Engineering all interfaces in 2D transistors

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Abstract
The optimization of any electronic device requires the engineering of all interfaces to control and boost all fundamental physical processes governing the performance. The decoration of such interfaces with ad hoc molecules and assemblies thereof is a viable route to leverage the functional complexity of devices, enabling functional diversification by mastering a "more-than Moore" strategy. The structural perfection of two-dimensional materials represents a major advantage for such interface tailoring to create hybrid multifunctional structures with ad hoc characteristics for applications in (opto)electronics, sensing and energy. Molecules can be designed and synthesized to physisorb or chemisorb onto 2D materials in a controlled fashion, enabling functional diversification. [1]
In my lecture I will review our recent works on the interface engineering of 2D materials based field-effect transistors (FETs) providing specific example on:
(1) The integration of chemically functionalized electrodes in top-contact FETs based on MoS_2 by contact engineering through the dry transfer of SAMs pre-modified electrodes. Charge injection was optimized by using ad-hoc thiolated molecules with controlled dipole moments, thereby boosting the device performance. When asymmetrically functionalized electrodes were employed, Schottky diodes with a high rectification ratio could be realized. [2]
(2) The functionalization of the two surfaces of 2D semiconductors either in a symmetric[3] or asymmetric[4] fashion with molecular switches, to confer additional properties to WSe_2, thereby rendering 2D material-based transistors capable to respond up to four different independent external stimuli.
(3) The covalent functionalization of solution-processed TMDs (MoS_2, WS_2 and ReS_2) with bi-dentate semiconducting molecules enabled to simultaneously heal sulfur vacancies in metal disulfides and covalently bridge adjacent flakes, by promoting percolation pathways for charge transport, yielding a significant enhancement of the transistor characteristics.[5]
Our modular strategies relying on the combination of 2D material with molecules offer a simple route to generate multifunctional coatings, foams and nanocomposites with pre-programmed properties to address key global challenges in electronics, sensing and energy applications.

References
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