Face to Face Transfer of Crack Free Graphene Wafer for Long-Distance Devices

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Abstract

Graphene is a two dimensional layer of sp2-bonded carbon atoms which has high mobility and optical transparency, in addition to flexibility, high mechanical strength and environmental stability.[1-2] A variety of possible applications ranging from solar cells and light-emitting devices to touch screens, photodetectors, ultrafast lasers, membranes, spin valves, high frequency electronics, etc. are being explored.[3] Graphene development could impact products in multiple industries, from flexible, wearable and transparent electronics, to high performance computing and spintronics. The integration of these new materials could bring a new dimension to future technologies, where faster, thinner, stronger, flexible, and broadband devices are needed. Although the demo devices for most applications only need high quality graphene of several microns in size, the future graphene based applications also require it to be high quality and large size. Recently, most preparations of graphene focus on the grain shape, intrinsic defects of graphene, like doping, atomic ripple, etc., which are not much affected by external factors.[4-8] However, the future applications of graphene need to endure several processed of treatment, like reactive ion etch, coating by different polymer, and different transfer processes. In contrast to the controllable growth of CVD graphene, its transfer method will be a bottleneck of the real application. Actually, the first reported CVD graphene grown on Cu foils can meet the application of most fields,[9] but its transfer method only remains in the small devices and testing in the lab.

The common used transfer method is “the wet transfer method”.[10-11] After many times improvement, this method is still used for small size graphene, usually less than 4 inch, and it is too handcraft and bad repeability. This transfer method from its metal cradle to an insulating scaffold usually causes tears, cracks, bubbles and folds in graphene films. The tear and cracks of graphene during transfer is the biggest bottleneck for the industrial use. They will break the uniformity, and bring in the random error for the integrated devices. In addition, the large size graphene films transfer, the more density of tears and cracks will exist. Therefore, an automatic and size of graphene free transfer method is the bottleneck for the graphene industry, most of their potential applications.

Here, we report in situ face to face method for graphene films transfer from metal surface to target substrate. This method can transfer any size of graphene films, and the transferred graphene films are nearly crack free, and also maintain the nature of high quality. This transfer can also be separated into several detail parts, and suitable for the semiconductor industry. The improvement of several times face to face transfer can help its successful transfer from metal surface to any substrate without cracks. This transfer method will speed up the application of large area CVD graphene films, and the crack free graphene films can be made into long distance devices, like waveguide, etc..

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Figure 1. Graphene transferred onto Si/SiO_2 wafer. a, Photograph of a uniform 4-inch and 8-inch graphene transferred from Cu film to wafers. The Insets show the specially damaged graphene cracks, which can show the existence of graphene. **b,** Typical optical image of face to face transferred graphene on Si/SiO2 wafers, showing nearly no crack existed.