Transfer-last Suspended Graphene Fabrication on Gold, Graphite and Silicon Nanostructures

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While most graphene devices fabricated so far have been by transferring graphene onto flat substrates first - [1], an interesting approach would be to transfer graphene onto patterned substrates to suspend graphene for future graphene nanoelectromechanical device applications - [2]. This novel "transfer-last" fabrication is beneficial for reducing possible damage of the suspended graphene caused by subsequent undercutting processes and typical substrate interactions. On the other hand, reduction of contact resistance between graphene and various electrodes, and possible integration with silicon technology are the issues to be investigated. This work focuses on developing the technique to transfer graphene on patterned nanostructures made of gold, nanocrystalline graphite (NCG) and silicon.

The nanostructures are patterned by electron beam lithography and a CVD-grown monolayer graphene is transferred by using wet process as schematically shown in Fig. 1 for the nanogap of gold electrodes (Fig. 1(a)) and of NCG electrodes (Fig. 1(b)), and for the array of the Si nanowires (Fig. 1(c)). The results of the transfer onto the gold and NCG electrodes with the gap of 250 nm are shown in Fig. 1 (d) and (e), respectively. The helium ion microscope (HIM) images show successful fabrication of graphene nanobridges in the gap. The distortion of the bridge and folding and cracks around the nanoelectrodes indicate the capillary force in drying process plays a crucial role. The better yield of the nanobridge formation for NCG electrodes is possibly due to the better uniformity of the electrode structure. This is encouraging as the graphene-NCG contact is expected to have better performance - [3]. Figure 1(f) shows a HIM image of a top view of the graphene on the Si nanowire array. The line and space pattern observed with the contrast between the adjacent stripes in the HIM image clearly suggests that the graphene is suspended over the gaps. Compared with the cases of the nanoelectrodes, larger area coverage without complete breakage up to 100 μm^2 is observed for the transfer on the line and space structure, which is promising for future large area application with further optimization.

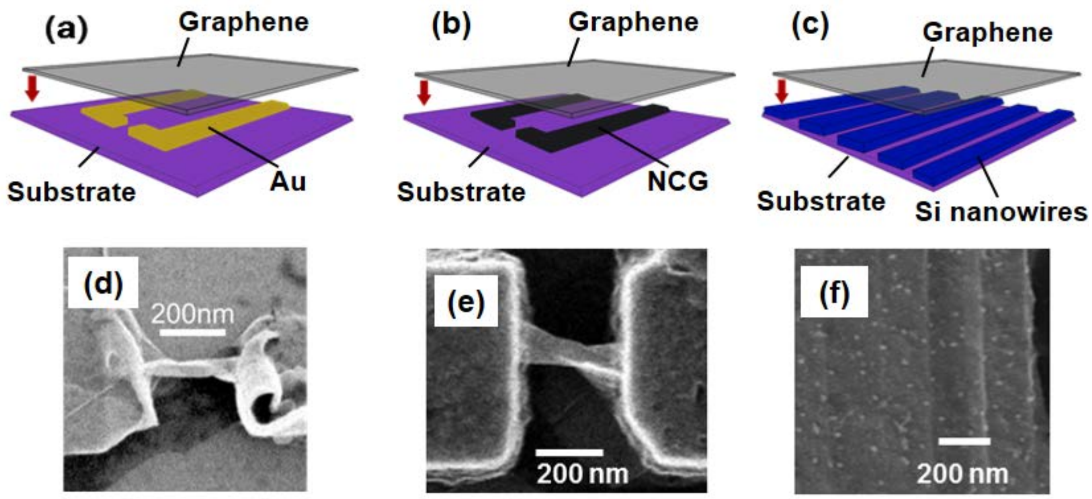

Figure 1. Schematics of the transfer-last process onto a) gold electrodes, b) NCG electrodes and c) Si nanowire array, and HIM images of suspended graphene in the 250-nm gap of (d) gold electrodes and (e) NCG electrodes, and (f) on the Si nanowire array pattern with the 200-nm-wide lines and spaces.

References
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