UNIVERSITY OF RHODE ISLAND
Department of Chemistry
SEMINAR

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Fang Liu

Columbia University

"Dissemble and Artificially Reassemble 2D van der Waals Crystals"

HOST

Jason Dwyer
Department of Chemistry
401-874-4648

Dissemble and Artificially Reassemble 2D van der Waals Crystals

Fang Liu, Columbia University

Two dimensional (2D) materials and their artificial structures hold great promises for electronic, optoelectronic, and quantum devices. Despite the rapid rise in research activities, the overwhelming demonstrations on exciting physical properties have relied on sample of micrometer dimensions obtained from, e.g., the famous Scotch-tape method. We developed a facile method to disassemble van der Waals (vdW) single crystals layer-by-layer into monolayers with near-unity yield, high quality, and macroscopic dimensions limited only by bulk crystal sizes. This approach takes us one step closer to mass production and commercialization of 2D materials. In this talk, I will demonstrate two applications. In the first example, we create multi-layer transition metal dichalcogenides with broken inversion symmetry, which leads to dramatic enhancement in nonlinear optical responses such as second harmonic generation (SHG). In the second example, we assemble the monolayers into heterostructures of atomically thin pn junctions, which undergoes ultrafast charge transfer upon photoexcitaton. We used time and angle resolved photoemission spectroscopy (TR-ARPES) to reveal the momentum-resolved conduction band (CB) electron dynamics, and revealed fast scattering dynamics across multiple CB valleys on fs time scale, assisted by phonon scattering. The interlayer charge transfer is accompanied by momentum specific band renormalization. These findings suggest the presence of both direct and indirect interlayer excitons and reveal constraints on achieving long-lived spin-valley polarization, a key aspect in spintronics for future data storage and transfer.