AVS Quantum Science Workshop
Room Redondo - Session AQS-FrA2

AVS Quantum Science Workshop: 2D Materials for Quantum Sensing

Moderator: Chip Eddy, Jr., ONR Global

3:50pm **AQS-FrA2-23 Artificial Graphene Nanoribbons with Tailored Topological States**, ***Nathan P. Guisinger***, Argonne National Laboratory **INVITED**

Low-dimensional materials functioning at the nanoscale are a critical component for a variety of current and future technologies.From the optimization of light harvesting solar technologies to novel electronic and magnetic device architectures, key physical phenomena are occurring at the nanometer and atomic length-scales and predominately at interfaces.In this presentation, I will discuss low-dimensional material research occurring in the Quantum and Energy Materials (QEM) group at the Center for Nanoscale Materials.Specifically, the synthesis of artificial graphene nanoribbons by positioning carbon monoxide molecules on a copper surface to confine its surface state electrons into artificial atoms positioned to emulate the low-energy electronic structure of graphene derivatives.We demonstrate that the dimensionality of artificial graphene can be reduced to one dimension with proper “edge” passivation, with the emergence of an effectively-gapped one-dimensional nanoribbon structure. Remarkably, these one-dimensional structures show evidence of topological effects analogous to graphene nanoribbons. Guided by first-principles calculations, we spatially explore robust, zero-dimensional topological states by altering the topological invariants of quasi-one-dimensional artificial graphene nanostructures. The robustness and flexibility of our platform allows us to toggle the topological invariants between trivial and non-trivial on the same nanostructure.Our atomic synthesis gives access to nanoribbon geometries beyond the current reach of synthetic chemistry, and thus provides an ideal platform for the design and study of novel topological and quantum states of matter.

4:30pm **AQS-FrA2-31 Quantum Sensing and Nuclear Spin Control with Spin Defects in a 2D Material**, ***Tongcang Li***, Purdue University **INVITED**

Spin defects in solids such as diamond have broad applications in quantum sensing and quantum networking. The recent discovery of spin defects in hexagonal boron nitride (hBN), a van der Waals (vdW) layered material, provides new opportunities for these applications. Thanks to its layered structure, hBN can be easily exfoliated and integrated with other materials and nanostructures. Spin qubits in hBN nanosheets will be particularly suitable for probing two-dimensional (2D) quantum materials at atomic and nanoscales. Recently, we created boron vacancy spin defects in hBN with femtosecond laser writing and ion implantation, demonstrated high-contrast plasmon-enhanced spin defects in hBN for quantum sensing [*Nano Letters* 21, 7708 (2021)], and investigated their excited-state spin resonance. In addition, we achieved optical polarization and coherent control of nuclear spins in hBN at room temperature [*Nature Materials* 21, 1024 (2022)]. Our work opens new avenues for manipulation of nuclear spins in vdW materials for quantum information science and technology.

5:10pm **AQS-FrA2-39 AQS Workshop Closing Remarks**,

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