys and Their Composites
Frazier, W. E., Donnellan, M. E.
Naval Air Warfare Center, Aircraft Div, Warminster, PA
NAWCADWAR-92003-60, 28 pp., 1992 (AD-A251 429)
Key Words: Al(3)Ti, aircraft structures, tensile properties, crystal structure, copper addition, melting point

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3. Microstructure and Tensile Properties of Fe(3)AI Produced by Combustion Synthesis/Hot Isostatic Pressing
Rabin, B. H., Wright, R. N.
TMS, Warrendale, PA
Metall Trans 23A, 35-40, 1992
Key Words: Fe(3)AI, tensile properties, microstructure, combustion synthesis

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Naval Air Warfare Center, Warminster, PA
Quarterly Progress Report Number One
Contract No.: N62269-91-C-0247
Rept No.: BDM/VAS-0746-91-TR, 15 pp., 1991 (AD-B161960)
Key Words: intermetallic compounds, turbine components, processing, microstructure, densification, near net shape forming, finite element analysis, control systems

5. Microstructure Control of Titanium Aluminide Powder Compacts by Thermochemical Processing
Apgar, L. S., Eylon, D.
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Key Words: Ti-24Al-11Nb, microstructure, PREP, thermomechanical treatment, hydrogenation, phase diagram, superplasticity

6. Structure and Some Properties of Electrolytic Powdered Intermetallics of Titanium and Iron
Zarubitskaya, L. I., Korobka, Yu. V.
Plenum Press, New York, NY
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Key Words: TiFe, hydrogen power generation, sintering, electrolytic powder, hydrogen capacity

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Stoloff, N. S., Alman, D. E.
Key Words: Al(3)Ta, NiAl, Ni(3)Al, NbAl(3), TiAl, phase diagram, reactive sintering, densification, injection molding, reaction milling, mechanical alloying, Charpy impact, tensile properties

8. Intrinsic Second-Phase Particles in Powder-Processed MoSi(2)
Cotton, J. D., Kim, Y. S., Kaufman, M. J.
Key Words: MoSi(2), hot pressing, arc melting, inclusions, fracture grain growth, carbon addition

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Bose, A., Page R. A., Misislek, W., German, R. M.
Key Words: Fe(3)AI, density, powder size, sintering temperature

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Moll, John H., Yolton, C. F., McTierman, B. J.
Key Words: Ti(3)Al, Ti-25Al-10Nb-3V-1Mo, Ti-6Al-2Sn-4Zr-6Mo, Ti-48 at pct Al-1 at pct V, microstructure, particle size, tensile properties, stress rupture, plasma spraying
11. Densification of Rapidly Solidified Titanium Aluminide Powders-II. The Use of a Sensor to Verify Hipping Models
Choi, B. W., Marschall, J., Deng, Y. G., McCullough, C., Paden, B., Mehrabian, R.
Acta Metall Mater 38 (11), 2245-52, 1990 (AD-D144 155)
Key Words: Ti-48 at pct Al-2.5 at pct Nb, Ti-50 at pct Al-2 at pct Nb, atomization, density, densification, rapid solidification, REP

12. Densification of Rapidly Solidified Titanium Aluminide Powders-I. Comparison of Experiments to Hiping Models
Choi, B. W., Deng, Y. G., McCullough, C., Paden, B., Mehrabian, R.
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Key Words: Ti-48 at pct Al-2.5 at pct Nb, Ti-50 at pct Al-2 at pct Nb, atomization, particle size, grain size, consolidation, rapid solidification, REP, density

13. Fabrication of the DO(22)-Type Intermetallic Compound AI3Ta via Powder Metallurgy Processes and its Characterization
Pak, H. R., Pak, J. S. L., Rigsbee, J. M., Wayman, C. M.
Mater Sci Eng A 128 (1), 129-39, 1990 (AD-D144 120)
Key Words: Al(3)Ti, aluminum, tantalum, crystal structure, lattice parameters, phase diagram, density, dislocations, grain boundaries, deformation, fabrication

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Fishman, S. G., Martin Marietta Astronautics Group, Denver, CO
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Key Words: Ti(2)Be(17), TiBe(12), microstructure, fracture surface, tensile properties, foil, roll bonding, fabrication

15. Modelling of Hipping Consolidation Applied to Ni(3)Al Powders
Wright, R. N., Williamson, R. L., Knibloc, J. R.
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Key Words: Ni(3)Al, Ni-19 at pct Al-8.5 at pct Cr, grain boundary diffusion, creep, tensile properties, atomization

16. Powder Processing of High Temperature Aluminides
German, R.M., Bose, A., Stoloff, N.S.
Materials Research Society, Pittsburgh, PA
Proc Symp High-Temperature Ordered Intermetallic Alloys III 133, 403-14, 1989 (AD-D143 438)
Key Words: NiAl, TiAl, NbAl(3), Ta(2)Al(4), TaAl(3), microstructure, tensile properties

17. High Temperature Intermetallics by Powder Processing
Bose, A., Moore, B., Stoloff, N.S., German, R. M.,
MPR Publishing Services Ltd., Bellstone, Shrewsbury, UK
Key Words: NiAl, Nb(3)Al, phase diagram, elongation, tensile properties

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Uehara, S., Sasano, H., Kaieda, Y., Suzuki, T.
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Key Words: TiNi, microstructure, microprobe analysis, martensitic transformation, density
19. **P/M Processing of Intermetallic Compounds of CsCl Type for High Temperature Applications**  
Vedula, K., Anderson, G., Pathare, V., Aslandis, I.  
Metal Powder Industries Federation, Princeton, NJ  
**Key Words:** FeAl, NiAl, hot extrusion, creep, compressive properties

20. **Progress of Powder Metallurgy in North America**  
Roll, K.H., Johnson, P.K.  
**Key Words:** copper, iron, Inconel 625, AISI 316L, M-2, NiFe, rapid solidification, injection molding

21. **The Effect of Grain Size on the High Temperature Plastic Deformation of Nb(3)Sn**  
Clark, J. B., Hopple, G. B., Wright, R. N.  
**Key Words:** Nb(3)Sn, compressive properties, grain size, creep, plastic deformation, activation energy

22. **Materials Research for Advanced Inertial Instrumentation. Task 3. Rare Earth Magnetic Material Technology as Related to Gyro Torquers and Motors**  
Das, D., Kumar, K.  
Charles Stark Draper Lab Inc., Cambridge, MA  
Technical Report  
Rept No: CSDL-R-1614, TR-5, 73 pp., 1982 (AD-A126 982 )  
**Key Words:** SmCo(5), plasma spraying, sintering, arc spraying

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Battelle Memorial Institute, Columbus, OH  
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**Key Words:** Ti-16Al-10Nb, Ti-12Al-19Nb, Ti-13Al-20Nb, Ti-36Al-5Nb, Ti-32Al-5Nb-5W, rolling, superplastic forming, joining, tensile properties, hardness, fatigue, creep test, bend test
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Muramatsu, Y., Funami, K., Halada, K., Hoshimoto, K.
J Jpn Inst Met 52 (8), 803-9, 1988 ( AD-D139 796 )
Key Words: Molybdenum alloys, microstructure, flexural properties, fracture toughness, transformation toughening

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Hofmann, H., Grosskopf, M., Hofmann-Antenbrink, M., Petzow, G.
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Key Words: molybdenum alloys, nickel addition, microstructure, bend properties

3. New Powder Technologies for Molybdenum Alloy Gun Barrel Liners
Barranco, J. M., Isserow, S.
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Key Words: gun barrels, REP, erosion resistance, hardness, bend test, tensile properties, creep rupture, compressive properties, fracture, molybdenum alloys

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Barranco, J., Ahmad, I., Isserow, S., Warenchak, R.
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German, R. M.
Rensselaer Observatory, Troy, NY
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**Key Words:** Nb-1Zr, W-30Re-20Mo, Mo-50Re, T-111, Ta-10W, niobium, tungsten, tantalum, porosity, dissimilar joining, weldability, fracture mechanics, cracking, degradation, diffusivity, interdiffusion

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1. **Rapid Solidification Processing of Niobium Alloys**

Jha, S. C., Ray, R.
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**Key Words:** C-103, niobium alloys, forging, tensile properties welding, scrap reclaimation

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**Key Words:** tungsten alloys, niobium alloys, steels, press forging, density, shrinkage

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Wadsworth, J., Robert, C. A., Rennhack, E. H.
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Arcella, F. G.
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**Key Words:** tantalum, niobium, tungsten, T-111, rhenium, dissimilar joining, electron beam welding, pressure bonding, interdiffusion, voids, aging, mathematical model, niobium alloys

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**Key Words:** Nb-1Zr, W-30Re-20Mo, Mo-50Re, T-111, Ta-10W, niobium, tungsten, tantalum, porosity, dissimilar joining, weldability, fracture mechanics, cracking, degradation, diffusivity, interdiffusion
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   Pak, H. R., Pak, J. S. L., Rigsbee, J. M., Wayman, C. M.
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   **Key Words:** \( \text{Al}(3)\text{Ti} \), aluminum, tantalum, crystal structure, lattice parameters, phase diagram, density, dislocations, grain boundaries, deformation, fabrication

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   Hanes, H. D., Seifert, D. A., Watts, C. R.
   Metals Information Analysis Center, West Lafayette, IN
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   **Key Words:** T-111, Ti-6Al-4V, AA A356-T61, IN-738, RENE' 80, Udimet 700, IN-792, welding, tensile properties, pressure bonding

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   **Key Words:** Nb-1Zr, W-30Re-20Mo, Mo-50Re, T-111, Ta-10W, niobium, tungsten, tantalum, porosity, dissimilar joining, weldability, fracture mechanics, cracking, degradation, diffusivity, interdiffusion

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1. **Hot Isostatic Pressing and Sintering Behavior of Yttrium Oxide Dispersed Tungsten**
   Ishiwata, Y., Itoh, Y., Kashiwaya, H.
   Elsevier, London, UK
   **Key Words:** tungsten, yttrium oxide addition, sintering, density, bend strength

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Foreign Technology Division, Wright-Patterson AFB, OH
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**Key Words:** tantalum, niobium, tungsten, T-111, rhenium, dissimilar joining, electron beam welding, pressure bonding, interdiffusion, voids, aging, mathematical model, niobium alloys

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**Key Words:** Nb-1Zr, W-30Re-20Mo, Mo-50Re, T-111, Ta-10W, niobium, tungsten, tantalum, porosity, dissimilar joining, weldability, fracture mechanics, cracking, degradation, diffusivity, interdiffusion

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   **Key Words:** creep, densification, porosity, finite element analysis

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   Department of Materials Science and Engineering, Illinois University at Urbana
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   Mg-8Si, Mg-5Li, Mg-12Li, Mg-5Li-5Si, Mg-8Li-5Si, Mg-12Li-5Si,
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   Key Words: AA A201, AISI 4330, AA C355-T6, 142-T4, AA A356-T61, IN-738, RENE’ 77, IN-792, RENE’ 80, stainless steel, porosity, tensile properties, fatigue

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   Vonk, S. J., Hoppin, G. S., Benn, K. W.
   Garrett Turbine Engine Co., Phoenix, AZ
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   Key Words: AA A201, porosity, microstructure, tensile properties, fatigue

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   Highberger, W. T., Scarich, G. V., Chanani, G. R.
   SAMPE, Azusa, CA
   Key Words: AA A201-T7, porosity, tensile properties, fatigue, crack growth rate

AA A356

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   Chou, J. S., Meyers, C. W.
   Trans Am Foundrymen's Soc 99, 165-1, 1991
   Key Words: AA A356, microcracking, porosity, plastic deformation

2. Experimental Investigations of deformation in HIPped A356 aluminum castings
   Meyers, C. W., Chou, J. S.
   Key Words: AA A356, casting, microstructure, fracture fracture toughness, tensile behavior, deformation
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Haynes, T. G., III. Tesar, A. M., Webster, D.

Modern Casting 76 (10), 26-8, 1986 (AD-D138 421)

Key Words: AA A356-T6, microstructure, fracture, tensile properties

4. Hot Isostatic Press

Author Anon

Foreign Technology Division, Wright-Patterson AFB, OH

Rept No: FTD-ID(RS)T-1406-84, 65 pp., 1985 (AD-B093 100L)

Key Words: Ti-6Al-4V, B-1900, IN-738, RENE' 77, IN-792, RENE' 80, AA C355, AA A356, 142-T4

5. Improving Casting Properties and Integrity with Hot Isostatic Pressing

Rooy, E. L.

Modern Casting 73(12), 18-20, 1983 (AD-D128 854)

Key Words: AA A356-T61, AA A357-T62, F132-T6, porosity, fatigue, tensile properties

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Irving, R. R., Iron Age 225 (33), 43-5, 1982 (AD-D126 241)

Key Words: AA A201, AISI 4330, AA C355-T6, 142-T4, AA A356-T61, IN-738, RENE' 77, IN-792, RENE' 80, stainless steel, porosity, tensile properties, fatigue

7. Cutting Metal Loss Tied to Near Net Shapes

Harvey, R. E. Iron Age 222 (42), 57-63, 1979 (AD-D116 853)

Key Words: RENE' 77, IN-738, IN-792, AA C355-T6, AA A356-T61 142-T6, net shape forming, fatigue, tensile properties

8. Improved Properties in Castings by Hot Isostatic Pressing

Glenn, G. M.

SAMPE Qtrly 8 (1), 1-9, 1976 (AD-D107 893)

Key Words: IN-738, RENE' 80, RENE' 120, RENE' 77, Ti-6Al-4V, AA A356, AA C355 porosity, tensile properties, microstructure, creep rupture, density, fatigue

9. Improvement of Nuclear Reactor Component Materials by Application of Hot Isostatic Processing (HIP)

Mueller, J. J.

Electric Power Research Inst, Palo Alto, CA

Rept No: EPRI-500-1, PB-250952, 64 pp., 1975 (AD-D107 180)

Key Words: Ti-6Al-4V, AA A356-T61, RENE' 95, IN-738, IN-792, RENE' 77, RENE' 80, nuclear reactor, turbine components, tensile properties, fatigue, creep rupture, cladding, defects

AA A357

1. Fracture Toughness and Fatigue Crack Growth Rate Testing of Premium Quality Vacuum Investment Cast 200 and 300 Series Aluminum Alloys

Bouse, G. K., Behrendt, M. R.

Proc Int Conf Aluminum Alloys: Their Physical and Mechanical Properties 3, 1665-80, 1986 (AD-D140 112)

Key Words: AA A201-T7, AA A206-T71, AA A157-T6, turbine components, airframes, crack growth rate, fracture toughness
2. Correction of Casting Faults by the Hot Isostatic Pressing of High Strength Aluminum Materials
Zeitler, H., Scharfenberger, W.
Aluminum English 60 (12), E803-8, 1984 (AD-D131 723)
Key Words: AA A357-T6, fracture defects, porosity, sand casting

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Rooy, E. L.
Modern Casting 73(12), 18-20, 1983 (AD-D128 854)
Key Words: AA A356-T61, AA A357-T62, F132-T6, porosity, fatigue, tensile properties

NTIS, N84-23555, Springfield, VA
Final Report, Dec 80-Jun 83
Rept No: N84-23555, 152 pp., 1983 (AD-D134 719)
Key Words: AA A357, titanium alloys, fracture mechanics, diffusion bonding, fatigue

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Bittence, J. C.
Mater Eng 88 (4), 54-7, 1978 (AD-D113 844)
Key Words: Inconel 718, IN-792, Ti-6Al-4V, 17-4PH, AA A357, porosity, fatigue, creep properties, deformation, cost

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Schweikert, W. H.
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
Proc Net Shape Metalworking Program Review 392-405, 1976 (AD-D119 186L)
Key Words: Inconel 718, Ti-6Al-4V, 17-4PH, AA A357, tensile properties, nondestructive testing

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Key Words: Al-8N-25Ti, electrode arc melting, microstructure, heat treatment, transgranular fracture, voids

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6-1 to 6-23, 1987 (AD-D139 987)
Key Words: Ti-6Al-4V, AA 7475, Supral 100, Supral 150, Supral 220, alclad coatings, microstructure, grain size, aging, elastic properties, fatigue, fracture toughness

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3. **Hot Isostatic Pressing of Aluminum-Silicon Castings**  
Chama, C. C.  
Pennsylvania State University, Dept. of Materials Science and Engineering, University Park, PA  
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275 pp., 1986 (AD-D139 361)  
**Key Words:** Al-7Si, Al-10Si, porosity, tensile properties

4. **Fracture Toughness and Fatigue Crack Growth Rate Testing of Premium Quality Vacuum Investment Cast 200 and 300 Series Aluminum Alloys**  
Bouse, G. K., Behrendt, M. R.  
Proc Int Conf Aluminum Alloys--Their Physical and Mechanical Properties, 3, 1665-80, 1986 (AD-D140 112)  
**Key Words:** AA A201-T7, AA A206-T71, AA A357-T6, turbine components, airframes, crack growth rate, fracture toughness

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Author Anon  
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**Key Words:** Ti-6Al-4V, B-1900, IN-738, RENE' 77, IN-792, RENE' 80, AA C355, AA A356, 142-T4

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Johnson, C. A.  
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**Key Words:** AA 6061-T6, 15-5PH, tensile properties, fracture, metallography, bend test, burst test

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Rooy, E. L.  
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Hofer, B.  
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**Key Words:** Al-10Si, Al-4Cu, Al-7Si, diffusion bonding, porosity, net shape forming, mechanical properties

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Belov, A. F., Tselikov, A. I., Trishkin, V. G., Rakovskiy, V. S., Rykalin, N. N.  
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Rept No: FTD-ID(RS)T-0412-82, 335 pp., 1982 (AD-B070 680L)  
**Key Words:** aluminum alloys, titanium alloys, mechanical properties, fatigue, cracking

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Widmer, R., Price, P. E.  
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**Key Words:** Ti-6Al-4V, stainless steel, aluminum alloys, porosity, rejuvenation, cost
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   Irving, R. R.
   Iron Age 225 (33), 43-5, 1982 (AD-D126.241)
   **Key Words:** AA A201, AISI 4330, AA C355-T6, 142-T4, AA A356-T61, IN 738, RENE 77, IN-792, RENE 80; stainless steel, porosity, tensile properties, fatigue

12. **The Development of Aluminum-Lithium Alloys**
   Gayle, Frank W.
   Reynolds Metals Co., Metallurgical Research Division, Richmond, VA
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   **Key Words:** Al-42.3Li, scandium addition, gallium addition, manganese addition, magnesium addition, silver addition, copper addition, iron addition, dispersion hardening, microstructure, hardness, tensile properties

13. **Trends in Casting Technology**
   Chandler, H. E., Baxter, D. F.
   Metal Prog 117 (1), 97-9, 1980 (AD-D117.224)
   **Key Words:** AA 6061-T6, AISI 4340, Fe-3Cr-19Cr-1.5Ni-2Mo, tensile properties

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   Harvey, R. E.
   Iron Age 222 (42), 57-63, 1979 (AD-D116.853)
   **Key Words:** RENE' 77, IN-738, IN-792, AA C355-T6, AA A356-T61, 142-T6, net shape forming, fatigue, tensile properties

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   Heine, H. J.
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   **Key Words:** Ti-6Al-4V, 18/8 stainless, 18Cr-10Ni, AA A360, B1914, B1925, 31964, B1981, airframes, aircraft structures, creep rupture, stress analysis, nondestructive testing, tensile properties, triboloy

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   Glenn, G. M.
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   **Key Words:** IN-738, RENE' 80, RENE' 120, RENE' 77, Ti-6Al-4V, AA A356, AA C355; porosity, tensile properties, microstructure, creep rupture, density, fatigue
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1. Characteristics of Mechanically Fastened Joints of CIP/HIP-1 Beryllium
Chou, S-C., Rainey, J. H., Swanson, R. A.
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Key Words: beryllium alloys, ion implantation, boride coatings, plasma deposition

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Wouch, G., Keith, G. H., Frost, R. T., Pinto, N.P.
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Key Words: beryllium, beryllium oxide addition, grain structure, space processing, zero gravity environment, thermal analysis

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Webster, D., Crooks, D. D.
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Key Words: beryllium, RR243, BSP9, T30, 9776, 9713, 8084, EF1, creep properties, cracking, grain boundaries, plastic deformation
COBALT ALLOYS

MAR-M509

1. Fatigue Dominated Damage Processes
Bressers, J., Remy, L., Hoffelner, W.
Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1
441-68, 1986 (AD-D142 075)
Key Words: MAR-M509, IN-738LC, Hastelloy X, Inconel 617, RA-333, A-286, Inconel 718, Incoloy 901, microstructure, cracking, granular fracture, fatigue

2. Aircraft Gas Turbine Materials and Processes
Kear, B. H., Thompson, E. R.
Science 208 (4446), 847-56, 1980 (AD-D126 322)
Key Words: Haynes 188, Inconel 617, HA8077, Waspaloy, B-1900, PWA 1422, Incoloy 901, IN-100, X-40, MAR-M509, Hastelloy X, turbine components, fan blades, compressor components, coatings, unidirectional solidification, superplastic forming

