Controlled Functionalization of Transition Metal Dichalcogenides: from Defects Healing to 3D Networks with Enhanced Electronic Connectivity

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Abstract (Century Gothic 11)

Transition metal dichalcogenides (TMDs) continue to attract significant attention due to their diverse physicochemical properties, rendering them promising candidates for cost-effective and practical applications in fields such as optoelectronics, biosensing, and energy technologies. The effectiveness of TMD-based devices relies heavily on the inherent characteristics and quality of the materials, which must be carefully tailored according to their intended use. However, the presence of structural defects inherited from both bulk systems and exfoliation procedures has thus far hindered device performance.[1] To address this challenge, considerable research efforts have been directed towards developing molecular strategies that leverage the defective nature of TMDs to precisely adjust their physicochemical properties and broaden their applicability. In my lecture I will highlight our recent advancements in functionalization approaches via the healing of structural defects in TMDs. We will demonstrate that the use of thiolated molecule offers efficient healing of sulphur,[2] selenium [3] and tellurium [4] vacancies. Additionally, the use of bidentate thiolated molecules enables to tether adjacent 2D nanosheets forming 3D covalent networks with improved electronic connectivity for high performance electronics.[5] Such characteristics can be improved further by exploiting a novel stepwise microfluidic-assisted approach, based on defect engineering of TMDs, to demonstrate for the first time the solution-processing of 2D heterostructures with enhanced electrical characteristics and novel functionalities. [6]
Our modular strategies relying on the combination of 2D materials with molecules offer a simple route to generate multifunctional coatings, foams and nanocomposites with pre-programmed properties to address key global challenges in electronics and sensing applications.

References

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