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MATERIALS SCIENCE & ENGINEERING DISTINGUISHED SEMINAR SERIES

Dr. Kyle S. Brinkman

Professor and Department Chair
Materials Science and Engineering
Clemson University
Clemson, SC

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Zoom Meeting Room

https://ucf.zoom.us/j/98700643816?pwd=UjY2dGZuMlA0b0hjenlKaDlnNWZrUT09

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Interdisciplinary Concepts in Ceramic Based Energy Materials: From Nuclear Waste to Fuel Cells

Mixed ionic-electronic conductors are widely used in ceramic based devices for energy conversion and storage. Implications for tailored design of ceramic composites in diverse applications such as high-level nuclear waste immobilization and solid oxide fuel cells will be discussed. Titanate-based hollandite represented by the general formula A2B8O16 where the A site is either a mono or divalent element and B site is either a di, tri or tetravalent element has been considered as one of the most promising host matrices for Cs immobilization due to its structural and thermodynamic stability as well as chemical durability. In this study, the A site consisted of Ba and Cs with a wide range of B site dopants including Zn, Ga, Fe and Al which were incorporated into the hollandite structure via a solid-state reaction method. The enthalpies of formation of the hollandite phases measured using high temperature oxide melt solution calorimetry were found to be negative, indicating these hollandites are thermodynamically stable with respect to their constituent oxides. Furthermore, the formation enthalpies were more negative and hence more favourable with increased Cs content across a wide range of B site dopants. In addition to formation energy measurements, select monolithic a powder-based aqueous leaching tests indicated that the hollandite phase with higher Cs-loading enhanced Cs retention. The impact of atomistic level structural features on the bulk thermodynamic properties of hollandite and Cs retention capacity will be discussed. Solid oxide fuel cells (SOFCs) efficiently convert the chemical energy in fuels into electricity. However, the elevated working temperature (800-1000℃), and the long-term performance/durability are the main obstacles limiting practical applications. Proton-conducting SOFCs (H-SOFCs) has attracted increased interest in recent years due to the lower working temperatures (400-700℃) and a lower activation energy for proton transport as compared to oxygen ion systems. The structure of these protonic ceramic materials, the characteristics of proton conducting mechanisms, and the materials development based on mixed ionic-electronic conductors will be summarized. The focus of this presentation will be the interdisciplinary nature of concepts encountered in nuclear and commercial application areas such as solid oxide fuel cell materials which "promote" ionic or electronic transport as compared to applications in nuclear waste immobilization focused on "blocking" transport.

Biography: Kyle Brinkman is the chair of the Department of Materials Science and Engineering at Clemson University in Clemson, SC. Brinkman received a Bachelor of Science in chemical engineering in 1998 and a Master of Science in materials science and engineering in 2000, both from Clemson. He graduated from the Swiss Federal Institute of Technology in Lausanne, Switzerland with a Ph.D. in materials science and engineering in 2004. Brinkman then served as a postdoctoral fellow at the Advanced Industrial Science and Technology Institute in Japan as part of a program sponsored by the Japanese Society for the Promotion of Science from 2005-2007. He later worked as a principal engineer in the Science and Technology Directorate of the U.S. Department of Energy's Savannah River National Lab from 2007-2014.
He has authored or co-authored more than 100 peer-reviewed technical publications and government reports, three patents and currently serves as an editor for the Journal of Materials Science and Co-director of Clemson's Nuclear NEESRWM "Nuclear Environmental Engineering Sciences and Radioactive Waste Management Center. He was the recipient of the Minerals, Metals and Materials Society (TMS) Young Leader International Scholar Award (2015) and the TMS Brimacombe Medalist Award (2020). He was awarded the National Institute of Ceramic Engineers, ACerS/NICE Karl Schwartzwalder-Professional Achievement in Ceramic Engineering (PACE) Award in 2015 and was elected an ACERS Fellow in 2020.