MAR14-2013-020114

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Physical foundations and future perspectives of the epitaxial silicene

ALESSANDRO MOLLE, CNR-IMM, Laboratorio MDM

Silicene, a graphene-like Si monolayer, has been so far a fascinating theoretical hypothesis [1] with no experimental counterpart as due to the natural sp^3 hybridization of Si bonding. Artificially forcing the silicene lattice was firstly made possible in the epitaxial growth of a Si monolayer on Ag(111) substrates [2]. Here it is shown through an *in situ* scanning tunnelling microscopy investigation [3] that unlike graphene, non-trivial atomistic arrangements (reconstructions) can coexist in multiphase silicene nanosheets as due to the balance between planar and buckled bonding [1]. This structural complexity is kinetic in character as it can be governed by tuning the thermal condition during growth or in a post-growth stage, and it is expected to bring absolutely peculiar physical properties [4]. Silicene is intrinsically limited by its intimate chemical instability. An *ad hoc* engineered Al_2O_3 encapsulation is proposed for *ex situ* investigations such as Raman spectroscopy [5]. Supported by *ab initio* calculations, the measured Raman spectrum of the silicene phases is consistent with a prevailing a sp^2 hybridization, and it also evidences a reconstruction dependent resonant/non-resonant behavior [6]. To integrate silicene in transistor structures, decoupling from the metallic templates is highly desired. New directions in this respect are outlined which include silicene deposition on cleavable substrates (e.g. Ag(111) films on mica), and the van der Waals growth of Si nanosheets on layered templates (such as MoS_2 layers). Perspectives on the silicene "portability" for a device-oriented exploitation will be discussed.

[1] S. Cahangirov, et al., Phys. Rev. Lett. 102, 236804 (2009).
[2] P. Vogt, et al., Phys. Rev. Lett. 108, 155501 (2012).
[3] D. Chiappe, et al., Adv. Mater. 24, 37, 5088 (2012).
[4] M. Ezawa, Phys. Rev. Lett. 109, 055502 (2012).
[5] A. Molle, et al., Adv. Func. Mat. 23, 4340 (2013).
[6] E. Cinquanta, et al. J. Phys. Chem. C 117, 16719 (2013).