NanoLab Talk

Thursday, 27th september, 2018 – 10.30

Seminar Room 1° floor

Department of Energy – Cesnef (Building 19) via Ponzio 34/3 Milan

Politecnico di Milano

"Designer artificial 2D materials"

Alessandro Molle

CNR-IMM Agrate Brianza

Abstract:

Making adjustable two-dimensional (2D) materials is an emerging route to reach a superior control of new functional properties. With this aim in mind, here I will give consideration to three distinct cases. First is the case of silicene, silicene derivatives, and their device applications [1]. General details on how to produce epitaxial silicene and the path for silicene transistors will be exposed. In parallel, emerging routes for silicene processing will be also discussed. Close to silicene is the second case of the general class of Xenes, namely 2D monoelemental lattice beyond graphene [2], including germanene, stanene, borophene, epitaxial phosphorene, and recently synthesized antimonene and tellurene. Buckling in Xenes can be taken as a leverage to tune the electronic and quantum properties making it possible for Xenes to appear as semiconductors, semimetals, metals topological and trivial insulators. Not only the wealth of electronic states in the Xenes makes them suitable as nanotechnology platform, but also topological transitions among some of these electronic states are predicted to take place as a function of an external solicitation (e.g. vertical electric field, applied stress) thus paving the way to the full exploitation of topological features in devices at the 2D level. I will show the route and challenges for Xenes to be integrated in nanoelectronic devices by briefly describing a universal approach to Xene processing and eventually the concept of a topological field effect transistor.

The third case is about the anisotropy design at the 2D level is the chemical vapour deposition of MoS_2 nanosheets on patterned substrates. The highly conformal character of the MoS_2 growth allows for the achievement of an anisotropically modulated MoS_2 nanosheet where the phonon and electronic properties are observed to be strongly morphology dependent. The so-induced morphological anisotropy is reflected in the anisotropy of the physical characteristics, such as the phonon spectrum, intrinsic charge fluctuations, and the exciton dynamics. Implications on the band-gap and exciton engineering will be discussed, and the potential for applications envisioned [3].

References

[1] A. Molle, C. Grazianetti, L. Tao, D. Tanneja, Md. H. Alam, and D. Akinwande, *Chem Soc. Rev*. (2018) 47, 6370.

[2] A. Molle, J. Goldberger, M. Houssa, Y. Xu, S.-C. Zhang, and D. Akinwande, *Nature Mater.* (2017) 16, 163.

[3] C. Martella, C. Mennucci, E. Cinquanta, A. Lamperti, E. Cappelluti, F. Buatier de Mongeot, and A. Molle., *Adv. Mater.* (2018) 30, 1705615.

About the speaker:

Dr. Alessandro Molle is a Senior Researcher at the Consiglio Nazionale delle Ricerche (CNR), Istituto per la Microelettronica e Microsistemi (IMM), unit of Agrate Brianza, where he carried out his Pot-Doc fellowship after his Ph.D. and MSc. from the University of Genoa. He has been chairing an M.Sc. and Ph.D. courses at the University of Milan-Bicocca and he co-edited a book on two-dimensional (2D) materials for nanoelectronics. He is principal investigator of an ERC Consolidator Grant 2017, and in charge of other national (Fondazione Cariplo, Regione Lombardia) and international (EU-FP7) grants. His main research interests are on the 2D Xenes and transition metal dichalcogenides.

For further information: carlo.casari@polimi.it