DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering
Spring Seminar Series

3:00 PM, Wednesday, May 24
PISB 104

"Coupled Anelastic and Dielectric Relaxations in Doped Binary Oxides with Fluorite Structure"

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Abstract:
Binary oxides doped with aliovalent cations are currently crucial materials in various devices where high ionic conductivity is required, including solid oxide fuel cells (SOFCs), sensors, and gas separation membranes. It is well established by now that doping binary oxides, such as zirconia and ceria, with aliovalent cations results in the formation of oxygen vacancies that are highly mobile at elevated temperatures (usually above 600 ^{o}C), thus enabling high ionic conductivity in those oxides. However, at lower temperatures, oxygen vacancies have reduced mobility as they are entrapped in different vacancy-cation complexes. We have shown recently that cyclic loading of 8mol% Yttria Stabilized Zirconia (8YSZ) in compression results in completely closed stress-strain hysteresis loops in the 25-600 ^{o}C temperature range. Mechanical spectroscopy studies in 0.001-400,000 Hz frequency range carried out using Dynamic Mechanical Analysis (DMA) and Resonant Ultrasound Spectroscopy (RUS) also showed that underlying energy dissipation mechanism is thermally activated and frequency dependent. In addition, results of in-situ neutron diffraction studies ruled out any stress induced phase transformation as a possible mechanism responsible for observed mechanical damping, as in the case of partially stabilized zirconia. However, we have found that applied compressive stress causes polarization in 8YSZ while applied electric field decreases mechanical damping and increases its apparent stiffness. Consequently, observed mechanical damping is attributed to the thermally activated, stress induced anelasic relaxation by short-range vacancy hopping around adjacent cations in oxygen vacancy-cation complexes, as the later also leads to the reorientation of electric dipoles introduced by oxygen vacancy-cation association in 8YS at lower temperatures. As a results, 8YSZ demonstrate piezoelectric-like behavior in the 25-600 ^{o}C temperature range as a result of lowering symmetry of its centrosymmetric cubic structure, by introduction of polar defects clusters with the lower symmetry. Similar coupling effects has been observed in other doped zirconia and ceria and will be discussed in more detail in this lecture.

Bio:
Dr. Miladin Radovic received his B.S. and M.S. in Mechanical Engineering from University of Belgrade, Belgrade, Serbia in 1997 and 1992, respectively. After receiving Ph.D. in Materials Engineering from Drexel University, Philadelphia, PA in 2001, Dr. Radovic joined High Temperature Materials Laboratory at Oak Ridge National Laboratory. In 2006 Dr. Radovic joined Texas A&M University as assistant professor, where he was promoted to associate professor with tenure in the Department of Materials Science and Engineering with adjunct position in the Department of Mechanical Engineering in 2012. He was also awarded the title of Visiting Associate Professor at the University of Sydney in 2013. Dr. Radovic's research interests are related to the processing of advanced structural and multi-functional ceramics for harsh environments and their thermal and mechanical properties. His current research is focused on the MAX phases, fast ionic conductors, metal-ceramic composites, and geopolymers. Dr. Radovic is author or co-author 7 book chapters and invited review papers, and over 120 peer-reviewed publications. Dr. Radovic received CAREER award from National Science Foundation in 2011, Herbert H. Richardson Faculty Fellowship from College of Engineering, Texas A&M University in 2013, International Collaboration Award from the University of Sydney in 2013 and Texas A&M Dean of Engineering Excellence Award in 2015. Dr. Radovic has been serving as Associate Department Head and Graduate Program Director at Materials Science and Engineering Department, Texas A&M University since 2013.

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