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Imaging the Electronic Structure of Strained Epitaxial Monolayer Graphene

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The development and adoption of nanoscale electronic devices requires metrology techniques that are sensitive to properties at similar length scales. Photoemission electron microscopy (PEEM) is based on the photoelectric effect with 10's of nanometer spatial resolution, and a variant of more well-known techniques such as x-ray photoelectron spectroscopy and angle-resolved photoemission. In addition to real space imaging capabilities, the PEEM can bridge the electronic band structure measurement gap between atomic-resolution scanning tunneling microscopy (STM) and millimeter-scale angle resolved photoemission (ARPES). Currently, third generation PEEM's are capable of measuring the kinetic energy of photoelectrons, and this makes the PEEM suitable for performing micrometer-scale ARPES (μ-ARPES) within the same instrument. Many nanoelectronic devices have typical active regions on the order of 30 μm^2 which is highly compatible for μ-ARPES.

Epitaxial graphene (EG) has technological applications in quantum Hall resistance standards. Here, we image EG topography in real space and measure the electronic structure of monolayer EG regions with μ-ARPES. We detect characteristic features of graphene such as electrons originating from the Dirac points and the π-band. On different regions of the sample which look topographically similar, we observe the electronic flat band where a Dirac point was expected. We performed Raman spectroscopy on the same regions that were analyzed by PEEM, and estimate a significant amount of compressive strain (~1.2%) by comparing the 2D and G positions using a vector decomposition model [1]. It has been proposed by others that the compressive strain could modify the electronic band structure in monolayer graphene [2, 3].

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