3. Quality of Castings of Superalloys
Bachelet, E., Lesoult, G.
Applied Sciences Publishers Ltd., London, UK
High Temperature Alloys for Gas Turbines 665-99, 1978 (AD-D116 360)
Key Words: IN-738, Udimet 500, X-40, IN-100, MC-102, M3608F, C263, mto-001, B1914, B1981, M-21, FSX-430, MAR-M509, IN-939, Alloy 713LC, creep properties, fatigue, crack growth, thermal fatigue, porosity

Bisset, J. W.
United Technologies Corp., East Hartford, CT
Rept No: N77-14026, PWA-5453, 42 pp., 1976 (AD-D107 956)
Key Words: MAR-M509, Hastelloy X, Waspaloy, IN-100, MAR-M200, turbine components, single crystals, hafnium addition, unidirectional solidification, cost

5. Study of Superalloys Produced via Powder Metallurgy
Hellner, L., Johansson, H., NTIS, N77-13210, Springfield, VA
Rept No: N77-13210, 56 pp., 1975 (AD-D109 492)
Key Words: X-40, MAR-M509, IN-738, dispersion hardening, cracking, microstructure, temperature effect, deformation, stress intensity, tensile properties

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Grant, N. J., Pelloux, R. M., Regis, M. N., Flemings, M. C., Merton, C.
Argon, A. S.
Massachusetts Institute of Technology, Center for Materials Science and Engineering, Cambridge, MA
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Key Words: IN-100, MAR-M509, Maraging 300, microstructure, tensile properties, fatigue, hardness, creep rupture, fracture toughness
X-40

1. Microstructural Damages Induced During the Repair Process
Davin, A., Lecomte-Mertens, Ch., Vierset, P., Louis, P.
Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part I
811-20, 1986 (AD-D142 085)
Key Words: Haynes 188, MAR-M200, X-40, turbine components, tensile properties, thermal shock, diffusion brazing, rejuvenation, repairs, welding

2. Repair and Rejuvenation Procedures for Aero-Gas-Turbine Hot-Section Components
Bell, S. R.
Mater Sci Technol 1 (8), 629-34, 1985 (AD-D133 818)
Key Words: Nimonic 108, RENE' 100, Nimocast PD21, X-40, C1023, turbine components, repair welding, microstructure, rejuvenation, creep

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Key Words: Haynes 188, Inconel 617, HA8077, Waspaloy, B-1900, PWA 1422, Incoloy 901, IN-100, X-40, MAR-M509, Hastelloy X, turbine components, fan blades, compressor components, coatings, unidirectional solidification, superplastic forming

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Bachelet, E., Lesoult, G.
Applied Sciences Publishers Ltd., London, UK
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Key Words: IN-738, Udiment 500, X-40, IN-100, MC-102, M3608F, C263, mto-001, B1914, B1981, M-21, FSX-430, MAR-M509, IN-939, Alloy 713LC, creep properties, fatigue, crack growth, thermal fatigue, porosity

5. Study of Superalloys Produced via Powder Metallurgy
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NTIS, N77-13210, Springfield, VA
Rept No: N77-13210, 56 pp., 1975 (AD-D109 492)
Key Words: X-40, MAR-M509, IN-738, dispersion hardening, cracking, microstructure, temperature effect, deformation, stress intensity, tensile properties

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1. Microstructural Damages Induced During the Repair Process
Davin, A., Lecomte-Mertens, Ch., Vierset, P., Louis, P.
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Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part I
811-20, 1986 (AD-D142 085)
Key Words: Haynes 188, MAR-M200, X-40, turbine components, tensile properties, thermal shock, diffusion brazing, rejuvenation, repairs, welding
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General Electric Co., Energy Systems Programs Department, Schenectady, NY
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**Key Words:** FSX-414, IN-738, GTD-111, turbine components, coatings, erosion, hot corrosion

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Kear, B. H., Thompson, E. R.
Science 208 (4446), 847-56, 1980 (AD-D126 322)
**Key Words:** Haynes 188, Inconel 617, HA8077, Waspaloy, B-1900, PWA 1422, Incoloy 901, IN-100, X-40, MAR-M509, Hastelloy X, turbine components, fan blades, compressor components, coatings, unidirectional solidification, superplastic forming

4. **Quality of Castings of Superalloys**
Bachelet, E., Lesoult, G.
Applied Sciences Publishers Ltd., London, UK
High Temperature Alloys for Gas Turbines 665-99, 1978 (AD-D116 360)
**Key Words:** IN-738, Udiment 500, X-40, IN-100, MC-102, M3608F, C263, mtO-001, B1914, B1981, M-21, FSX-430, MAR-M509, IN-939, Alloy 713LC, creep properties, fatigue, crack growth, thermal fatigue, porosity

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Mishka, K. H.
Mater Eng 84 (3), 22-4, 1976 (AD-D104 639)
**Key Words:** MA956E, CAPIVAC IV, Pyromet CTX-1, Haynes 556, Haynes 8077, MA754E, MA757E, turbine components, zirconium coatings, tensile properties, creep rupture, thermal processing, thermal fatigue, oxidation, gamma prime, oxide dispersion strengthening

Freche, J. C., Ashbrook, R. L.
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**Key Words:** HS-31, microstructure, heat treatment, creep rupture, tensile properties
IRON ALLOYS

17-4PH

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McCallum, R., Lang, W.
NTIS, PB85-234813, Springfield, VA
Technical Report
Rept No: NEL-697, 35 pp., 1985 (AD-D135 646)
Key Words: 17-4PH, EN40B, microstructure, fatigue, cracking

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Irving, R. R.
Iron Age 224 (6), 77-81, 1981 (AD-D120 406)
Key Words: JT-9D, MERL 76, 17-4PH, RENE' 120, IN-792, IN-738, turbine components, porosity

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Bittenbender, J. C.
Mater Eng 88 (4), 54-7, 1978 (AD-D113 844)
Key Words: Inconel 718, IN-792, Ti-6Al-4V, 17-4PH, AA A357, porosity, fatigue, creep properties, deformation, cost

4. High Integrity Casting Program
Schweikert, W. H.
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
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Key Words: Inconel 718, Ti-6Al-4V, 17-4PH, AA A357, tensile properties, nondestructive testing

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Nagan, R. M.
SAMPE Qtrly 6 (4), 1-7, 1975 (AD-D102 565)
Key Words: 17-4PH, Hastelloy X, Inconel 718, Ti-6Al-4V, aircraft structures, turbine components, tensile properties

AISI 4340

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Chandler, H. E., Baxter, D. F.
Metal Prog 117 (1), 97-9, 1980 (AD-D117 224)
Key Words: AA 6061-T6, AISI 4340, Fe-3C-19Cr-1.5Ni-2Mo, tensile properties

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Sheinker, A. A.
TRW Inc., Materials Technology, Cleveland, OH
Technical Report
Rept No: TRW-ER-8097, 66 pp., 1979 (AD-A080 637)
Key Words: AISI 4340, metallography, fractography, tensile properties, Charpy impact
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Lessman, G. G., Bryant, W. A.
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**Key Words:** AISI 4340, Inconel 718, hardness, tensile properties

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Gnanamuthu, D. S., Basaran, M., Kattamis, T. Z., Mehrabian, R., Flemings, M. C.
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**Key Words:** AISI 4340, thermomechanics, porosity, heat treatment

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**Key Words:** MA956, grain boundaries, oxide dispersion, strengthening, tensile properties

2. Materials for Advanced Turbine Engine--MATE
Evans, D. J., Sheffler, K. D., Friedrich, L. A.
Pratt and Whitney Aircraft Group, East Hartford, CT
Mar-May 82
Contract No: NAS 3-20072
1982, 21 pp. ( AD-D125 191 )
**Key Words:** Hastelloy X, Incoloy 901, MA956, Udimet 700, MERL 76, turbine components, combustors, erosion, coatings, oxide dispersion strengthening

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48 pp., 1981 ( AD-D120 953 )
**Key Words:** MERL 76, MA956, Hastelloy X, Incoloy 901, aircraft structures, combustor liners, turbine components, tensile properties, creep, crack growth, coatings, thermal fatigue

4. New Superalloys, Better Processing Promise More Durable Turbine Parts
Mishka, K. H.
Mater Eng 84 (3), 22-4, 1976 ( AD-D104 639 )
**Key Words:** MA956E, CAPIVAC IV, Pyromet CTX-I, Haynes 556, Haynes 8077 MA754E, MA757E, turbine components, zirconium coatings, tensile properties, creep rupture, thermal processing, thermal fatigue, oxidation, gamma prime, oxide dispersion strengthening
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1. Manufacturing Technology of 15-5PH Castings for Compressor Housings
   Froehner, T. A., Weed, S. J.
   Naval Weapons Center, China Lake, CA
   Final Report Mar 81-May 84
   Rept No: NWC-TP-6604, 21 pp., 1986 (AD-B101788L)
   Key Words: 15-5PH, hardening, investment casting

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   Hoffelner, W.
   Kluwer Academic Publishers, Norwell, MA
   Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1
   413-39, 1986 (AD-D142075)
   Key Words: Incoloy 800H, IN-738LC, IN-939, microstructure, creep, corrosive environment

3. Fatigue Dominated Damage Processes
   Bressers, J., Remy, L., Hoffelner, W.
   Kluwer Academic Publishers, Norwell, MA
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   441-68, 1986 (AD-D142075)
   Key Words: MAR-M509, IN-738LC, Hastelloy X, Inconel 617, RA-333, A-286, Inconel 718, Incoloy 901, microstructure, cracking, granular fracture, fatigue

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   Johnson, C. A.
   Naval Weapons Center, China Lake, CA
   Final Report Mar 81-May 84
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   Key Words: AA 6061-T6, 15-5PH, tensile properties, fracture, metallography, bend test, burst test

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   Andersson, T.
   Powder Metall Int 17 (1), 27-30, 1985 (AD-D131955)
   Key Words: 20Cr-18Ni, 20Cr-25Ni, 22Cr stainless, 26Cr stainless, welding, microstructure, microsegregation, tensile properties

6. Progress of Powder Metallurgy in North America
   Roll, K.H., Johnson, P.K.
   Key Words: copper, iron, Inconel 625, AISI 316L, M-2, NiFe, rapid solidification, injection molding

7. Integrally Cast Low-Cost Compressor
   Hessler, Barton H., Muntner, M. S., Cargo, Don, Roopchand, B.
   Avco Lycoming Div, Stratford, CT
   Final Technical Report
   Rept No: TACOM-TR-12673, 134 pp., 1983 (AD-A127663)
   Key Words: Custom 450, turbine components, fatigue, corrosion-fatigue, tensile properties
8. Overview of Temperature and Environmental Effects on Fatigue of Structural Metals
Coffin, L. F.
Plenum Press, New York, NY
Proc 27th Sagamore Army Materials Research Conf 1-40, 1983 (AD-D131 509)
**Key Words:** RENE' 95, A-286, stainless steel, Udiment 700, Waspaloy, MERL 76, IN-100, NASA HIB-7, crack growth, fatigue

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**Key Words:** AISI 4600, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Waspaloy, IN-100, AISI 329, 12Cr steel, injection molding, cost, applications

7. **Feasibility Study on the use of Small-Angle Neutron Scattering for Microstructural Determinations of Technological Alloys**  
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**Key Words:** copper, iron, Inconel 625, AISI 316L, M-2, NiFe, rapid solidification, injection molding

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Mishka, K. H.
Mater Eng 84 (3), 22-4, 1976 (AD-D104 639)
**Key Words:** MA956E, CAPIVAC IV, Pyromet CTX-1, Haynes 556, Haynes 8077, MA754E, MA757E, turbine components, zirconium coatings, tensile properties, creep rupture, thermal processing, thermal fatigue, oxidation, gamma prime, oxide dispersion strengthening
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Radivich, J. F.
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**Key Words:** TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Ti-8Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900, MAR-M200, turbine components, fracture mechanics, fatigue, creep rupture

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   **Key Words:** B-1900, microstructure, grain growth, fractography, tensile properties, fatigue

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4. **Aircraft Gas Turbine Materials and Processes**
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   **Key Words:** Haynes 188, Inconel 617, HA8077, Waspaloy, B-1900, PWA 1422, Incoloy 901, IN-100, X-40, MAR-M509, Hastelloy X, turbine components, fan blades, compressor components, coatings, unidirectional solidification, superplastic forming

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   **Key Words:** B-1900, IN-792, Ti-6Al-4V, IN-100, tensile properties, turbine components, fatigue, creep rupture

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   **Key Words:** MAR-M509, IN-738LC, Hastelloy X, Inconel 617, RA-333, A-286, Inconel 718, Incoloy 901, microstructure, cracking, granular fracture, fatigue
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**Key Words:** 17-4PH, Hastelloy X, Inconel 718, Ti-6Al-4V, aircraft structures, turbine components, tensile properties

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IN-100

1. **Rejuvenation Procedures to Recover Creep Properties of Nickel-Base Superalloys by Heat Treatment and Hot Isostatic Pressing Techniques**
   Baldan, A.
   **Key Words:** IN-100, Nimonic 80A, Nimonic 115, Nimonic 75, Nimonic 105, Nimonic 90, IN-738, IN-738LC, Inconel X-750, turbine components, creep, grain size, cavitation

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   Arsenault, R. J., Louat, N., Shahinian, P., Singh, A. K., Chaki, T.
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   Morishita, M., Nagai, H., Shoj, K.
   **Key Words:** IN-100, MFEI, 76, microstructure, swaging, creep rate, liquid sintering, creep rupture

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   Bell, S. R.
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   **Key Words:** Nimonic 108, RENE' 100, Nimocast PD21, X-40, C1023, turbine components, repair welding, microstructure, rejuvenation, creep

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Gayda, J., Miner, R. V.
**Key Words:** Waspaloy, IN-100, RENE' 95, turbine components, fatigue, creep-fatigue, crack growth, porosity, fracture mechanics, tensile properties, microstructure,

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Van Der Vet, W. J.
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Huff, H., Wortmann, J.
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**Key Words:** IN-100, Nimonic 90, Nimonic 108, turbine components, welding, creep, rejuvenation

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VerSnyder, F. L.
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**Key Words:** MAR-M200, IN-100, Udimet 700, carbon addition, boron addition, zirconium addition, cobalt addition, turbine components, corrosion, oxidation, REP, creep rupture, thermal fatigue

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Kluwer Boston Inc., Hingham, MA
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Pelloux, R. M.
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Final Report
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**Key Words:** Udimet 700, Waspaloy, IN-100, microstructure, creep, fatigue, embrittlement

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**Key Words:** Ti-6Al-4V, IN-100, seam welding, microstructure, diffusion bonding

16. All Systems Are Go for Powder Metallurgy
Irving, R. R.
Iron Age 223 (28), 41-5, 1980 (AD-D118 875)
**Key Words:** AISI 4600, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Waspaloy, IN-100, AISI 329, 12Cr steel, injection molding, cost, applications

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Dennison, J. P., Elliot, I. C., Wilshire, B.
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**Key Words:** Nimonic 105, IN-100, fracture mechanics, creep, heat treatment

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Kear, B. H., Thompson, E. R.
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**Key Words:** Haynes 188, Inconel 617, HA8077, Waspaloy, B-1900, PWA 1422, Incoloy 901, IN-100, X-40, MAR-M509, Hastelloy X, turbine components, fan blades, compressor components, coatings, unidirectional solidification, superplastic forming

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**Key Words:** AF-2-1DA, AF-115, NASA IIB-7, NASA IIB-11, MAR-M200, MA6000E, WAZ-D, WAZ20, IN-100, service life, creep rupture, tensile properties, coatings, corrosion, thermal fatigue, unidirectional solidification

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**Key Words:** IN-100, Waspaloy, RENE' 95, Inconel 718, welding, grain size, bonding, recrystallization, temperature effect
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**Key Words:** IN-738, Udiment 500, X-40, IN-100, MC-102, M3608F, C263, mto-001, B1914, B1981, M-21, FSX-430, MAR-M509, IN-939, Alloy 713LC, creep properties, fatigue, crack growth, thermal fatigue, porosity

24. **HIP'ing Raises Casting Performance Levels**  
Freeman, W. R., Jr.  
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**Key Words:** B-1900, IN-792, Ti-6Al-4V, IN-100, tensile properties turbine components, fatigue, creep rupture

25. **Premium Quality Castings**  
Freeman Jr., W. R.  
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH  
Proc Net Shape Metalworking Program Review 406-17, 1976 (AD-D119 187L)  
**Key Words:** IN-792, IN-738, IN-100, RENE' 80, Alloy 713L, Alloy 713LC, B-1900, MAR-M200, tensile properties, fatigue

26. **Cost/Benefit Analysis of Advanced Materials Technologies for Future Aircraft Turbine Engines**  
Bisset, J. W.  
United Technologies Corp., East Hartford, CT  
Project Completion Report  
Rept No.: N77-14026, PWA-5453, 42 pp., 1976 (AD-D107 956)  
**Key Words:** MAR-M509, Hastelloy X, Waspaloy, IN-100, MAR-M200, turbine components, single crystals, hafnium addition, unidirectional solidification, cost

27. **Materials and Processing Technology for Advanced Gas Turbines**  
Hauser, H. A.  
SAMPE Qtrly 6 (3), 8 pp., 1975 (AD-D101 035)  
**Key Words:** TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Ti-8Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900, MAR-M200, turbine components, fracture mechanics, fatigue, creep rupture

28. **The Nature of the Sulfo-Carbides Observed in Nickel-Base Superalloys**  
Wallace, W., Holt, R. T., Terada, T.  
Metall 6 (6), 511-26, 1973 (AD-D106 657)  
**Key Words:** Alloy 713C, IN-100, Udiment 700, sulfur addition, carbide phases, crack growth

29. **Structure and Property Control Through Rapid Quenching of Liquid Metals**  
Grant, N. J., Pelloux, R. M., Regis, M. N., Flemings, M. C., Merton, C.  
Argon, A. S.  
Massachusetts Institute of Technology, Center for Materials Science and Engineering, Cambridge, MA  
Contract No.: DAHC15-70-C-0283  
130 pp., 1972 (AD-739 340)  
**Key Words:** IN-100, MAR-M509, Maraging 300, microstructure, tensile properties, fatigue, hardness, creep rupture, fracture toughness
1. **Rejuvenation Procedures to Recover Creep Properties of Nickel-Base Superalloys by Heat Treatment and Hot Isostatic Pressing Techniques**
   Baldan, A.
   **Key Words:** IN-100, Nimonic 80A, Nimonic 115, Nimonic 75, Nimonic 105, Nimonic 90, IN-738, IN-738LC, Inconel X-750, turbine components, creep, grain size, cavitation

2. **Assessment of Service Induced Microstructural Damage and Its Rejuvenation in Turbine Blades**
   Koul, A. K., Castillo, R.
   Metall Trans 19a (8), 2049-66, 1988 (AD-D139 440)
   **Key Words:** IN-738LC, turbine components, microstructure, grain boundaries, fractography, degradation, service life, rejuvenation, creep properties

3. **Rejuvenation of Service-Exposed IN 738 Turbine Blades**
   Koul, A.K., Immarigeon, J-P, Castillo, R., Lowden, P., Liburdi, J.
   The Metallurgical Society of AIME, Warrendale, PA
   Proc 6th Int Symp Superalloys 1988 755-64, 1988 (AD-D142 328)
   **Key Words:** IN-738, turbine components, rejuvenation, service life, aluminide coatings, creep rupture

4. **The Effect of Service Exposure on the Creep Properties of Cast IN-738LC Subjected to Low Stress High Temperature Creep Conditions**
   Castillo, R., Koul, A.K., Immarigeon, J-P.A.
   The Metallurgical Society of AIME, Warrendale, PA
   Proc 6th Int Symp Superalloys 1988 805-14, 1988 (AD-D142 331)
   **Key Words:** IN-738LC, turbine components, grain boundaries, fracture, creep rupture, stress cracking

5. **Mechanical Properties of Conventionally Cast, Directionally Solidified, and Single-Crystal Superalloys**
   Quested, P. N., Osgerby, S.
   Mater Sci Technol 2 (5), 461-75, 1986 (AD-D140 385)
   **Key Words:** IN-935, IN-738, IN-939, IN-597, IN-738LC, MAR-M246, MAR-M002, MAR-M247, Alloy 713LC, unidirectional solidification, creep

6. **Creep Dominated Damage Processes**
   Hoffelner, W.
   Kluwer Academic Publishers, Norwell, MA
   Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1 413-39, 1986 (AD-D142 074)
   **Key Words:** Incoloy 800H, IN-738LC, IN-939, microstructure, creep, corrosive environment

7. **Fatigue Dominated Damage Processes**
   Bressers, J., Remy, L., Hoffelner, W.
   Kluwer Academic Publishers, Norwell, MA
   Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1 441-68, 1986 (AD-D142 075)
   **Key Words:** MAR-M509, IN-738LC, Hastelloy X, Inconel 617, RA-333, A-286, Inconel 718, Incoloy 901, microstructure, cracking, granular fracture, fatigue
8. Effect of Fabrication and Repair Procedures on the Performance of IN 738 LC and IN 939
Esser, W., McLean, M., Schneider, K.
Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1
593-622, 1986 (AD-D142 076)
Key Words: IN-738LC, IN-939, turbine components, welding, gas tungsten arc welding, electron beam welding, creep rupture strength, hot corrosion, welding, tensile properties, fatigue

9. The Behavior of Nimonic 105 and IN 738 LC Under Creep and LCF Testing
Persson, P-O., Persson, C., Burman, G., Lindblom, Y.
Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 2
1501-15, 1986 (AD-D142 159)
Key Words: Nimonic 105, IN-738LC, fatigue strain, creep

