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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)

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Number of Papers published in non peer-reviewed journals:

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**FTE Equivalent: Total Number:** 

#### **Student Metrics**

This section only applies to graduating undergraduates supported by this agreement in this reporting period	
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## Names of personnel receiving PHDs

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Sub Contractors (DD882)

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#### **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).

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

# **Armor Ceramics Symposium 2014**

# 38<sup>th</sup> 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, highpressure, 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 38<sup>th</sup> International Conference & Exposition on Advanced Ceramics and Composites. The 12<sup>th</sup> 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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