New devices based on 2D materials integrated on wide-bandgap semiconductors

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Silicon carbide and group-III Nitrides (GaN, AlN, InN and their alloys) currently play a strategic role in energy efficient power conversion, high frequency electronics and optoelectronics. During the last 10 years, the integration of graphene and semiconducting 2D materials (MoS_2 and other TMDs) with these wide-bandgap (WBG) semiconductors has been the object of intensive investigation, with the double aim to address some key issues of SiC and GaN technology, and to demonstrate advanced or novel device functionalities. This talk provides an overview of recent developments and open challenges in this field. Furthermore, perspective device applications based on 2D materials/WBG heterostructures are discussed.

Epitaxial graphene growth provides SiC(0001) with a high mobility 2DEG, opening the way to the monolithic integration of power and high frequency devices in the same material platform. Graphene Schottky junctions with AlGaN/GaN heterostructures have been used as the key element of a hot electron transistor (vertical unipolar device exploiting ballistic transport in the monolayer thin graphene base), showing great promise for THz applications. More recently, the integration of large area monolayer or few layers MoS_2 with 4H-SiC and GaN has been systematically explored using different scalable approaches, i.e. single and double step chemical vapour deposition (CVD), pulsed laser deposition (PLD), molecular beam epitaxy (MBE), and advanced exfoliation/transfer approaches. Finally, MoS_2/SiC and MoS_2/GaN heterojunction diodes with excellent rectification properties and tunable current injection by tailoring the doping of MoS_2 or SiC (GaN) surface have been demonstrated.

This work was supported, in part, by MUR in the framework of the FlagERA JTC 2019 project ETMOS and within the PRIN2022 project “2DIntegratE” (2022RHRZN2).