Quantum transport in nanopatterned graphene - without killing the patient

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After the initial excitement about graphene's high performant and scientifically rich electronic properties, one of the most obnoxious roadblocks have been to pattern graphene on a small scale. In theory, nanostructuring of graphene opens for the electronic and photonic properties to be "programmed" to match specific applications or to bring out entirely new physics. In practice, even low levels of edge disorder and contamination associated with even the best lithographic processes, ruins the electronic properties. This has effectively shut down the hope of controlling transport at the quantum level, as well as trivially downscaling graphene electronic components to scales common for mainstream silicon electronics. I will discuss progress we have made in engineering the graphene edges[1,2], and focus on a recent example [3]. We show that by combining encapsulation in hexagonal boron nitride with high-density lithography, and carefully tuning the etching process, we are able to pattern graphene on the 10 nm scale (Fig. 1), and still preserve the detailed magnetotransport signatures predicted by tight-binding calculations. The surprising survival of the subtle moire-superlattice signatures associated with twisting of the crystalline interlayers opens for construction of circuits and components that exploit this emerging branch of solid-state physics.

References

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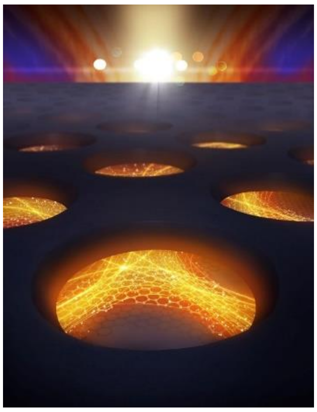
Figures



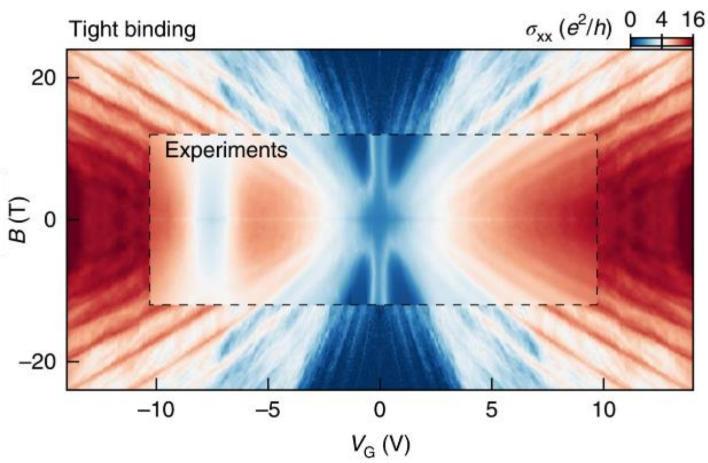


Figure 1. By carefully etching holes in graphene through a protective encapsulation layer of hexagonal boron nitride (left), with a spacing of just 12 nanometers, the electronic band structure can be engineered in a deterministic way (right).