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Effect of Post-Synthesis Treatments on 1L-MoS2 Nanocomposite Properties

S. Nanomaterials of the future: advancements in energy and sensing

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Abstract

Recent advances in two-dimensional (2D) nanomaterials have created new opportunities in the fields of photonics, optoelectronics and sensing.[1] Monolayer Van der Waals materials, such as semiconducting transition metal dichalcogenides (TMDs), are particularly valuable because of their atomic-scale thickness, direct bandgap, and excellent electronic and mechanical properties.[2] Within this family, monolayer molybdenum disulfide (1L-MoS2) stands out as a model material due to its natural abundance and attracting optical properties like a bright photoemission centered at 1.8eV, which originates from direct excitonic recombination across the bandgap of the material.[3] This property is closely linked to the material's strain and doping levels, both of which are influenced by interactions into a heterostructure or with the substrate. Additionally, defects introduced during the synthesis can significantly impact its optical and electronic performances.[4]

Our research focuses on how post-synthesis thermal treatments performed under controlled atmosphere influence the properties of 1L-MoS2 in relation to its surroundings and in connection to defects.[5] To explore the capabilities of 1L-MoS2 within a nanocomposite device, we studied its properties when interacting with conducting, semiconducting or insulating substrates. Post-synthetic thermal treatments were found to induce predictable changes in strain, doping, and emission characteristics attributable also to defects recovery. By comparing flakes from different preparation methods grown on different substrates, we were able to generalize the results, suggesting a strategy to mitigate the production method limitations or a recovery of defects by the specific thermal treatment. These findings help us to optimize devices based on 1L-MoS2 while demonstrating the potential of tailored post-synthesis treatments to enhance the optical properties of such material.

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