5-73-63-4

PLASMA JET WELDING, COATING, AND CUTTING: AN ANNOTATED BIBLIOGRAPHY

64-5

SPECIAL BIBLIOGRAPHY
SB-63-21

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Compiled by

SCOTT J. BUGINAS

SPECIAL BIBLIOGRAPHY
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Work done in support of Lockheed Independent Research Program

Lockheed

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A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

SUNNYVALE, CALIFORNIA

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ABSTRACT

The search was made in the literature of 1960 – 1962. News-release type articles were included because of our interest in manufacturing applications. Anonymous articles are interfiled alphabetically by title within the bibliography which is arranged alphabetically by author.

Search completed February 1963

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1. Anderson, J. E. and L. K. Case
An analytical approach to plasma torch chemistry.
INDUSTRIAL & ENGINEERING CHEMISTRY-
PROCESS DESIGN AND DEVELOPMENT 1: 161–165,
Jul 1962.

Available thermodynamic and kinetic data are applied to predict quantitatively the overall results that are obtained when hot hydrogen from the plasma torch is mixed with methane and the mixture is subsequently quenched. The results of the analytical treatment are compared to experimental data and the agreement is very good.

2. Berg, Richard E.
Plasma cutting torches. AMERICAN MACHINIST 105
(24): 93–96, 1961.

An argon-hydrogen mixture is blown through a high-current tungsten arc. General design and operation features of commerical torch units are discussed. Ferrous metals may be cut with the addition of iron powder to the gas feed. Aluminum or magnesium plate up to 5 inches thick can be cut. Stainless steel, nickel, monel and inconel plate up to 4 inches thick can be cut.

3. Browning, J. A.
Machining with a plasma jet. AMERICAN
MACHINIST/METALWORKING MANUFACTURING
106: 94–95, 11 Jun 1962.

Refractory materials, Rene 41, mild steel and H-11 alloy were cut, machined and threaded with a plasma jet which developed temperatures up to 30,000° F.

4. Browning, J. A.
Plasma flame speeds metalworking. TOOL
ENGINEER 44 (4): 105–108, Apr 1960.

The theory of temperature generation in a plasma arc is presented. Industrial applications are mentioned.

5. Browning, J. A.
Thermal air cutting; process and economics.
WELDING JOURNAL 41: 458–466, May 1962.

6. Butta, M.
A new type of cutting torch: the "plasma torch."
MACCHINE (8): 791, 1959. (In Italian)

A brief description of the operation and applications of the torch.

7. Christiansen, F.
Plasma torch: applied plasma physics.
NAG-TIDSSKRIFTET 25 (3): 42–44, 1961
(In Norweigian)

The physics of the plasma effect is discussed. Types of torches for metallizing and cutting are described and applications in rockets and nuclear equipment are mentioned.

8. Clark, J. W. and Wodke, C. H.
Plasmarc torch cuts off "hot" plates. IRON AGE
188: 90–91, 13 Jul 1961.

9. Fischer, G. W.
Which metal spray coating; plasma or metallizing?
MACHINERY 68: 83–90, Aug 1962.

10. Gage, R. M.
The plasma arc can now be used for welding and
weld surfacing. WELDING DESIGN & FABRICA-
TION 34: 76–78, 80, Apr 1961.

Principles of plasma arc welding, heat transfer, transferred and non-transferred arc torches are discussed. Plating, cutting, welding and weld surfacing operations with high-strength materials and refractory metals are described.

11. Gage, R. M.
The plasma torch. ELECTRONIQUE INDUSTRIELLE 31: 45–47, Feb 1960. (In French)

The operation of the plasma torch and its use in spraying and cutting metals are presented.

12. Gerhold, E. A.
Hard-facing with plasma spray guns. BRITISH WELDING JOURNAL 7 (5): 327–330, 1960.

Plasma arc operating principles and characteristics and torch design are discussed. A production unit which can achieve temperatures up to 16,000°C is described. Denser, more adherent deposits can be made with a plasma gun than with metallizing techniques.

