Topology and porosity of 3D NanoPorous Graphene

Iolanda Di Bernardo[§]
N. Motta[‡], Y. Ito*, S. Lupi[§¥], C. Mariani[§], M.G. Betti[§]

[§]*Sapienza Università di Roma, Piazzale Aldo Moro 2, Roma, Italy*
¥CNR-IOM and Sapienza Università di Roma
[‡]Queensland University of Technology, 2 George Street, Brisbane, QLD (Australia)
**Inst. of Appl. Phys., Graduate School of Pure and Appl. Sciences, University of Tsukuba, Tsukuba, Japan.*
**PRESTO, Japan Science and Technology Agency, Saitama, Japan*
Iolanda.dibernardo@uniroma1.it

Graphene and other sp^2 carbon based, low dimensional materials – like Carbon NanoTubes - have been intensively studied for their incredible properties, often intrinsic to their structure. Packing and folding graphene sheets into 3d micro- and meso-porous structures allows the synthesis of C-based materials with an extremely high surface areal density, which behold a great potential, e.g., for energy storage applications [1].

We performed the morphological and vibrational characterization of Nano-Porous Graphene (NPG) samples, exhibiting a three dimensional micro-structure made up of interconnected tubular branches encaging pores few hundreds nm wide (see Fig. 1) [2,3], which could be a suitable candidate for the building of advanced prototypes for C-based electrodes, as it has been shown that both the presence of defects (induced, e.g., by curvature) and a high surface to volume ratio can enhance the lithium uptake in graphene flakes [1].

We present herewith an extensive investigation of NPG samples with different pore sizes, doping levels and degree of graphitization, by a combination of state-of-the-art experimental techniques such as Helium Ion Microscopy, spectromicroscopy and microRaman mapping. The high average 2D/G intensity ratio (I_{2D}/I_G=2.6±0.6) reported in Fig. 2 for an undoped NPG sample assesses its high crystallinity, while its broad distribution reveals the local presence of bent areas, borders and defects which induce a distortion of the perfect hexagonal lattice. We have been able to bring to light a one to one correspondence between the topology and the vibrational microRaman spectrum of the NPG samples, which appear to preserve the typical properties of 2d graphene while constituting an ideal 3d structure for potential electrodes.

References

[1] Hassoun, J. et al, NanoLett ,14 (2014) 4901
[2] Ito, Y. et al., Angew. Chem., 126 (2014) 1
[3] Ito, Y. et al., Adv. Mater, 26 (2014) 414

Figures

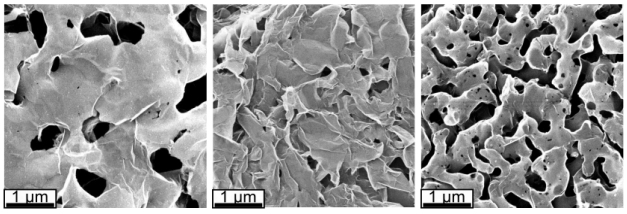

Figure 1: Helium Ion Microscopy of NPG samples with different nominal pore size and different doping.

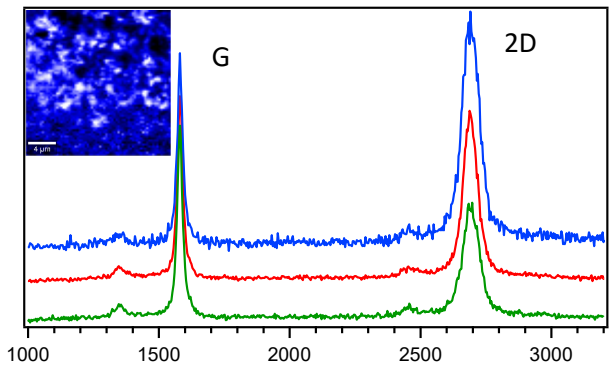

Figure 2: Raman spectra collected in three different spots of a non-doped NPG sample, normalized to the G band Intensity. Inset: 2D/G intensity mapping over a 21x21µm² area.