10. Hot Isostatic Press
Author Anon, Foreign Technology Division, Wright-Patterson AFB, OH
Rept No: FTD-ID(RS)T-1406-84, 65 pp., 1985 (AD-B093 100L)
Key Words: Ti-6Al-4V, B-1900, IN-738, RENE’ 77, IN-792, RENE’ 80, AA C355, AA A356, 142-T4

11. Experience with Repair of Stationary Gas-Turbine Blades--View of a Turbine Manufacturer
Schneider, K., Jahnke, B., Burgel, R., Ellner, J.
Mater Sci Technol 1 (8), 613-9, 1985 (AD-D133 816)
Key Words: IN-738LC, turbine components, repairs, brazing, welding, microstructure, microcracking, oxidation, silicide coatings, fatigue, creep rupture

12. Refurbishing Procedures for Blades of Large Stationary Gas Turbines
Keinenburg, K-H., Esser, W., Deblon, B.
Mater Sci Technol 1 (8), 620-8, 1985 (AD-D133 817)
Key Words: IN-738LC, Nimonic 80A, Udimet 520, turbine components, repair technique, corrosion, erosion, fatigue, tensile properties, tungsten arc welding

13. Creep Life Predictions in Nickel-based Superalloys
Koul, A. K., Castillo, R., Willett, K.
Mater Sci Eng 66 (2), 213-26, 1984 (AD-D131 247)
Key Words: MAR-M200, IN-738LC, Inconel X-750, turbine components, deformation, grain size, long term tests, shear stress

14. Effects of Trace Elements on Mechanical Properties of Superalloys
McLean, M., Strang, A., Met Technol 11 (10), 454-64, 1984 (AD-D131 862)
Key Words: IN-100, MAR-M002, IN-738, IN-939, IN-718, Inconel X-750, grain boundaries, porosity, creep rupture

15. Problems and Possibilities for Life Extension in Gas Turbine Components
Koul, A. K., Wallace, W., Thamburaj, R.
National Aeronautical Establishment, Structures and Materials Section
Proc Propulsion and Energetics 63rd (B) Specialists’ Meeting on Engine Cyclic Durability by Analysis and Testing, Lisse, Netherlands
10-1 to 10-32, 1984 (AD-D132 383)
Key Words: Inconel X-750, IN-738LC, Udimet 700, IN-100, Incoloy 901, turbine components, damage tolerance, EDM, creep, machining

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Burke, M. A., Beck, C. G., Jr., Crombie, E. A.
The Metallurgical Society of AIME, Warrendale, PA
Proc 5th Int Symp Superalloys 1984 63-71, 1984 ( AD-D132 827 )
Key Words: IN-738LC, microstructure, crack propagation, fatigue, unidirectional solidification

17. Assessment of Damage Accumulation and Property Regeneration by Hot Isostatic Pressing and Heat Treatment of Laboratory-Tested and Service Exposed IN738LC
McLean, M., Tipler, H. R.
The Metallurgical Society of AIME, Warrendale, PA
Proc 5th Int Symp Superalloys 1984 73-82, 1984 ( AD-D132 828 )
Key Words: IN-738LC, turbine components, microstructure, stress intensity

18. Comparison of Property Regeneration Techniques and Life Prediction Procedures Applied to Laboratory Tested and Service Exposed Ni-Cr Alloys
McLean, M., Peck, M. S.
Final Report
Rept No: NPL-DMA-A-91, 48 pp., 1984 ( AD-D134 696 )
Key Words: IN-738LC, turbine components, crystallography, creep, heat treatment, rupture

19. Improvement of Material Properties of Ni-Base Alloy Investment Castings by Hot Isostatic Processing
Tsuji, I., Kawai, H.
NTIS, PB84-113422, Springfield, VA
Technical Report
Rept No: MTB-159, 8 pp., 1983 ( AD-D130 515 )
Key Words: IN-738, IN-738LC, Udimet 500, Alloy 713C, turbine components, fatigue

20. Rejuvenation of Used Turbine Blades by Hot Isostatic Pressing and Reheat Treatment
Cheung, K. L., Leach, C. C., Willett, K. P., Koul, A. K.
Westinghouse Canada Ltd., Hamilton, Ontario, Canada
Proc 53rd Meeting of the AGARD Structures and Materials Panel, Maintenance in Service of High Temperature Parts
10-1 to 10-6, 1982 ( AD-D125 467 )
Key Words: inconel X-750, IN-738, Nimonic 115, Nimonic 105, Inconel 700, turbine components, microstructure, rejuvenation, creep

21. HIP Processing--Potentials and Applications
Van Der Vet, W. J.
Chromalloy American Co., Midwest City, OK
Proc 53rd Meeting of the AGARD Structures and Materials Panel, Maintenance in Service of High Temperature Parts
11-1 to 11-16, 1982 ( AD-D125 468 )
Key Words: Inconel X-750, Udimet 500, RENÉ 100, B-1900, Nimonic 105, IN-738, IN-782, turbine components, fatigue, thermal cycling, creep rupture

22. Regeneration of the Creep Properties of a Cast Ni-Cr-Base Alloy
Tipler, H. R.
National Physical Lab, Teddington, UK
Proc 53rd Meeting of the AGARD Structures and Materials Panel, Maintenance in Service of High Temperature Parts
12-1 to 12-6, 1982 ( AD-D125 469 )
Key Words: IN-738LC, creep, tensile properties, rejuvenation
23. **High-Temperature Electron Beam Welding of the Nickel-Base Superalloy IN-738LC**

Jahnke, B.

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**Key Words:** IN-738LC, turbine components, microstructure, hot cracking, tensile properties, fatigue

24. **Hipping is One Way to Check Porosity in Cast Components**

Irving, R. R.

Iron Age 225 (33), 43-5, 1982 (AD-D126 241)

**Key Words:** AA A201, AISI 4330, AA C355-T6, 142-T4, AA A356-T61, IN-738, RENE’ 77, IN-792, RENE’ 80, stainless steel, porosity, tensile properties, fatigue

25. **Scope for Repair Welding Gas Turbine Blades**

Eisner, W.

Pract Metall 19 (4), 199-214, 1982 (AD-D126 799)

**Key Words:** IN-738LC, Nimonic 90, Nimonic 105, Udimet 520, turbine components, microstructure, tensile properties, welding

26. **Development of Hybrid Gas Turbine Bucket Technology**

Peterson, L. G., Gracccecin, D. E., Schilling, W. F., Ostergren, W. J.

General Electric Co., Gas Turbine Division, Schenectady, NY

Technical Paper

Rept No : ASME-82-GT-94, 10 pp., 1982 (AD-D127 264)

**Key Words:** RENE’ 00, RENE’ 150, Udimet 700, MAR-M200, IN-939, RENE’ 125, RENE’ 120, GTD-111, IN-738, turbine components, tensile properties, unidirectional solidification, dissimilar joining, diffusion bonding, creep rupture

27. **High Cyclic Fatigue Properties of Cast Nickel Base Superalloys IN 738LC and IN 939**

Schneider, K., Gnirrs, G., McColvin, G.

Kluwer Boston Inc., Hingham, MA

Proc Conf High Temperature Alloys for Gas Turbines 319-44, 1982 (AD-D133 996)

**Key Words:** IN-738C, IN-939, grain size, porosity, particle size, fatigue

28. **Mechanisms of High Cycle Fatigue of Cast Nickel Base Alloys**

Schneider, K., Gnirrs, G., Truck, B., Arnim, G. V.

Kluwer Boston Inc., Hingham, MA

Proc Conf High Temperature Alloys for Gas Turbines 685-701, 1982 (AD-D134 014)

**Key Words:** IN-738LC, IN-939, grain refinement, crack initiation, fatigue life

29. **Hipping: A Good Way to Improve Properties**

Irving, R. R.

Iron Age 224 (6), 77-81, 1981 (AD-D120 406)

**Key Words:** JT-9D, MEP-L 76, 17-4PH, RENE’ 120, IN-792, IN-738, turbine components, porosity

30. **Long Term Materials Test Program: Materials Evaluation—Improved Simulation Tests**


General Electric Co., Energy Systems Programs Department, Schenectady, NY

Technical Report

Rept No : DE82-000649, 54 pp., 1981 (AD-D125 182)

**Key Words:** FSX-414, IN-738, GTD-111, turbine components, coatings, erosion, hot corrosion
31. European Concerted Action COST 50--Materials for Gas Turbines UK17--An Investigation of the Creep Fracture Process in a Cast Ni-Cr Base Alloy, IN738LC
Tipler, H. R., Peck, M. S.
NTIS, PB83-212787, Springfield, VA
Final Rept Round Two
Rept No.: NPL-DMA-A-33, 118 pp., 1981 (AD-D128 455)
Key Words: IN-738LC, turbine components, cracking, porosity, creep rupture, tensile properties

32. Heat Treatment of Hot Isostatically Processed IN-738 Investment Castings
Beddoes, J. C., Wallare, W.
Metall 13 (2), 185-94, 1980 (AD-D118 440)
Key Words: IN-738, turbine components, creep rupture twinning, heat treatment

33. Cutting Metal Loss Tied to Near Net Shapes
Harvey, R. E.
Iron Age 222 (42), 57-63, 1979 (AD-D116 853)
Key Words: RENE', 77, IN-738, IN-792, AA C355-T6, AA A356-T61, 142-T6, net shape forming, fatigue, tensile properties

34. Hot Isostatic Processing of IN-738 Turbine Blades
Van Drunen, G., Liburdi, J., Wallace, W., Terada, T.
Westinghouse Canada Ltd. Hamilton (Ontario) turbine and Generator Div
Proc 47th Meeting of the AGARD Structures and Materials Panel, Advanced Fabrication Processes
Rept No.: AGARD-CP-256, 13-1 to 13-12, 1979 (AD-D117 188)
Key Words: IN-738, turbine components, creep rupture, tensile properties, fatigue, Larson-Miller curves, thermal cycling

35. Damage Accumulation and Fracture in Creep of Nickel-Base Alloys
Tipler, H. R., Lindblom, Y., Davidson, J. G.
Applied Sciences Publishers Ltd., London, UK
Key Words: IN-597, Nimonic 115, IN-738LC, Nimonic 80A, MAR-M200, Udiment 500, Udiment 710, Udiment 720, turbine components, microstructure, grain boundaries, cracking, creep properties, fatigue, thermal fatigue, cavitation corrosion

36. Quality of Castings of Superalloys
Bachelet, E., Lesoult, G.
Applied Sciences Publishers Ltd., London, UK
High Temperature Alloys for Gas Turbines 665-99, 1978 (AD-D116 360)
Key Words: IN-738, Udiment 500, X-40, IN-100, MC-102, M3608F, C263, mto-001, B1914, B1981, M-21, FSX-430, MAR-M509, IN-939, Alloy 713LC, creep properties, fatigue, crack growth, thermal fatigue, porosity

37. High Cycle Fatigue of Nickel-Base Alloys-European Concerted Action--Cost 50-Materials for Gas Turbines, Project UK8
McColvin, G. M.
NTIS, N79-18022, Springfield, VA
Final Report
Rept No.: N79-18022, T.R. 2977, 99 pp., 1977 (AD-D115 653)
Key Words: Incoloy 901, IN-738, Nimonic 90, Nimonic 115, Inconel 718, fatigue, tensile properties, creep rupture, grain size
38. **Premium Quality Castings**
Freeman Jr., W. R.
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
Proc Net Shape Metalworking Program Review 406-17, 1976 (AD-D119 187L)
**Key Words:** IN-792, IN-738, IN-100, RENE’ 80, Alloy 713L, Alloy 713LC, B-1900, MAR-M200, tensile properties, fatigue

39. **Improved Properties in Castings by Hot Isostatic Pressing**
Glenn, G. M.
SAMPE Qtrly 8 (1), 1-9, 1976 (AD-D107 893)
**Key Words:** IN-738, RENE’ 80, RENE’ 120, RENE’ 77, Ti-6Al-4V, AA A356, AA C355, porosity, tensile properties, microstructure, creep rupture, density, fatigue

40. **Processing: The Rediscovered Dimension in High Temperature Alloys**
Semchyshen, M.
Standardization News 4 (4), 9-19, 1976 (AD-D110 676)
**Key Words:** Inconel 718, RENE’ 80, AISI 4140, Udimet 700, TZM, IN-738, Waspaloy, remelting, alloying, creep rupture

41. **Materials and Processing Technology for Advanced Gas Turbines**
Hauser, H. A.
SAMPE Qtrly 6 (3), 8 pp., 1975 (AD-D101 035)
**Key Words:** TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Ti-8Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900, MAR-M200, turbine components, fracture mechanics, fatigue, creep rupture

42. **Improvement of Nuclear Reactor Component Materials by Application of Hot Isostatic Processing (HIP)**
Mueller, J. J.
Electric Power Research Inst, Palo Alto, CA
Phase One Survey Report
Rept No: EPRI-500-1, PB-250952, 64 pp., 1975 (AD-D107 180)
**Key Words:** Ti-6Al-4V, AA A356-T61, RENE’ 95, IN-738, IN-792, RENE’ 77, RENE’ 80, nuclear reactor, turbine components, tensile properties, fatigue, creep rupture, cladding, defects

43. **Study of Superalloys Produced via Powder Metallurgy**
Heliner, L., Johansson, H.
NTIS, N77-13210, Springfield, VA
Final Report
Rept No: N77-13210, 56 pp., 1975 (AD-D109 492)
**Key Words:** X-40, MAR-M509, IN-738, dispersion hardening, cracking, microstructure, temperature effect, deformation, stress intensity, tensile properties

**IN-792**

1. **Hot Isostatic Press**
Author Anon
Foreign Technology Division, Wright-Patterson AFB, OH
Rept No: FTD-II(RS)T-1406-84, 65 pp., 1985 (AD-B093 100L)
**Key Words:** Ti-6Al-4V, B-1900, IN-738, RENE’ 77, IN-792, RENE’ 80, AA C355, AA A356, 142-T4
2. **Polycrystalline Grain Controlled Castings for Rotating Compressor and Turbine Components**
   Ewing, B. A., Green, K. A.
   The Metallurgical Society of AIME, Warrendale, PA
   Proc 5th Int Symp Superalloys 1984 33-42, 1984 (AD-D132 824)
   **Key Words:** Microcast X, IN-792, MAR-M247, AF-95, turbine components, microstructure, tensile properties, creep rupture

3. **Hipping is One Way to Check Porosity in Cast Components**
   Irving, R. R.
   Iron Age 225 (33), 43-5, 1982 (AD-D129 241)
   **Key Words:** AA A201, AISI 4330, AA C355-T6, 142-T4, AA A356-T61, IN-738, RENE’ 77, IN-792, RENE’ 80, stainless steel, porosity, tensile properties, fatigue

4. **Hipping: A Good Way to Improve Properties**
   Irving, R. R.
   Iron Age 224 (6), 77-81, 1981 (AD-D120 406)
   **Key Words:** JT-9D, MERL 76, 17-4PH, RENE’ 120, IN-792, IN-738, turbine components, porosity

5. **Applications of Composite Gas Turbine Components**
   General Electric Co., Gas Turbine Division, Schenectady, NY
   Semi-Annual Technical Progress Rept-Phase I
   Rept No: DE82-004710, 30 pp., 1981 (AD-D125 782)
   **Key Words:** MAR-M200, Udimet 700, IN-792, turbine components, tensile properties, creep, fatigue, diffusion bonding, unidirectional solidification

6. **A Solid-to-Solid HIP Bond Pressing Concept for the Manufacturing of Dual-Property Turbine-Wheels for Small Gas Turbines**
   Ewing, B. A.
   ASM International, Metals Park, OH
   Proc 4th Int Symp Superalloys, Superalloys 1980 169-78, 1980 (AD-D120 647)
   **Key Words:** MAR-M246, IN-792, turbine components, net shape forming, diffusion bonding, dissimilar joining, tensile properties, thermal fatigue

7. **HIP’ing Various Precision Cast Engine Components in Nickel-Based Superalloys**
   Lamberigts, M., Diderrich, E., Coutouradis, D., de Lamotte, E., Drapier, J. M.
   **Key Words:** Alloy 713LC, IN-792, MAR-M002, MAR-M004, IN-100, jet engines, turbine components, creep, microstructure

8. **Cutting Metal Loss Tied to Near Net Shapes**
   Harvey, R. E.
   Iron Age 222 (42), 57-63, 1979 (AD-D116 853)
   **Key Words:** RENE’ 77, IN-738, IN-792, AA C355-T6, AA A356-T61, 142-T6, net shape forming, fatigue, tensile properties

9. **HIP, the Great Healer of Castings**
   Bittence, J. C.
   Mater Eng 88 (4), 54-7, 1978 (AD-D113 844)
   **Key Words:** Inconel 718, IN-792, Ti-6Al-4V, 17-4PH, AA A357, porosity, fatigue, creep properties, deformation, cost
10. **HIP'ing Raises Casting Performance Levels**
Freeman, W. R., Jr., Metal Prog 112 (3), 33-8, 1977 (AD-D110 513)
**Key Words:** B-1900, IN-792, Ti-6Al-4V, IN-100, tensile properties, turbine components, fatigue, creep rupture

11. **Premium Quality Castings**
Freeman Jr., W. R.
Manufacturing Technology Division, AFB, Wright-Patterson AFB, OH
Proc Net Shape Metalworking Program Review 406-17, 1976 (AD-D119 187)
**Key Words:** IN-792, IN-738, IN-100, RENE’ 80, Alloy 713L, Alloy 713LC, B-1900, MAR-M200, tensile properties, fatigue

12. **Materials and Processing Technology for Advanced Gas Turbines**
Hauser, H. A., SAMPE Qtrly 6 (3), 8 pp., 1975 (AD-D101 035)
**Key Words:** TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900, MAR-M200, turbine components, fracture mechanics, fatigue, creep rupture

13. **Improvement of Nuclear Reactor Component Materials by Application of Hot Isostatic Processing (HIP)**
Mueller, J. J., Electric Power Research Inst, Palo Alto, CA
Phase One Survey Report
Rept No.: EPRI-500-1, PB-250952, 64 pp., 1975 (AD-D107 180)
**Key Words:** Ti-6Al-4V, AA A356-T61, RENE’ 95, IN-738, IN-792, RENE’ 77, RENE’ 80, nuclear reactor, turbine components, tensile properties, fatigue, creep rupture, cladding, defects

**IN-939**

1. **Mechanical Properties of Conventionally Cast, Directionally Solidified, and Single-Crystal Superalloys**
Quested, P. N., Osgerby, S.
Mater Sci Technol 2 (5), 461-75, 1986 (AD-D140 385)
**Key Words:** IN-935, IN-738, IN-939, IN-597, IN-738LC, MAR-M246, MAR-M002, MAR-M247, Alloy 713LC, unidirectional solidification, creep

2. **Creep Dominated Damage Processes**
Hoffelner, W., Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1 413-39, 1986 (AD-D142 074)
**Key Words:** Incoloy 800H, IN-738LC, IN-939, microstructure, creep, corrosive environment

3. **Effect of Fabrication and Repair Procedures on the Performance of IN 738 LC and IN 939**
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Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1 593-622, 1986 (AD-D142 076)
**Key Words:** IN-738LC, IN-939, turbine components, welding, gas tungsten arc welding, electron beam welding, creep rupture strength, hot corrosion, welding, tensile properties, fatigue
4. Effects of Trace Elements on Mechanical Properties of Superalloys
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Key Words: IN-100, MAR-M002, IN-738, IN-939, 11-718, Inconel X-750, grain boundaries, porosity, creep rupture

5. Development of Hybrid Gas Turbine Bucket Technology
Peterson, L. G., Hrencecin, D. E., Schilling, W. F., Ostergren, W. J.
General Electric Co., Gas Turbine Division, Schenectady, NY
Rept No: ASME-82-GT-94, 10 pp., 1982 (AD-D127 264)
Key Words: RENE' 80, RENE' 150, Udimet 700, MAR-M200, IN-939, RENE' 125, RENE' 120, GTD-111, IN-738, turbine components, tensile properties, unidirectional solidification, dissimilar joining, diffusion bonding, creep rupture

6. High Cycle Fatigue Properties of Cast Nickel Base Superalloys IN 738LC and IN 939
Schneider, K., Gnirrs, G., McColvin, G.
Kluwer Boston Inc., Hingham, MA
Proc Conf High Temperature Alloys for Gas Turbines 319-44, 1982 (AD-D133 996)
Key Words: IN-738C, IN-939, grain size, porosity, particle size, fatigue

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Schneider, K., Gnirrs, G., Truck, B., Armin, G. V.
Kluwer Boston Inc., Hingham, MA
Proc Conf High Temperature Alloys for Gas Turbines 685-701, 1982 (AD-D134 014)
Key Words: IN-738LC, IN-939, grain refinement, crack initiation, fatigue life

8. Quality of Castings of Superalloys
High Temperature Alloys for Gas Turbines 665-99, 1978 (AD-D116 360)
Key Words: IN-738, Udimet 500, X-40, IN-100, MC-102, M3608F, C263, mto-001, B1914, B1981, M-21, FSX-430, MAR-M509, IN-939, Alloy 713LC, creep properties, fatigue, crack growth, thermal fatigue, porosity