13. Hackman, R. L.
Putting plasma jets to work. TOOL AND MANUFACTURING ENGINEER 46: 85–89, Mar 1961.

Discusses the design of plasma arc torches and their applications in cutting, plating and welding.

14. Hayes, G. A. and U. L. Johns
AN INVESTIGATION OF THE FEASIBILITY OF FORMING ALLOY COATINGS WITH A PLASMA JET. Naval Ordnance Test Station, China Lake, Calif. Technical paper 2616. 2 Feb 1961, 38p. (NAVWEPS rept. 7617). ASTIA AD-253 053 (Also available from Office of Technical Services PB 171 843. $1.00)

Alloy coatings formed by spraying mixtures of metal powders with a plasma arc are discussed. An inert spraying chamber must be installed to spray at a higher temperature without excessive oxidation. The powder feed mechanism is modified to introduce each powder separately into the plasma stream. A high temperature vacuum annealing furnace is added to increase coating density and homogeneity and improve adhesion by diffusion.

15. Heckner, H.
The plasma arc as a heat source. SCHWEISSEN UND SCHNEIDEN 12(3): 114-115, Mar 1960 (In German), (Also in NAVIRES (130), 196, Mar 1961)

Discusses the construction and operation of a plasma arc torch, and its applications.

16. The importance of the plasma jet.
MACHINERY 98: 807, 858, 12 Apr 1961.

Reports on a paper presented at an ASTE meeting. Torches are used to cut 4-inch thick copper plate.

17. Ingham, H. S.
Flame sprayed protective coatings, made from refractory materials. MATERIALS PROTECTION, 1962, 1, No. 1, 74-8.

Flame and plasma arc spraying of refractory coatings are reviewed and applications and properties of the coatings are presented.

18. Jackson, Clarence E.
The science of arc welding. WELDING JOURNAL 39 (4): 129s-140s, 1960.

Tungsten arc plasma radiation and temperatures are included in this published lecture.

19. Kramer, B.E., M.A. Levinstein and J.W. Grenier
THE EFFECT OF ARC PLASMA DEPOSITION ON THE STABILITY OF NON-METALLIC MATERIALS. General Electric Co., Cincinnati, Ohio. Final rept., Apr. 60 - May 61. May 61, 57pp. incl. illus. tables. (Contract NOa(s) 60-6076-c) ASTIA AD-264 602

The oxides of Al, Cr, Zr, Ce, Hf and mixtures of Zr and Nb; the carbides of Hf, Ta, and Zr; the nitrides of Ti and Ta; and the boride of Zr can be sprayed on a graphite substrate without chemical or microstructure alteration; the operating conditions for the deposition of these materials were determined. Properties useful in design data:

the coefficient of thermal expansion, density, compressive strengths, electrical resistance and hardness were obtained. The resistance of the deposited coatings to a 5000°F, high velocity air blast was determined as well as the static oxidation behaviour. Al_2O_3, Cr_2O_3 and Zr boride conferred resistance to graphite in the blast test. The carbide and nitride did not withstand the oxidation erosion test.

20. Kulagin, I. D., and A. V. Nikolaev
The arc plasma jet as a heat source in the working of materials. WELDING PRODUCTION 5(9): 1-11, Sep 1959. (translated from SVAROCHNOE PROIZVODSTVO 5(9): 1-4, Sep 1959

Describes how to create a plasma jet in an inert atmosphere using helium or argon with carbon or tungsten electrodes. The arc plasma heads for manual or automatic welding are described. Thermal and mechanical properties of the jet are included.

21. Levinstein, M. A. ,ed.
RECENT ADVANCES IN ARC-PLASMA METALLIZING. In Commission I: "Gas welding and allied processes," Colloquium on Metal Spraying, ANNUAL ASSEMBLY OF THE INTERNATIONAL INSTITUTE OF WELDING, Liege, The Institute. 23p., 1960. (Inquire via the Technical and Scientific Secretary of the International Institute of Welding, M.A. Leroy, 32 boulevard de le Chapelle, Paris 18^e). (Also in METAL FINISHING JOURNAL 6(72):, 467-474, 1960)

Includes a discussion of the physical and mechanical properties of the deposited metals after spraying and heat treating.

