Projet MSCA IF MULTI2DSWITCH : MULTIfunctional optoelectronic devices based on hybrid heterostructures of 2D materials and photochromic SWITCHes

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MULTI2DSWITCH will offer an extremely talented and promising young researcher, with a PhD in physics and an extraordinary track record, world-class training through research in the cross-disciplinary and supra-sectorial field of 2D materials (2DMs) based multifunctional electronics. The proposed research lies at the interface between physics, chemistry and electrical engineering, in the interdisciplinary realms of supramolecular sciences, materials- and nano-science. The overall mission is to train the fellow to become an independent scientist and to prepare him for a leading position in academia or industry. MULTI2DSWITCH's research programme targets a fundamental breakthrough in the field 2DMs by using a combination of bottom-up and top-down methods to design ultraflat, flexible and photoswitchable heterostructures of 2D crystals and molecular self-assembled monolayers (SAMs). In order to do so, a highly-ordered SAM of photochromic molecules (azobenzenes, diarylethenes or spiropyrans) is prepared on the surface of a graphene layer, by means of lowcost solution processing techniques. The graphene/SAM bilayer is subsequently encapsulated with a 2D semiconductor from the family of transition metal dichalcogenides (TMDs) using the flake-transfer techniques commonly employed for van-der- Waals heterostructure assembly. The photo-tunable properties of the newly prepared hybrid heterostructures will be exploited to develop a series of proof-of-concept multifunctional devices, including optically-switchable diodes and field-effect transistors (FETs), and optically-programmable memory cells. Thanks to the high-degree of mechanical flexibility of both the 2D crystals and the molecular SAMs, these devices will be suitable for integration on flexible substrates. Ultimately, MULTI2DSWITCH aims at developing high-performance flexible multifunctional optoelectronic devices with figures of merit greatly surpassing those of the corresponding state-of-the-art organic devices.