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Probing Graphene/MoS_2 Nanocomposites: A Scanning Probe Microscopy Study

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Two-dimensional materials including graphene and molybdenum disulfide are widely used in various domains such as energy storage, sensor technology, transistor development and hydrogen production due to the synergistic effects of their intrinsic properties. To elucidate the interactions between these materials and harness their application potential, scanning probe microscopy (SPM) serves as an indispensable tool.[1] In this study, we employed various Scanning Probe Microscopy (SPM) techniques to investigate a nanocomposite containing chemically synthesized graphene (GR) and molybdenum disulfide (MoS_2). The aim was to elucidate the properties and interactions between the nanocomposite's constituents. Synthesized via the liquid-liquid interfacial route (LLIR),[2] the materials were subjected to a suite of characterization methods, including UV-Vis and Raman spectroscopy, X-ray diffraction, and Scanning Electron Microscopy. These techniques confirmed the material's formation and supported the SPM findings. SPM analyses, conducted in contact and dynamic modes, along with phase contrast microscopy, lateral force microscopy (LFM), and PeakForce Quantitative Nanomechanics, provided insights into the frictional, deformational, adhesive, and stiffness characteristics of the nanocomposite. Notably, the presence of GR and MoS_2, along with GR by-products such as amorphous carbon and iron oxides (II and III), in the GR/MoS_2 film revealed distinct properties when compared to the pure films. The GR film exhibited increased stiffness, a characteristic less pronounced in the GR/MoS_2 and MoS_2 samples, as determined by PeakForce measurements. Remarkably, the nanocomposite demonstrated an increased deformation and reduced adhesion when compared to the GR film, suggesting that MoS_2's interaction with GR alters the material's final properties. Through this study we can elucidate the potential interactions between graphene and MoS_2, and their influence on the resultant material's properties.

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