VIDEO ARTICLE

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Nano-Mechanical behavior and Room-Temperature Plasticity of Refractory Metal Carbides

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Abstract

Refractory carbides of transition metals (Zr, Ta, etc.), owing to a mixture of ionic, covalent, and metallic bonding, exhibit high hardness, high elastic moduli, good resistance to wear, ablation, and corrosion, as well as excellent high-temperature mechanical strength. They are attractive as high-temperature structural components in aerospace vehicles. Although these materials are exceptionally hard, their structural applications at low temperatures have been limited because of their brittleness. The design of ceramic materials possessing both high hardness and enhanced ductility has been a long-standing challenge. Various research studies have focused on this topic with limited success. Here, we present a brief review of our recent results obtained from in-situ, direct observations of mechanical deformation during uniaxial compression of group IV and group V transition-metal carbide (ZrC and TaC) single crystals inside a transmission electron microscope. Our studies provide new insights into the mechanical deformation mechanisms and help to identify strategies for enhancing room-temperature plasticity in this class of materials.

Biography of Presenting Author

Jenn-Ming Yang, Professor and Associate Dean of International Initiatives and Online Programs, received his B.S. in Materials Science and Engineering at National Tsing-Hua University, Taiwan. After two years of military service, he worked for Texas Instruments, Taiwan, as an engineer in charge of electronic packaging materials. He came to the United States in 1982 and received his Ph.D. in Metallurgy from the University of Delaware. He joined the faculty at UCLA's Department of Materials Science and Engineering in 1986.

At UCLA his major research interests are in processing and mechanical characterization of light weight metallic and composites for structural applications. This is primarily focused on investigating the fundamental problems related to processing, microstructure and behavior of metallic and composites for advanced aerospace structural and ground transportation applications. These efforts are to create a science base in quantitative relations between the microstructural parameters and macroscopic mechanical response

of high temperature metallic and composites. Such relationships would permit dependable engineering of composite structural components for safe and reliable service at elevated temperatures. Currently, Yang's group is conducting experimental and theoretical work to study the processing, deformation and fracture of ultra-lightweight structural nanocomposites and nanostructured metallic materials.

Yang's group is also conducting experimental work to study the nanomechanical behavior of nanostructured metallic and ceramic materials. This includes conducting nanomechanical testing of various advanced materials inside a scanning and transmission electron microscope to elucidate the deformation mechanisms and damage accumulation.

Yang currently supervises six Ph.D. and three M.S. students. He also collaborates with several aircraft engine companies in the United States and Europe. His work has resulted in more than 200 publications in journals and proceedings. Yang has received the National Science Foundation Foundation's Presidential Young Investigator Award, Alcoa Foundation Award, the Ford Foundation Award, and R&D 100 Award.

PROFESSIONAL EXPERIENCE

7/13 - present - Associate Dean, International Initiatives and Online Programs, Director, Engineering MS Online Program Henry Samueli School of Engineering and Applied Science, UCLA
7/09 - 6/13 - Chairman, Department of Materials Science and Engineering, UCLA
7/96 - present - Professor, Department of Materials Science and Engineering, UCLA.
7/04 - 6/09 - Vice Chair, Undergraduate Program
7/93 - 6/02 - Vice Chair, Graduate Program
7/92 - 6/96 - Associate Professor, Department of Materials Science and Engineering, UCLA.
8/86 - 6/92 - Assistant Professor, Department of Materials Science and Engineering, UCLA.
6/81 - 8/82 - Quality and Reliability Assurance Engineer, Texas Instruments

EDUCATION

Ph.D. (1986) Applied Sciences - Metallurgy, University of Delaware, Delaware
B.S. (1979) Materials Science and Engineering, National Tsing-Hua University, Taiwan

HONORS AND AWARDS

UCLA Faculty Career Development Award, 1989 Presidential Young Investigator Award, National Science Foundation, 1990-1995. Best Paper Award, Japan Society of Mechanical Engineers, 2007 R&D 100 Award, 2010 (R&D 100 Awards! recognizes and ! celebrates the top ! 100 technology ! products of the ! year).

RESEARCH ACTIVITIES

Deformation and Fracture of Titanium Matrix Composites Processing and Behavior of Ceramic Matrix Composites Analysis and Modeling of Fiber-Metal Laminates
In-Situ Micro-Mechanical Characterization of Nanostructured Materials Synthesis and Characterization of Nano-Materials Carbon Nanotube Yarns and Fibers Recycling of Thermoset Polymer Matrix Composites Additive Manufacturing of Metallic Alloys and Composites

JOURNAL EDITORSHIP

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