MSE Seminar

Virtual

Friday, Sept. 10, 2021

10:10 AM – 11:00 AM

Zoom link: **https://virginiatech.zoom.us/j/85127022000**

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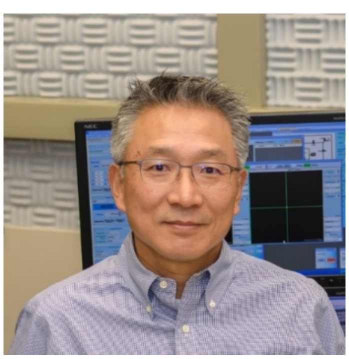
"Discovery of New Low-Dimensional Nanomaterial Phases and NanoArt"

With the advancement of new technology/computation in the era of materials genome, we are studying the ever-increasing number of new and emerging materials for potential new applications. We often deal with non-conventional processes or non-equilibrium conditions for the fabrication and processing of materials, and that provides ample opportunities for finding new material phases not predicted by phase diagrams or theory. In particular, atomic-resolution electron microscopy combined with various *in-situ* capabilities provides fertile ground for discovering new materials/phases. I present two new material phases recently discovered: • Mo_6Te_6 nanowire and • various forms of tellurium, such as helical Te and 2D Tellurene. Mo_6Te_6 nanowire phase was formed from $MoTe_2$ by catalyzer-free in-situ vacuum heating in TEM. This is a new phase that the phase diagram has predicted. Its lattice structure is monoclinic, with six central atoms of molybdenum surrounded by six atoms of tellurium. It has one-dimensional nanowire morphology with about 0.8 nm in diameter. Two different forms of Tellurium were fabricated: a helical needle-like Te and a two-dimensional chalcogen, namely tellurene – a 2D tellurium allotrope. We used molecular beam epitaxy for helical Te nanostructures. Field-effect transistors fabricated from helical Te exhibited high hole mobilities. A wafer-bonding assisted self-assembly process, a new approach synthesizing and stabilizing the low-dimensional structure, was used to fabricate Tellurene between two CdTe single crystals. Tellurene is found to be metallic in character, as predicted by first-principles calculations, with electronic band structures containing Dirac-cone-like features and exhibiting significant asymmetric spin-orbit band splitting. Atomic-resolution scanning transmission electron microscopy (STEM) imaging/chemical mapping confirmed its structure and led to the definitive identification of each phase reported here. In addition, I will introduce "NanoArt," a new discipline that discovers and accentuates the artistic beauty of nanometer-sized natural and artificial materials and showcase some of my NanoArt collections and Artificial Intelligent (AI) stylized NanoArt pieces.



Moon Kim is a Louis Beecherl, Jr., Distinguished Professor of Materials Science and Engineering at the University of Texas at Dallas. He also has a joint appointment as Adjunct Professor in the Simmons Comprehensive Cancer Center at the UT Southwestern Medical Center in Dallas. He is an elected fellow of Microscopy Society of America and a co-founder of 2Lux Media, Inc. He earned his B.S., M.S., and Ph.D. in Materials Science from Arizona State University in 1984, 1986, and 1988, respectively. He has published over 450 refereed articles with SCI h-index of 60, 2 paper books, 2 iBooks ("Hello, Nano" - available in Apple's iBookstore and Amazon.com), and 1 appbook ("Art & Tech" – available in Apple's iTunes Store. He has also held 2 NanoArt exhibitions. Dr. Kim's current research includes nanoscale fabrication and atomic-scale characterization of various functional nanostructures/devices for applications in nano-electronics, power electronics, energy, electrochemical and bio-devices, 3D visualization technologies such as virtual reality (VR), Augmented reality (AR), image recognition, and hologram for enhanced education, and artificial intelligence (AI) platforms for emerging applications. More at: http://moonkim.org/