Current annealing recovery from electron beam induced damages in suspended graphene

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Abstract

Electron beam irradiation has proved to create degradation in the electrical properties of supported and suspended graphene [1]. However, it is unavoidable if fabrication or characterization techniques such as electron beam lithography (EBL), electron beam induced etching (EBIE) [2] or scanning electron microscopy are used.

Here we present an *in situ* study showing that the damages of electron beam irradiation on the electrical and structural properties of suspended graphene can be recovered through current annealing. Current annealing is effective, as long as the dose of the irradiation does not exceed a threshold value. This value is well above the standard range of doses required for EBL exposure. Even when the threshold is exceeded by multiple, low-level exposures, the sample quality can be restored by current annealing after each cycle. We also show, that the effect of electron irradiation is reduced when a suitable annealing current is passed through the graphene during irradiation.

Finally, we show that current annealing allows the nanopatterning of suspended graphene through EBIE [2] preserving the electrical properties of the device. In order to reduce excessive damages, the irradiation dose for the patterns was calibrated to be the minimal required to efficiently pattern the suspended graphene. As shown in figure 1, multiple patterning steps can be used to create a freestanding, 400nm wide nanoribbon, without altering the electrical characteristic of graphene, provided that current annealing is performed after the exposure of each line of the pattern.

References

[1] I. Childres, L. A. Jauregui, M. Foxe, J. Tian, R. Jalilian, I. Jovanovic, and Y. P. Chen, Appl. Phys. Lett. **97**, 173109 (2010).
[2] B. Sommer, J. Sonntag, A. Ganczarczyk, D., G. Prinz, A. Lorke, and M. Geller, Sci. Rep. **5**, 7781 (2015).

Figures

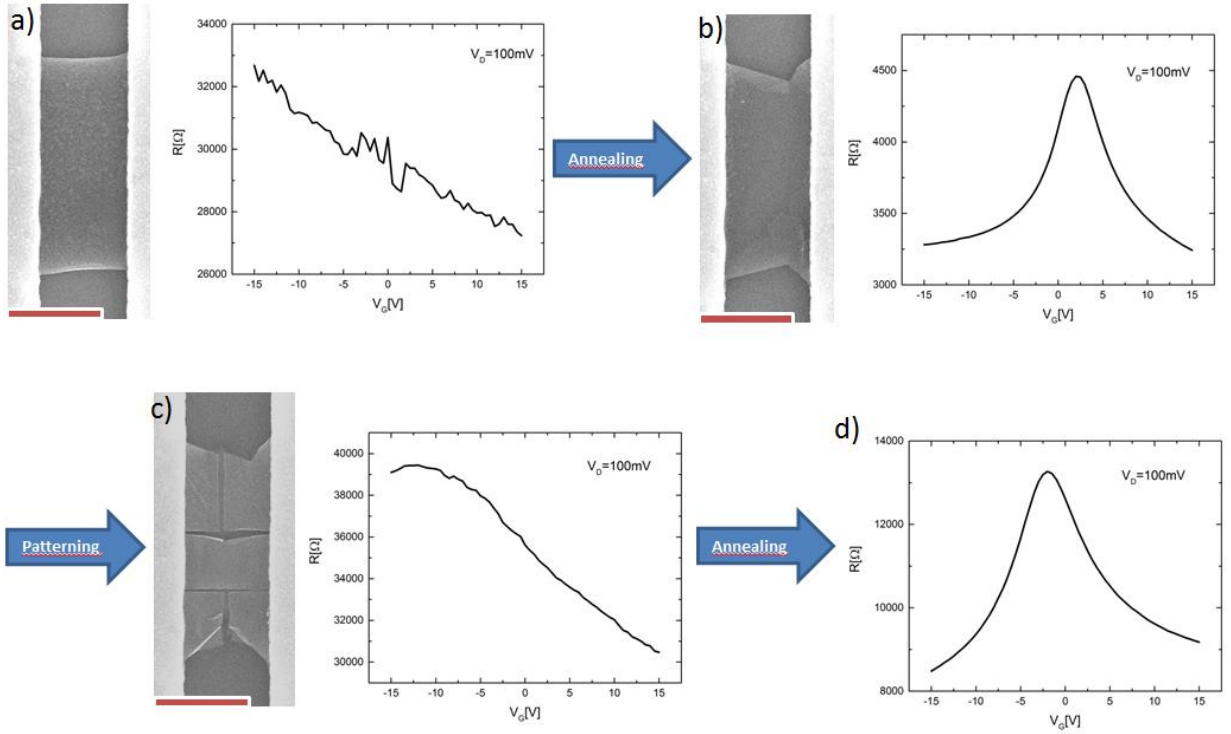

Fig. 1: Scanning electron micrograph, and electrical measurements of a suspended graphene microribbon, a) after electron beam irradiation, b) after current annealing, c) after patterning, d) after current annealing. The red scale bar is 500nm long.