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Method for Functionalization of Pristine Two-Dimensional Transition Metal Dichalcogenides Via Covalent Chemistry

Two-dimensional, transition metal dichalcogenides (TMDCs) are a class of layered materials that are attracting significant research mainly due to their potential applications in flexible electronics, energy harvesting/storage, and photonics. TMDCs consist of a transition metal bonded to two semiconductor elements (chalcogenides) and have physical properties that depend on layer thickness. Tuning the properties require adding an organic group (functionalization) that enables control of the layer thickness and thus, the properties. However, previous efforts to functionalize TMDCs lack in creating a reliable, undamaged material. Therefore, scientists are now looking to find improved routes to chemically tune TMDC's and ultimately incorporate them into devices in the industry.

Researchers at ASU have developed a simplified method to alter the physical and chemical properties of 2-D transition metal dichalcogenides (TMDCs). The process works by modifying 2-D TMDCs through covalent bond chemistry to attach an organic group that enables tuning of the TMDC's properties. The resulting TMDC is more homogeneous in structure with robust organic adlayers that preserve the electrical properties and structural uniformity. Namely, the method conserves the material's ability to exhibit photoluminescence which is subsequently tunable, and thus useful in sensing/sensors as well as other general applications. Overall, the method allows tuning of the material's properties while maintaining a reliable structure that is practical to implement.

Potential Applications

- Flexible electronics
- Energy harvesting and storage
- Photonics
- Semiconductors

Benefits and Advantages

- Customization and Tunability – the finalized TMDC structures enable tuning of different chemical properties by containing organic functional groups and permitting further bonding of other molecules/materials
- Robust and Reliable Structure – the method produces a material with uniform layering that results in a stable configuration without damaging the material
- Simpler Process – the novel method for functionalizing works without relying on invasive means such as transforming the semiconductor to a metallic form, non-covalent functionalization, or ion bombardment/oxidation

For more information about the inventor(s) and their research, please see:

Dr. Qing Hua Wang's directory webpage