Measuring van der Waals interactions of monolayer materials

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Van der Waals interactions play a major role in the science of monolayer materials, yet their measurement has received a limited attention. We exploit AFM to measure an attractive van der Waals (vdW) force acting on a sharp AFM tip from a composite sample consisting of a monolayer material supported on a thick substrate. The force is measured as a function of a separation between the tip and the monolayer/substrate stack in the range from 2–20 nm for graphene/silicon oxide, fluorinated graphene/silicon oxide, MoS_2/graphite and $MoSe_2$/graphite. The obtained results indicate that distinct contributions to the force from the monolayer and substrate can be distinguished by their different dependence on the separation, an inverse cubed for the former and inverse square for the latter. Thus, van der Waals interaction for different monolayer materials is determined and compared to the traditional bulk materials. Further, we demonstrate that the monolayer materials screen van der Waals interactions of the underlying substrate, with full screening in graphene/silicon oxide and partial screening in fluorinated graphene/silicon oxide, MoS_2/graphite and $MoSe_2$/graphite.