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14. ABSTRACT The Armor Ceramics Symposium was held January 27-29, 2014 in Daytona Beach, FL as part of the 38th International Conference & Exposition on Advanced Ceramics and Composites. The 12th edition of this symposium consisted of over 70 oral and poster presentations on topics such as Synthesis and Processing, Materials Characterization, Quasi-static and Dynamic Behavior, Modeling, Testing and Evaluation, and Applications. The symposium continues to foster discussion and collaboration between academic, government and industry personnel from around the globe. A peer-reviewed proceedings was published that included 14 papers from this symposium.					
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Report Title

Final Report: Armor Ceramics Symposium 2014 - ACerS 38th International Conference on Advanced Ceramics and Composites

ABSTRACT

The Armor Ceramics Symposium was held January 27-29, 2014 in Daytona Beach, FL as part of the 38th International Conference & Exposition on Advanced Ceramics and Composites. The 12th edition of this symposium consisted of over 70 oral and poster presentations on topics such as Synthesis and Processing, Materials Characterization, Quasi-static and Dynamic Behavior, Modeling, Testing and Evaluation, and Applications. The symposium continues to foster discussion and collaboration between academic, government and industry personnel from around the globe. A peer reviewed proceedings was published that included 14 papers from this symposium. The papers were published in The American Ceramic Society's Ceramic Engineering and Science Proceedings (see citation below):

Ceramic Engineering and Science Proceedings, Volume 35, Issue 4; Advances in Ceramic Armor X; Jerry LaSalvia, Editor; Andrew Gyekenyesi and Michael Halbig, Volume Editors, 2014

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received

Paper

TOTAL:

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received

Paper

TOTAL:

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

12/29/2014 1.00 Geert Roebroeks, Erik Carton , P. Karandikar, B. Givens, A. Liszkiewicz, S. Wong, M. Aghajanian, Lionel Vargas-Gonzalez, Victor Rodriguez-Santiago, Andres A. Bujanda, Brandon S. Aldinger, Houzheng Wu, Santonu Ghosh, Claire E.J. Dancer, Richard I Todd, V. DeLucca , R. A. Haber, Leslie Lamberson, Helmut Werheit, Kanak Kuwelkar, Vladislav Domnich, K. D. Behler, A. Z. Hutchinson III, J. C. LaSalvia, Tyler Munhollon, Kanak Kuwelkar, M. Fatih Toksoy, William Rafaniello, Minh Vu , Michael Grinfeld. Advances in Ceramic Armor X, CESP Volume 35, Issue 4, 2014, 38th Intl. Conference on Advanced Ceramics and Composites. 27-JAN-14, . : ,

TOTAL: 1

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

<u>NAME</u>	<u>PERCENT_SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Post Doctorates

<u>NAME</u>	<u>PERCENT_SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Under Graduate students supported

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields: 0.00

Names of Personnel receiving masters degrees

<u>NAME</u>
Total Number:

Names of personnel receiving PHDs

<u>NAME</u>
Total Number:

Names of other research staff

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

Technology Transfer

The Armor Ceramics Symposium was held January 27-29, 2014 in Daytona Beach, FL as part of the 38th International Conference & Exposition on Advanced Ceramics and Composites. The 12th edition of this symposium consisted of over 50 oral and poster presentations. The 2014 symposium continued to foster discussion and collaboration between academic, government and industry personnel from around the globe. A peer reviewed proceedings was published that included 14 papers from this symposium. The papers were published in The American Ceramic Society's Ceramic Engineering and Science Proceedings (see citation below) and is available via John Wiley & Sons (www.wiley.com/go/ceramics).

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Armor Ceramics Symposium 2014

38th International Conference on Advanced Ceramics and Composites

Organized by The American Ceramic Society

Daytona Beach, FL - January 26-31, 2014

Symposium Chair: Jerry LaSalvia, US Army Research Lab

Principle Investigator for ARO Funding: Andy A. Wereszczak, ORNL

SUMMARY

The success of the Ceramic Armor Materials by Design symposium at Pack Rim IV International Conference on Advanced Ceramics and Glasses in November 2001 coupled with the U.S. military actions in response to the September 11, 2001 terrorist attacks were two of the reasons for creating an annual symposium on armor ceramics. Furthermore the success of the Pac Rim symposium showed the need for an annual unclassified gathering focused on the challenges related to the development, identification and fabrication of armor ceramics. Prior to November 2001 the vast majority of meetings were classified with restrictions on who could attend. The primary objective of the Armor Ceramics Symposium is to provide an annual forum for the presentation and discussion of unclassified information and ideas pertaining to the development, optimization, and evaluation of ceramic materials for armor applications. It was determined that the maximum benefit of such a symposium would be realized by holding it in conjunction with the annual International Conference and Exposition on Advanced Ceramics and Composites organized by the Engineering Ceramics Division of the American Ceramic Society.

