Developing low-cost graphene devices
Chang-Soek Lee, Waleed Moujahid, Bérengère Lebental, Marc Châtelet, François Le Normand, Jean Luc Maurice, Costel-Sorin Cojocaru

To cite this version:
Chang-Soek Lee, Waleed Moujahid, Bérengère Lebental, Marc Châtelet, François Le Normand, et al.. Developing low-cost graphene devices. GDR-I Nanotubes and Graphene, Jan 2012, France. hal-00860864

HAL Id: hal-00860864
https://hal.archives-ouvertes.fr/hal-00860864
Submitted on 11 Sep 2013

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
DEVELOPING LOW-COST GRAPHENE DEVICES

C. S. Lee, W. Moujahid, B. Lebental, M. Châtelet, F. Le Normand, J.-L. Maurice, and C. S. Cojocaru

1LPICM, CNRS UMR7647, École polytechnique, 91128 Palaiseau Cedex, FRANCE
2IFSTTAR, 58, boulevard Lefebvre, 75732 Paris Cedex 15, France
3InESS (Institut d’Électronique du Solide et des Systèmes), UMR 7163 Université de Strasbourg-CNRS, 23, rue du Loess, BP 20 CR, 67037 Strasbourg Cedex 2, France

In spite of numerous efforts for developing the applications of graphene, it remains difficult to put the remarkable physical properties of this material into devices. This is mainly due to the fact that large-area (industrial) graphene includes in its structure and on its surfaces a significant density of defects that make as many traps and scattering centres for charge carriers. The idea of the present work, contrary to diminishing the defect density, is to use the defects and the very large surface to volume ratio of that 2D material, to transform it into high sensitivity sensors.

When defects are useful, low-temperature growth becomes the method that best satisfies both physical and financial demands. Here, we further decrease preparation costs by performing growth not only at low temperature directly on the final insulating substrate (glass), but also by printing the device contacts by ink-jet printing. Graphene layers actually develop at the interface between a metallic catalytic film and the insulating substrate during plasma-enhanced chemical vapour deposition (PE-CVD).

Resistivity of the graphene foils was measured by the four-point methods using ink-jet printed electrodes, and a resistivity as low as 820 ohms/sq were obtained. Moreover, the sensitivity of such graphene foils to water vapour was evaluated, with the prospect to use them in humidity sensors for civil engineering.

In this presentation, we explain how graphite may precipitate at the interface in addition to the surface. Then we show examples of graphene obtained at temperatures in between 450 and 550°C, on glass (Fig.), fused silica, alumina and SiO2//Si. Transmission electron microscopy indicates that the structure is nanocrystalline. We finally show the humidity response of the fabricated device. Results seem to indicate that high-defect density, thin deposits are more sensitive to water vapour than thicker ones.

References

Figure: Example of graphene-on-glass obtained by PE-CVD. Top: process for obtaining graphene directly on the insulating substrate. (a) Deposition of Ni film by evaporation; (b) PECVD: graphene layers develop at the surface of the Ni film, and at the interface with the insulating substrate. (c) To uncover interfacial graphene, top layer graphene is first etched off in situ by strong water vapour plasma; Ni is then etched using standard wet process, leaving graphene laying directly on a functional substrate (d, e). Bottom: graphene-on-glass obtained after 12-mn PE-CVD at 450 °C. (e) Optical image (scale bar is 0.1 mm) after removal of the nickel film and top-surface graphene, the electrical probes are visible; (f) typical Raman spectrum; (g) transmittance. The resistance per square measured on patterned device is 800 Ω.

corresponding author: jean-luc.maurice@polytechnique.edu