Materials Science & Engineering Seminar Series

Carnegie Mellon University
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presents

Extreme Is Not Uncommon: Electronics In The Silicon Age

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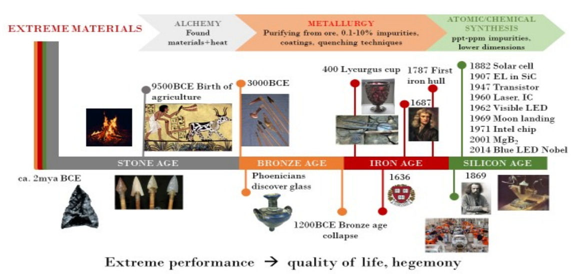
ABSTRACT: The history of civilization has been underscored by the availability and use of extreme materials. For example, the collapse of the bronze age due to the wide availability and perfection of iron tools/weapons shows how resources, and their use, determine geopolitical power. The availability of extreme materials enables extreme functionalities to be realized. These functionalities, such as artificial light, transportation, and agriculture, lead to enhanced quality of life, as well as the furthering of hegemony. Today, we routinely experience extreme environments in our commute to work (automotive engine, combustion and electric), when we look up a fact on our cellphones during a bar bet (high density computation), and when we fly to see loved ones. Further improvement in the performance of these devices/tools is only possible through engineering new extreme materials. It turns out that the next frontier in engineering electronics is in thermally limited design of semiconductor systems, a design paradigm with tradeoffs. To break these tradeoffs, one needs to engage progressively smaller atoms such as lithium, boron, carbon, nitrogen etc, which form stronger bonds due to their smaller size. These stronger bonds lead to lighter materials that are harder, more thermally conductive/stable, and effectively eliminate standby power losses. However, these atoms have very rich, and therefore complex chemistries that are difficult to control. They also require very high temperature processing due to their high melting/boiling points, which becomes challenging. In addition, they are also very difficult to dope with impurities for conductivity engineering, requiring new materials synthesis strategies. In this talk, we will take examples from more "moderate" post-silicon wide bandgap (WBG) extreme materials such as SiC/Graphene, GaN, and see how they will scale to ultra-wide bandgap (UWBG) materials, such as AlGaN, BN, B_4C, Ga_2O_3 etc. We will look at materials synthesis, device design, and how material quality and device performance affect overall system level performance. There will be an emphasis on compact electric power systems, which are the next frontier in transportation, power generation/distribution, as well as other extreme environments such as space.



BIOGRAPHY:MVS Chandrashekhar is an Associate Professor of Electrical Engineering at University of South Carolina, and Visiting Professor of ECE at Morgan State University. Dr. Chandrashekhar received his PhD in ECE from Cornell University in 2007, and stayed on as a postdoctoral associate there for 2 years before starting his own laboratory in SC. He is an expert in wide bandgap (WBG) and ultra-wide bandgap (UWBG) semiconductors and related extreme materials for nanoelectronics, with over 17 years of experience. His current research interests are in UWBG III-nitrides, SiC, graphene and boron carbide for power electronics and low-level optical/chemical sensing applications. Dr. Chandrashekhar's expertise in crystal growth, materials characterization, device design, fabrication and characterization has led to over 70 journal articles, with over 3200 citations (h-index=23). His research has been funded by DoD, DOE, and NSF, leading to 7 patents issued and many more pending. He has given several conference and invited presentations, including the TEDx Columbia, SC (2015) meeting. Dr. Chandrashekhar is co-founder of Widetronix, an energy company in the SiC WBG space. To this day, he still has not seen an electron directly.

Doherty Hall 2210, 11:30AM
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