PHYSICAL CHEMISTRY SEMINAR

Wednesday, March 20, 2024
10:30-11:30 a.m. BRWN 4102

"Nanoimaging the Electronic States and Phonon Dynamics of Heterogeneous 2D Materials"

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Abstract:

Heterogeneity plays a critical role in chemistry, from the role of defect states in the carrier dynamics of organic semiconductors to interfaces and surfaces in heterogenous catalysis. However, our ability to visualize nano-scale heterogeneity in materials – including ferroic domains and material edges – and their effect on electronic and phonon dynamics has been hampered by the simple challenge of our inability to meet the necessary nanometer and femtosecond timescales. In this talk I will discuss recent efforts by my group to determine the interplay of heterogeneity and morphology on the intrinsic optoelectronic and thermoelectric properties of materials. Using polarization-dependent photoemission electron microscopy (PD-PEEM) we have imaged the spatially dependent optical selection rules of black phosphorus,[1] distinguishing edge-specific modes, and antiferroelectric domains of β'-In2Se3,[2] with spatial resolution as good as 25 nm. Using ultrafast transmission electron microscopy, we've been able to determine how the bond anisotropy and structural morphology of few-layer black phosphorus impacts phonon dynamics.[3] Ultimately my group seeks to identify ways to modify the impact of structural heterogeneity in materials and rationally design energy efficient inorganic and organic/inorganic hybrid interfaces on the nanoscale using morphology and molecular interfaces.

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Department of Chemistry

1. Joshi, P. P., Li, R., Spellberg, J. L., Liang, L. & King, S. B. Nanoimaging of the Edge-Dependent Optical Polarization Anisotropy of Black Phosphorus. *Nano Lett* 22, 3180–3186 **(2022)**.

2. Spellberg, J. L., Kodaimati, L., Joshi, P. P., Mirzajani, N., Liang, L. & King, S. B. Electronic structure orientation as a map of in-plane antiferroelectricity in β'-In2Se3. *ChemRxiv* **(2024)** doi:10.26434/chemrxiv-2024-lmx75

3. Joshi, P. P., Unruh, D., Gage, T. E., Li, R., Liu, H., Liang, L., Arslan, I., Chan, M. K. Y. & King, S. B. Anomalous reduction in black phosphorus phonon velocities driven by lattice anisotropy. *ChemRxiv* **(2023)**. doi:10.26434/chemrxiv-2023-r0qq2-v2