Impact of chemistry on the interface with substrate of MoS_2 nanosheets grown by ambient pressure chemical vapor deposition

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Few layered MoS_2 attracts much of interest in different fields thanks to their peculiar properties. When considering micro and nano electronics, MoS_2 nanosheets are foreseen for integration as a channel material for overcoming the short-channel effects in ultra-scaled field-effect transistors (FETs).[1][2] However, the on-current in such short-channel FETs is limited by the contact resistance (Rc) related to energy barrier at the interface between the semiconductor channel and contact metal. Furthermore, ultrathin MoS_2 is also used in tunneling stacks to fabricate transistors with very steep sub-threshold slope, mandatory for low voltage electronics.[3] In these devices, the electron band alignment at MoS_2 interfaces directly affects the electrostatics of the stacks such as built-in voltages, transistor thresholds, as well as tunneling barrier heights. In this respect, a detailed study of the interface between the MoS_2 nanosheets and the substrate is essential to unveil in details its properties and possibly correlated them with the specific conditions during the growth process. When chemical-based growth methods are employed to obtain the MoS2 nanosheets, the impact of the chemistry used in the precondition of the substrate and during the growth process needs a dedicated investigation to discriminate any role in defining the properties at the MoS_2/SiO_2 interface.

On this scope we grew by atmospheric pressure chemical vapor deposition (AP-CVD) 2 to 3 layers MoS_2 nanosheets on SiO_2(50nm)/Si using different methods based on vapor phase reaction (VPR) of MoO_3 and sulfur solid powders or sulfurization of solid precursor ultrathin film (SPF), spin-coated, containing Mo compounds (eg. AHM) in solution with Na or K based chemicals, such as NaOH or KCl. We characterize the so-grown MoS_2 with Raman spectroscopy, SEM, AFM, XPS and internal photoemission of electrons (IPE). The latter, that determines the energy of the semiconductor valence band (VB) relative to the reference level of the insulator conduction band (CB), unveiled a significant change (≈0.6 eV) in the electron barrier depending on the growth method, possibly ascribed to the interaction of hydroxile groups from NaOH and AHM promoters with the oxide surface leading to interface dipole modification, in SPF approach.

References (if needed)

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