Interfacing molecules with 2D materials: sophisticated structures enabling complex functions

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2D materials hold exceptional physical properties which render them particularly interesting as active building blocks for the emergence of disruptive technologies in sensing, opto-electronic and energy storage. However, their properties are hardly tunable. The controlled interfacing of 2D materials with molecules and assemblies thereof represents a promising strategy for imparting new properties to 2D materials, rendering them multifunctional and multiresponsive.
In my lecture I will present our recent findings on the chemical functionalization of 2D materials to engineer hybrid systems via the controlled interfacing of its two surfaces either in a symmetric or asymmetric fashion with molecular switches. In this way, additional properties have been conferred to MoS_2, back phosphorous or WSe_2, thereby rendering 2D material-based transistors capable to respond to as many as four different independent stimuli. Such an approach is also exploited for the development of physical sensors for medical diagnosis and health monitoring, upon use of active materials with sensitivities in the low-pressure or medium-pressure range. Example of flexible piezoresistive pressure sensors compatible with wearable technologies for digital healthcare, human-machine interfaces and robotics will be provided.
Our modular strategies relying on the combination of 2D materials with molecules offer a simple route to generate multifunctional coatings, foams and nanocomposites with pre-programmed properties to address key global challenges in electronics and sensing applications.