Fabrication of clean, ultra-high density graphene antidot lattices

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The introduction of periodic arrays of holes in graphene, so-called graphene antidot lattices (GALs), has for certain geometries been predicted to induce tunable bandgaps in graphene, and is expected to be a facile route towards bandstructure engineering [1,2]. To observe clear signs of quantum-effects, periods of the GAL should be kept well below 50 nm, and has so-far only been observed in samples where the superlattice was introduced due to the Moiré pattern from graphene on hexagonal boron nitride (hBN). However, the common approaches of masking the graphene directly with polymers introduce contamination and defects, obscuring any subtle quantum effects introduced by the patterning.

We demonstrate ultra-dense nano-patterning in high-performance devices of hBN-encapsulated graphene fabricated by the hot pick-up technique [3]. The hBN-encapsulation increases the device quality and protects the graphene while etching the superlattices.

Hexagonal and square lattices with sub-30nm periods, i.e. the center-to-center distance, are fabricated with single-shot exposures in a 100kV electron-beam system. The periods of the GALs made here with single-shot exposures are the densest structures defined via EBL in hBN-encapsulated graphene devices.

References

[1] T. G. Pedersen *et. al*, PRL, 100.13 (2008) 136804
[2] J. A. Fürst *et. al*, New Journal of Physics, 11 (2009) 095020
[3] F. Pizzocchero *et. al*, Nat. Comm., 7 (2016) 11894

Figures

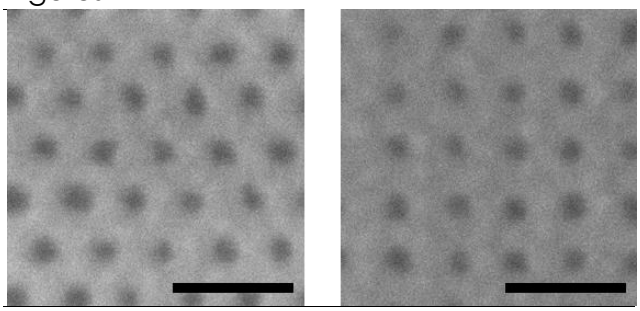

Figure 1: Scanning electron microscope images of antidots patterned in hexagonal boron nitride. Scalebars are 50 nm.

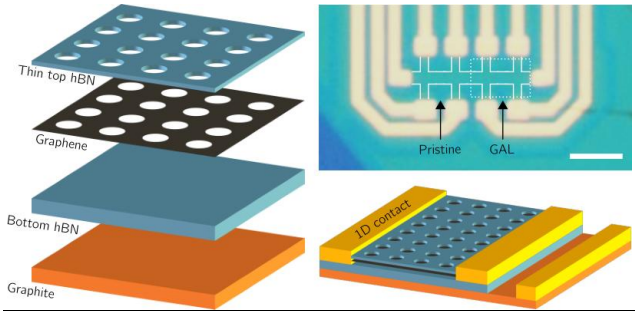

Figure 2: Schematic and optical image of a device made with a pristine part and a part of ultra-high density graphene antidot structures.