Incoloy 901

1. Fatigue Dominated Damage Processes
Bressers, J., Remy, L., Hoffelner, W.
Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1 441-68, 1986 (AD-D142 075)
Key Words: MAR-M509, IN-738LC, Hastelloy X, Inconel 617, RA-333, A-286, Inconel 718, Incoloy 901, microstructure, cracking, granular fracture, fatigue

2. Problems and Possibilities for Life Extension in Gas Turbine Components
Koul, A. K., Wallace, W., Thamburaj, R.
National Aeronautical Establishment, Structures and Materials Section
Proc Propulsion and Energetics 63rd (B) Specialists' Meeting on Engine Cyclic Durability by Analysis and Testing, Lisse, Netherlands 10-1 to 10-32, 1984 (AD-D132 383)
Key Words: Inconel X-750, IN-738LC, Udimet 700, IN-100, Incoloy 901, turbine components, damage tolerance, EDM, creep, machining
3. **Materials for Advanced Turbine Engine--MATE**
   Evans, D. J., Sheffler, K. D., Friedrich, L. A.
   Pratt and Whitney Aircraft Group, East Hartford, CT
   Contract No: NAS 3-20072, 1982, 21 pp. (AD-D125 191)
   **Key Words:** Hastelloy X, Incoloy 901, MA956, Udimet 700, MERL 76, turbine components, combustors, erosion, coatings, oxide dispersion strengthening

4. **Materials for Advanced Turbine Engine-MATE**
   Evans, D. J., Henricks, R. J., Friedrich, L. A.
   Pratt and Whitney Aircraft Group, Commercial Products Div. East Hartford, CT
   Quarterly Technical Progress Report Number Twenty, Dec 80-Feb 81
   Contract No: NAS 3-20072, 48 pp., 1981 (AD-D120 953)
   **Key Words:** MERL 76, MA956, Hastelloy X, Incoloy 901, aircraft structures, combustor liners, turbine components, tensile properties, creep, crack growth, coatings, thermal fatigue

5. **Aircraft Gas Turbine Materials and Processes**
   Kear, B. H., Thompson, E. R.
   Science 208 (4446), 847-56, 1980 (AD-D126 322)
   **Key Words:** Haynes 188, Inconel 617, HA8077, Waspaloy, B-1900, PWA 1422, Incoloy 901, IN-100, X-40, MAR-M509, Hastelloy X, turbine components, fan blades, compressor components, coatings, unidirectional solidification, superplastic forming

6. **High Cycle Fatigue of Nickel-Base Alloys-European Concerted Action--Cost 50-Materials for Gas Turbines, Project UK8**
   McColvin, G. M.
   NTIS, N79-18022, Springfield, VA
   **Key Words:** Incoloy 901, IN-738, Nimonic 90, Nimonic 115, Inconel 718, fatigue, tensile properties, creep rupture, grain size

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**Inconel 625**

1. **Cast 625 Hot Isostatic Pressing (HIP) Parameters - a Statistically Designed Study**
   Carlson, R. G.
   TMS, Warrendale, PA
   **Key Words:** Inconel 625, tensile properties, computer model, defects

2. **Severe Sour Gas Service Performance of HIP-Clad Alloy 625**
   Bednarowicz, T. A., Byrd, J. D., Raymond, E. L., Bunch, P. D.
   Materials Performance 28 (1), 59-63, 1989 (AD-D140 727)
   **Key Words:** Inconel 625, corrosive medium, sour gas wells

3. **Repair Techniques for Gas Turbine Components**
   Liburdi, J.
   Liburdi Engineering Ltd. Burlington, Ontario, Canada
   Proc 61st Meeting of the AGARD Structures and Materials Panel, Advanced Joining of Aerospace Metallic Materials
   Rept No: AGARD-CP-398, 22-1 to 22-12, 1985 (AD-D139 985)
   **Key Words:** Inconel X-750, Inconel 625, Udimet 500, Inconel 700, diffusion brazing, vacuum deposition, tensile properties, creep rupture
4. Progress of Powder Metallurgy in North America
Roll, K.H., Johnson, P.K.
Key Words: copper, iron, Inconel 625, AISI 316L, M-2, NiFe, rapid solidification, injection molding

Inconel 718

1. The Effect of Laves Phase on the Mechanical Properties of Wrought and Cast + HIP Inconel 718
Schirra, J. J., Caless, R. H., Hatala, R. W., TMS, Warrendale, PA
Key Words: Inconel 718, tensile properties, microstructure, fracture toughness, impact toughness, fatigue, cracking

2. An Evaluation of the Effects of Filler Metal Composition on Cast Alloy 718 Simulated Repair Welds
Kelly, T. J., Cremisio, W. H., Simon, W. H.
Weld J 68 (1), 14-s to 18-s, 1989 (AD-D140 251)
Key Words: Inconel 718, microstructure, HAZ, welding, fatigue

3. Elemental Effects on Cast 718 Weldability
Kelly, T. J., Weld J 68 (2), 44-s to 51-s, 1989 (AD-D140 721)
Key Words: Inconel 718, turbine components, microstructure, tensile properties, rupture strength, welding

4. Near-Threshold Crack Growth in Nickel-Base Superalloys
Van Stone, R. H., Krueger, D. D., ASTM, Philadelphia, PA
Key Words: RENE' 95, Inconel 718, microstructure, grain size, fatigue crack growth, tensile properties

5. Microstructure and Properties of Ni-Fe Base Ta-718
Loewenkamp, S.A., Radavich, J.F., Kelly, T.
The Metallurgical Society of AIME, Warrendale, PA
Key Words: Inconel 718, microstructure, tensile properties creep rupture

6. Effect of HIP Parameters on Fine Grain Cast Alloy 718
Siereveld, P., Radavich, J.F., Kelly, T., Cole, G., Widmer, R.
The Metallurgical Society of AIME, Warrendale, PA
Key Words: Inconel 718, microscopy, grain growth, porosity, heat treating, tensile properties

7. Effects of Thermal and Thermo-Mechanical Treatments on the Mechanical Properties of Centrifugally Cast Alloy 718
Michel, D. J., Smith, H. H., Naval Research Lab, Washington DC
Rept No: NRL-MR-6101, 22 pp., 1987 (AD-A188 195)
Key Words: Inconel 718, fatigue, crack growth, creep rupture microstructure, crystallography, brittle fracture, aging, thermomechanical treatment, homogenizing
8. **The Role of Hot Isostatic Pressing--Now and in the Future**
   Widmer, R.
   ASM International, Metals Park, OH
   Proc Nicholas J. Grant Symp, Processing and Properties of Advanced High Temperature Alloys, 105-16, 1986 ( AD-D139 357 )
   **Key Words:** Udiment 700, Inconel 718, densification, fatigue, creep rupture

9. **Fatigue Dominated Damage Processes**
   Bressers, J., Remy, L., Hoffelner, W.
   Kluwer Academic Publishers, Norwell, MA
   Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1 441-68, 1986 ( AD-D142 075 )
   **Key Words:** MAR-M509, IN-738LC, Hastelloy X, Inconel 617, RA-333, A-286, Inconel 718, Incoloy 901, microstructure, cracking, granular fracture, fatigue

10. **Effects of Trace Elements on Mechanical Properties of Superalloys**
    McLean, M., Strang, A.
    Met Technol 11 (10), 454-64, 1984 ( AD-D131 862 )
    **Key Words:** IN-100, MAR-M002, IN-738, IN-939, IN-718, Inconel X-750, grain boundaries, porosity, creep rupture

11. **Fatigue Growth of Surface Cracks in Nickel-Based Superalloys**
    Brown, C. W., Hicks, M. A.
    Int J Fatigue 4 (2), 73-81, 1982 ( AD-D124 743 )
    **Key Words:** Inconel X-750, Inconel 718, turbine components, microstructure, grain size, crack growth, fatigue, tensile properties

12. **Hot Isostatic Pressing of Alloy IN-718**
    Lamberigts, M., Herman, C., Louis, P., Wallemacq, J. P., Drapier, J. M.
    Kluwer Boston Inc., Hingham, MA
    Proc Conf High Temperature Alloys for Gas Turbines 999-1011, 1982 ( AD-D134 030 )
    **Key Words:** Inconel 718, turbine components, welding, tensile properties, creep rupture

13. **Healing Defects by HIP**
    Dreger, D. R.
    Mach Des 53 (12), 79-85, 1981 ( AD-D121 264 )
    **Key Words:** Inconel 718, porosity, welding, cracking, fatigue, creep, tensile properties

14. **Use of a d-c Potential Drop Crack Monitoring Technique in the Development of Defect Tolerant Disk Alloys**
    Van Stone, R. H., Krueger, D. D., Duvelius, L. T.
    ASTM, Philadelphia, PA
    Proc 14th National Symp Fracture Mechanics 2, 553-78, 1981 ( AD-D128 740 )
    **Key Words:** RENE' 95, Inconel 718, turbine components, microstructure, tensile properties, crack growth, fatigue

15. **Process Optimization of Cast Alloy 718 for Water Cooled Gas Turbine Application**
    Bouse, G. K., Schilke, P. W.
    ASM International, Metals Park, OH
    Proc 4th Int Symp Superalloys, Superalloys 1980 303-10, 1980 ( AD-D120 660 )
    **Key Words:** Inconel 718, turbine components, dislocation structure, homogenizing, tensile properties
16. **New Method for Cast Superalloy Frames**  
Schweikert, W. H., Bailey, P. G.  
**Key Words:** Inconel 718, turbine components, fatigue, microstructure, welding, chemical milling

17. **Investigation of Rejuvenation of Fatigue Damage in IN-718**  
Clauer, A. H., Leis, B. N., Hoover, G., Seifert, D. A.  
Battelle Memorial Institute, Columbus, OH  
Final Report  
Rept No.: AFML-TR-78-90, 115 pp., 1978 (AD-A068 333)  
**Key Words:** IN-718, microstructure, rejuvenation, fatigue, tensile properties

18. **HIP, the Great Healer of Castings**  
Bittence, J. C.  
Mater Eng 88 (4), 54-7, 1978 (AD-D113 844)  
**Key Words:** Inconel 718, IN-792, Ti-6Al-4V, 17-4PH, AA A357, porosity, fatigue, creep properties, deformation, cost

19. **Original HCl Surface Treatment for Diffusion Bonding of Nickel Superalloy Specimens**  
Billard, D., Trottier, J. P.  
Met Technol 5 (9), 309-19, 1978 (AD-D114 028)  
**Key Words:** IN-100, Waspaloy, RENE' 95, Inconel 718, welding, grain size, bonding, recrystallization, temperature effect

20. **High Cycle Fatigue of Nickel-Base Alloys-European Concerted Action--Cost 50-Materials for Gas Turbines, Project UK8**  
McColvin, G. M.  
NTIS, N79-18022, Springfield, VA  
Final Report  
Rept No.: N79-18022, T.R. 2977, 99 pp., 1977 (AD-D115 653)  
**Key Words:** Incoloy 901, IN-738, Nimonic 90, Nimonic 115, Inconel 718, fatigue, tensile properties, creep rupture, grain size

21. **Superalloy Casting Process**  
Schweikert, W. H., Piwonka, T. S.  
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH  
Proc Net Shape Metalworking Program Review 93-116, 1976 (AD-D119 169L)  
**Key Words:** Inconel 718, forging, turbine components, tensile properties, fatigue

22. **High Integrity Casting Program**  
Schweikert, W. H.  
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH  
Proc Net Shape Metalworking Program Review 392-405, 1976 (AD-D119 186L)  
**Key Words:** Inconel 718, Ti-6Al-4V, 17-4PH, AA A357, tensile properties, nondestructive testing

23. **Processing: The Rediscovered Dimension in High Temperature Alloys**  
Semchyschen, M.  
Standardization News 4 (4), 9-19, 1976 (AD-D110 676)  
**Key Words:** Inconel 718, RENE' 80, AISI 4140, Udiment 700, TZM, IN-738, Waspaloy, remelting, alloying, creep rupture

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24. Precision Castings State-of-the-Art
Nagan, R. M., SAMPE Qtrly 6 (4), 1-7, 1975 (AD-D102 565)
Key Words: 17-4PH, Hastelloy X, Inconel 718, Ti-6Al-4V, aircraft structures, turbine components, tensile properties

25. Complex Rotor Fabrication by Hot Isostatic Pressure Welding
Lessman, G. G., Bryant, W. A.
Weld J 51 (12), 606s-614s, 1972 (AD-180 534)
Key Words: AISI 4340, Inconel 718, hardness, tensile properties

Inconel X-750

1. Rejuvenation Procedures to Recover Creep Properties of Nickel-Base Superalloys by Heat Treatment and Hot Isostatic Pressing Techniques
Key Words: IN-100, Nimonic 80A, Nimonic 115, Nimonic 75, Nimonic 105, Nimonic 90, IN-738, IN-738LC, Inconel X-750, turbine components, creep, grain size, cavitation

2. Repair Techniques for Gas Turbine Components
Liburdi, J., Liburdi Engineering Ltd. Burlington, Ontario, Canada
Proc 61st Meeting of the AGARD Structures and Materials Panel, Advanced Joining of Aerospace Metallic Materials
Rept No: AGARD-CP-398, 22-1 to 22-12, 1985 (AD-D139 985)
Key Words: Inconel X-750, Inconel 625, Udimet 500, Inconel 700, diffusion brazing, vacuum deposition, tensile properties, creep rupture

3. Creep Life Predictions in Nickel-based Superalloys
Koul, A. K., Castillo, R., Willett, K.
Mater Sci Eng 66 (2), 213-26, 1984 (AD-D131 247)
Key Words: MAR-M200, IN-738LC, Inconel X-750, turbine components, deformation, grain size, long term tests, shear stress

4. Effects of Trace Elements on Mechanical Properties of Superalloys
McLean, M., Strang, A., Met Technol 11 (10), 454-64, 1984 (AD-D131 862)
Key Words: IN-100, MAR-M002, IN-738, IN-939, IN-718, Inconel X-750, grain boundaries, porosity, creep rupture

5. Problems and Possibilities for Life Extension in Gas Turbine Components
Koul, A. K., Wallace, W., Thamburaj, R.
National Aeronautical Establishment, Structures and Materials Section
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10-1 to 10-32, 1984 (AD-D132 383)
Key Words: Inconel X-750, IN-738LC, Udimet 700, IN-100, Incoloy 901, turbine components, damage tolerance, EDM, creep, machining

6. Fatigue Growth of Surface Cracks in Nickel-Based Superalloys
Brown, C. W., Hicks, M. A.
Int J Fatigue 4 (2), 73-81, 1982 (AD-D124 743)
Key Words: Inconel X-750, Inconel 718, turbine components, microstructure, grain size, crack growth, fatigue, tensile properties
7. **Rejuvenation of Used Turbine Blades by Hot Isostatic Pressing and Reheat Treatment**  
Cheung, K. L., Leach, C. C., Willett, K. P., Koul, A. K.  
Westinghouse Canada Ltd., Hamilton, Ontario, Canada  
Proc 53rd Meeting of the AGARD Structures and Materials Panel, Maintenance in  
Service of High Temperature Parts  
10-1 to 10-6, 1982 (AD-D125 467)  
**Key Words:** Inconel X-750, IN-738, Nimonic 115, Nimonic 105, Inconel 700,  
turbine components, microstructure, rejuvenation, creep

8. **HIP Processing--Potentials and Applications**  
Van Der Vet, W. J.  
Chromalloy American Co., Midwest City, OK  
Proc 53rd Meeting of the AGARD Structures and Materials Panel, Maintenance in  
Service of High Temperature Parts  
11-1 to 11-16, 1982 (AD-D125 468)  
**Key Words:** Inconel X-750, Udiment 500, RENE' 100, B-1900, Nimonic 105, IN-738,  
IN-782, turbine components, fatigue, thermal cycling, creep rupture

**MAR-M002**

1. **Mechanical Properties of Conventionally Cast, Directionally Solidified, and  
Single-Crystal Superalloys**  
Quested, P. N., Osgerby, S.  
Mater Sci Technol 2 (5), 461-75, 1986 (AD-D140 385)  
**Key Words:** IN-935, IN-738, IN-939, IN-597, IN-738LC, MAR-M246, MAR-M002,  
MAR-M247, Alloy 713LC, unidirectional solidification, creep

2. **Effects of Trace Elements on Mechanical Properties of Superalloys**  
McLean, M., Strang, A.  
Met Technol 11 (10), 454-64, 1984 (AD-D131 862)  
**Key Words:** IN-100, MAR-M002, IN-738, IN-939, IN-718, Inconel X-750, grain  
boundaries, porosity, creep rupture

3. **Characterizations of Elevated Temperature Fatigue Crack Growth Rates**  
Crompton, J. S., Morley, S. A., Martin, J. W.  
The Metallurgical Society of AIME, Warrendale, PA  
Proc 5th Int Symp Superalloys 1984 761-9, 1984 (AD-D132 885)  
**Key Words:** MAR-M002, Nimonic AP1, unidirectional solidification, fatigue  
crack, stress relaxation

4. **The Effect of Hot Isostatic Pressing on the Creep and Fracture Behavior of the Cast  
Superalloy MAR-M002**  
Burt, H., Dennison, J. P., Elliott, I. C., Wilshire, B.  
Mater Sci Eng 53 (2), 245-50, 1982 (AD-D125 089)  
**Key Words:** MAR-M002, microstructure, porosity, cracking, surface defects,  
fracture mechanics, creep, ductility

5. **HIP'ing Various Precision Cast Engine Components in Nickel-Based Superalloys**  
Lamberigts, M., Diderrich, E., Costousourdias, D., de Lamotte, E., Drapier, J. M.  
**Key Words:** Alloy 713LC, IN-792, MAR-M002, MAR-M004, IN-100, jet engines,  
turbine components, creep, microstructure

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6. **Casting Conditions, Microstructure and Creep Properties of MAR-M-002 Blades**
Viator, P., Coutsouradis, D., Habraken, L., Drapier, J. M.
Applied Sciences Publishers Ltd., London, UK
Proc Conf High Temperature Alloys for Gas Turbines 875-91, 1978 (AD-D116 366)
**Key Words:** MAR-M002, turbine components, rotor blades, microstructure, porosity, grain boundaries, creep rupture, precipitation, segregation, thermomechanical treatment

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### MAR-M200

1. **Microstructural Damages Induced During the Repair Process**
Davin, A., Lecomte-Mertens, Ch., Vierset, P., Louis, P.
Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1
811-20, 1986 (AD-D142 085)
**Key Words:** Haynes 188, MAR-M200, X-40, turbine components, tensile properties, thermal shock, diffusion brazing, rejuvenation, repairs, welding

2. **Structural Damage and Rejuvenation of Used Turbine Blades**
Lamberigts, M., Lecomte-Mertens, Ch., Vierset, P.
Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 1
821-30, 1986 (AD-D142 086)
**Key Words:** MAR-M200, turbine components, microstructure, aging, rupture strength, service life, rejuvenation

3. **Creep Life Predictions in Nickel-based Superalloys**
Koul, A. K., Castillo, R., Willett, K.
Mater Sci Eng 66 (2), 213-26, 1984 (AD-D131 247)
**Key Words:** MAR-M200, IN-738LC, Inconel X-750, turbine components, deformation, grain size, long term tests, shear stress

4. **Development of Hybrid Gas Turbine Bucket Technology**
Peterson, L. G., Hrencecin, D. E., Schilling, W. F., Ostergren, W. J.
General Electric Co., Gas Turbine Division, Schenectady, NY
Rept No: ASME-82-GT-94, 10 pp., 1982 (AD-D127 264)
**Key Words:** RENE’ 80, RENE’ 150, Udimet 700, MAR-M200, IN-939, RENE’ 125, RENE’ 120, GTD-111, IN-738, turbine components, tensile properties, unidirectional solidification, dissimilar joining, diffusion bonding, creep rupture

5. **Superalloy Technology-Today and Tomorrow**
Ver Snyder, F. L., Kluwer Boston Inc., Hingham, MA
Proc Conf High Temperature Alloys for Gas Turbines 1-49, 1982 (AD-D133 988)
**Key Words:** MAR-M200, IN-100, Udimet 700, carbon addition, boron addition, zirconium addition, cobalt addition, turbine components, corrosion, oxidation, REP, creep rupture, thermal fatigue

6. **Precision Casting of Turbine Blades and Vanes**
Drapier, J. M., Kluwer Boston Inc., Hingham, MA
Proc Conf High Temperature Alloys for Gas Turbines 887-908, 1982 (AD-D134 025)
**Key Words:** Alloy 713LC, IN-100, MAR-M200, PWA 1480, MAR-M247, CMSX2, turbine components, rejuvenation, oxidation, vacuum melting, unidirectional solidification

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7. Applications of Composite Gas Turbine Components
General Electric Co., Gas Turbine Division, Schenectady, NY
Rept No: DE82-004710, 30 pp., 1981 (AD-D125 782)
**Key Words:** MAR-M200, Udimet 700, IN-792, turbine components, tensile properties, creep, fatigue, diffusion bonding, unidirectional solidification

8. HIP Rejuvenation of Damaged Blades
Stewart, D. C., Bennett, G. T.
Pratt and Whitney Aircraft Group, Government Products Div, West Palm Beach, FL
Interim Technical Report One and Two, Aug 77-Mar 79
Rept No: FR-11642, 115 pp., 1979 (AD-D108 398L)
**Key Words:** IN-100, MAR-M200, unidirectional solidification, creep properties, aluminides, PWA 73 coating, surface defects, rejuvenation

