**报告摘要：**

**History of Thermal Protection Systems**

Thermal protection systems (TPS) are used to protect space vehicles from the heat of entry or reentry into an atmosphere after space flight. A vehicle requires propulsion to leave and a thermal protection system to enter or come back. These materials must protect the vehicle from both the convective and radiative heating that occurs during flight through an atmosphere. They must be efficient and reliable, which means they must behave predictably and protect the vehicle and contents as efficiently as possible with the minimum mass and or volume. This talk will trace some of the developments in these materials over the years, with particular emphasis on US space missions which built on earlier and concurrent military technology. The role of the “Space Race” and the political climate of the time will be included. Both reusable and ablative systems will be discussed, and how the use of these materials has changed over time, especially with respect to The Space shuttle program and recent missions including those to Mars. Some future needs for space exploration will also be discussed.

**Recent Research on Carbide Ultra-High Temperature Ceramics at Missouri University of Science and Technology**

This presentation will review recent research on ultra-high temperature carbide ceramics at the Missouri University of Science and Technology including synthesis, mechanical properties, and vacancy ordering in zirconium carbide, synthesis and properties of high entropy carbides, and processing and properties of zeta-phase tantalum carbide. Research on zirconium carbide ceramics is focused on elucidating the intrinsic properties of ZrCx ceramics. High purity ZrCx with different carbon stoichiometries has been synthesized and densified. Vacancy ordering was identified using neutron diffraction in carbon-deficient carbides. Studies of mechanical properties are also underway. High entropy carbides have been synthesized by carbothermal reduction of mixed oxides. Sub-micron powders with oxygen contents of less than 0.5 wt% were densified at temperatures below 1900°C. Finally, the synthesis, densification, and properties of zeta phase tantalum carbide (ζ-Ta4C3-x) have been studied. Powders were synthesized by reaction of tantalum hydride with carbon and then densified by hot pressing. Properties including strength and fracture toughness were measured. The presentation will conclude with a summary of future directions for these projects.

**Recent Research on Boride-Based Ultra-High Temperature Ceramics at Missouri University of Science and Technology**

This presentation will briefly overview the Missouri University of Science and Technology (Missouri S&T) campus, the Department of Materials Science and Engineering at Missouri S&T and in particular the faculty performing ceramic engineering R&D at Missouri S&T. The presentation will then review recent research on ultra-high temperature boride-based ceramics, including processing, properties, and microstructural analysis. Research on zirconium diboride ceramics is focused on elucidating the intrinsic properties of ZrB2 ceramics. High purity ZrB2 was borothermally synthesized, using purer grades of zirconia and boron, at 1100°C for 2 hours in vacuum (~5 Pa) and then hot pressed to near full density for mechanical property studies, including measurement of flexure strength from room temperature up to 2300°C. Nominally phase pure diborides, including ZrB2, HfB2, and TaB2 have been synthesized by reaction processing to study the role of transition metal impurities on their thermal properties, including thermal diffusivity, electrical resistivity and thermal conductivity. ZrB2 containing solid solution additions of tantalum ranging from 0 to 6 at% were synthesized by reactive hot pressing of zirconium and tantalum hydrides and amorphous boron. Finally, research is being performed on fusion welding of ZrB2-based ceramics with studies focused on determining the appropriate phases needed to optimize welds and reduce grain growth in the fusion zone. The presentation will conclude with a summary of future directions for these projects.

**Optical transparent ceramic materials for solid state laser applications**

Polycrystalline transparent ceramics have been emerging as a highly promising and valuable materials for potential utilization in a wide range of optical and photonic applications, including sensor protection, lasers, solid-state lighting, scintillators, and optoelectronics. To produce high quality transparent optical ceramics, it is essential to study the fundamental science involved in the processing of the materials. The scientific goal of these studies is to understand the mechanisms which control optical transmittance and chemical defect behaviors in optical materials, in order to remove or minimize defects that cause light scattering and absorption. This talk also includes a review of the history development of the ceramic materials for laser applications, including some significant milestones and achievements, and will emphasize the start-of-the-art fundamental sciences and technologies in the research and development of laser ceramics. New processing technologies and novel laser materials will also be described to forecast future of ceramic laser materials.

**Fabrication of CMC for high temperature application - Directions in KIMS**

HfC-SiC, HfB2-SiC, ZrC-SiC, ZrB2-SiC nano composites and Cf/HfC-SiC UHTCMC were prepared and their ablation behavior was tested using an oxy-acetylene torch and arc-jet plasma facility. The materials did not have strong recession after the testing using oxy-acetylene torch at 2700℃ for 30 min. in air. The thickness of the oxide layer on the surface of the HfC-SiC composites was less than 200μm, showing excellent oxidation resistance of the HfC-SiC nano composites. The oxidation of the carbon fibers in the Cf/HfC-SiC UHTCMC was successfully suppressed by the formation of the protective layer on the surface of the CMC. The recession rate of the HfC-SiC nano-composite was 5×10-4mm/s at 2700℃.

Arc-jet testing was performed with changing the heat flux between 2 – 10MW/m2 for 60 seconds. The ablation rate was 6×10-4mm/s at 2000℃ when the heat flux was 2MW/m2. The ablation rate of the HfC-SiC nano-composites was 5×10-2mm/s at 2500℃ under the heat flux of 5MW/m2. The material could not withstand the intensive heating when the heat flux increased to 10MW/m2. The surface temperature exceeded 3,000℃ within 0.2 second after testing. Intensive crack formation was observed in the samples and the growth of SiC grains occurred in the cracks. The ablation behavior of HfB2-SiC, ZrC-SiC and ZrB2-SiC nano-composites was also analyzed.

