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Using charged defects in BN to create rewritable graphene quantum dots and visualize quantum interference

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Heterostructures of graphene and hexagonal boron nitride (BN) are highly tunable platforms that enable the study of novel physical phenomena and technologically promising nanoelectronic devices. Common control schemes employed in these studies are electrostatic gating and chemical doping. However, these methods have significant drawbacks, such as complicated fabrication processes that introduce contamination and irreversible changes to material properties, as well as a lack of flexible control. To address these problems we have developed a new method that employs light and/or electric field excitation to control defect charge (from the single impurity level to ensembles) in the underlying BN. We have used optoelectronic and scanning tunneling spectroscopy measurements to characterize these BN defects. We find that by manipulating defect charge in BN it is possible to create rewritable tip-induced doping patterns such as gate-tunable graphene pn junctions and quantum dots. This creates new opportunities for mapping the electronic states of confined electrons in graphene and to visualize their quantum interference behavior.