9. The Promise of more Heat Resistant Turbine Materials
Freche, J. C., Ault, G. M.
Prod Engineering 50 (7), 35-9, 1979 (AD-D115 942)
**Key Words:** AF 2-1DA, AF-115, NASA IIB-7, NASA IIB-11, MAR-M200, MA6000E, WAZ-D, WAZ20, IN-100, service life, creep rupture, tensile properties, coatings, corrosion, thermal fatigue, unidirectional solidification

10. Damage Accumulation and Fracture in Creep of Nickel-Base Alloys
Tipler, H. R., Lindblom, Y., Davidson, J. G.
Applied Sciences Publishers Ltd., London, UK
**Key Words:** IN-597, Nimonic 115, IN-738LC, Nimonic 80A, MAR-M200, Udimet 500, Udimet 710, Udimet 720, turbine components, microstructure, grain boundaries, cracking, creep properties, fatigue, thermal fatigue, cavitation corrosion

11. Coatings for Directionally Solidified Gamma Prime-Gamma Plus Alpha Eutectics
Smeggil, J.
United Technologies Research Center, East Hartford, CT
Rept No: R77-912959-1, 12 pp., 1977 (AD-D108 260)
**Key Words:** MAR-M200, hafnium addition, nickel aluminide coatings, CoCrAlY coatings, NiCoCrAlY coatings, platinum addition, thermal expansion, oxidation, sulfidation, unidirectional solidification

12. Premium Quality Castings
Freeman Jr., W. R.
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
Proc Net Shape Metalworking Program Review 406-17, 1976 (AD-D119 187L)
**Key Words:** IN-792, IN-738, IN-100, RENE' 80, Alloy 713L, Alloy 713LC, B-1900, MAR-M200, tensile properties, fatigue

Bisset, J. W.
United Technologies Corp., East Hartford, CT
Rept No: N77-14026, PWA-5453, 42 pp., 1976 (AD-D107 956)
**Key Words:** MAR-M509, Hastelloy X, Waspaloy, IN-100, MAR-M200, turbine components, single crystals, hafnium addition, unidirectional solidification, cost
14. Materials and Processing Technology for Advanced Gas Turbines
Hauser, H. A., SAMPE Qtrly 6 (3), 8 pp., 1975 (AD-D101 035)
Key Words: TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo,
Ti-8Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900,
MAR-M200, turbine components, fracture mechanics, fatigue,
creep rupture

MAR-M246

1. Advanced Single Crystal for SSME Turbopumps
Fritzemeier, L. G., Rockwell International, Rocketdyne Div, Canoga Park, CA
Contract No: NAS3-24646, 8 pp., 1988 (AD-D138 556)
Key Words: MAR-M246, fatigue, creep rupture, tensile properties

2. Mechanical Properties of Conventionally Cast, Directionally Solidified, and
Single-Crystal Superalloys
Quested, P. N., Osgerby, S.
Mater Sci Technol 2 (5), 461-75, 1986 (AD-D140 385)
Key Words: IN-935, IN-738, IN-939, IN-597, IN-738LC, MAR-M246, MAR-M002,
MAR-M247, Alloy 713LC, unidirectional solidification, creep

3. A Solid-to-Solid HIP Bond Pressing Concept for the Manufacturing of Dual-Property
Turbine-Wheels for Small Gas Turbines
Ewing, B. A., ASM International, Metals Park, OH
Proc 4th Int Symp Superalloys, Superalloys 1980 169-78, 1980 (AD-D120 647)
Key Words: MAR-M246, IN-792, turbine components, net shape forming, diffusion
bonding, dissimilar joining, tensile properties, thermal fatigue

4. The Metallurgical Aspects of Hot Isostatically Pressed Superalloy Castings
Antony, K. C., Radavich, J. F.
Key Words: Alloy 713C, MAR-M246, microstructure, porosity, tensile
properties, creep rupture, fatigue, fracture toughness

MAR-M247

1. Manufacturing Processes for Long-Life Gas Turbines
Hoppin, G. S., III, Danesi, W. P.
J Met 38 (7), 20-3, 1986 (AD-D136 463)
Key Words: MAR-M247, turbine components, diffusion bonding

2. Metallurgical Advancements in Investment Casting Technology
Dardi, L. E., Dalal, R. P., Yaker, C.
ASM International, Metals Park, OH
Proc Nicholas J. Grant Symp, Processing and Properties of Advanced High Temperature
Alloys 25-39, 1986 (AD-D139 354)
Key Words: MAR-M247, Ni-7Al-14Mo, Ti-6Al-4V, turbine components, fatigue
properties, unidirectional solidification
3. **Mechanical Properties of Conventionally Cast, Directionally Solidified, and Single-Crystal Superalloys**  
   Quested, P. N., Osgerby, S.  
   Mater Sci Technol 2 (5), 461-75, 1986 (AD-D140 385)  
   **Key Words:** IN-935, IN-738, IN-939, IN-597, IN-738LC, MAR-M246, MAR-M002, MAR-M247, Alloy 713LC, unidirectional solidification, creep

4. **Development of a Conventional Fine Grain Casting Process**  
   Wouds, M., Benson, H.  
   The Metallurgical Society of AIME, Warrendale, PA  
   Proc 5th Int Symp Superalloys 1984 3-12, 1984 (AD-D132 321)  
   **Key Words:** Alloy 713LC, MAR-M247, turbine components, microstructure, creep rupture, tensile properties, fatigue

5. **Polycrystalline Grain Controlled Castings for Rotating Compressor and Turbine Components**  
   Ewing, B. A., Green, K. A.  
   The Metallurgical Society of AIME, Warrendale, PA  
   Proc 5th Int Symp Superalloys 1984 33-42, 1984 (AD-D132 824)  
   **Key Words:** Microcast X, IN-792, MAR-M247, AF-95, turbine components, microstructure, tensile properties, creep rupture

6. **Properties of Cast MAR-M-247 for Turbine Blisk Applications**  
   Kaufman, M.  
   The Metallurgical Society of AIME, Warrendale, PA  
   Proc 5th Int Symp Superalloys 1984 43-52, 1984 (AD-D132 825)  
   **Key Words:** MAR-M247, turbine components, defects, crack growth, tensile properties, fatigue, threshold stress

7. **Precision Casting of Turbine Blades and Vanes**  
   Drapier, J. M.  
   Kluwer Boston Inc., Hingham, MA  
   Proc Conf High Temperature Alloys for Gas Turbines 887-908, 1982 (AD-D134 025)  
   **Key Words:** Alloy 713LC, IN-100, MAR-M200, PWA 1480, MAR-M247, CMSX2, turbine components, rejuvenation, oxidation, vacuum melting, unidirectional solidification

**MERL 76**

1. **Development of Gatorized(R) MERL 76 for Gas Turbine Disk Applications**  
   Caless, R. H., Paulonis, D. F.  
   The Metallurgical Society of AIME, Warrendale, PA  
   **Key Words:** MERL 76, turbine components, grain size, crack growth, tensile properties, flow stress, gatorizing, fatigue

2. **On the Sintered Ni-Base Superalloy (VI)--Effect of Microstructures on the Creep Property**  
   Morishita, M., Nagai, H., Shoji, K.  
   **Key Words:** IN-100, MERL 76, microstructure, swaging, creep rate, liquid sintering, creep rupture
3. **Overview of Temperature and Environmental Effects on Fatigue of Structural Metals**
   Coffin, L. F.
   Plenum Press, New York, NY
   Proc 27th Sagamore Army Materials Research Conf 1-40, 1983 (AD-D131 509)
   **Key Words:** RENE' 95, A-286, stainless steel, Udimet 700, Waspaloy, MERL 76, IN-100, NASA IIB-7, crack growth, fatigue

4. **Materials for Advanced Turbine Engine-MATE**
   Evans, D. J., Sheffler, K. D., Friedrich, L. A.
   Pratt and Whitney Aircraft Group, East Hartford, CT
   Mar-May 82
   Contract No: NAS 3-20072
   1982, 21 pp. (AD-D125 191)
   **Key Words:** Hastelloy X, Incoloy 901, MA956, Udimet 700, MERL 76, turbine components, combustors, erosion, coatings, oxide dispersion strengthening

5. **The Relationship Between Structure, Properties, and Processing in Powder Metallurgy Superalloys**
   Davidson, J. H., Aubin, C.
   Kluwer Boston Inc., Hingham, MA
   Proc Conf High Temperature Alloys for Gas Turbines 853-86, 1982 (AD-F134 024)
   **Key Words:** Udimet 700, Nimonic API, MERL 76, RENE' 95, turbine components, microstructure, crack propagation, fatigue, creep rupture, impact, thermomechanical treatment

6. **Hipping: A Good Way to Improve Properties**
   Irving, R. R.
   Iron Age 224 (6), 77-81, 1981 (AD-D120 406)
   **Key Words:** JT-9D, MERL 76, 17-4PH, RENE' 120, IN-792, IN-738, turbine components, porosity

7. **Materials for Advanced Turbine Engine-MATE**
   Evans, D. J., Henricks, R. J., Friedrich, L. A.
   Pratt and Whitney Aircraft Group, Commercial Products Div, East Hartford, CT
   Quarterly Technical Progress Report Number Twenty, Dec 80-Feb 81
   Contract No: NAS 3-20072
   48 pp., 1981 (AD-D120 953)
   **Key Words:** MERL 76, MA956, Hastelloy X, Incoloy 901, aircraft structures, combustor liners, turbine components, tensile properties, creep, crack growth, coatings, thermal fatigue

**Nimonic 90**

1. **Rejuvenation Procedures to Recover Creep Properties of Nickel-Base Superalloys by Heat Treatment and Hot Isostatic Pressing Techniques**
   Bildan, A.
   Mater Sci 26 (13), 3409-21, 1991
   **Key Words:** IN-100, Nimonic 80A, Nimonic 115, Nimonic 75, Nimonic 105, Nimonic 90, IN-738, IN-738LC, Inconel X-750, turbine components, creep, grain size, cavitation
2. Repair and Regeneration of Turbine Blades, Vanes, and Discs
Huff, H., Wortmann, J.
Motoren und Turbinen Union GMBH, Munich, Germany
Proc 53rd Meeting of the AGARD Structures and Materials Panel, Maintenance in Service of High Temperature Parts
13-1 to 13-7, 1982 ( AD-D125 470 )
Key Words: IN-100, Nimonic 90, Nimonic 108, turbine components, welding, creep, rejuvenation

3. Scope for Repair Welding Gas Turbine Blades
Elsner, W.
Pract Metall 19 (4), 199-214, 1982 ( AD-D126 799 )
Key Words: IN-738LC, Nimonic 90, Nimonic 105, Udimet 520, turbine components, microstructure, tensile properties, welding

McColvin, G. M.
NTIS, N79-18022, Springfield, VA
Final Report
Key Words: Incoloy 901, IN-738, Nimonic 90, Nimonic 115, Inconel 718, fatigue, tensile properties, creep rupture, grain size

Nimonic 105

1. Rejuvenation Procedures to Recover Creep Properties of Nickel-Base Superalloys by Heat Treatment and Hot Isostatic Pressing Techniques
Baldan, A.
Key Words: IN-100, Nimonic 80A, Nimonic 115, Nimonic 75, Nimonic 105, Nimonic 90, IN-738, IN-738LC, Inconel X-750, turbine components, creep, grain size, cavitation

2. The Behavior of NIM 105 and IN738 LC Under Creep and LCF Testing
Persson, P-O., Persson, C., Burman, G., Lindblom, Y.
Kluwer Academic Publishers, Norwell, MA
Proc High Temperature Alloys for Gas Turbines and Other Applications 1986-Part 2
1501-15, 1986 ( AD-D142 159 )
Key Words: Nimonic 105, IN-738LC, fatigue strain, creep

3. Refurbishing Superalloy Components for Gas Turbines
Lindblom, Y.
Mater Sci Technol 1 (8), 636-41 and 643, 1985 ( AD-D133 819 )
Key Words: Nimonic 105, turbine components, coatings, repairs, microstructure, rejuvenation, creep rate, fatigue

4. Refurbishing Superalloy Components for Gas Turbines
Lindblom, Y.
Mater Sci Technol 1 (8), 636-41, 1985 ( AD-D319 428 )
Key Words: Nimonic 105, turbine components, SEM, optical microscopy, blade life, creep
5. Rejuvenation of Used Turbine Blades by Hot Isostatic Pressing and Reheat Treatment
   Cheung, K. L., Leach, C. C., Willett, K. P., Koul, A. K.
   Westinghouse Canada Ltd., Hamilton, Ontario, Canada
   Proc 53rd Meeting of the AGARD Structures and Materials Panel, Maintenance in
   Service of High Temperature Parts, 10-1 to 10-6, 1982 (AD-D125 467)
   Key Words: Inconel X-750, IN-738, Nimonic 115, Nimonic 105, Inconel 700,
   turbine components, microstructure, rejuvenation, creep

6. HIP Processing--Potentials and Applications
   Van Der Vet, W. J., Chromalloy American Co., Midwest City, OK
   Proc 53rd Meeting of the AGARD Structures and Materials Panel,
   Maintenance in Service of High Temperature Parts
   11-1 to 11-16, 1982 (AD-D125 468)
   Key Words: Inconel X-750, Udimet 500, RENE' 100, B-1900, Nimonic 105, IN-738,
   IN-782, turbine components, fatigue, thermal cycling, creep rupture

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   Elsner, W., Pract Metall 19 (4), 199-214, 1982 (AD-D126 799)
   Key Words: IN-738LC, Nimonic 90, Nimonic 105, Udimet 520, turbine components,
   microstructure, tensile properties, welding

8. An Assessment of Hot Isostatic Pressing and Reheat Treatment for the Regeneration of
   Creep Properties of Superalloys
   Dennison, J. P., Elliot, I. C., Wilshire, B.
   ASM International, Metals Park, OH
   Key Words: Nimonic 105, IN-100, fracture mechanics, creep, heat treatment

Nimonic 115

1. Rejuvenation Procedures to Recover Creep Properties of Nickel-Base Superalloys by
   Heat Treatment and Hot Isostatic Pressing Techniques
   Key Words: IN-100, Nimonic 80A, Nimonic 115, Nimonic 75, Nimonic 105, Nimonic
   90, IN-738, IN-738LC, Inconel X-750, turbine components,
   creep, grain size, cavitation

2. Rejuvenation of Used Turbine Blades by Hot Isostatic Pressing and Reheat Treatment
   Cheung, K. L., Leach, C. C., Willett, K. P., Koul, A. K.
   Westinghouse Canada Ltd., Hamilton, Ontario, Canada
   Proc 53rd Meeting of the AGARD Structures and Materials Panel, Maintenance in
   Service of High Temperature Parts, 10-1 to 10-6, 1982 (AD-D125 467)
   Key Words: Inconel X-750, IN-738, Nimonic 115, Nimonic 105, Inconel 700,
   turbine components, microstructure, rejuvenation, creep

3. Damage Accumulation and Fracture in Creep of Nickel-Base Alloys
   Tipler, H. R., Lindblom, Y., Davidson, J. G.
   Applied Sciences Publishers Ltd., London, UK
   Key Words: IN-597, Nimonic 115, IN-738LC, Nimonic 80A, MAR-M200, Udimet 500,
   Udimet 710, Udimet 720, turbine components, microstructure,
   grain boundaries, cracking, creep properties, fatigue, thermal
   fatigue, cavitation corrosion
4. High Cycle Fatigue of Nickel-Base Alloys-European Concerted Action-- Cost
50-Materials for Gas Turbines, Project UK8
McColvin, G. M.
NTIS, N79-18022, Springfield, VA
Final Report
Key Words: Incoloy 901, IN-738, Nimonic 90, Nimonic 115, Inconel 718,
fatigue, tensile properties, creep rupture, grain size

PWA 1480

1. The Role of the gamma/gamma prime Eutectic and Porosity on the Tensile Behavior of a
Single-Crystal Nickel-Base Superalloy
Walston, W. S., Bernstein, I. M., Thompson, A. W.
Metall Trans A 22A, 1443-51, 1991
Key Words: PWA 1480, tensile properties, porosity, fracture, single crystals

2. Advanced Single Crystal for SSME Turbopumps
Fritzemeier, L. G.
Rockwell International, Rocketdyne Div, Canoga Park, CA
Final Contractor Report
Rept No: RURD 88-273, N89-21072, 48 pp., 1989 ( AD-D141 694 )
Key Words: PWA 1480, space shuttle, turbine components, porosity, crack
propagation, tensile properties, creep, rupture strength, fatigue

3. The Influence of High Thermal Gradient Casting, Hot Isostatic Pressing and Alternate
Heat Treatment on the Structure and Properties of a Single Crystal Nickel Base
Superalloy
Fritzemeier, L.G.
The Metallurgical Society of AIME, Warrendale, PA
Key Words: PWA 1480, space shuttle, porosity, creep rupture, tensile
properties, fatigue, hydrogen environment

4. Advanced Single Crystal for SSME Turbopumps
Fritzemeier, L. G.
Rockwell International, Rocketdyne Div, Canoga Park, CA
Quarterly Technical Progress Report, Mar-Jun 87
Contract No: NAS3-24646
6 pp., 1987 ( AD-D138 334 )
Key Words: PWA 1480, defects, tensile properties, fatigue

5. Mechanical Behavior and Processing of DS and Single Crystal Superalloys
Khan, T., Caron, P., Nakagawa, Y. G.
J Met 38 (7), 16-9, 1986 ( AD-D136 462 )
Key Words: CMSX2, PWA 1480, Alloy 454, tensile properties, creep rupture,
fatigue

6. Precision Casting of Turbine Blades and Vanes
Drapier, J. M.
Kluwer Boston Inc., Hingham, MA
Proc Conf High Temperature Alloys for Gas Turbines 887-908, 1982 ( AD-D134 025 )
Key Words: Alloy 713LC, IN-100, MAR-M200, PWA 1480, MAR-M247, CMSX2, turbine
components, rejuvenation, oxidation, vacuum melting, unidirectional solidification
Rene' 80

1. **High Pressure Turbine Blade Life Extension**
   Smith, H. H., Michel, D. J.
   Naval Research Lab, Washington DC
   Final Memorandum Report
   Rept No: NRL-MR-6861, 47 pp., 1991 ( AD-A240 654 )
   **Key Words:** Rene' 80H, MERL 72, turbine components, tensile properties, creep rupture, microstructure, welding

2. **Deformation Mechanisms of Thermostructural Materials**
   Arsenault, R. J., Louat, N., Shahinian, P., Singh, A. K., Chaki, T.
   Crystal Growth and Materials Testing Associates, Lanham, MD
   Final Report
   Rept No: 162, 46 pp., 1987 ( AD-A184 070 )
   **Key Words:** IN-100, Rene' 80, turbine components, CoCrAl coatings, creep rupture, thermal fatigue, barrier coatings, dislocation

3. **Hot Isostatic Press**
   Author Anon
   Foreign Technology Division, Wright-Patterson AFB, Glk
   Rept No: FTD-ID(RS)T-1406-84, 65 pp., 1985 ( AD-B093 100L )
   **Key Words:** Ti-6Al-4V, B-1900, IN-738, Rene' 77, IN-792, Rene' 80, AA C355, AA A356, 142-T4

4. **A Mechanistically Based Model for High Temperature Notched LCF of Rene' 80**
   Domas, P. A., Antolovich, S. D.
   Eng Fract Mechanics 21 (1), 203-14, 1985 ( AD-D131 953 )
   **Key Words:** Rene' 80, microstructure, heat treatment, fatigue, tensile properties

5. **Hipping is One Way to Check Porosity in Cast Components**
   Irving, R. R.
   Iron Age 225 (33), 43-5, 1982 ( AD-D126 241 )
   **Key Words:** AA A201, AISI 4330, AA C355-T6, 142-T4, AA A356-T61, IN-738, Rene' 77, IN-792, Rene' 80, stainless steel, porosity, tensile properties, fatigue

6. **Development of Hybrid Gas Turbine Bucket Technology**
   Peterson, L. G., Hrencecin, D. E., Schilling, W. F., Ostergren, W. J.
   General Electric Co., Gas Turbine Division, Schenectady, NY
   Technical Paper
   Rept No: ASME-82-GT-94, 10 pp., 1982 ( AD-D127 264 )
   **Key Words:** Rene' 80, Rene' 150, Udimet 700, MAR-M200, IN-939, Rene' 125, Rene' 120, GTD-111, IN-738, turbine components, tensile properties, unidirectional solidification, dissimilar joining, diffusion bonding, creep rupture

7. **Turbine Blade Technology--Present and Future**
   Allen, R. E., Sidenstick, J. E.
   American Institute of Aeronautics and Astronautics, New York, NY
   Proc Century 2 Aerospace Conf, American Society of Mechanical engineers, San Francisco, CA, Aug 1960
   7 pp., 1981 ( AD-D126 839 )
   **Key Words:** Rene' 80, Rene' 150, turbine components, aircraft structures, coatings, welding
8. **Premium Quality Castings**  
Freeman Jr., W. R.  
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH  
Proc Net Shape Metalworking Program Review 406-17, 1976 (AD-D119 187L)  
**Key Words:** IN-792, IN-738, IN-100, RENE' 80, Alloy 713L, Alloy 713LC, B-1900, MAR-M200, tensile properties, fatigue  

