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RESEARCH & COLLABORATION PROFILE |

KEY WORDS: Photoelectron Spectroscopy, Surface/Interface Science, Perovskites, 2D Semiconductors, Optoelectronics



Research Snapshot. Prof. Shin investigates the electronic structure and interfacial energetics of emerging semiconductors using in-situ photoelectron spectroscopy and synchrotron-based analysis. His research spans metal-halide perovskites, two-dimensional semiconductors, organic semiconductors, polymers, and quantum dots, with emphasis on energy-level alignment, charge transfer, doping phenomena, and their relevance to solar cells and light-emitting devices.

RESEARCH EXPERTISE

- **Photoelectron spectroscopy & electronic structure:** extensive in-situ XPS, UPS, ARPES, and IPES experience, including synchrotron-based measurements.
- **Surface and interface science:** energy-level alignment and charge-transfer processes at semiconductor and organic interfaces.
- **Metal-halide perovskites:** electronic properties, oxygen-induced doping, 2D/3D perovskite interfaces, and device-relevant energetics.
- **2D semiconductors:** TMDC monolayers and heterostructures, including defect-related electronic structure and dielectric-screening effects.
- **Optoelectronic materials & devices:** organic/perovskite thin-film fabrication and characterization for solar cells and light-emitting devices.

RECENT RESEARCH HIGHLIGHTS

- **2D/3D perovskite interface (Adv. Funct. Mater. 2023):** established how the electronic properties and energy-level alignment of a 2D Ruddlesden-Popper perovskite with a 3D perovskite enable interfacial energy transfer.
- **Reversible oxygen doping (Adv. Mater. 2021; APL Mater. 2021):** clarified reversible oxygen-induced p-doping in lead-halide perovskites and its characteristic mechanisms and time scales.
- **2D semiconductor interface physics (ACS Nano / Adv. Sci. 2021):** contributed to studies of substrate dielectric screening, charge transfer, and energy transfer in monolayer TMDC heterostructures.

POTENTIAL COLLABORATION RESEARCH

Best-fit collaborator areas: photoelectron spectroscopy & synchrotron analysis | perovskite interfaces | 2D semiconductors | optoelectronic devices

1. **Interface electronic structure:** in-situ UPS/XPS/IPES/ARPES studies of energy-level alignment, interfacial charge transfer, and electronic-state evolution.
2. **Perovskite doping and interface control:** correlating processing or environmental conditions with doping behavior and interfacial energetics.
3. **2D semiconductor heterostructures:** probing band alignment, defect-related states, dielectric screening, and ground-state charge transfer.
4. **Device-oriented interface studies:** linking measured interfacial energetics to charge extraction and recombination in solar-cell and light-emitting-device structures.

SELECTED RECENT PUBLICATIONS

- **Adv. Funct. Mater. 2023, 33, 2208980 -** 2D Ruddlesden-Popper/3D perovskite energy-level alignment and interfacial energy transfer.
- **Adv. Mater. 2021, 33, 2100211 -** mechanism and time scales of reversible oxygen-induced p-doping of $MAPbI_3$.
- **APL Mater. 2021, 9, 081104 -** reversible oxygen-induced p-doping of mixed-cation halide perovskites.
- **Mater. Horiz. 2021, 9, 2101 -** electronic properties of metal-halide perovskites and their interfaces: the basics.

CONTACT

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https://sites.google.com/view/dshinlab/

REPRESENTATIVE RESEARCH THEMES / METHODS

PHOTOELECTRON SPECTROSCOPY
UPS · XPS · ARPES · IPES

PEROVSKITE INTERFACES
energy levels · doping

2D SEMICONDUCTORS
TMDCs · vdW interfaces

OPTOELECTRONIC DEVICES
solar cells · LEDs