Enhancing centimeter-sized epitaxial graphene quantum Hall arrays with superconducting NbTiN interconnections

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Epitaxial graphene (EG) forms as a single-crystal and can be obtained on the centimeter scale. The EG growth scale and homogeneity have improved to the point that one can realize devices suitable for general applications, like larger scale electronics, and more specialized applications, such as quantized Hall resistance standards [1-2]. Limitations of reliable access to the quantum Hall plateaus other than i = 2 have motivated efforts to create a system of devices in series and in parallel, specifically for the development of quantum Hall array resistance standards. One issue for these scalable resistance networks, based on multiple Hall bar elements, is that they often suffer from accumulated internal resistances directly from contacts, spreading, and unwanted Hall resistance contributions from resistive metallic interconnections. We report the fabrication of centimeter-scale, EG-based array devices functionalized with chromium tricarbonyl [$Cr(CO)_3$]. Niobium titanium nitride (NbTiN) was used for contacts and interconnections, which minimized the unwanted internal resistances while its superconductivity was maintained. The device was designed to reduce contact resistances and prevent quantized Hall resistance deviations caused by Andreev reflections [3]. Versatility of these devices has been demonstrated by selecting different array elements across which quantized resistances were measured. Furthermore, the functionalization process enables carrier density stability in air and provides a condition upon which uniform doping can be applied to the array without the need for large-scale electrostatic gates.

References

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Figures

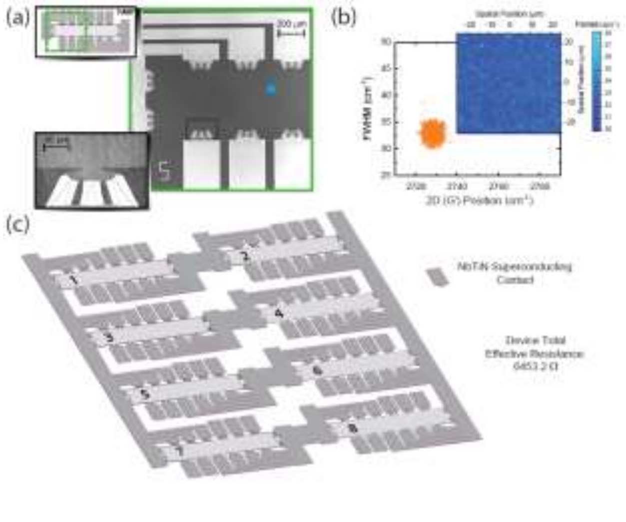

Figure 1: (a) Confocal laser scanning microscope image of one region of an example device. The small blue region is the location of an acquired Raman map, to scale. (b) The full widths at half maximum of the 2D (G') peaks from the Raman map are plotted against the corresponding Raman shift of those peaks. In the upper right inset, the 2D (G') peak FWHMs are plotted as a function of spatial position within the blue square in (a) to depict the homogenous growth. (c) An example array is illustrated as a guide to visualizing how various quantized resistances can be measured.