22. Levinstein, M. A., A. Eisenlohr, and B. E. Kramer
Properties of plasma-sprayed materials. (WELDING JOURNAL, 40(1), 8s - 13s, 1961

Arc-plasma metallizing equipment is described.

23. Lohrie, B.
Plasmajets headed for production roles.
(STEEL, 147, 110-112, 1960)

Plasmajets for depositing refractory metals and ceramic materials are described.

24. Mash, D. R.
Plasma-arc spraying of refractory metals.
Canadian Machinery and Metalworking, 73(8): 81-83,
Aug 1962

The maximum plasma spray particle sizes are given for refractory metals, 304 stainless, tantalum carbide, beryllium oxide and zirconium oxide. Applications of plasma and spraying are given.

25. Mash, D. R.
Plasma-arc spraying of space-age materials.
Western Machinery and Steel World, 53: 48-53,
Apr 1962

The effects of welding and cutting and other factors on the physical and mechanical properties and corrosion resistance of refractory metals, stainless steels and other materials are discussed.

26. Mock, J. A.
Plasma arc-torch fabricates tough materials.
MATERIALS IN DESIGN ENGINEERING 49(3):
133-134, 1959.

Refractory metals can be deposited as coatings or built up to form rocket and missile parts or other manufactured items.

27. Monroe, R. E.
New joining processes for uncommon materials.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS,
61-AV-61, 1961, 7p. (Summary appears in Mechanical
Engineering 83(8): 79-80, Aug 1961).

Review of electron beam, ultrasonic, plasmajet and explosive welding, inert gas-shielded electrode welding, diffusion bonding and brazing techniques for uncommon materials such as Cb, W, Ti, and Zr.

28. Mosby, H. V.
Plasma-jet coating: Ultra-high temperature applications for rocket motors. (AIRCRAFT PRODN., 23(6): 1961.

Refractory metals and common metals such as copper, nickel and aluminum or any material which can be melted without decomposition can be deposited.

29. Nash, D. R., N. E. Weare, and D. L. Walker
Process varaibles in plasma-jet spraying.
J. METALS, 13(7): 1961.

Power input, arc-gas flow and spray distance have a strong influence on deposition efficiency and coating depth. The powder-feed rate and powder-gas flow have moderate effects, and changes in traverse rates have little or no effects on deposition efficiency and depth.

30. Nessler, C. G., and J. R. Palermo
Plasma arc coatings. MATERIALS IN DESIGN ENGINEERING 55: 109-113, Jun 1962

Metallic and nonmetallic parts are coated with various carbides, cermets, borides, nitrides, alloys and pure metals. The strength, wear and heat and corrosion resistance of plasma arc coatings are discussed.

31. New electric forming methods offer potentials for light metals; magnetic forming and plasma forming. LIGHT METAL AGE 20: 8-9, Feb 1962.

32. O'Brien, R. L.
Plasma arc; new fabricating tool.
SAE JOURNAL 69: 84-86, Jul 1961

Plasma arc used for cutting, underwater cutting, plating and surfacing is described.

33. Okada, M., et al
Fundamental researches on plasma jet and its application. TECHNOL. REP. OSAKA UNIV. 10 (384): 209-219, 1960. (In English)

Carbon, copper and tungsten electrodes were used in the plasma torch. Cathode position was found to affect the electrical characteristics and the stability of the plasma flame. A dark space was noticed in front of the anode. Plasma welding is described.

34. Pearcy, M. A.
Composition plasma arc spraying. Lockheed Missiles and Space Division, Lockheed Aircraft Corp., Sunnyvale, Calif. Special Bibliography No. SB 61-7, 6p., Mar 1961.

The bibliography presents a selection of the literature of 1959 and 1960 on the plasma arc spraying of metals.

35. Phelps, H. C.
Plasma flame cutting of mild steel seen as competitive with oxy-fuel process. WELDING ENGINEER 45 (12): 33-37, Dec 1960.

Describes commercial equipment comprising a torch, control console and a dc power source. Quality cuts in ferrous and nonferrous materials are obtained at increased speeds and less cost.

