van der Waals epitaxy of 2D layered heterostructures: the MBE laboratory at IMM-CNR Lecce

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Van der Waals epitaxy (vdWE) of 2D materials (graphene, h-BN, and transition metal dichalcogenides – TMDCs) offer a unique playground to tailor the physical properties of individual 2D materials by assembling them into novel heterostructures [1].

Devices are usually fabricated through mechanical stacking of single 2D material monolayers onto each other's [2] to obtain 2D (vertical) heterostructures. However, the grow of complex vdW heterostructures with truly atomic-layer control and contamination-free interfaces remains a challenging task. The molecular beam epitaxy (MBE) of 2D materials is being explored [3,4] in reason of its advantages over CVD [5] methods: (i) the self-limiting MBE growth of 2D materials; (ii) the possibility of in-situ UHV surface-science studies, and (iii) an easier control of monolayer growth over large diameter size.

Here we describe the MBE facility for vdWE of 2D materials being set up at CNR-IMM in Lecce (Italy). The MBE reactor is a RIBER Compact 21 CLS system designed for the vdWE of 2D materials over a 2" dia. wafer at process temperatures up to 1500°C (for best graphene and h-BN epitaxy). The reactor can be fitted with up to 7 elemental sources (for graphene, h-BN and TMDCs growth) and is equipped with a 12-keV RHEED system, and a beam equivalent pressure (BEP) probe. A carbon sublimation, a UHV double-bucket electron-gun evaporation source (for Mo and W) and a VCOR valved-cracker cells (for Se) will be initially installed. MBE-grown $MoSe_2$, WSe_2, $Mo_xW_{1-x}Se_2$ and graphene-TMDCs heterostructures will be investigated for applications to single-photon emitting devices [6].

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