**报告人简历：**

**Dr. Sylvia Johnson**

From 2000 to 2009 Dr. Sylvia Johnson held the position of Chief of the Thermal Protection Materials and Systems Branch at the NASA Ames Research Center, where she was recognized for contributing to substantial technical and facility improvements. She then became the Chief Materials Technologist, of the Entry Systems and Technology Division before retiring from NASA in late 2016. Before joining NASA, Dr. Johnson spent 18 years in research at SRI International, (SRI), where she held many positions, including the Director of Ceramic and Chemical Product Development. At SRI, she broadened her experience in materials research and development for a variety of materials and worked with industry, government, domestic and international clients. Dr. Johnson is a recipient of the 2011 James I. Mueller Award from the American Ceramic Society and was inducted into the World Academy of Ceramics in 2014. She presented the Edward Orton Jr. Memorial Lecture for the American Ceramic Society in October 2015 and is featured in the book, Women in Ceramics, (2015) and on the women of NASA website. In addition to many lectures she has given on technical and research topics, Dr. Johnson has published over 50 papers, edited two books, and received seven U.S. patents. Dr. Johnson received a Bachelor of Science (Hons) in Ceramic Engineering from the University of New South Wales (Sydney, Australia), and a Master of Science and a Doctorate in Materials Science and Engineering from the University of California, Berkeley. She is now the President of the American Ceramic Society and is currently an Honorary Professor of Materials at the University of Birmingham, UK.

**Prof. William G. Fahrenholtz**

William G. (Bill) Fahrenholtz is a Curators’ Distinguished Professor of Ceramic Engineering in the Department of Materials Science and Engineering at the Missouri University of Science and Technology and the Editor-in-Chief of the Journal of the American Ceramic Society. He earned B.S. and M.S. degrees in Ceramic Engineering at the University of Illinois at Urbana-Champaign in 1987 and 1989, respectively. He completed his Ph.D. in Chemical Engineering at the University of New Mexico (UNM) in 1992. He was elected a Fellow of the American Ceramic Society in 2007 and was named Editor-in-Chief of the Journal of the American Ceramic Society in January 2017. His current research focuses on the processing, characterization, and mechanical testing of advanced structural ceramics for use in environments with extreme thermal loads, mechanical forces, and/or chemical reactivities. He has published over 140 papers in peer-reviewed journals and given over 100 invited presentations on his research.

**Prof. Gregory E. Hilmas**

Gregory E. (Greg) Hilmas is Curators’ Distinguished Professor of Ceramic Engineering and Chair of the Department of Materials Science and Engineering at Missouri University of Science and Technology. He received his BS in Materials Science & Engineering from the University of Minnesota in 1986, his MS in Ceramic Engineering from The Ohio State University in 1989, and his PhD in Materials Science & Engineering from the University of Michigan in 1993. At Missouri S&T, he has received twelve campus-wide Outstanding Teaching Awards, three Sustained Excellence in Teaching Awards, and eleven Faculty Excellence Awards for his teaching, research, and service. Greg research expertise lies in the area of processing-microstructure-property relationships in structural ceramics and ceramic matrix composites. He was elected as a Fellow of the American Ceramic Society (ACerS) in 2009 and was a recent recipient of the Arthur L. Friedberg Award from ACerS in 2013. He is the author or co-author of more than 200 journal and proceedings papers, holds eleven U.S. patents, and has three patents pending for the development of novel ceramic and composite architectures.

**Prof. Yiquan Wu**

Dr. Yiquan Wu is a professor of ceramics and materials science at the Kazuo Inamori School of Engineering at the New York State College of Ceramics at Alfred University. He received his Master from Shanghai Institute of Ceramics, and Ph.D. from Imperial College London, England. His current research focuses on transparent materials for optical and photonic applications, as well as the synthesis and characterization of nanostructured materials for energy and biomedical applications. He serves as the Editor of Journal of American Ceramic Society, is secretary-Elect for ACerS’s Basic Science Division, and also was the past President of the ACerS’ Ceramics Education Council. His research work has been funded by the National Science Foundation, Department of Defense, European Union Marie Curie Program, national laboratories, and industry. He is a recipient of several awards including the NSF CAREER award, the US AFOSR Young Investigator Award, Global Star Award of the American Ceramic Society, K.C. Wong Education Foundation Award, and the Presidential Award of the Chinese Academy of Sciences. Dr. Wu has published over 85 peer-reviewed articles and delivered 36 conference presentations, and also organized and chaired more than 20 international conference symposia on optical materials, thin films, laser sintering, biomaterials, nanostructured materials, and advanced ceramics.

**Dr. Sea-Hoon Lee**

Dr. Sea-Hoon Lee is a principal researcher of the Powder/ceramic department, Korea Institute of Materials Science, Changwon, Korea. He received his B.S. and M.S. degree at school of engineering, Hanyang University in 1994 and 1996. He earned his Ph. D. degree at department of chemistry, University of Stuttgart in 2004. He worked as a post-doctor at PML, Max-Planck-Institute for Metal Research (MPI-MF), Germany and National Institute for Materials Science (NIMS), Japan during 2004-2008. He joined Korea Institute of Materials Science (KIMS) as a senior researcher at 2008. He authored and co-authored more than 30 domestic and international patents and 80 SCI indexed papers in the field of materials science.