Direct imaging of magnetotransport at graphene-metal interfaces with a single-spin quantum sensor

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Magnetotransport underlines many important phenomena in condensed matter physics, such as the Hall effect [1] and magnetoresistance (MR) effect [2-4]. Thus far, most magnetotransport studies are based on bulk resistance measurements without direct access to microscopic details of the spatial transport pattern. Here, we report the first nanoscale imaging of magnetotransport using a scanning single-spin quantum magnetometer, which is demonstrated in a graphene-metal hybrid device at room temperature [5]. By visualizing the current flow at elevated magnetic fields (~0.5 T), we directly observe the Lorentz deflection of current near the graphene-metal interface, which is a hallmark of magnetotransport [1]. Combining the local current distribution with global resistance measurements, we reveal that transport properties of the hybrid are governed by a complex interplay of intrinsic MR around the Dirac cone, carrier hydrodynamics, interface resistance, and the nanoscale device geometry. Furthermore, accessing the local transport pattern across the interface enables quantitative mapping of spatial variations in contact resistance, which is commonly present in electronic devices made from two-dimensional materials yet non-trivial to characterize. Our work demonstrates the potential of nanoscale current imaging techniques for studying complex electronic transport phenomena that are difficult to probe by resistance-based measurements.

References

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Figures

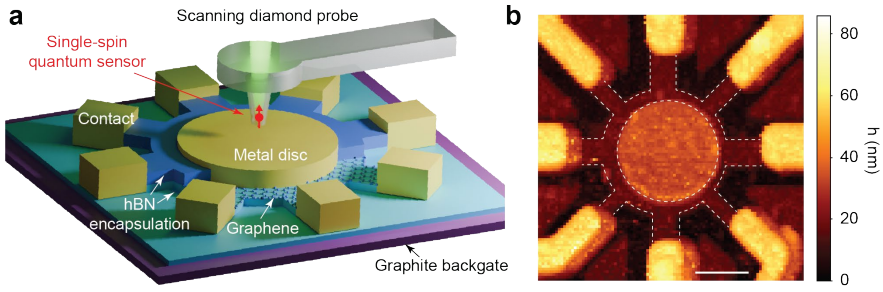

Figure 1: a Experimental arrangement for imaging current flow through the graphene-metal hybrid device using a scanning single-spin quantum magnetometer. **b** Topography of the hybrid device, showing the van-der-Pauw geometry with an inner metal disc, an outer graphene ring and eight metal contacts. Dashed contours mark the edge of the graphene sheet. Scale bar, 1 μm.