Selective growth graphene films on Gallium-FIB irradiated domains

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Graphene, a two-dimensional crystal of carbon atoms arranged in a honeycomb lattice, is a zero band gap with very unique electronic, optical and mechanical properties [1]. One crucial technological problem, that still governs future applicability of this material, is related to structuring this material while preserving its exceptionally high crystallinity and electronic properties. Previously our team has been investigating Graphene structural modifications using a high spatial resolution FIB capable of ion dose control down to a few tens of ions per spot. Local surface properties of a graphene monolayer grown on a SiC substrate [2] were investigated leading to arrays of artificial defects engineering and in tailoring nano-ribbons into suspended sheets or graphene flakes [3].

In this work we will detail our investigations on the influence of a precise (dimensions, dose control and fluence stability) Ga+ ion irradiation to selectively modify a copper precursor surface to promote the growth of graphene in surface domains having up to 50x50µm sizes. Graphene films were then subsequently synthetized using chemical vapor deposition (CVD) technique with the FIB patterned copper foil used as the catalytic substrate for graphene growth. The main advantage of using CVD graphene films is that several square centimeters-sized films having only a few atomic layers can easily be obtained and checked using Raman spectroscopy.
The morphology and electronic properties of the graphene films are very promising and will be discussed in detail.

[1] K. S. Novoselov, Z. Jiang, Y. Zhang, S. V. Morozov, H. L. Stormer, U. Zeitler, J. C. Maan, G. S. Boebinger, P. Kim, and A. K. Geim, Science 315, 1379 (2008)
[2] Local ion irradiation of thin graphene films grown on SiC substrates Prevel B., Benoit J. -. M., Bardotti L., Melinon P., Sato A. Mayumi, Ouerghi A., Lucot D., Bourhis E., Gierak J., Microelectronic Engineering, vol. 98, p. 206-209 (2012)
[3] J. Gierak, D. Lucot, A. Ouerghi, G. Patriarche, E. Bourhis, G. Faini, D. Mailly, MRS Online Proceedings Library / Volume 1259 / 1259-S18-04, (2011)