FUNCTIONAL FILMS AND CERAMICS
Dr. Alp Sehirlioglu

The presentation summarizes our recent efforts in developing new functional materials with a focus on operation in extreme environments. Discussion will include both fundamental aspects of behavior and the path to next generation of devices and applications. Two main topics will be discussed:

(i) Oxide based heterointerfaces: Formation of a two dimensional conducting interface between two perovskite insulators (i.e., LaAlO$_3$ on SrTiO$_3$) was first reported in 2004. In 2006 it was reported for the first time that the conductivity of the hetero-interface could be switched between two states by application of an external field (analogous to gate voltage). This technologically significant but still infant discovery holds great potential for next-generation extreme environment electronics that can have both (i) higher information density and (ii) larger operation domain. Other potential applications for quasi two-dimensional electron gas (Q-2D-EG) include colossal magneto-resistance memory, high temperature superconductors, thermoelectric convertors, and thermal management systems. However, the fundamental understanding of the Q-2D-EG formation and the factors that affect the conductivity and mobility of charge carriers are still under intense debate. This presentation will focus on the strain development at the interface, contact resistance and the interfacial diffusion. Possible new applications will also be introduced.

(ii) High temperature thermoelectrics: With global energy consumption approaching 50 TW/y, new power generation strategies are needed to meet the demand. Waste heat is an abundant source that is underutilized as an energy resource. Thermoelectric (TE) technology provides direct conversion of heat to electric power by utilizing the Seebeck effect. Over the last decade, progress in higher conversion efficiency has been achieved by implementation of nano-technology. However, successful commercialization of thermoelectric technology will be dependent upon conversion efficiency, material cost and environmental toxicity. This presentation will focus on development of Metal silicide - Si/Ge based eutectics as high temperature thermoelectrics. Eutectic structures contain highly coherent boundaries that would decrease thermal conductivity without decreasing the electrical conductivity that is required for high figure of merit. Focus will be given to systems that contain safer and abundant elements (W, Mo, Si, Ge, B and P), in comparison with state-of the art materials based on rare and environmentally unfriendly tellurides.

Dr. Alp Sehirlioglu received his Bachelor’s Degree in Metallurgical and Materials Engineering at Middle East Technical University (Ankara, Turkey) in 1997. He finished his M.S at Alfred University in 2000 and his Ph.D. at University of Illinois at Urbana Champaign in 2005. He is currently a research assistant professor at Department of Materials Science and Engineering, Case Western Reserve University and holds an Adjunct Faculty position in Department of Mechanical Engineering at University of Akron. Dr. Alp Sehirlioglu received several awards including the AFOSR Young Investigator Award for the project titled “Oxide Based Heterointerfaces for Extreme Environment Electronics” in 2011 and Charles F. Lucks Award, by International Thermal Conductivity Conference, Inc., 2009. He was the plenary presenter at the 30th International Thermal Conductivity Conference and 18th International Thermal Expansion Symposium. Dr. Alp Sehirlioglu is an active member of the American Ceramic Society where he organized symposiums and worked in technical programming committees. He is the co-chair of the newly-formed Young Professionals Network at the society. He has also been serving in the Ferroelectrics Committee at the Institute of Electrical and Electronics Engineers (IEEE) since 2011. Dr. Alp Sehirlioglu has close to 20 first authored papers, gave 8 invited seminars and 8 invited talks. His research focus is on developing functional energy materials for extreme environments. He is currently working on high temperature piezoelectrics, high temperature thermoelectrics, oxide based heterointerfaces and material plasma interactions in ionic thrusters.