Holographic and convergent beam electron diffraction imaging

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Low-energy electron (30 –250 eV) in-line holography [1] (also known as or point-projection imaging [2]) is realized by placing a sample at a few tens of nanometers in front of an electron source (usually a sharp tungsten tip) where electrons are extracted by field emission, Fig. 1a. When electron wave passes through the sample, part of the wave is scattered. The interference between the scattered and unperturbed waves creates an in-line hologram which is acquired by the detector, positioned at a few centimeters from the electron source. Three subjects will be discussed: biological imaging, imaging of charged impurities in graphene [3] (Fig. 1b) with elementary charge precision and charge flow in DNA molecules [4].

The second part of the presentation will address a convergent beam electron diffraction of 2D crystals and van der Waals heterostructures realized at 80 keV [5]. Based on the interference of electron waves scattered on different crystals in the stack, this approach allows one to reconstruct the relative rotation, stretching, and out-of-plane corrugation of the layers with atomic precision. Being holographic in nature, this approach allows extraction of quantitative information about the 3D structure of the typical defects from a single image covering thousands of square nanometers. Furthermore, qualitative information about the defects in the stack can be extracted from the convergent diffraction patterns even without reconstruction, simply by comparing the patterns in different diffraction spots.

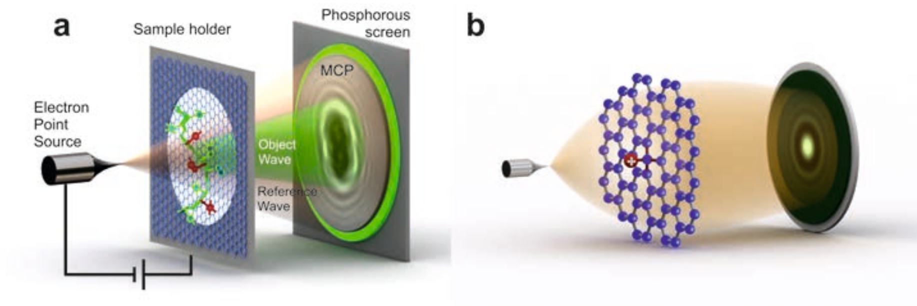

Fig. 1: Principle of in-line holography with low-energy electrons. (a) Imaging biomolecules deposited on graphene. (b) Formation of an in-line hologram from a positively charged impurity.

References:

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