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Ming Hsieh Institute Seminar Series
Ming Hsieh Department of Electrical Engineering

Nano Science & Technology

Scalable Manufacturing for Quantum Materials in Angstrom Precision

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Date: Wednesday, January 18, 2023
Time: 10:30 am
Location: EEB 132

Abstract: The figures of merit of quantum devices based on semiconductor 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 that of typical approaches. In this talk, I will describe our development of additive manufacturing of bilayer graphene leveraging chemical vapor deposition and ‘smart’ processes. While the number of exciting quantum effects observed in bilayer graphene increases, a significant gap persists in transforming these discoveries into practical applications, owing to the small-scale samples obtained via top-down approaches. We realized a layer-by-layer (that is, Frank-van der Merwe) growth mode in large-scale bilayer graphene, with no island impurities, which is unprecedented in any van der Waals-stacked materials. Machine learning is adopted to assist spectroscopy, enabling the ‘smart’ characterization following the chemical vapor deposition. After growth, a transfer is necessary to move bilayer graphene from the growth substrate to a destination substrate with a mandatory sacrificial support layer. This process induces residuals, wrinkles, and cracks, thus deteriorating 2D materials from their intrinsic properties. We utilized the Marangoni effect, also known as the ‘tears of wine’, to enable ‘smart’ transfer by building a surface tension gradient in transfer liquids. We demonstrate our autonomous Marangoni-flow transfer technique can transfer bilayer graphene without a support layer, resulting in residue-free bilayer graphene. In addition, I will discuss our recent progress in the subtractive manufacturing of semiconductors and quantum hardware in Angstrom precision using the atomic layer etching technique.

Biography:
Dr. Haozhe Wang is currently KNI Prize Postdoctoral Fellow at the California Institute of Technology (Caltech). He is working on atomic layer etching (ALE) technology for quantum materials to remedy surface imperfections in electronic and optical quantum devices. Before joining Caltech, he obtained his Ph.D. in Electrical Engineering from the Massachusetts Institute of Technology (MIT) in 2020, working on the scalable synthesis and application of quantum materials.

Hosted by Prof. Jianhua (Joshua) Yang, Prof. Han Wang, Prof. Chongwu Zhou, Prof. Stephen Cronin, and Prof. Wei Wu.
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