hBN/SLG heterostructures for high-mobility 2D devices

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The discovery of graphene and other 2D materials has revolutionized solid-state physics, creating a field of study in its own. Interestingly, the ease of mechanical exfoliation to obtain high-quality samples of these materials democratized the research and propelled forward their study. Moreover, the exotic properties of these materials that arise from their peculiar two-dimensional atomic lattices enable semiconductor devices with functionalities and specification that cannot really be reproduced, even with the state-of-the-art fabrication of silicon devices.

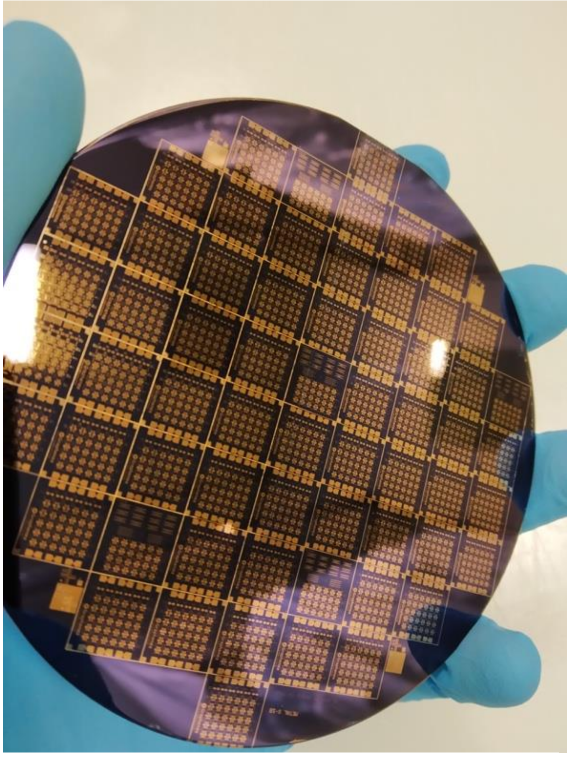

Figure 1. hBN/SLG devices fabricated on a 4 inch wafer.

However, these 2D materials still need much improvement in material synthesis and processing. Particularly, the mobility of these materials needs to be very much improved to fully seize their potential in electronics and optoelectronics, as well as sensing. This can be done with contact optimization, deposition optimization and many other approaches.

For this purpose, a method to grow hexagonal boron nitride (hBN) was developed using solid precursors such as ammonia borane, which have a much lower toxicity and are much cheaper. These hBN films were grown using a chemical vapour deposition technique, which a standard technique within semiconductor manufacture, readily scalable. The substrate for the growth is a Cu foil which as a widely use material and inexpensive, which further enhances the scalability of this technique. The samples grown were as small as a few millimeters squared and as large as four inches.

Moreover, a transfer process was developed to transfer these hBN films grown on Cu foils to arbitrary substrates. hBN films were transferred onto a half 4 inch wafer, and then subsequently transferred graphene. This allows the comparison of bare SLG and hBN/SLG heterostructures on the same substrate and film, removing variability and stochastic factors that might blur the difference between both structures.

Lastly, a fabrication process was developed to pattern and metallize the SLG and hBN/SLG films, being able to fabricate functional devices at the wafer scale (see Fig.1). The yield of these structures was high (>70%) and a direct comparison of SLG and hBN/SLG structures enabled its proper characterization. The conclusion was that hBN by itself doesn't improve dramatically the properties of graphene.