Speaker： Vincent TUNG

Title: Defect Engineering At The Atomically Thin Limit

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Abstract:

As two-dimensional (2D) materials continue to push the boundaries of materials science and engineering, achieving precise control over their atomic-scale structure at the wafer scale is paramount for realizing their full potential in next-generation electronic, photonic, and quantum technologies. This seminar will explore how fundamental principles—encompassing reaction kinetics, mass transport, defect formation, and epitaxial strain—can be strategically leveraged to engineer the structure-property relationship in 2D materials. A critical aspect of our approach is the rational design of synthesis environments to regulate defect formation through reaction chemistry and diffusion control. By optimizing precursor dynamics and surface reaction pathways, we effectively suppress the formation of vacancies and grain boundary defects that would otherwise degrade electronic and mechanical performance. This approach has enabled the scalable synthesis of electronic-grade 2D semiconductors with significantly improved charge transport properties. Beyond reaction engineering, we have developed epitaxial strategies to manipulate grain structures and interfacial interactions, which are key determinants of carrier mobility, mechanical robustness, and integration compatibility. By employing guided nucleation techniques and substrate templating, we have successfully fabricated highly ordered 2D architectures, including self-aligned nanoribbon arrays, anti-parallel grains with spatially distributed 8-member-ring pores, and mono- and bilayer thin films with continuous single crystallinity. These methodologies ensure wafer-scale uniformity while preserving intrinsic material properties, offering a scalable path toward industrial application. By integrating materials science fundamentals with advanced engineering strategies, our work establishes a roadmap for precise atomic-level control of 2D materials. The insights gained not only advance the understanding of 2D material growth mechanisms but also provide a foundation for their seamless integration into high-performance device architectures, bridging the gap between academic research and industrial-scale implementation.

EDUCATION & RESEARCH EXPERIENCE

Vincent Tung completed his Ph.D. at the University of California, Los Angeles (UCLA) and was an Institute for Sustainability and Energy at Northwestern (ISEN) postdoctoral fellow at Northwestern University. He has been a Professor at the Department of Chemical System Engineering at the University of Tokyo since July 2022. He is the recipient of the NSF CAREER Award, New Doctoral Investigator of ACS Petroleum Award, Research Excellence of the University of California System, and an author of 109 articles. His research interests are in material chemistry, processing, and epitaxy growth of two-dimensional (2D) layered materials and their vdW heterostructures for next-generation semiconductors and membranes.