YY2.05

Coherent Low-energy (below 250eV) Electron Diffractive Imaging of Freestanding Graphene

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It has recently been demonstrated that electrons with kinetic energies in the range of 50-250 eV do not cause radiation damage to biomolecules, enabling the investigation of an individual molecule for an extended period of time. Since the electron wavelength associated with this kinetic energy range is between 0.77 Å (for 250 eV) and 1.7 Å (for 50 eV), low-energy electrons have the potential for non-destructive imaging of single biomolecules and in particular individual proteins at atomic resolution. We have developed and implemented an experimental scheme for low-energy electron coherent diffraction imaging. A sharp tungsten tip acts as source of a divergent beam of coherent low-energy electrons, which is collimated by a dedicated electrostatic microlens of only 2.5 micron in diameter. The resulting parallel beam is directed towards the sample and at a distant detector its diffraction pattern is recorded. For our investigations objects of interest can be deposited onto an ideally transparent support such as graphene. Graphene has already been employed as a support for imaging objects such as hydrogen atoms, gold nanoparticles, $CoCl_2$ nanocrystals and biological molecules in TEM. When graphene is visualized with low-energy electrons, it is sufficiently transparent and does not get damaged during continuous exposure to the radiation, which makes graphene an ideal substrate for coherent diffraction imaging of biomolecules using low-energy electrons. Here, we report coherent diffraction patterns of freestanding ultra-clean graphene obtained with electrons of 150-250 eV kinetic energies. We show the first reconstruction of low-energy electron coherent diffraction pattern at 2Å resolution. Finally, we will discuss the next steps towards atomic resolution imaging of biomolecules with coherent low-energy electron diffraction.