9. **Improved Properties in Castings by Hot Isostatic Pressing**  
Glenn, G. M., SAMPE Qtrly 8 (1), 1-9, 1976 (AD-D107 893)  
**Key Words:** IN-738, RENE' 80, RENE' 120, RENE' 77, Ti-6Al-4V, AA A356, AA C355 porosity, tensile properties, microstructure, creep rupture, density, fatigue  

10. **Processing: The Rediscovered Dimension in High Temperature Alloys**  
Semchyshen, M.  
Standardization News 4 (4), 9-19, 1976 (AD-D110 676)  
**Key Words:** Inconel 718, RENE' 80, AISI 4140, Udimet 700, TZM, IN-738, Waspaloy, remelting, alloying, creep rupture  

11. **Improvement of Nuclear Reactor Component Materials by Application of Hot Isostatic Processing (HIP)**  
Mueller, J. J., Electric Power Research Inst, Palo Alto, CA  
Rept No: EPRI-500-1, PB-250952, 64 pp., 1975 (AD-D107 180)  
**Key Words:** Ti-6Al-4V, AA A356-T61, RENE' 95, IN-738, IN-792, RENE' 77, RENE' 80, nuclear reactor, turbine components, tensile properties, fatigue, creep rupture, cladding, defects  

**Rene' 95**

1. **Constraint-Loss Model for the Growth of Surface Fatigue Cracks**  
Van Stone, R. H., Gilbert, M. S., Gooden, O. C., Laflen, J. H.  
ASTM, Philadelphia, PA  
Proc Fracture Mechanics, Nineteenth Symp  
Rept No: ASTM-STP-969, 637-56, 1988 (AD-D139 960)  
**Key Words:** RENE' 95, surface defects, fracture mechanics, fatigue crack growth  

2. **Near-Threshold Crack Growth in Nickel-Base Superalloys**  
Van Stone, R. H., Krueger, D. D.  
ASTM, Philadelphia, PA  
Proc Fracture Mechanics, Nineteenth Symp  
Rept No: ASTM-STP-969, 883-906, 1988 (AD-D139 966)  
**Key Words:** RENE' 95, Inconel 718, microstructure, grain size, fatigue crack growth, tensile properties  

3. **Modelling of Deformation and Microstructural Changes in P/M RENE' 95 Under Isothermal Forging Conditions**  
Alniak, O., Morphy, D. D., Terada, T., Koul, A. K., Immarigeon, J-P.  
National Aeronautical Establishment, Ottawa, Canada  
Proc 65th Meeting of the AGARD Structures and Materials Panel 2-1 to 2-18, 1987 (AD-D140 764)  
**Key Words:** RENE' 95, microstructure, grain refinement, deformation, flow stress, compression tests
Flom, D. G.
General Electric Corporate Research and Development, Schenectady, NY
Final Report Jul 79-Aug 83
Rept No: AFWAL-TR-84-4059-Vol-5, 230 pp., 1984 (AD-B088 346L)
Key Words: Ti-6Al-4V, RENE’ 95, turbine components, gun tubes, laser machining

5. Effects of Processing and Microstructure on the Fatigue Behavior of the Nickel-Base Superalloy RENE’ 95
Miner, R. V., Gayda, J.
Int J Fatigue 6 (3), 189-93, 1984 (AD-D130 746)
Key Words: RENE’ 95, grain size, fatigue crack, tensile properties, aging

6. Fatigue Crack Initiation and Propagation in Several Nickel-Base Superalloys at 650
Gayda, J., Miner, R. V.
Key Words: Waspaloy, IN-100, RENE’ 95, turbine components, fatigue, creep-fatigue, crack growth, porosity, fracture mechanics, tensile properties, microstructure

7. Overview of Temperature and Environmental Effects on Fatigue of Structural Metals
Coffin, L. F.
Plenum Press, New York, NY
Proc 27th Sagamore Army Materials Research Conf 1-40, 1983 (AD-D131 509)
Key Words: RENE’ 95, A-286, stainless steel, Udimet 700, Waspaloy, MERL 76, IN-100, NASA IIB-7, crack growth, fatigue

8. The Relationship Between Structure, Properties, and Processing in Powder Metallurgy Superalloys
Davidson, J. H., Aubin, C.
Kluwer Boston Inc., Hingham, MA
Proc Conf High Temperature Alloys for Gas Turbines 853-86, 1982 (AD-D134 024)
Key Words: Udimet 700, Nimonic API, MERL 76, RENE’ 95, turbine components, microstructure, crack propagation, fatigue, creep rupture, impact, thermomechanical treatment

9. Use of a d-c Potential Drop Crack Monitoring Technique in the Development of Defect Tolerant Disk Alloys
Van Stone, R. H., Krueger, D. D., Duvelius, L. T.
ASTM, Philadelphia, PA
Proc 14th National Symp Fracture Mechanics 2, 553-78, 1981 (AD-D128 740)
Key Words: RENE’ 95, Inconel 718, turbine components, microstructure, tensile properties, crack growth, fatigue

10. Review of Superalloy Powder Metallurgy Processing for Aircraft Gas Turbine Applications
Bartos, J. L.
ASTM, Philadelphia, PA
Proc Symp MiCon 78, 564-77, 1979 (AD-D126 411)
Key Words: RENE’ 95, turbine components, tensile properties, creep rupture, net shape forming
11. **Material for Advanced Turbine Engines-MATE**  
Bamberger, E. N., Mosier, J. S., Harrison, R. W.  
General Electric Co., Aircraft Engine Group, Evendale, OH  
Eighth Quarterly Engineering Report One, Dec-Feb 78  
Rept No: R78AEG265, 111 pp., 1978 (AD-D112 563)  
**Key Words:** RENE' 95, RENE' 150, turbine components, unidirectional solidification, creep properties, crack growth, notch sensitivity, tensile properties, thermal properties, oxidation, corrosion, fatigue

12. **Materials for Advanced Turbine Engines-MATE**  
Bamberger, E. N., Mosier, J. S., Harrison, R.W.  
General Electric Co., Aircraft Engine Group, Evendale, OH  
Ninth Quarterly Engineering Report, Mar-May 78  
Rept No : R78AEG356, 20 pp., 1978 (AD-D113 124)  
**Key Words:** RENE’ 95, RENE’ 150, turbine components, unidirectional solidification, coatings, microstructure, net shape forming

13. **Material for Advanced Turbine Engines-MATE**  
Arnold, D. B., Mosier, J. S., Harrison, R. W.  
General Electric Co., Aircraft Engine Group, Evendale, OH  
Quarterly Engineering Report Number Ten, Jun-Aug 78  
Rept No : R78AEG496, 56 pp., 1978 (AD-D113 898)  
**Key Words:** RENE’ 95, RENE’ 150, turbine components, compressor components, unidirectional solidification, tensile properties, fatigue, creep rupture, coatings

14. **Original HCl Surface Treatment for Diffusion Bonding of Nickel Superalloy Specimens**  
Billard, D., Trottier, J. P.  
Met Technol 5 (9), 309-19, 1978 (AD-D114 028)  
**Key Words:** IN-100, Waspaloy, RENE’ 95, Inconel 718, welding, grain size, bonding, recrystallization, temperature effect

15. **Material for Advanced Turbine Engines-MATE**  
Bamberger, E. N., Mosier, J. S.  
General Electric Co., Aircraft Engine Group, Evendale, OH  
Quarterly Engineering Report Number Six, Jun-Aug 77  
Rept No : R77AEG529, 56 pp., 1977 (AD-D110 864)  
**Key Words:** RENE’ 95, RENE’ 150, turbine components, unidirectional solidification, fatigue, creep rupture, tensile properties, fracture surface, temperature effect

16. **MATE-Materials for Advanced Turbine Engines**  
Bamberger, E. N., Mosier, J. S., Harrison, R. W.  
General Electric Co., Aircraft Engine Group, Evendale, OH  
Seventh Quarterly Engineering Report, Sept.-Nov. 1977  
Rept No : R77AEG647, 41 pp., 1977 (AD-D111 589)  
**Key Words:** RENE’ 95, RENE’ 150, turbine components, unidirectional solidification, solution heat treatment

17. **Application of Hot Isostatic Pressing to Aircraft Gas Turbines**  
Evans, D. J.  
Plenum Press, New York, NY  
Proc 6th AIRAPT Int High Pressure Conf 2, 656-63, 1977 (AD-D126 192)  
**Key Words:** Udiment 700, RENE’ 95, Ti-6Al-4V, turbine components, tensile properties, creep rupture, net shape forming
18. Improvement of Nuclear Reactor Component Materials by Application of Hot Isostatic Processing (HIP)

Mueller, J. J.
Electric Power Research Inst, Palo Alto, CA
Phase One Survey Report
Rept No: EPRI-500-1, PB-250952, 64 pp., 1975 (AD-D107 180)
Key Words: Ti-6Al-4V, AA A356-T61, RENE' 95, IN-738, IN-792, RENE' 77, RENE' 80, nuclear reactor, turbine components, tensile properties, fatigue, creep rupture, cladding, defects

19. Manufacturing Methods for the Production of Disc Shapes by Contour Rolling

Arnold, D. B.
General Electric Co., Aircraft Engine Group, Evendale, OH
Interim Engineering Progress Report Number Five, Apr-Jun 72
Rept No: AFML-IR-204-1(V), 22 pp., 1972 (AD-179 851L)
Key Words: RENE' 95, Hastelloy X, AISI 304, AF 2-1DA, microstructure, hot rolling

Rene' 120

1. Development of Hybrid Gas Turbine Bucket Technology

Peterson, L. G., Hrencecin, D. E., Schilling, W. F., Ostergren, W. J.
General Electric Co., Gas Turbine Division, Schenectady, NY
Technical Paper
Rept No: ASME-82-GT-94, 10 pp., 1982 (AD-D127 264)
Key Words: RENE' 80, RENE' 150, Udimet 700, MAR-M200, IN-939, RENE' 125, RENE' 120, GTD-111, IN-738, turbine components, tensile properties, unidirectional solidification, dissimilar joining, diffusion bonding, creep rupture

2. Hot Isostatic Pressing in the Aerospace Industry

Price, P. E.
Metal Prog 121 (2), 46-7, 1982 (AD-D200 345)
Key Words: RENE' 120, Ti-6Al-4V, aerospace applications, mechanical properties

3. Hipping: A Good Way to Improve Properties

Irving, R. R.
Iron Age 224 (6), 77-81, 1981 (AD-D120 406)
Key Words: JT-9D, MERL 76, 17-4PH, RENE' 120, IN-792, IN-738, turbine components, porosity


Price, P.
Ind Heat 46 (6), 8-10, 1979 (AD-D115 742)
Key Words: Ti-6Al-4V, RENE' 120, Ti-6Al-2Sn-4Zr-2Mo, microstructure, fatigue

5. Improved Properties in Castings by Hot Isostatic Pressing

Glenn, G. M.
SAMPE Qtrly 8 (1), 1-9, 1976 (AD-D107 893)
Key Words: IN-738, RENE' 80, RENE' 120, RENE' 77, Ti-6Al-4V, AA A356, AA C355, porosity, tensile properties, microstructure, creep rupture, density, fatigue
Rene' 150

1. Development of Hybrid Gas Turbine Bucket Technology
   Peterson, L. G., Hrencecin, D. E., Schilling, W. F., Ostergren, W. J.
   General Electric Co., Gas Turbine Division, Schenectady, NY
   Technical Paper
   Rept No : ASME-82-GT-94, 10 pp., 1982 ( AD-D127 264 )
   Key Words: RENE' 80, RENE' 150, Udimet 700, MAR-M200, IN-939, RENE' 125,
   RENE' 120, GTD-111, IN-738, turbine components, tensile
   properties, unidirectional solidification, dissimilar joining,
   diffusion bonding, creep rupture

2. Turbine Blade Technology--Present and Future
   Allen, R. E., Sidenstick, J. E.
   American Institute of Aeronautics and Astronautics, New York, NY
   Proc Century 2 Aerospace Conf, American Society of Mechanical engineers, San
   Francisco, CA, Aug 1980
   7 pp., 1981 ( AD-D126 839 )
   Key Words: RENE' 80, RENE' 150, turbine components, aircraft structures,
   coatings, welding

3. Material for Advanced Turbine Engines-MATE
   Bamberger, E. N., Mosier, J. S., Harrison, R. W.
   General Electric Co., Aircraft Engine Group, Evendale, OH
   Eighth Quarterly Engineering Report One, Dec-Feb 78
   Rept No : R78AEG265, 111 pp., 1978 ( AD-D112 563 )
   Key Words: RENE' 95, RENE' 150, turbine components, unidirectional
   solidification, creep properties, crack growth, notch
   sensitivity, tensile properties, thermal properties,
   oxidation, corrosion, fatigue

4. Materials for Advanced Turbine Engines-MATE
   Bamberger, E. N., Mosier, J. S., Harrison, R.W.
   General Electric Co., Aircraft Engine Group, Evendale, OH
   Ninth Quarterly Engineering Report, Mar-May 78
   Rept No : R78AEG356, 20 pp., 1978 ( AD-D113 124 )
   Key Words: RENE' 95, RENE' 150, turbine components, unidirectional
   solidification, coatings, microstructure, net shape forming

5. Material for Advanced Turbine Engines-MATE
   Arnold, D. B., Mosier, J. S., Harrison, R. W.
   General Electric Co., Aircraft Engine Group, Evendale, OH
   Quarterly Engineering Report Number Ten, Jun-Aug 78
   Rept No : R78AEG496, 56 pp., 1978 ( AD-D113 898 )
   Key Words: RENE' 95, RENE' 150, turbine components, compressor components,
   unidirectional solidification, tensile properties, fatigue, creep rupture, coatings

6. Material for Advanced Turbine Engines-MATE
   Bamberger, E. N., Mosier, J. S.
   General Electric Co., Aircraft Engine Group, Evendale, OH
   Quarterly Engineering Report Number Six, Jun-Aug 77
   Rept No : R77AEG529, 56 pp., 1977 ( AD-D110 864 )
   Key Words: RENE' 95, RENE' 150, turbine components, unidirectional
   solidification, fatigue, creep rupture, tensile properties,
   fracture surface, temperature effect

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7. **MATE - Materials for Advanced Turbine Engines**  
Bamberger, E. N., Mosier, J. S., Harrison, R. W.  
General Electric Co., Aircraft Engine Group, Evendale, OH  
Seventh Quarterly Engineering Report, Sept.-Nov. 1977  
Rept No : R77AEG647, 41 pp., 1977 (AD-D111589)  
**Key Words:** RENE' 95, RENE' 150, turbine components, unidirectional solidification, tensile properties, solution heat treatment

8. **HIP of Near-Net Shapes**  
Dulis, E. J., Fleck, J. N.  
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH  
Proc Net Shape Metalworking Program Review 369-82, 1976 (AD-D119184L)  
**Key Words:** PA 101, Ti-6Al-4V, net shape forming, forging

**Udimet 500**

1. **Repair Techniques for Gas Turbine Components**  
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properties, creep rupture, thermal processing, thermal 
fatigue, oxidation, gamma prime, oxide dispersion 
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TITANIUM AND TITANIUM ALLOYS

Titanium

1. Large Structural Titanium Castings
   Barice, W. J.
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   **Key Words:** titanium, Ti-6Al-4V, Ti-5Al-2.5Sn, Ti-6Al-2Sn-4Zr-2Mo,
   Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Transage 175, turbine components

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   Isostatic Pressing
   Witt, R., Magnuson, J.
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   Vaughan, R. F., Blenkinsop, P. A., Morton, P. H.
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Ti-6Al-2Sn-4Zr-2Mo

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   **Key Words:** Ti-6Al-2Sn-4Zr-2Mo, skull melting, chemical milling

2. Developments in Titanium Alloy Casting Technology
   Eylon, D., Froes, F. H., Gardiner, R. W.
   J Met 35 (2), 35-47, 1983 (AD-D126 785)
   **Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo,
   Ti-5Al-2.5Sn, Transage 175, Beta III, Ti-10V-2Fe-3Al, microstructure, net shape forming, welding, tensile
   properties, fracture toughness, fatigue, crack growth

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3. **Large Structural Titanium Castings**  
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**Key Words:** titanium, Ti-6Al-4V, Ti-5Al-2.5Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Transage 175, turbine components

4. **Cast Titanium Components for Rotating Gas Turbine Applications**  
Ewing, B. A.  
General Motors Corp., Detroit Diesel Allison Division  
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**Key Words:** Ti-6Al-4V, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Transage 175, turbine components, net shape forming, Charpy impact, tensile properties, fatigue, cost

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Price, P.  
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**Key Words:** Ti-6Al-4V, RENE' 120, Ti-6Al-2Sn-4Zr-2Mo, microstructure, fatigue

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**Ti-6Al-2Sn-4Zr-6Mo**

1. **Developments in Titanium Alloy Casting Technology**  
Eylon, D., Froes, F. H., Gardiner, R. W.  
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**Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo, Ti-5Al-2.5Sn, Transage 175, Beta III, Ti-10V-2Fe-3Al, microstructure, net shape forming, welding, tensile properties, fracture toughness, fatigue, crack growth

2. **Large Structural Titanium Castings**  
Barice, W. J.  
*J Aircr* 19 (8), 687-91, 1982 (AD-D125 528)  
**Key Words:** titanium, Ti-6Al-4V, Ti-5Al-2.5Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Transage 175, turbine components

3. **Cast Titanium Components for Rotating Gas Turbine Applications**  
Ewing, B. A.  
General Motors Corp., Detroit Diesel Allison Division  
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**Key Words:** Ti-6Al-4V, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Transage 175, turbine components, net shape forming, Charpy impact, tensile properties, fatigue, cost
4. All Systems Are Go for Powder Metallurgy
Irving, R. R.
Iron Age 223 (28), 41-5, 1980 (AD-D118 875)
Key Words: AISI 4600, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Waspaloy, IN-100, AISI 329, 12Cr steel, injection molding, cost, applications

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Kubel, E. J., Jr.
Key Words: Ti-6Al-4V, turbine components, near net shape, rapid solidification

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   **Key Words:** Ti-6Al-4V, UH-60A Black Hawk, casting, arc melting, fatigue, tensile properties

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   Foreign Technology Division, Wright-Patterson AFB, OH  
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   **Key Words:** Ti-6AI-4V, B-1900, IN-738, RENE' 77, IN-792, RENE' 80, AA C355, AA A356, 142-T4

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    **Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, forging, extrusion, fatigue, tensile properties

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    Eylon, D., Froes, F. H., Levin, L.  
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    **Key Words:** Ti-6Al-4V, microstructure, crack growth, fatigue stress, tensile properties

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    Soltesz, S. M., Smickley, R. J., Dardi, L. E.  
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Key Words: Ti-6Al-4V, repair welding, microstructure, fatigue crack

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Key Words: Ti-6Al-4V, tensile properties, heat treatment

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Key Words: Ti-6Al-4V, microstructure, fatigue, Charpy impact, tensile properties

21. Status of Titanium Net-Shape Technology
Key Words: Ti-6Al-4V, isothermal forging, net shape, tensile properties, fracture toughness

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Eylon, D., Froes, F. H., Gardiner, R. W.  
J Met 35 (2), 35-47, 1983 (AD-D126 785)  
**Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-5Al-2.5Sn, Transage 175, Beta III, Ti-10V-2Fe-3Al, microstructure, net shape forming, welding, tensile properties, fracture toughness, fatigue, crack growth

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Widmer, R., Price, P. E.  
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**Key Words:** Ti-6Al-4V, stainless steel, aluminum alloys, porosity, rejuvenation, cost

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**Key Words:** titanium, Ti-6Al-4V, Ti-5Al-2.5Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Transage 175, turbine components

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**Key Words:** Ti-6Al-4V, welding, crack growth, tensile properties, hardness, fatigue

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**Key Words:** Ti-6Al-4V, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Transage 175, turbine components, net shape forming, Charpy impact, tensile properties, fatigue, cost

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**Key Words:** Ti-6Al-4V, fatigue, molding, mechanical properties

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**Key Words:** Ti-6Al-4V, tensile properties, fatigue, net shape forming, superplastic forming

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Ulitchny, M. G.  
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**Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, fracture toughness, aging, tensile properties

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**Key Words:** Ti-6Al-4V, microstructure, fatigue, creep

36. **All Systems Are Go for Powder Metallurgy**  
Irving, R. R.  
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**Key Words:** AISI 4600, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Waspaloy, IN-100, AISI 329, 12Cr steel, injection molding, cost, applications

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**Key Words:** Ti-6Al-4V, fatigue, net shape forming, diffusion bonding

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**Key Words:** Ti-6Al-4V, Waspaloy, turbine components, rejuvenation, tensile properties

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Key Words: Ti-6Al-4V, turbine components, buckling strength, tensile properties, fatigue, superplastic forming, creep rupture, welding, shear stress

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49. Feasibility Study on the use of Small-Angle Neutron Scattering for Microstructural Determinations of Technological Alloys
Herman, H.
State University of New York at Stony Brook, Department of Materials Sciences, NY
Final Report
Contract No: N00014-78-M-0074
58 pp., 1978 (AD-A061 867)
Key Words: Ti-6Al-4V, HY-130, AISI 304, Udimet 700, creep-fatigue, crack detection

