Fabrication of graphene-based devices by Ultraviolet Nanoimprint Lithography

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We present a technique to realize patterned graphene on gold contacts based on Ultraviolet Nanoimprint Lithography (UV-NIL) for the fabrication of graphene based devices like photodetectors and transistors. Graphene is a single layer of carbon atoms arranged in a honeycomb crystal lattice. In 2004 graphen's stability and high mobility have been shown for the first time [1].
Previously we described how to realize micro and nanostructures on graphene using UV-NIL [2], which is a powerful technique to realize micro and nanostructures on large area within seconds by using a nano patterned stamp [3]. For applications like photodetectors graphene has to be electrically contacted. Since the realization of nanostructured gold contacts with photolithography is challenging and e-beam writing is not scalable for mass production, we have chosen a combined UV-NIL and lift-off technique for our process. With this technique gold contacts with features in the µm and nm range were fabricated (Figure 1). As a next step CVD graphene is patterned on the Cu substrate (Figure 2 and 3). This can be done using optical lithography or UV-NIL. Due to the fact that the graphene adheres quite well to the Cu, patterning of the graphene is quite easy in comparison to patterning already transferred graphene on SiO_2. Here the adhesion is often insufficient and routes have to be found to increase the graphene adhesion to the substrate before structuring can be successful. The transfer is done using a thermal release tape. This tape is pressed on the structured graphene on the Cu (Figure 2 and 4) and the Cu is removed by a succeeding wet chemical etching step. The structured graphene remains on the thermal release tape which is then pressed onto a SiO_2 wafer with the Au contacts on top. At 120°C the tape releases the structured graphene on the surface of the wafer. The aim is to combine the UV-NIL fabrication of Au structures on SiO_2 wafers and the transfer process of structured graphene on top for fabrication of graphene transistors and photo detectors. The contact of graphene to gold has to be examined. Raman measurements, optical as well as transport measurements will be performed.

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[2] I. Bergmair et al. Nanotechnology 23, 335301 (2012)
[3]Chou, S.Y. et al., Appl. Phys. Lett. 67 (21) 3114 (1995)

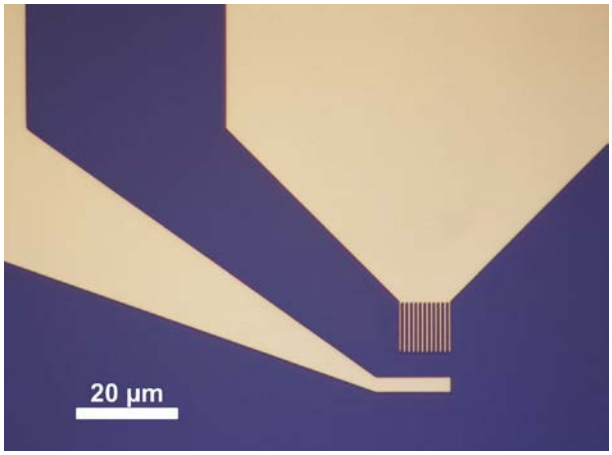

Figure 1: Optical microscope image of one photodetector Au contact fabricated by UV-NIL and lift-off technique.

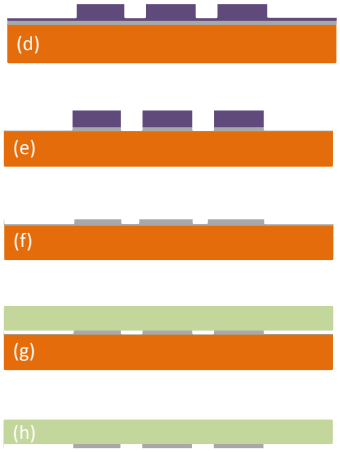

Figure 2: Schematic drawing of structuring process of graphene on Cu and transfer to thermal release tape. d) lithography on graphene on Cu wafer, e) etching of graphene, f) removing photoresist, g) adhesion of thermal release tape on graphene h) etching of Cu.

Figure 3: Photograph of microstructures patterned on a quarter 4" Aixtron graphene/Cu wafer.

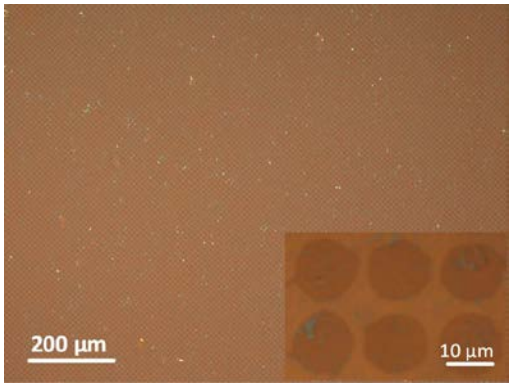

Figure 4: Optical microscope image of transferred graphene microstructures.