West Virginia University.
BENJAMIN M. STATLER COLLEGE OF ENGINEERING AND MINERAL RESOURCES

MATERIALS SCIENCE AND ENGINEERING (MS&E) SEMINAR SERIES
Friday September 4, 2020 at 3:00 pm via Zoom

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Registration is required

Understanding 2-D Interfacial "Phases" (Complexions) to Help Decipher the Materials Genome and Beyond

Jian Luo from University of California, San Diego

Abstract: A piece of ice melts at 0 °C, but a nanometer-thick surface layer of the ice can melt at tens of degrees below zero. This phenomenon, known as "premelting," was first recognized by the physicist Michael Faraday. Materials scientists have discovered that interfaces in engineered materials can exhibit more complex phase-like behaviors at high temperatures, which can affect the fabrication and properties of a broad range of metallic and ceramic materials. Specifically, recent studies of 2-D grain-boundary (GB) phases (also called "complexions") shed light on several long-standing mysteries in materials science, including the origins and atomic-level mechanisms of solid-state activated sintering, as well as liquid metal and GB embrittlement [*Science* 333: 1730 (2011) & 358:97 (2017); *Nature Comm.* 9:2764 (2018)]. Since bulk phase diagrams are arguably one of the most useful tools for materials design, it is conceived that GB "phase" (complexion) diagrams can be developed as a useful materials science tool [see, *e.g.*, JACerS 95:2358 (2012); *Acta* 20:268 (2016) & 130:329 (2017); *Scripta* 130:165 (2017) & 158:11 (2019); *PRL* 120: 085702 (2018)]. Analogous 2-D surface phases have also been studied and utilized to improve the performance of various materials for energy-related applications, including batteries, supercapacitors, and oxygen-ion conductors [see a recent review: *Energy Storage Materials* 21:50 (2019) and references therein].

If time permits, I will also briefly discuss our other on-going studies on **(a)** flash sintering [see, *e.g.*, a recent viewpoint article: *Scripta* 146:260 (2018) and references therein]), where includes, e.g., "water-assisted flash sintering" that can flash ZnO ($T_m \approx 1975$ °C) at room temperature to subsequently sinter it to ~98% density in ~30 seconds and **(b)** discoveries of new classes of high-entropy ceramics, including: high-entropy borides as a new class of ultra-high-temperature ceramics, high-entropy perovskites, YSZ-like fluorite oxides, and silicides, as well as single-phase high-entropy intermetallic compounds that bridge high-entropy alloys and ceramics. Our most recent efforts attempt to expand "high-entropy ceramics (HECs)" to "compositionally-complex ceramics (CCCs)," where we have demonstrated that medium-entropy compositions can often outperform their high-entropy counterparts [see, *e.g.*, a preprint for a Perspective for the 1000th issue of *J. Mater. Sci.* at arXiv:2002.05251 and references therein].

Bio: Jian Luo graduated from Tsinghua University with dual Bachelor's degrees: one in Materials Science and Engineering and another in Electronics and Computer Technology. After receiving his M.S. and Ph.D. degrees from M.I.T., Luo worked in the industry for more than two years with Lucent Technologies Bell Laboratories and OFS/Fitel. In 2003, he joined the Clemson faculty, where he served as an Assistant/Associate/Full Professor of Materials Science and Engineering. In 2013, he moved to UCSD as a Professor of NanoEngineering and Professor of Materials Science and Engineering. He received a National Science Foundation CAREER award in 2005 (from the Ceramics program) and an Air Force Office of Scientific Research Young Investigator award in 2007 (from the Metallic Materials program). Professor Luo is a Vannevar Bush Faculty Fellow and a Fellow of the American Ceramic Society. Recently, he was selected as one of the TMS 2019 Brimacombe Medalists.

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