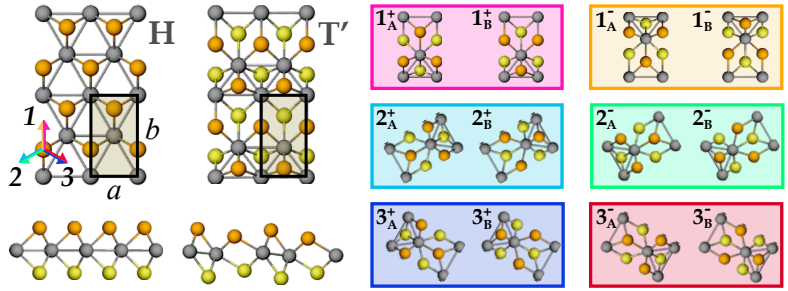
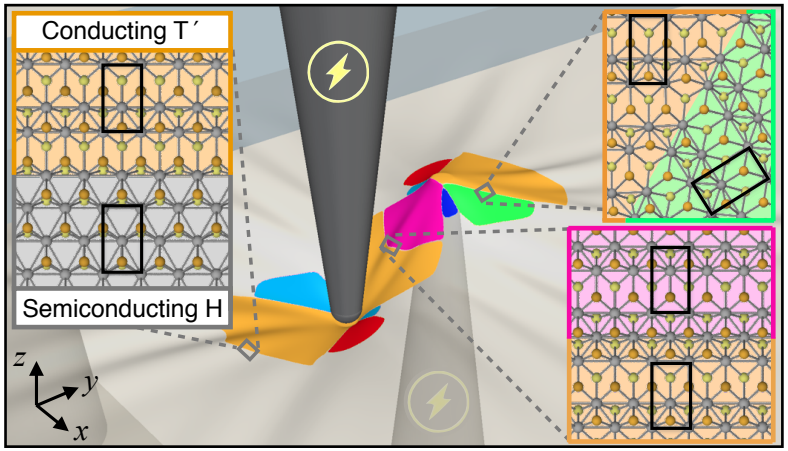
Dynamic Phase Engineering of Bendable Transition Metal Dichalcogenide Monolayers

Patterning Microstructures On-the-Fly for Rapid Changes in Functionality





Dynamic phase engineering of 2D TMDs with strain. TOP: H and T′ crystal structures and the 12 T′ orientational variants (color coded). BOTTOM: Strain-induced multivariant T′ domain bridging two indenters in an H-$MoTe_2$ monolayer.

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Work performed at Princeton University and the University of Pennsylvania

Scientific Achievement

Bendable TMD monolayers can be employed as dynamically programmable 2D electromechanical materials, whose morphology and mechanical response can be controlled by applying strain either uniformly or through local probes to generate functionally patterned conductive T′ domains in an otherwise semiconducting H monolayer.

Significance and Impact

Rapid local switching between domains with qualitatively different transport properties enables dynamic "drawing" of localized conducting regions, opening several interesting device-relevant functionalities such as the ability to dynamically "rewire" a device in real time or create nano-electromechanical devices with no moving parts.

Research Details

- A multi-scale first-principles informed simulation methodology was formulated and employed to describe evolution of microstructural H and T′ domain morphologies in bendable TMD monolayers.
- Phase diagrams were mapped as a function of applied strain.
- Strain accomodating microstructural patterns were characterized and several strategies for domain patterning were proposed and demonstrated.

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