In 2002 a committee was formed to organize a focused session entitled "Topics in Ceramic Armor". This first session was held in January 2003 and consisted of 32 oral and poster presentations covering the areas of Novel Material Concepts, Dynamic Testing and Modeling, and Transparent Ceramics. On average 100-125 people were in attendance throughout this day and a half session. Within three years this session evolved into an international 2-day symposium with over 60 oral and poster presentations and an average daily attendance of approximately 140 people. Presently the symposium is now 2.5 days in length and annually has

over 70 presentations including international presentations from scientists and engineers from England, Japan, Sweden, Israel, Germany, Japan and Korea.

HOW THIS SYMPOSIUM RELATES TO THE RESEARCH INTEREST TO THE US ARMY

The Army's primary goal is to provide its soldiers with the equipment to do their job and return home safely. A strategic element of the future success of the US military against a myriad of potential threats is the performance of armor systems for air and ground vehicles as well as the individual soldier. Ceramic materials are currently used in many armor systems and they will be integral components of future systems. This symposium continues the search for novel material concepts and the development of valid armor design and characterization tools to predict performance.

The 2014 symposium includes the following proposed topic areas:

- **Synthesis and Processing:** oxides, carbides, borides, monolithic and composites, toughened, damage-tolerant, conventional and novel, powders, green body forming, densification, surface modification, planar and curved shapes with/without topological features, scale-up, etc.
- **Materials Characterization:** chemistry, phases, microstructure, crystal structure, defects, flaws and flaw statistics, bulk, surface, microscopy, spectroscopy, nondestructive, residual stress, etc.
- **Quasi-static and Dynamic Behavior:** mechanical properties, low and high-rate, high-pressure, large deformation, shear, multi-stress states, shock, fracture, fragmentation, damage, inelastic deformation mechanisms, phase transitions, size-scale effects, etc.
- **Modeling:** synthesis and processing, material, system, analytical, computational, continuum, atomistic, multi-scale, thermodynamics, mechanics, phenomenological, physically-based, microstructural, damage, inelastic deformation mechanisms, phase transitions, fracture, fragmentation, impact, penetration, residual stress, homogeneous and heterogeneous deformation, failure, size-scale effects, novel numerical techniques, etc.

- **Testing and Evaluation:** full scale, lab scale, conventional and fundamental, in-situ/real time and post-test characterization, size-scale effects, nondestructive characterization, technique development, wear and erosion, thermal, fatigue, residual stress, etc.
- **Application:** laminate systems, rigid systems, flexible systems, etc.

In addition, a special focus topic on Adhesive Bonding of Ceramics and Glasses is planned for the 2014 Symposium. In many ceramic armor systems, proper bonding of ceramic and glass materials to other system components is crucial to achieving good performance and managing residual stresses. A session devoted to this topic will help provide a better understanding of theoretical and applied issues associated with the use of polymeric adhesives for joining ceramic and glass materials in armor systems, as well as help identify new areas of research. Possible sub-topics include, but are not limited to, the structure and chemical make-up of surfaces, surface treatments, fundamentals of adhesion, adhesive characteristics and properties, mechanical properties of bonded interfaces, durability, process modeling, and modeling of interfaces.

RESULTS

The Armor Ceramics Symposium was held January 27-29, 2014 in Daytona Beach, FL as part of the 38th International Conference & Exposition on Advanced Ceramics and Composites. The 12th edition of this symposium consisted of over 50 oral and poster presentations on the symposium topics listed above. The symposium continues to foster discussion and collaboration between academic, government and industry personnel from around the globe. A peer reviewed proceedings was published that included 14 papers from this symposium. The papers were published in The American Ceramic Society's *Ceramic Engineering and Science Proceedings* (see citation below) and is available via John Wiley & Sons (www.wiley.com/go/ceramics).

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