Molecular functionalization of 2D materials:
high-performance opto-electronic devices

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Two dimensional materials exhibit exceptional physical and chemical properties which can be further enhanced and enriched via the controlled functionalization with molecules and (supra)molecular assemblies thereof yielding hybrid systems with ad hoc characteristics for applications in (opto)electronics, sensing and energy. Molecules can be designed and synthesized in order to physisorb or chemisorb onto 2D materials in a controlled fashion.
In my lecture I will review our recent findings on the functionalization of 2D materials to engineer hybrid systems via:
- physisorption of molecular switches onto the two surfaces of scotch tape and CVD 2D ambipolar semiconductors, following a Janus approach, as a route to confer two distinct and additional properties to WSe_2, rendering the 2D material-based transistors capable to respond to three different independent stimuli.
- chemisorption of doubly-thiolated molecules onto solution-processed semiconducting transition metal dichalcogenides as a way to simultaneously heal sulfur vacancies in metal disulfides (MS_2) and covalently bridge adjacent flakes, thereby promoting percolation pathways for the charge transport, leading to an increase by one order-of-magnitude in field-effect mobility, I_{ON} / I_{OFF} ratio, and switching times of liquid-gated transistors.

Our modular strategies relying on the combination of 2D material with molecules offer a simple route to generate multifunctional 2D materials-based coatings, foams and nanocomposites with pre-programmed properties to address key global challenges in electronics, sensing and energy applications.

FIGURES

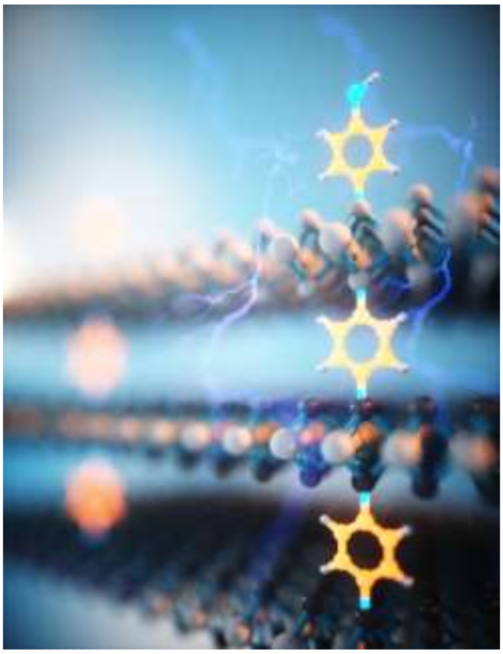

Figure 1: 1,4-benzenedithiol molecules simultaneously healing sulfur vacancies in solution-processed MoS_2 and covalently bridging adjacent flakes, to create percolation pathways for the charge transport in transistors.