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Atomic-scale measurements of charge distribution in 2D structures

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Two-dimensional (2D) materials generally exhibit a range of desirable and outstanding properties. Yet, their implementation in future nanoelectronics is strongly affected by the unavoidable presence of structural defects, so that a thorough understanding of the influence from the most prevalent defects in a material is critical. However, the characterisation of a particular defect poses a considerable challenge, requiring high-resolution measurements that are sensitive to the electronic structure of the material. The use of differential-phase contrast (DPC) in scanning transmission electron microscopy (STEM) achieves this purpose by leveraging the interaction between the fine electron probe and the intrinsic electromagnetic fields of a sample. For thin specimens, the results of this interaction can be directly measured from the intensity distribution of the probe, allowing for the mapping of projected electrostatic configurations at atomic scales. However, the sensitivity of such measurements increases their susceptibility to both the characteristics of the sample and the configuration of the instrument, making it necessary to develop solid methodologies that allow for more accurate analyses. In this talk, a DPC-STEM investigation into the influence of atomic-scale defects on the functional properties of the 2D semiconductor material MoS_2 is presented. Defect-induced changes to the pristine atomic electrostatic configuration are determined, leading to insights regarding issues identified in practical applications of the material. Additionally, a methodology for quantifying the influence of key instrumental parameters on DPC-STEM observations analysis is demonstrated on extensive image simulations.

References:

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