PURDUE UNIVERSITY

School of Materials Engineering

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Thursday, February 17, 2023, 9:30-10:30 am
Wang Hall Room 1004 or Webex:
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Towards the Atomic Limit in Scalable Semiconductor Manufacturing

Haozhe 'Harry' Wang is currently KNI Prize Postdoctoral Fellow at the California Institute of Technology (Caltech). His research focuses on atomic layer etching (ALE) technology for semiconductors to engineer surface imperfections in semiconductors and quantum materials. Haozhe 'Harry' Wang received his BSc and MSc in Materials Science and Engineering at Shanghai Jiao Tong University. Prior to joining Caltech, he obtained his Ph.D. in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology (MIT), working on the scalable synthesis and application of 2D semiconductors.

Abstract: The figures of merit of advanced devices based on semiconductors and quantum materials are increasingly limited by imperfections introduced in nanofabrication. Further advances in capabilities demand both additive and subtractive manufacturing methods with vastly improved precision compared to typical approaches.

In this seminar, I will first describe our development of Angstrom-precise additive manufacturing for atomic-layered semiconductors leveraging chemical vapor deposition and 'smart' processes. While the number of exciting physical phenomena observed in bilayer graphene increases, a significant gap persists in transforming these discoveries into practical applications, owing to the small-scale superlattices obtained via top-down approaches. We realized layer-by-layer (that is, Frank-van der Merwe) manufacturing in large-scale bilayer graphene, with no island impurities, which is unprecedented in any van der Waals-stacked semiconductors. After growth, we utilized the Marangoni effect, also known as the 'tears of wine', to enable 'autonomous' transfer by building a surface tension gradient in transfer liquids. Furthermore, machine learning is adopted to assist spectroscopy, enabling the 'smart' characterization following Angstrom-precise manufacturing.

In addition, I will discuss our recent progress in the subtractive manufacturing of semiconductors in monolayer precision for quantum applications. Our development of atomic layer etching, a reversal process of conventional atomic layer deposition, enables layer-by-layer engineering of the surfaces of semiconductors and superconductors to remedy imperfections in photonic and electronic quantum devices.