Nanostructuring of graphene layers by AFM local anodic oxidation

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Graphene is a promising material with unique physical properties for nanoelectronics[1]. Phenomena like quantum Hall effect or spin transport have been investigated and the fabrication of electronic devices like SETs and bi-layer transistors has been already demonstrated[2,3]. However, the feasibility of practical graphene-based electronics is still constrained by the possibility to completely control the properties, dimensions and localization of the graphene layers.

Epitaxial graphene on SiC is a suitable option for the formation of nanoelectronic devices. The synthesis technique for graphitization consists of Si sublimation of SiC substrates. We have recently demonstrated that this method provides high quality, copious and large size of graphene layers in a controllable manner[4]. Here, we present a new approach to tailor the dimensions of graphene-based devices by local anodic oxidation based on atomic force microscopy (LAO-AFM)[5]. We have achieved the optimal conditions (voltage, AFM operation mode, speed, etc) to locally oxidize graphene layers with nanometer resolution, using an experimental procedure slightly different than in a previous work [6].

Epitaxial graphene layers have been contacted by EBL and nanostructured using the AFM LAO (fig.1). Electrical measurements performed before and after LAO process demonstrate the viability of the technique (fig.2). Electrical Force Microscopy allows testing in situ the electrical disconnection of graphene areas (fig.3). In conclusion, we demonstrate that LAO-AFM is a simple and powerful technique for prototyping a wide range of graphene nanoelectronic devices.

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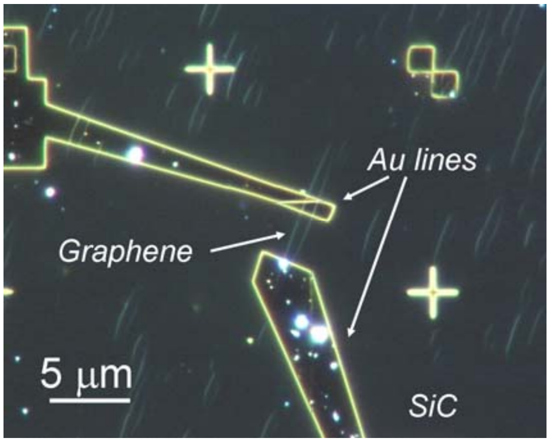

Fig 1. Dark field optical image showing the graphene layers on SiC and the electrical contacts

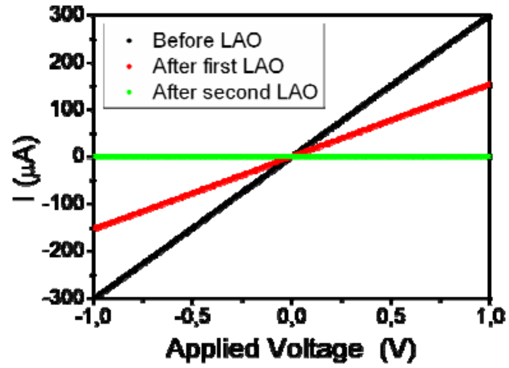

Fig 2. Electrical measurements before, after the first pattern and after the second pattern in figure 3.

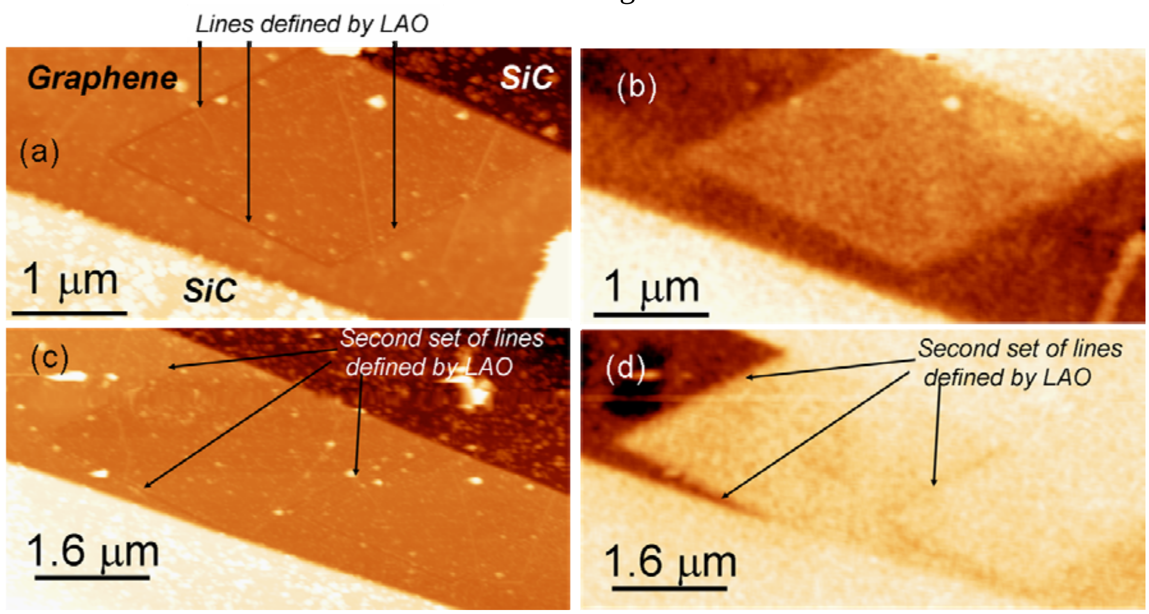

Fig 3. Example of patterning of graphene by AFM local anodic oxidation. (a) AFM topographical image after the first patterning of the layer. (b) AFM electrical force microscopy (EFM) after the first patterning of the layer. (c) AFM topographical image after the second patterning of the layer. (d) EFM image after the second patterning of the layer. (Z scale a and c: 30 nm; Z scale b and d: 4 degrees.