Università degli Studi di Roma "Tor Vergata"
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SEMINARIO DI STRUTTURA

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"Growing graphene on semiconducting nanostructures: an atomistic description."

Abstract

The predictions about the great potential of graphene for future 2D electronics, due to the conduction properties of its Dirac massless electrons, have not been yet fulfilled. Graphene is a semimetal with zero bandgap, a key issue that still challenges its use as controlled resistor or switch. Scientists are now actively looking at producing a bandgap in graphene or using alternative semiconducting 2D materials.

We grow graphene over small SiC nanostructures obtained by FIB patterning with lateral sizes ranging from tens of nm to 1 μm. Thermal decomposition of SiC has proven to be an excellent method to grow transfer-free wafer-scale graphene, but to date there has been no report about the growth of graphene on nanometer-scale SiC mesas, and very little is known about the effect of changing the dimension and characteristic of the substrate on which graphene is grown. By using a combination of high-resolution Scanning Tunneling Microscopy (STM) images, Xray Photoelectron Spectroscopy (XPS) and first principle calculations we have been able to provide a full atomic description of the transformation mechanism of 3C-SiC into graphene upon thermal decomposition, starting from the top layer down to the bulk [1, 2].
The surface transformation leading from SiC(111) to Graphene progresses by continuing the annealing, which produces silicon sublimation, leading to a bottom-up growth governed by a square root time law. This suggests that Si diffusion occurring across graphene overlayer is the rate-limiting step of the growth, dictated by a high defect density at the interface.
On the nanostructures a similar process occurs, but the growth is affected by the heat distribution, which needs to be taken into account.

1. B. Gupta, E. Placidi, C. Hogan, N. Mishra, F. Iacopi and N. Motta, Carbon **91** (0), 378-385 (2015).
2. F. Zarotti, B. Gupta, F. Iacopi, A. Sgarlata, M. Tomellini and N. Motta, Carbon **98**, 307-312 (2016).

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