Integration strategies and nanoscale electrical characterization of MoS_2 on wide bandgap semiconductors

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Molybdenum Disulfide (MoS_2) belongs to the family of transition metal dichalcogenides (TMDs), which are layered materials formed by stacks of X-M-X trilayers (being M=Mo,W transition metals and X=S, Se, Te chalcogens) with covalent in-plane bonds and weak van der Waals interaction between the layers. The semiconducting properties with a thickness dependent energy bandgap (1.2 eV indirect bandgap from multilayers to 1.8-1.9 eV direct gap for a single layer) [1], combined with a high electron mobility (200-400 cm^2/Vs) [2], make MoS_2 suitable for a wide number of potential applications in electronics, optoelectronics and sensing. In this context, many efforts are currently in progress to integrate large-area 1L MoS_2 films on SiC and GaN substrates, with the aim to develop 2D/3D heterojunction diodes and photodetectors taking benefit of the combination of WBG semiconductors and MoS_2 properties.

This talk will present an overview of the state of the art integration strategies for MoS_2 on WBG semiconductors, with a special focus on a two-step growth method, consisting in the sulfurization of pre-deposited deposited ultra-thin MoOx films, which proved very effective to achieve uniform 1L MoS_2 coverage on large areas by controlling the initial film thickness [3-4]. The structural, chemical, vibrational/optical and electrical properties of the obtained MoS_2/WBG heterostructures have been extensively investigated by the combination of several characterization techniques (AFM, XPS, TEM, Raman, Photoluminescence, C-AFM and KPFM). In particular the relevant electronic properties of these systems, such as the energy band alignments at the heterointerfaces, have been evaluated, paving the way to new device applications.

This work has been supported by the FlagERA-JTC 2019 project ETMOS, the MUR-PNRR projects iENTRANCE@ENL (No. IR00000027) and the PRIN project “2DIntegratE” (2022RHRZN2).

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