36. The plasma arc - a new tool for welding and cutting. WELDING FABRICATION AND DESIGN 3 (12): 10-11, Aug 1960.

37. Plasma arc metal spraying. METAL INDUSTRY, 101(1): 11-12, 6 Jul 1962

Operating characteristics and electrical parameters for spraying with tungsten and molybdenum are described. Liquid stabilized arcs are used in nitrogen, hydrogen, argon, helium and air atmospheres.

38. The plasma arc torch. WELDING AND METAL FABRICATION, 27: 287-290, July 1959.

Wire or powder is heated to temperatures up to 16,648° C with the torch.

39. The plasma-arc torch finds a wide range of tasks. WELDING JOURNAL 39(3): 236-237, Mar 1960.

Discusses the application of the torch in fabricating, coating and materials testing.

40. Plasma arcs set for full production role. STEEL 148: 70-72, 29 May 61.

Applications of the plasma arc in cutting 4 or 5 in. ferrous and nonferrous metals at speeds up to 300 ipm. for, plating missile and rocket parts, surfacing and welding all metals at speeds comparable to those of standard Mig and Tig arc welding processes.

41. Plasma flame spraying equipment; Metco, Ltd. ENGINEER 213: 1093, 22 Jun 1962.

42. Plasma jet. (Jet de plasma). LE MONITEUR PROFESSIONAL DE l'ELECTROCITE 16 (166): 32, 15 Dec 1961. (In French)

Information on the plasma used in metal spraying applications is provided.

43. Plasma torch learns to weld. AMERICAN MACHINIST/METALWORKING MANUFACTURING 105: 115, 17 Apr 61.

Describes an advanced type of Tig welding in which the arc and the inert gas pass through a constricted orifice designed to turn the gas into a plasma at 10,000° F. and up.

44. Plasma torches cut metals with arc-heated air: save time and expense. MARINE ENGINEERING LOG 67: 103, May 1962.

45. Podkovich, E. G., et al
The structure and properties of pseudo-alloys obtained by electric and flame metal spraying.
TRUDY ROSTOVSK. INST. SEL'SK. KHOZ. MASHINOSTROENIE 12: 46-51, 1959. (In Russian)

Flame sprayed coatings have a smaller particle size, fewer oxides and are less porous than electrically sprayed coatings. Mechanical properties and efficiency of the flame sprayed coatings were better.

46. Poulsen, S. C.
The oxyacetylene plasmadyne of plasma arc.
MACHINE MODERNE, 56: 25-29, Apr 1962.

Welding and coating metal machine components with tungsten, tantalum, niobium, molybdenum, zinc, lead, copper, brass, aluminum, stainless steel or zirconium or aluminum oxide degree of purity and deposition thickness are discussed.

47. Present industrial use of the plasma torch.
(La torche a plasma est maintenant industrielle)
L'INDUSTRIE FRANCAISE 10 (113): 700-710, Jul-Aug 1961. (In French)

Fundamentals of torch operation and industrial applications.

48. Reininger, H.
Further developments in metal spraying.
METALLOBERFLACHE, 15 (2): 52-7; (3) 88-90, 1961. (In German)

A review covering equipment, surface preparation structure of coatings, after-treatment, spray welding and spray soldering processes, protective properties, sprayed bearings and testing.

49. Roesler, G.
High frequency plasma torch, ELECTRO-WARME 19(6): 232-236, Jun 1961. (In German)

Contains a description of the physical phenomena in a plasma jet, and of the materials used in torch construction.

50. Rother, W.
The plasma generator - a coming tool. SCHWEISS-TECHNIK 11 (2): 77-78, Feb 1961. (In German)

The operating principles and design of a short arc and long arc generator are presented.

51. Schad, H.
16,000° C obtained by means of the plasma jet torch. JOURNAL DE LA SOUDURE 50(2): 36-39, Feb 1960. (In French)

Principles and applications of the plasma jet torch are discussed.

