FIELD-EFFECT TRANSISTORS BASED ON REDUCED GRAPHENE OXIDE

A. Liscio[a], E. Treossi[a], J. M. Mativetsky[b], G. P. Veronese[c], R. Rizzoli[c], P.Samorì[b] and V. Palermo[a*]

[a]ISOF-Istituto per la Sintesi Organica e la Fotoreattività - Consiglio Nazionale delle Ricerche, Bologna, Italy,
[b]ISIS - CNRS, Université de Strasbourg, Strasbourg, France
[c]IMM-Istituto per la Microelettronica e Microsistemi - Consiglio Nazionale delle Ricerche, Bologna, Italy
*Corresponding author: *palermo@isof.cnr.it*

Graphene has rapidly emerged as an extremely promising system for electronic, optical, thermal, and electromechanical applications.[1] The industrial exploitation of graphene will require large scale and cost-effective production methods, while providing a balance between ease of fabrication and final material quality. Currently, however, the preparation of graphene typically requires vacuum conditions, high temperatures, or the use of hazardous solvents.[2] Here we describe a simple electrochemical approach to fabricate graphene-based field-effect-transistors (FETs), starting from aqueous solutions of graphene-oxide (GO), entirely processed under ambient conditions.[3] The process relies on the site-selective reduction of GO sheets deposited in between micro- or nano-electrodes. Electrochemical reduction processes can be induced i) by applying a pulsed potential difference between drain and source electrodes covered by the GO film or ii) by rastering a conductive-AFM tip. The former macroscopic approach provides to product ambipolar graphene-based devices starting from commercial interdigital three-terminal structures. On the other hand, the AFM-tip-induced electrochemical reduction is a local process providing to draw the conductive pattern on otherwise-insulating graphene oxide with a lateral resolution of few hundreds of nanometers. The progress of the GO reduction was monitored by performing a current-voltage measurement at low voltages (i.e. below 1 V) after each voltage pulse. Transistors with micrometer-scale tip-reduced graphene channels that featured ambipolar transport and an 8 order of magnitude increase in current density upon reduction were successfully fabricated. Moreover, conductive-AFM and Kelvin Probe Force Microscopy (a.k.a. KPFM) techniques are used to quantitatively assess the local electrical and the surface potential voltage characteristics of reduced graphene oxide along the source-drain channel in different structural configurations (single layer, defects, multilayers) with a lateral resolution less than 20 nm.

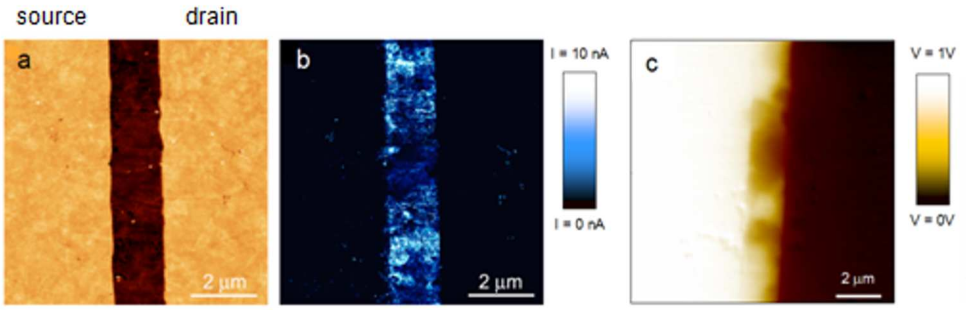

Figure 1: (a) AFM and (b) corresponding current images of grounded source-drain electrodes covered by reduced GO film. (c) KPFM image acquired on the same region where 1 V is applied to source while drain is grounded. Current and voltage are shown using false-colour scales.

References

[1] A.K. Geim, Science, 324 (2009) 1530.
[2] S. Stankovich *et al.*, Nature, 442 (2006) 282.
[3] J.M. Mativetsky *et al.*, Journal of the American Chemical Society, 132 (2010) 14130.
[4] This work was supported by the ESF EuroGraphene project GOSPEL, the EC through the Marie-Curie ITN-GENIUS (p.id 264694)