50. HIP, the Great Healer of Castings
Bittence, J. C.
Mater Eng 88 (4), 54-7, 1978 (AD-D113 844)
Key Words: Inconel 718, IN-792, Ti-6Al-4V, 17-4PH, AA A357, porosity, fatigue, creep properties, deformation, cost

51. Casting High-Performance, High-Integrity Components
Heine, H. J.
Key Words: Ti-6Al-4V, 18/8 stainless, 18Cr-10Ni, AA A360, B1914, B1925, B1964, B1981, airframes, aircraft structures, creep rupture, stress analysis, nondestructive testing, tensile properties, tribaloy

52. A Retrospective View of Metallurgy During the 25 Years of the Gillett Lectures
Jaffee, R. I.
Key Words: AISI 316, Ti-6Al-4V, titanium, zirconium, hafnium, embrittlement, fracture mechanics
53. Repair of Titanium Airframe Castings by Hot Isostatic Pressing
Magnuson, J.
Metall 10 (2), 223-32, 1977 (AD-D109428)
**Key Words:** Ti-6Al-4V, porosity, microstructure, defects, voids, metallography

54. HIP'ing Raises Casting Performance Levels
Freeman, W. R., Jr.
Metal Prog 112 (3), 33-8, 1977 (AD-D110513)
**Key Words:** B-1900, IN-792, Ti-6Al-4V, IN-100, tensile properties turbine components, fatigue, creep rupture

55. Application of Hot Isostatic Pressing to Aircraft Gas Turbines
Evans, D. J.
Plenum Press, New York, NY
Proc 6th AIRAPT Int High Pressure Conf 2, 656-63, 1977 (AD-D126192)
**Key Words:** Udimet 700, RENE' 95, Ti-6Al-4V, turbine components, tensile properties, creep rupture, net shape forming

56. HCF Crack Initiation Analysis of Ti-6Al-4V Cast and HIP Specimens
Eylon, D.
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
Proc Net Shape Metalworking Program Review 73-87, 1976 (AD-D119168L)
**Key Words:** Ti-6Al-4V, fracture surface, crack propagation, microstructure, fatigue stress, grain boundaries

57. HIP of Near-Net Shapes
Dulis, E. J., Fleck, J. N.
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
Proc Net Shape Metalworking Program Review 369-82, 1976 (AD-D119184L)
**Key Words:** PA 101, Ti-6Al-4V, net shape forming, forging

58. High Integrity Casting Program
Schweikert, W. H.
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
Proc Net Shape Metalworking Program Review 392-405, 1976 (AD-D119186L)
**Key Words:** Inconel 718, Ti-6Al-4V, 17-4PH, AA A357, tensile properties, nondestructive testing

59. Improved Properties in Castings by Hot Isostatic Pressing
Glenn, G. M.
SAMPE Qtrly 8 (1), 1-9, 1976 (AD-D107893)
**Key Words:** IN-738, RENE' 80, RENE' 120, RENE' 77, Ti-6Al-4V, AA A356, AA C355 porosity, tensile properties, microstructure, creep rupture, density, fatigue

60. Comparative Evaluation of Forged Ti-6Al-4V Bar made from Shot Produced by the REP and CSC Processes
Vaughan, R. F., Blenkinsop, P. A., Morton, P. H.
Imperial Metal Industries (Kynoch) Ltd., Birmingham, UK MPR Publishing Services Ltd., Bellstone, Shrewsbury, UK
8 pp., 1976 (AD-D110190)
**Key Words:** Ti-6Al-4V, tensile properties, fracture toughness, fracture surface, titanium, CM steels, superalloys, surface layers, morphology, composition surface
61. Materials and Processing Technology for Advanced Gas Turbines
Hauser, H. A.
SAMPE Qtrly 6 (3), 8 pp., 1975 (AD-D101 035)
Key Words: TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo,
Ti-8Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900,
MAR-M200, turbine components, fracture mechanics, fatigue,
creep rupture

62. Precision Castings State-of-the-Art
Nagan, R. M.
SAMPE Qtrly 6 (4), 1-7, 1975 (AD-D102 565)
Key Words: 17-4PH, Hastelloy X, Inconel 718, Ti-6Al-4V, aircraft structures,
turbine components, tensile properties

63. Improvement of Nuclear Reactor Component Materials by Application of Hot Isostatic
Processing (HIP)
Mueller, J. J.
Electric Power Research Inst, Palo Alto, CA
Phase One Survey Report
Rept No.: EPRI-500-1, PB-250952, 64 pp., 1975 (AD-D107 180)
Key Words: Ti-6Al-4V, AA A356-T61, RENE’ 95, IN-738, IN-792, RENE’ 77, RENE’
80, nuclear reactor, turbine components, tensile properties,
fatigue, creep rupture, cladding, defects

64. Manufacturing of Titanium Airframe Components
Witt, R., Magnuson, J.
Grumman Aerospace Corp., Bethpage, NY
Final Report, Apr 74-Apr 75
Contract No.: N00019-74-C-0301
90 pp., 1975 (AD-D301 610)
Key Words: Ti-6Al-4V, Ti-6Al-6V-2Sn, net shape, fracture toughness

65. Titanium Powder Metallurgy
Sutcliffe, P. W., Mardon, P. G.
AGARD Structures and Materials Panel, 17 pp., 1974 (AD-D102 697)
Key Words: Ti-6Al-4V, tensile properties, density, cost

Ti-6Al-6V-2Sn

1. Comparison of Various Fabrication Methods for the Production of an Aircraft
Structural Component from Titanium Semifabricates (I)
Mietrach, D., Blomeier, K.
Aluminum English 61 (2), E83-8, 1985 (AD-D132 335)
Key Words: Ti-6Al-4V, Ti-6Al-6V-2Sn, forging, extrusion, fatigue, tensile
properties

2. Developments in Titanium Alloy Casting Technology
Eylon, D., Froes, F. H., Gardiner, R. W.
J Mct 35 (2), 35-47, 1983 (AD-D126 785)
Key Words: Ti-6Al-4V, Ti-6Al-6V-2Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo,
Ti-5Al-2.5Sn, Transage 175, Beta III, Ti-10V-2Fe-3Al,
microstructure, net shape forming, welding, tensile
properties, fracture toughness, fatigue, crack growth
3. Mechanical Properties of Titanium Castings
Ulitchny, M. G., Bendix Corp., Kansas, MO
Rept No: BDX-613-2680, 11 pp., 1981 (AD-D124 358)
**Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, fracture toughness, aging, tensile properties

4. Engineering Design, Development, Fabrication and Testing Services Related to 155-mm, XM785 Nuclear Projectile
Steiner, E. G., Ballheim, R. W., Brinker, G. G.
Chamberlain Mfg. Corp., Research and Development Division, Waterloo, IA
Rept No: C8182-PR-026, 452 pp., 1980 (AD-B052 420L)
**Key Words:** Ti-6Al-6V-2Sn, projectiles, ballistic tests, spin test

5. Manufacturing of Titanium Airframe Components
Witt, R., Magnuson, J.
Grumman Aerospace Corp., Bethpage, NY
Final Report, Apr 74-Apr 75
Contract No: N00019-74-C-0301, 90 pp., 1975 (AD-D301 610)
**Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, net shape, fracture toughness

**Transage 175**

1. Titanium Near Net Shape Components for Demanding Airframe Applications
Witt, R. H., Ferreri, A. L.
SAMPE Qtrly 17 (3), 55-62, 1986 (AD-D135 849)
**Key Words:** Ti-6Al-4V, Transage 175, Transage 134, fracture toughness, tensile properties

2. Data Sheet: Transage 175 (Ti-2.7Al-13V-7Sn-2Zr) High-Strength Cast Alloy
Crossley, F. A.
The Metallurgical Society of AIME, Warrendale, PA
Proc Symp Beta Titanium Alloys in the 1980's 493-6, 1984 (AD-D136 674)
**Key Words:** Transage 175, thermal stability, density, tensile properties

3. Cast Transage 175 Titanium Alloy for Durability Critical Structural Components
Crossley, F. A., Barice, W. J.
J Aircr 20 (1), 66-9, 1983 (AD-D126 651)
**Key Words:** Transage 175, tensile properties, notch sensitivity, fatigue

4. Developments in Titanium Alloy Casting Technology
Eylon, D., Froes, F. H., Gardiner, R. W.
J Met 35 (2), 35-47, 1983 (AD-D126 785)
**Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo, Ti-5Al-2.5Sn, Transage 175, Beta III, Ti-10V-2Fe-3Al, microstructure, net shape forming, welding, tensile properties, fracture toughness, fatigue, crack growth

5. Large Structural Titanium Castings
Barice, W. J.
J Aircr 19 (8), 687-91, 1982 (AD-D125 528)
**Key Words:** titanium, Ti-6Al-4V, Ti-5Al-2.5Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Transage 175, turbine components
6. **Cast Titanium Components for Rotating Gas Turbine Applications**
   Ewing, B. A., General Motors Corp., Detroit Diesel Allison Division
   Proc 54th Meeting of the AGARD Structures and Materials Panel
   13-1 to 13-14, 1982 (AD-D127 041)
   **Key Words:** Ti-6Al-4V, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Transage 175, turbine components, net shape forming, Charpy impact, tensile properties, fatigue, cost

7. **Influence of Hot Isostatic Processing and Heat Treatment Variables on the Tensile Properties of Cast Transage 175 Alloy, Ti-2.5Al-13V-7Sn-2Zr**
   Crossley, F. A., Barice, W. J., SAMPE, Azusa, CA
   Proc 27th National SAMPE Symp and Exhibition 667-78, 1982 (AD-D127 142)
   **Key Words:** Transage 175, Ti-2.5Al-13V-7Sn-2Zr, heat treatment, age hardening, tensile properties

8. **Mechanical Properties of Two Cast and Hot Isostatically Processed Martensitic Transage Titanium Alloys**
   Crossley, F. A., Barice, W. J.
   J Met 33 (2), 26-32, 1981 (AD-D120 560)
   **Key Words:** Transage 129, Ti-2Al-11V-2Sn-11Zr, Transage 134, Transage 175, tensile properties, fatigue, density

**Miscellaneous Titanium Alloys**

1. **Cast Beta-Titanium Alloy Ready for Flight**
   McKenzie, R.M.
   Adv Mater Processes 136 (1), 45-6, 1989 (AD-D143 200)
   **Key Words:** Ti-15V-3Cr-3Al-3Sn, cyclic aging, tensile properties

2. **Alloy Development, Processing and Characterization of Devitrified Titanium Base Microcrystalline Alloys**
   Whang, Sung H.
   Barnett Institute of Chemical Analysis and Materials Science, Northeastern University, Boston, MA
   Annual Report, Contract No: N00014-82-K-0579, 17 pp., 1986 (AD-A172 140)
   **Key Words:** titanium alloys, aluminum addition, tin addition, yttrium addition, lanthanum addition, thorium addition, erbium addition, microscopy, age hardening, melt spinning, tensile properties

3. **Deformation of Rapidly Solidified Ti-2Er**
   Kampe, S. L., Koss, D. A.
   Department of Materials Science and Engineering, Pennsylvania State University, University Park, PA
   Technical Report Number Three
   Contract No: N00014-86-K-0381, 8 pp., 1986 (AD-A173 734)
   **Key Words:** Ti-2Er, grain size, strain rate, flow stress, vacuum annealing

4. **Structure-Property Relationships in Centrifugally Cast IMI 550**
   Kearns, M. W., Ward-Close, C. M.
   SAMPE J 22 (1), 7-11, 1986 (AD-D134 747)
   **Key Words:** IMI 550, tensile properties, fracture toughness, creep, aging
5. **Titanium Near Net Shape Components for Demanding Airframe Applications**
Witt, R. H., Ferreri, A. L.
SAMPE Qtrly 17 (3), 55-62, 1986 (AD-D135 849)
**Key Words:** Ti-6Al-4V, Transage 175, Transage 134, fracture toughness, tensile properties

6. **Manufacturing Process for the Hot Isostatic Pressing of Large Titanium PM (Powder Metallurgy) Shapes**
Petersen, V. C., Chandhok, V. K., Moll, J. H.
Colt Industries Inc., Crucible Materials Research Center, Pittsburgh, PA
Rept No: AFWAL-TR-85-4120, 474 pp., 1985 (AD-B101 439L)
**Key Words:** titanium alloys, crack propagation, fracture, weldability, toughness, machinability

7. **Titanium Mill Production**
Belov, A. F.
Deutsche Gesellschaft Metallk., Germany
Proc 5th Int Conf Titanium, Titanium--Science and Technology 1, 31-8, 1985 (AD-D135 651)
**Key Words:** VT5L, tensile properties, fatigue, heat treatment

8. **Alloy Development, Processing and Characterization of Devitrified Titanium Based Microcrystalline Alloys**
Whang, S. H.
Barnett Institute of Chemical Analysis and Materials Science, Northeastern University, Boston, MA
Annual Report, Contract No: N00014-82-K-0597, 113 pp., 1984 (AD-A149 609)
**Key Words:** Ti-5Sn-3Y, Ti-5Sn-4.5La, Ti-8Mo-2.5Al-1.5B, Ti-6Al-4V-2Si, Ti-2.5Al-5.5Er, Ti-5Al-2Si, Ti-12Zr-4.5Si, Ti(5)Si(3), Al(3)La, Ti-5Al-2.5Sn-3Ce, Ti-5Al-2.5Sn-1B, Ti-5Al-2.5Sn-2Y, Ti-5Al-2.5Sn, Ti-6.5Si, Ti-5Al-4Zr-2.5Sn-3La, Ti-8Zr-3.5Al-3.5Si, rapid solidification, hardness, rare earth solubility

9. **Emerging Trends in Aerospace Materials and Processes**
Chandler, H. E.
Metal Prog 125 (5), 21-9, 1984 (AD-D130 023)
**Key Words:** Ti-10V-2Fe-3Al, Ti-15V-3Cr-3Al-3Sn, steel, aircraft, net shape forming, manufacturing

10. **Thermal Treatment of Titanium Alloy TA6Zr5D Obtained by Powder Metallurgy**
Quesne, C., Severac, C., Servant, C.
NTIS, PB86-159415, Springfield, VA
Technical Translation Rept No: PB86-159415, 55 pp., 1984 (AD-D140 123)
**Key Words:** IMI 685, microstructure, porosity, precipitation, tensile properties

11. **Developments in Titanium Alloy Casting Technology**
Eylon, D., Froes, F. H., Gardiner, R. W.
J Met 35 (2), 35-47, 1983 (AD-D126 785)
**Key Words:** Ti-6Al-4V, Ti-6Al-6V-2Sn, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo, Ti-5Al-2.5Sn, Transage 175, Beta III, Ti-10V-2Fe-3Al, microstructure, net shape forming, welding, tensile properties, fracture toughness, fatigue, crack growth
   NTIS, N84-23555, Springfield, VA
   Rept No: N84-23555, 152 pp., 1983 (AD-D134 719)
   **Key Words:** AA A357, titanium alloys, fracture mechanics, diffusion bonding, fatigue

13. Treatment Processes of Light and Heat Resistant Alloys
   Belov, A. F., Tselikov, A. I., Trishkin, V. G., Rakovskiy, V. S., Rykalin, N. N.
   Foreign Technology Division, Wright-Patterson AFB, OH
   Rept No: FTD-ID(RS)T-0412-82, 335 pp., 1982 (AD-B070 680L)
   **Key Words:** aluminum alloys, titanium alloys, mechanical properties, fatigue, cracking

14. Large Structural Titanium Castings
   Barice, W. J.
   J Aircr 19 (8), 687-91, 1982 (AD-D125 528)
   **Key Words:** titanium, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-2Mo, Ti-6Al-2Sn-4Zr-6Mo, Transage 175, turbine components

15. Recent Advancement in Titanium Near-Net Shape Technology
   Chen, C. C.
   J Met 34 (11), 30-5, 1982 (AD-D126 098)
   **Key Words:** Ti-6Al-4V, Ti-10V-2Fe-3Al, net shape forming, cost

16. Cast Titanium Components for Rotating Gas Turbine Applications
   Ewing, B. A.
   General Motors Corp., Detroit Diesel Allison Division
   Proc 54th Meeting of the AGARD Structures and Materials Panel 13-1 to 13-14, 1982 (AD-D127 041)
   **Key Words:** Ti-6Al-4V, Ti-6Al-2Sn-2Zr-2Mo-2Cr, Ti-6Al-2Sn-4Zr-6Mo, Transage 175, turbine components, net shape forming, Charpy impact, tensile properties, fatigue, cost

17. Influence of Hot Isostatic Processing and Heat Treatment Variables on the Tensile Properties of Cast Transage 175 Alloy, Ti-2.5Al-11V-7Sn-2Zr
   Crossley, F. A., Barice, W. J.
   SAMPE, Azusa, CA
   Proc 27th National SAMPE Symp and Exhibition 667-78, 1982 (AD-D127 142)
   **Key Words:** Transage 175, Ti-2.5Al-11V-7Sn-2Zr, heat treatment, age hardening, tensile properties

18. Mechanical Properties of Two Cast and Hot Isostatically Processed Martensitic Transage Titanium Alloys
   **Key Words:** Transage 129, Ti-2Al-11V-2Sn-11Zr, Transage 134, Transage 175, tensile properties, fatigue, density

19. Advanced Manufacturing Methods for High Quality Low Cost Titanium Powder Production
   Peebles, R. E.
   General Electric Co., Aircraft Engine Group, Evendale, OH
   Rept No: AFML-IR-189-77T(4), 59 pp., 1978 (AD-D114 365L)
   **Key Words:** Ti-6Al-4V, Ti-5Al-2Sn-2Zr-4Cr-4Mo, isothermal process, forging, hydriding
20. Research to Conduct an Exploratory Experimental and Analytical Investigation of Alloys
Ruckle, D. L., Blackburn, M. J., Hayden, S. Z.
Pratt and Whitney Aircraft Group, East Hartford, CT
Fourth Quarterly Report Nov 75-Feb 76
Rept No: EII-75-200-4001-3, 46 pp., 1976 (AD-D108 056L)
Key Words: Ti-16Al-10Nb, TiAl, turbine components, fatigue, bend test, ECG, EDM, creep, Charpy impact, creep rupture, notch properties, tensile properties

21. Materials and Processing Technology for Advanced Gas Turbines
Hauser, H. A.
SAMPE Qtrly 6 (3), 8 pp., 1975 (AD-D101 035)
Key Words: TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Ti-8Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900, MAR-M200, turbine components, fracture mechanics, fatigue, creep rupture
INTERMETALLIC COMPOUNDS

TiAl

1. **Flow Softening and Microstructure Evolution during Hot Working of Wrought Near-Gamma Titanium Aluminides**
   Semiatin, S. L., Frey, N., El-Soudani, S. M., Bryant, J. D.
   **Key Words:** TiAl, Ti-48 at pct Al-2.5 at pct Nb, Ti-48 at pct Al-2 at pct Nb-2 at pct Cr, isothermal forging, hot compression test

2. **Design, Manufacture, and Evaluation of Titanium Aluminide Components**
   O'Connell, T. E., Blackburn, M. J., Smith, M. P.
   Pratt and Whitney Aircraft Group, Government Products Div, West Palm Beach, FL
   Interim Report Feb-Apr 84
   Rept No: FR-18287, 45 pp., 1984 (AD-D130 536L)
   **Key Words:** TiAl, turbine components, extrusion, ring rolling, tensile properties, solution heat treatment

3. **R&D on Composition and Processing of Titanium Aluminide Alloys for Turbine Engines**
   Blackburn, M. J., Smith, M. P.
   Pratt and Whitney Aircraft Group, Government Products Div, West Palm Beach, FL
   Rept No: PWA-PR-16259, 103 pp., 1982 (AD-B069 620)
   **Key Words:** TiAl, Ti(3)Al, Ti-25Al-10Nb-3V-1Mo, Ti-48 at pct Al-1 at pct V, turbine components, aluminides, microstructure, modulus, tensile properties, creep rupture, Charpy impact, fatigue, fracture toughness, thermal properties

4. **Research to Conduct an Exploratory Experimental and Analytical Investigation of Alloys**
   Ruckle, D. L., Blackburn, M. J., Hayden, S. Z.
   Pratt and Whitney Aircraft Group, East Hartford, CT
   Rept No: EII-75-200-4001-3, 46 pp., 1976 (AD-D108 056L)
   **Key Words:** Ti-16Al-10Nb, TiAl, turbine components, fatigue, bend test, ECG, EDM, creep, Charpy impact, creep rupture, notch properties, tensile properties

5. **Materials and Processing Technology for Advanced Gas Turbines**
   Hauser, H. A., SAMPE Qtrly 6 (3), 8 pp., 1975 (AD-D101 035)
   **Key Words:** TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo, Ti-8Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900, MAR-M200, turbine components, fracture mechanics, fatigue, creep rupture

**Miscellaneous Intermetallic Compounds**

1. **Flow Softening and Microstructure Evolution during Hot Working of Wrought TNear-Gamma Titanium Aluminides**
   Semiatin, S. L., Frey, N., El-Soudani, S. M., Bryant, J. D.
   **Key Words:** TiAl, Ti-48 at pct Al-2.5 at pct Nb, Ti-48 at pct Al-2 at pct Nb-2 at pct Cr, isothermal forging, hot compression test

