Robust fabrication of suspended structures from CVD graphene

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Abstract

Suspended graphene is interesting for nanoelectromechanical systems (NEMS) due to its high stiffness combined with low mass [1] and RF applications due to the increased electrical mobility. [2] For suspended as well as supported devices, it is important to have a large-scale fabrication route. We developed a robust and scale fabrication route for suspended devices from CVD graphene towards industrial applications. By taking particular care of the etching mask/graphene interface, we repeatedly achieved fully self-supported graphene beams in all of the 14 devices on each sample but one or two. A representative SEM image can be observed as in Figure 1a. In addition, we saw that it is possible to suspend more complicated geometries as in Figure 1b which are intended for more elaborate electrical measurements including the extraction of Hall mobility and elimination of contact resistance in suspended graphene structures. Furthermore, we have seen that it was possible to promote or impede periodic fold formation perpendicular to the beam length that survived heat treatments as well as suspending. Such folds, especially sharp ones are predicted to influence local electronic properties as well as chemical reactivity. [3] Therefore, it is imperative to have control over their formation.

Compressive strain is a result of the high temperatures of the CVD process in company with the negative thermal expansion coefficient of graphene. While this is partially relaxed into systematic and/or randomly distributed folds, Raman spectroscopy showed that the compression is, in fact, not fully relaxed even at the final step of fabrication. Our preliminary electrical measurements on graphene devices on SiO_2 showed promising contact resistance and Hall mobility. Our care of the interface resulted in contact resistivity values of ~ 2 – 3 Ω µm which is on the lower end of the published values for Cr/Au metals. [4] We calculated a mobility of ~1200 $cm^2 V^{-1} s^{-1}$ from Hall measurements where we swept the magnetic fields up to 11 T at 4 K and 20 K. While this value appears low, it agrees with electrical mobility in non-annealed CVD graphene devices.

References

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Figures

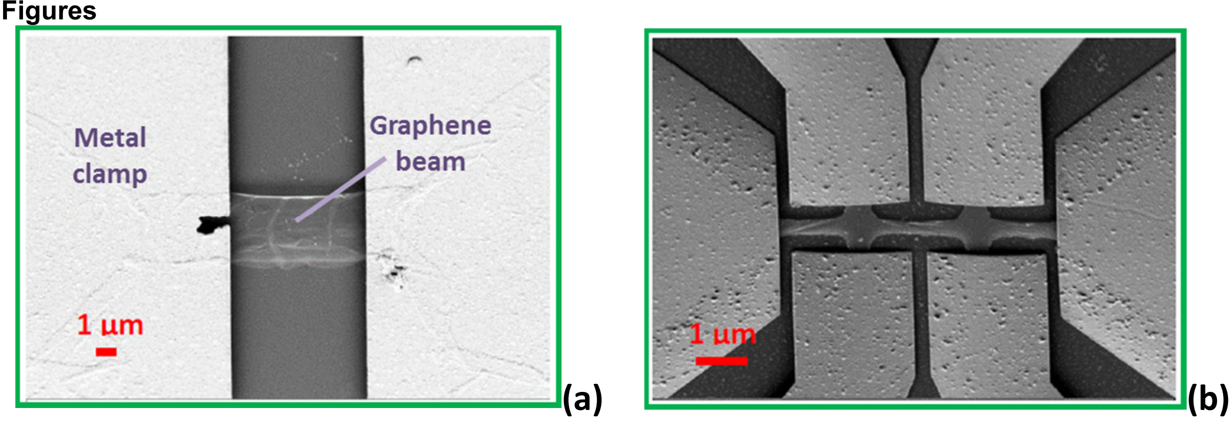

Figure 1. a) Tilted SEM image of devices patterned by optical lithography. **b)** SEM image of suspended devices with more complicated structures. The beam is patterned by ebeam lithography.