52. Scholz, O.
The high frequency plasma flame, a new heat source. SCHWEISSEN UND SCHNEIDEN 11: 497-498, Dec 1959. (In German)

The design and operation of a plasma torch are discussed and potential applications are mentioned.

53. Selover, T. B., Jr.
Properties of nickel fume generated in a plasma jet. METAL PROGRESS 82: 1544, Aug 1962

54. Sherwood, P. W.
Ultra-high temperature spraying. PRODUCT FINISHING, 14 (11): 98-100, 1961.

Flame plating with a temperature possibility above 6,000° F, and plasma arc spraying with temperatures above 20,000° F are described for applying refractory coatings.

55. Singleton, R. H., E. L. Bolin and F. W. Carl
Tungsten fabrication by arc spraying. JOURNAL OF METALS 13 (7): 483-486, 1961.

The development of plasma arc spraying for fabrication freestanding tungsten bodies is described and production potentials are discussed.

56. Stetson, A. R., and C. A. Hauck
Plasma-spraying techniques for toxic and oxidizable materials. J. METALS, 13 (7): 479-482, 1961.

The toxicity and oxidation problems connected with the plasma spraying of beryllium and beryllium oxide and some carbides and nitrides can be controlled by spraying with the proper facilities.

57. Sunnen, J.
An arc device for the application of very high temperatures. ARCOs 38: 38-47-3854, 1961. (In French)

A description of the plasma jet torch and its use is provided. A history and a discussion of the principles of constricted arc operation is included.

58. Technology's newest baby: The plasma torch. MACHINE MODERNE, 53: 9-12, May 1959.

Description and operation; use in welding cutting, melting, forming and coating.

59. Thorpe, M. L.
Plasma arc equipment. (assigned to Metallizing Engineering Co., Inc., USA) French Patent 1,260,262, 7 May 1960.

60. Torch cuts with 60,000-F air. MECHANICAL ENGINEERING 84: 66, Jul 1962.

61. Tourin, R. H.
Infrared techniques for temperature measurement in plasmajets. ASME TRANSACTIONS Ser. C. 84: 164-168, May 1962.

62. Trub, W., and R. Oechslin
Plasma jet cutting. ALUMINUM SUISSE,
12 (2): 93-95, 1962. (In French and German).

A tungsten electrode is used with hydrogen and nitrogen gases to cut aluminum.

63. Vagi, J. J., et al
REVIEW OF RECENT DEVELOPMENTS IN METALS
JOINING. Defense Metals Information Center,
Battelle Memorial Institute. DMIC Memo 125 5p.,
1 Sep 1961.

Includes information on plasma jet welding.

64. Wendel, H.
The plasma jet torch: international literature
review. SCHWEISS-TECHNIK 11 (5): 206-209,
May 1961. (In German)

The design fundamentals and operation of a plasma torch are presented. The use of the torch for cutting is reviewed.

65. Where is plasma arc today? AMER.
MACHINIST, 103 (22): 125-127, 1959;
(also in METALWORKING PRODN. 104 (4):
158-160, 1960).

66. White, R. W., R. K. Carlson and B. A. Forcht
The calibration and use of a 40 KW plasma arc
as a high temperature materials test tool.
PLATING, 49 (3), 274-8, 1962.

67. Witting, E.
Principles and applications of the plasma-arc processes.
SCHWEISSEN U. SCHNEIDEN, 14 (5), 193-200, 1962.

The generation of the arc plasma in operating torches is described. An arc struck between the tungsten cathode and a workpiece gives a high heat input into the base metal and is used for cutting materials beyond the flame-cutting range. When the anode is the outer casing of the torch, the nontransmitted arc is used for spray deposition.

68. Zuchowski, R. S. and R. P. Culbertson
Plasma arc weld surfacing. WELDING JOURNAL
41: 548-555, Jun 1962.

Overlays of 0.010 to 1/8 inch having low dilution values and good deposition rates can be produced with the plasma arc process. Microstructures of weld surfaces applied at 14,000 to 18,000°K and composed of powdered 316 stainless, copper, tin, tungsten carbide, or iron, cobalt, nickel or chronium alloys were studied.

SOURCE — AGENCY

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