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2. Mechanical Properties of Fe-Modified L1(2)-Type Al3Ti
Inoue, H. R. P., Cooper, C. V., Favrow, L. H., Hamada, Y., Wayman, C. M.
Materials Research Society, Pittsburgh, PA
Key Words: Al(3)Ti, Al-25 at pct Ti-7.5 at pct Fe, microstructure,
dislocation structure, compressive properties, fracture
surface, intergranular fracture, brittle fracture

3. Fatigue and Fracture of Intermetallic Alloys
Cooper, C. V., Inoue, H. E., Giamei, A. F., Favrow, L. H.
United Technologies Research Center, East Hartford, CT
Annual Report
Rept No: R91-917992-2, 47 pp., 1991 (AD-A238 686)
Key Words: Al(3)Ti, turbine components, iron addition, copper addition,
nickel addition, phase transformation, microstructure, fatigue, fracture

4. Elastic Modulus of NiAl-TiB(2) Composites in the Temperature Range 300 to 1273 K
Viswanadham, R. K., Mannan, S. K., Kumar, K. S.
Key Words: NiAl, boride addition, modulus of elasticity

5. The Effect of 0.1 Atomic Percent Zirconium on the Cyclic Oxidation Behavior of Beta-NiAl for 3000 Hours at 1200 C
Barrett, C. A.
National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH
Technical Memorandum
Rept No: NASA-TM-101408, 18 pp., 1989 (AD-D141 688)
Key Words: NiAl, zirconium addition, microstructure, spalling, cyclic test,
oxidation, long term tests

6. Investigation of As-Cast and Rapidly Solidified Al(3)Sc
Tarnacki, J., Kim, Y.W.
Scr Metall 23 (7), 1063-8, 1989 (AD-D142 932)
Key Words: Al(3)Sc, microscopy, melt spinning, hardness, compressive
properties

7. Environmental Effects in Niobium Base Alloys and other Selected Intermetallic Compounds
Meier, G. H., Thompson, A. W.
Department of Materials Science and Engineering, Pittsburgh University, PA
Annual Report Number One
Rept No: AFOSR-TR-89-0366, 68 pp., 1988 (AD-A206 072)
Key Words: NbAl(3), Nb-21Ti-10Al-15Si, Ti-24Al-11Nb, Nb-21Ti-25Si,
Nb-25Ti-12.5Al-25Si, Nb-25Ti-12.5Ta-12.5Al-25Si, turbine
components, tensile properties, fracture toughness, crack
growth

8. Progress of Powder Metallurgy in North America
Roll, K.H., Johnson, P.K.
Key Words: copper, iron, Inconel 625, AISI 316L, M-2, NiFe, rapid solidification, injection molding

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9. **R&D on Composition and Processing of Titanium Aluminide Alloys for Turbine Engines**  
Blackburn, M. J., Smith, M. P.  
Pratt and Whitney Aircraft Group, Government Products Div, West Palm Beach, FL  
Interim Report  
Rept No: PWA-FR-16259, 103 pp., 1982 (AD-B069 620)  
**Key Words:** TiAl, Ti(3)Al, Ti-25Al-10Nb-3V-1Mo, Ti-48 at pct Al-1 at pct V,  
turbine components, aluminides, microstructure, modulus,  
tensile properties, creep rupture, Charpy impact, fatigue,  
fracture toughness, thermal properties

10. **Rolling, Forming and Joining Titanium-Aluminide Sheet**  
 Battelle Memorial Institute, Columbus, OH  
Final Report  
Rept No: AFML-TR-78-59, 130 pp., 1978 (AD-B031 214)  
**Key Words:** Ti-16Al-10Nb, Ti-12Al-19Nb, Ti-13Al-20Nb, Ti-36Al-5Nb,  
Ti-32Al-5Nb-5W, rolling, superplastic forming, joining,  
tensile properties, hardness, fatigue, creep test, bend test

11. **Materials and Processing Technology for Advanced Gas Turbines**  
Hauser, H. A.  
SAMPE Qtrly 6 (3), 8 pp., 1975 (AD-D101 035)  
**Key Words:** TiAl, Ti(3)Al, Ti-6Al-4V, Ti-6Al-2Sn-4Zr-6Mo, Ti-6Al-2Sn-4Zr-2Mo,  
Ti-8Al-1Mo-1V, IN-100, IN-738, IN-792, Alloy 713, B-1900,  
MAR-M200, turbine components, fracture mechanics, fatigue,  
creep rupture
REFRACTORY METALS AND ALLOYS

1. **The Joining of Refractory Metals by Hot Isostatic Pressing**
   Werdecker, W., Aldinger, F.
   High Temp-High Pressures 14 (2), 183-97, 1982 (AD-D127 724)
   **Key Words:** Inconel 601, Kanthal A-1, molybdenum, stainless steel, dissimilar joining, diffusion bonding, microhardness

2. **Processing: The Rediscovered Dimension in High Temperature Alloys**
   Semchyshen, M.
   Standardization News 4 (4), 9-19, 1976 (AD-D110 676)
   **Key Words:** Inconel 718, RENE’ 80, AISI 4140, Udimet 700, TZM, IN-738, Waspaloy, remelting, alloying, creep rupture

3. **Processing and Characterization of Several Tungsten Alloys**
   Hall, R. C., Ossin, A., Ammon, R. L., Buckman, R. W., Aronin, L.
   Proc 20th National SAMPE Symp and Exhibition, 13 pp., 1975 (AD-D107 039)
   **Key Words:** W-10Cu, W-2ThO2, W-4Re, W-0.5HfC, turbine components, leading edges, microstructure, tensile properties, thermal properties

4. **Interdiffusion Behavior of Tungsten or Rhenium and Group V and VI Elements and Alloys of the Periodic Table-Part I**
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   Sinclair, A.N., Graf, M., Moles, M.C., Doleby, M., DaSilva, V.
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   **Key Words:** Zircaloy, Zr-2.5Nb, pressure tube, fabricated defects

2. **Progress of Powder Metallurgy in North America**
   Rolt, K.H., Johnson, P.K.
   **Key Words:** copper, iron, Inconel 625, AISI 316L, M-2, NiFe, rapid solidification, injection molding

3. **A Retrospective View of Metallurgy During the 25 Years of the Gillett Lectures**
   Jaffee, R. I.
   **Key Words:** AISI 316, Ti-6Al-4V, titanium, zirconium, hafnium, embrittlement, fracture mechanics

4. **Hot Isostatic Pressure Healing of Navy Gun Metal Castings**
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   Battelle Memorial Institute, Columbus, OH
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   Contract No: N00024-73-C-5375
   41 pp., 1974 (AD-787 598)
   **Key Words:** copper alloy 903, gun metal, microstructure, porosity, defects, tensile properties
3. Miscellaneous
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1. Applications of Coating Technology and HIP to Advanced Materials Processing
Nicholls, J. R., Stephenson, D. J.
Mater High Temp 9 (2), 110-20, 1991
Key Words: nickel, copper, phosphor bronze, Ni-13Al, MAR-M002, AA 7075, AA 8090, silver, Inconel 625, ion plating, electron beam evaporation, coatings, microstructure, creep, diffusion bonding

2. The Influence of Specimen Geometry on Near Threshold Fatigue Crack Growth
Vecchio, R. S., Crompton, J. S., Hertzberg, R. W.
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Key Words: Udimet 700, AA 2024-T3, grain size, crack growth, fatigue crack

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Author Anon
Foreign Technology Division, Wright-Patterson AFB, OH
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Key Words: Ti-6Al-4V, B-1900, IN-738, RENE’ 77, IN-792, RENE’ 80, AA C355, AA A356, 142-T4

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Key Words: nickel alloys, aluminum alloys, steels, T63 turbine components, defects, fatigue, fabrication, cracking, fracture, ultrasonic testing, stress analysis

5. Metalforming’s Big Push to Systems Technologies
Larsen, R. J., Harvey, R. E., Post, C. T., Weimer, G. A., LeCerf, B. H.
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Key Words: Ti-6Al-4V, copper, aluminum, stainless steel, superplastic forming, diffusion bonding

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   Frommeyer, G.
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   Key Words: 5Cr steel, 18Cr stainless, forging, atomization, tensile properties, rapid solidification

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   Key Words: Pyromet X-15, T-111, Ti-6Al-4V, diffusion welding, bonding, dissimilar joining

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   Key Words: stainless steel, welds, microstructure, mechanical properties

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6. **Feasibility Study on the use of Small-Angle Neutron Scattering for Microstructural Determinations of Technological Alloys**
   Herman, H.
   State University of New York at Stony Brook, Department of Materials Sciences, NY
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   58 pp., 1978 (AD-A061 867)
   Key Words: Ti-6Al-4V, HY-130, AISI 304, Udiment 700, creep-fatigue, crack detection
7. Technological Considerations in the Forging of Superalloy Rotor Parts
Wilkinson, N. A.
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**Key Words:** Waspaloy, Udiment 700, Inconel 718, A-286, grain size, grain boundaries, thermomechanical treatment, notch sensitivity, tensile properties, creep properties, fatigue size, Charpy impact, dislocation structure

8. Compositional and Structural Aspects of Processing Nickel-Base Alloys
Knott, A. R., Symonds, C. H.
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**Key Words:** Monel 400, Nimonic 75, Nimonic 80A, Nimonic 90, Nimonic 105, Nimonic 115, Nimonic PE13, Inconel 600, Inconel 718, Incoloy 800, Incoloy 825, microstructure, deformation, segregation, grain size

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**Key Words:** niobium alloys, titanium alloys, AISI 310, Inconel X-750, Inconel 706, Inconel 718, Incoloy 903, AA 6061, A-286, Invar, Kromarcs 58, 21-6-9 steel, tensile properties, fatigue

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**Key Words:** Inconel 625, AISI 4130, cladding, corrosion, tensile properties, dissimilar joining

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   Key Words: Waspaloy, Inconel 718, IN-100, RENE' 95, MERL 76, Udimet 700, tensile properties, creep rupture, fatigue

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   DeRidder, A. J., Koch, R.
   ASTM, Philadelphia, PA
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   Key Words: RENE' 95, Waspaloy, Inconel 718, IN-100, microstructure, thermomechanical treatment
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**Key Words:** IN-100, Waspaloy, RENE'95, Inconel 718, welding, grain size, bonding, recrystallization, temperature effect

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Knott, A. R., Symonds, C. H.
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**Key Words:** Monel 400, Nimonic 75, Nimonic 80A, Nimonic 90, Nimonic 105, Nimonic 115, Nimonic PE13, Inconel 600, Inconel 718, Incoloy 800, Incoloy 825, microstructure, deformation, segregation, grain size

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**Key Words:** niobium alloys, titanium alloys, AISI 310, Inconel X-750, Inconel 706, Inconel 718, Incoloy 903, AA 6061, A-286, Invar, Kromarc 58, 21-6-9 steel, tensile properties, fatigue

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**Key Words:** RENE'95, forging, cyclic loading, fatigue, crack closure
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Miner, R., Gayda, J., Maier, R. D.
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Key Words: Waspaloy, Udimet 700, RENE' 95, IN-100, MERL 76, NASA IIB-7, turbine components, microstructure, creep-fatigue, slip

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Key Words: RENE' 95, Waspaloy, Inconel 718, IN-100, microstructure, thermomechanical treatment

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Billard, D., Trottier, J. P.
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Key Words: IN-100, Waspaloy, RENE' 95, Inconel 718, welding, grain size, bonding, recrystallization, temperature effect

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Bamberger, E. N., Mosier, J. S.
General Electric Co., Aircraft Engine Group, Evendale, OH
First Quarterly Engineering Report
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Key Words: RENE' 95, Compressor discs, tensile properties, creep rupture, chemical milling, machining, microstructure, density, solution heat treatment

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Evans, D. J.
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Key Words: Udimet 700, RENE' 95, Ti-6Al-4V, turbine components, tensile properties, creep rupture, net shape forming

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Udimet 700

1. The Influence of Specimen Geometry on Near Threshold Fatigue Crack Growth
   Vecchio, R. S., Crompton, J. S., Hertzberg, R. W.
   Fatigue Fract Eng Mater Struct 10 (4), 333-42, 1987 (AD-D137 808)
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   Key Words: Ti-6Al-4V, B-1900, IN-738, RENE' 77, IN-792, RENE' 80, AA C355, AA A356, 142-T4

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   Key Words: Udimet 700, cylinders, microstructure, gamma prime, deformation, compressive properties, thermomechanical treatment

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   Gessinger, G. H.
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   Key Words: IN-738, IN-738LC, Udimet 700, Nimonic 80A, turbine components, oxide dispersion strengthening, tensile properties, corrosion, thermal fatigue, hardness, grain growth

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8. Technological Considerations in the Forging of Superalloy Rotor Parts
Key Words: Waspaloy, Udimet 700, Inconel 718, A-286, grain size, grain boundaries, thermomechanical treatment, notch sensitivity, tensile properties, creep properties, fatigue size, Charpy impact, dislocation structure

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Waspaloy

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2. Hot Isostatic Pressing of PM and Cast Components
   Stephenson, D. J., Downing, M.
   Key Words: IN-792, IMI 829, IMI 318, IN-738, Alloy 713C, Ti-6Al-4V, nickel, tensile properties, defects, near net shape forming, fatigue, density

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   Tien, J. K., Borofka, J. C., Casey, M. E.
   J Met 38 (12), 13-7, 1986 (AD-D136449)
   Key Words: nickel alloys, turbine components, crack growth, fatigue, vacuum induction, electroslag, electron beam melting

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   Author Anon
   Foreign Technology Division, Wright-Patterson AFB, OH
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   Key Words: Ti-6Al-4V, B-1900, IN-738, RENE’ 77, IN-792, RENE’ 80, AA C355, AA A356, 142-T4

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   Key Words: nickel alloys, aluminum alloys, steels, T63 turbine components, defects, fatigue, fabrication, cracking, fracture, ultrasonic testing, stress analysis

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   Uhl, W. K., Pendley, M. R.
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   Key Words: Inconel 625, AISI 4130, cladding, corrosion, tensile properties, dissimilar joining

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   Turner, F.
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Carlson, D. M.
ASM International, Metals Park, OH
Key Words: AF-115, turbine components, creep rupture, tensile properties

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Key Words: Ti-10Mo-6Cr-2.5Al, Ti-7Mo-4Cr-2.5Al, Ti-10Mo-8V-2.5Al, IMI 679, IMI 685, Ti-6Al-25Sn-4Zr-2Mo, Ti-10V-2Fe-3Al, Inconel 718, Waspaloy, Incoloy 901, fatigue, crack growth

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Reed, R. P., Clark, A. F., Van Reuth, E. C.
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Contract No: ARPA Order-2569, 636 pp., 1975 (AD-A019 230)
Key Words: niobium alloys, titanium alloys, AISI 310, Inconel X-750, Inconel 706, Inconel 718, Incoloy 903, AA 6061, A 286, Inv-ir, Kromarc 58, 21-6-9 steel, tensile properties, fatigue

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Ti-6Al-4V

1. Hot Isostatic Pressing of PM and Cast Components
   Stephenson, D. J., Downing, M.
   Key Words: IN-792, IMI 829, IMI 318, IN-738, Alloy 713C, Ti-6Al-4V, nickel, tensile properties, defects, near net shape forming, fatigue, density

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   Author Anon
   Foreign Technology Division, Wright-Patterson AFB, OH
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   Michael, C. J.
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   Key Words: Ti-6Al-4V, turbofan engine, fan blades, superplastic forming, diffusion bonding, tensile properties, fatigue

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   Broichhausen, J., Telfah, M.
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   Key Words: Ti-6Al-4V, Ti-6Al-4Ti-2Sn, aircraft structures, welding, diffusion bonding, superplastic forming, net shape forming
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   Hightberger, W. T.
   Metal Prog 115 (3), 56-59, 1979 (AD-D114 858)
   **Key Words:** Ti-6Al-6V-2Sn, Ti-6Al-4V, Corona-5, Ti-4.5Al-5Mo-1.5Cr, aircraft structures, net shape forming, superplastic forming, diffusion bonding

9. **Metalforming's Big Push to Systems Technologies**
   Larsen, R. J., Harvey, R. E., Post, C. T., Weimer, G. A., LeCerti, B. H.
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    Heman, H.
    State University of New York at Stony Brook, Department of Materials Sciences, NY
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    Battelle Memorial Institute, Columbus, OH
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    **Key Words:** Udiment 700, RENE' 95, Ti-6Al-4V, turbine components, tensile properties, creep rupture, net shape forming

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1. **Hot Isostatic Pressing of PM and Cast Components**
   Stephenson, D. J., Downing, M.
   **Key Words:** IN-792, IMI 829, IMI 318, IN-738, Alloy 718C, Ti-6Al-4V, nickel, tensile properties, defects, near net shape forming, fatigue, density
2. **Additional Fracture and Strength Test Results for A723 Steel and 38644 Titanium**  
Underwood, J. H., Kamdar, M. H., Fujczak, R. R.  
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**Key Words:** A723, 38644, cylinders, pressure vessels, fracture toughness, fatigue, crack growth, notch fatigue, burst test, aluminum coating

3. **Microstructural Coarsening at High Temperatures in Rapidly Solidified Ti-5wt.%Al-2.9wt.%Y and Ti-5wt.%Al-7.5wt.%Th**  
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Key Words: Ti-6Al-4V, Ti-15V-3Cr-3Al-3Sn, aircraft structures, superplastic
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Metallurgia and Metal Forming 44 (6), 251-6, 1977 (AD-D110 439)
Key Words: Ti-16Al-1ONb, aluminum alloys, turbine components, microstructure,
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thermal properties, fracture, hardness, fatigue, tensile properties, creep rupture, notch properties

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Reed, R. P., Clark, A. F., Van Reuth, E. C.
National Bureau of Standards, Cryogenics Division, Boulder, CO
Semi-Annual Technical Report
Contract No: ARPA Order-2569
636 pp., 1975 (AD-A019 230)
Key Words: niobium alloys, titanium alloys, AISI 310, Inconel X-750, Inconel
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58, 21-6-9 steel, tensile properties, fatigue
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   Semiatin, S. L., Frey, N., El-Soudani, S. M., Bryant, J. D.
   Key Words: TiAl, Ti-48 at pct Al-2.5 at pct Nb, Ti-48 at pct Al-2 at pct Nb-2
   at pct Cr, isothermal forging, hot compression test

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   Kim, Y-W.
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   crystal structure, phase diagram, microstructure, grain size,
tensile properties, fracture toughness, oxidation, crack
growth, creep, thermomechanical treatment, fracture surface
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1. Application of Diffusion Welding in the USA
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   Vance, R. R., Courtney, T. H.
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   **Key Words:** Cu-15 vol. % Nb, density, hardness, mechanical alloying, microstructure

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   Nicholls, J. R., Stephenson, D. J.
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   **Key Words:** nickel, copper, phosphor bronze, Ni-13Al, MAR M002, AA 7075, AA 8090, silver, Inconel 625, ion plating, electron beam evaporation, coatings, microstructure, creep, diffusion bonding

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   Blackford, J. R., Tidbury, L. E.
   TMS, Warrendale, PA
   **Key Words:** coatings, vapor deposition, microscopy, electron microprobe analysis

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   Raman, R. V., Rele, S. V., Lasley, C. C., Krotz, P. D.
   Metal Powder Industries Federation, Princeton, NJ
   **Key Words:** copper alloy 1035, chromium addition, zirconium addition, microstructure, particle size distribution, vacuum plasma spraying, tensile properties

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   Lancaster, J. S., Kushner, B. B.
   BDM International Inc., Arlington, VA
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   Rept No : BDM/ROS-90-0562-TR, 175 pp., 1990 ( AD-A223 035 )
   **Key Words:** artificial intelligence, control systems, models

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   Lavernia, E. J., Gomez, E., Grant, N. J.
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   **Key Words:** Mg-8Al-0.2Zr, Mg-6Al-0.3Zr, microstructure, hot rolling, tensile properties

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   Wadley, H. G., Kahn, A. H., Gefen, Y., Mester, M.
   **Key Words:** copper, density sensors, metallography, yield properties
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**Key Words:** samarium alloys, cobalt addition, heat treatment, spinning, nonsuperconducting generators

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Michael, M. D., Cappetta, J.  
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**Key Words:** XM-785-Nb-Ti, diffusion bonding, projectiles, processing ultrasonic testing

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Steiner, E. G., Kaisand, D. D.  
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**Key Words:** XM-785 projectile, manufacturing

14. **Metalforming’s Big Push to Systems Technologies**  
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**Key Words:** Ti-6Al-4V, copper, aluminum, stainless steel, superplastic forming, diffusion bonding

15. **Reliability of Hot Isostatic Systems**  
Bowles, A. G.  
Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH  
Proc Net Shape Metalworking Program Review 281-7, 1976 (AD-D119 179L)  
**Key Words:** reliability, design, pressure vessels

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   Conaway, R. M.
   Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
   Proc Net Shape Metalworking Program Review 288-98, 1976 (AD-D119 1801.)
   Key Words: densification, bonding, consolidation

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   Younger, F. K.
   Manufacturing Technology Division, AFML, Wright-Patterson AFB, OH
   Proc Net Shape Metalworking Program Review 299-308, 1976 (AD-D119 1811.)
   Key Words: design, equipment, pressure vessels
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