Sharp structural characterization of G/h-BN heterostructures by HRTEM

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Abstract

Vertical stacking of two-dimensional (2D) crystals has recently attracted substantial interest due to unique properties and potential applications they can introduce. [1]
This work focuses on graphene and hexagonal nitride boron (h-BN) heterostructures, a combination that is of great interest in electronics and optoelectronics. Indeed these two materials are mutually compatible with identical honeycomb lattices and functionally complementary. Whereas graphene is a conductor, h-BN, also called white graphene, is a large gap semiconductor, transparent to visible light. It has recently been shown by measurements on exfoliated samples that transport properties of BN supported graphene could approach intrinsic graphene limits. [2]
Our motivation is to find an efficient way to characterize the structure of 2D materials such as graphene and boron nitride at the atomic scale using High Resolution Transmission Electron Microscopy (HRTEM). Experimental data are recorded with a JEOL ARM TEM equipped with a cold FEG operating at 80 KeV and an aberration corrector for the objective lens. Careful analysis of the phase contrast governing HRTEM images has been performed on the basis of image simulations in order to give a clear understanding of the contrast within 2D materials. This study takes into account both the experimental conditions such as microscope parameters and the tilt angle between the sample and the electron beam as well as the sample structure (number of layers, degree of roughness etc…). We propose here a quantitative method to identify the thickness, the nature of the stacking in our 2D materials and to characterize structural defects. Particular attention was dedicated to the study of triangular hole growth mechanism in hexagonal nitride boron under electron beam irradiation.

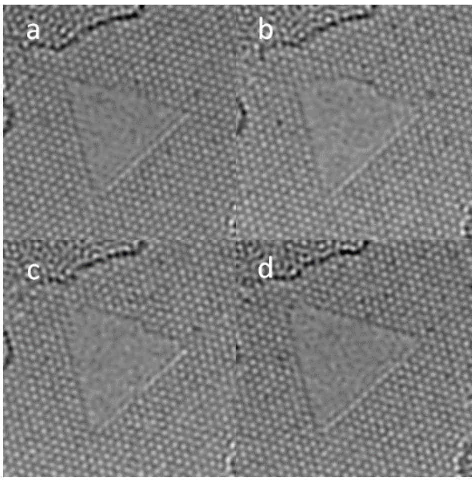

Figure 1: HRTEM images showing the growth of a triangular hole in monolayer hexagonal boron nitride under electron beam irradiation. This figure illustrates the growth mechanism which maintains the shape and orientation of the holes, from a triangle shaped hole (a) to a larger triangle shaped hole (d)

References

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