Synthesizing 2D materials for optoelectronics: approaches and prospects

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One of the major issues in graphene-based optoelectronics is to scale-up high-quality graphene and to demonstrate high-performing devices over large areas. In this talk different synthetic approaches for obtaining graphene (and other 2d materials) over large areas will be discussed and the scalable fabrication of optoelectronic devices presented.

Single-crystal graphene arrays obtained via deterministic seeding on Cu foil [1] will be discussed as an appealing approach for wafer scale integration of graphene with high mobilities (i.e., μ > 10000 cm2/Vs). Optoelectronic devices fabricated on arrays will be introduced.

Also, an original approach for the fabrication of efficient photodetectors from scalable tungsten disulfide/graphene heterostructures will be presented. Such photodetectors present, when illuminated with red light, a maximum responsivity R ~ 220 $A \cdot W^{-1}$, a detectivity D* ~ 2×10^9 Jones and a −3 dB bandwidth of 250 Hz [2]. Also, they display wavelength-selective memory which makes them of interest for the implementation of 2D-based data storage devices.

Finally, it will be presented an approach to obtain high-quality graphene on the c-plane of Al_2O_3(0001) substrates with a metal-free and single-step approach in a commercially available chemical vapor deposition (CVD) reactor (HT-BM, Aixtron). The graphene grown displays a preferential orientation which is 30° rotated with respect to the sapphire substrate. The carrier mobility is above 2000 cm^2 /V·s at room temperature. The presented CVD approach is of appeal in virtue of its implementation in a commercial system, ease of scalability, and as it yields metal-free graphene.

References

[1] V. Miseikis et al., 2D Materials 4 (2), (2017) 021004

[2] A. Rossi et al., Nanoscale, 10, (2018) 4332 - 4338

Figures

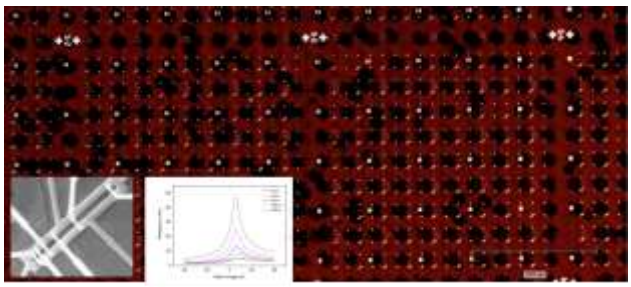

Figure 1: scalable graphene arrays with homogeneous electrical performance.

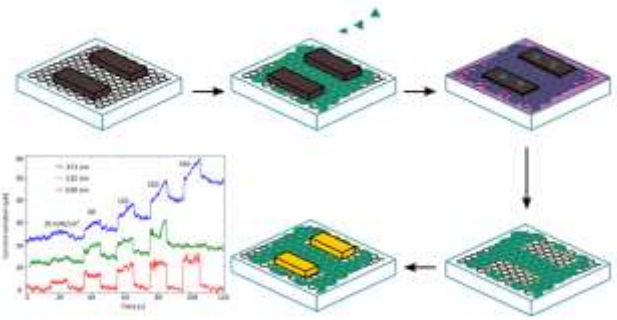

Figure 2: scalable WS2/graphene photodetectors with light-dependent behaviour.

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