

The Atomic Structure of ABC Rhombohedral Stacked Trilayer Graphene.

Supporting Information

Jamie H. Warner^{1*}, Masaki Mukai², Angus I. Kirkland¹

¹*Department of Materials, University of Oxford, Parks Rd, Oxford, OX1 3PH, United Kingdom.*

²*JEOL Ltd, 3-1-2 Musashino, Akishima, Tokyo 196-8558 Japan.*

*Jamie.warner@materials.ox.ac.uk

S1. Microscope conditions

HRTEM was performed using the Oxford -JEOL JEM-2200MCO field-emission gun transmission electron microscope, fitted with CEOS probe and image aberration correctors and a double Wien Filter monochromator operated with a 5 μm slit to reduce the energy spread of the electron beam to 217 meV (measured as the FWHM of the zero loss peak) at an accelerating voltage of 80 kV. Data was recorded using a Gatan Ultrascan 4k x 4k CCD camera with 1-2 second acquisition times. The beam current used for imaging was measured using a faraday cage giving typical current densities at the sample of $\sim 0.2\text{--}2 \times 10^6$ electrons/($\text{nm}^2 \cdot \text{s}$). Multislice image simulations were performed using JEMS software with supercells constructed using Accelrys DS Viewer Pro.

The calculated phase plate due to residual aberrations is shown in figure S1(a) and the Zemlin tableau of 21 diffractograms recorded immediately before image acquisition in figure S1(b). The

residual aberrations of the JEOL 2200MCO (typke notation) are summarized below. The limiting aberration at a $\pi/4$ phase limit (27mrad) is B2 and at a 6π phase limit (56mrad) C5.

Defocus: C1 = -204 nm

2-fold astigmatism: A1 = 2.201 nm

3-fold Astigmatism: A2 = 23.25 nm

Axial Coma: B2 = 26.34 nm

3rd order Spherical aberration: C3 = -1.162 μm

4-fold astigmatism: A3 = 278.2 nm

3-fold Star aberration: S3 = 266.7 nm

5-fold astigmatism: A4 = 32.25 μm

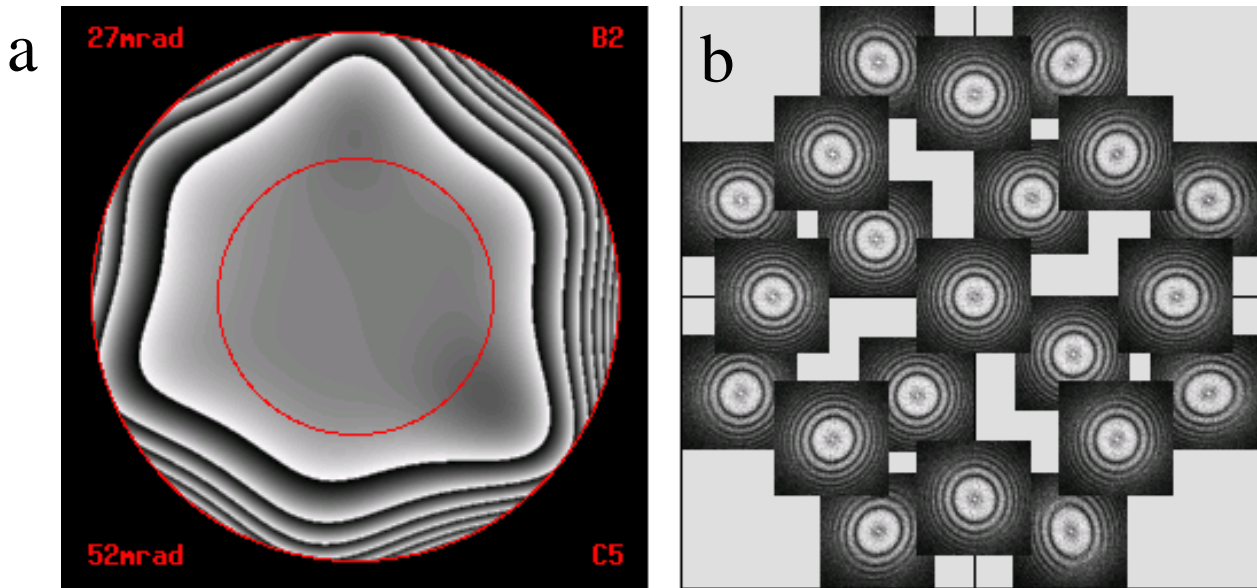


Figure S1 (a) Phase plate due to residual aberrations for the JEOL 2200MCO at 80 kV prior to image acquisition, calculated using an enhanced Zemlin tableau with an outer tilt angle of 36 mrad showing $\pi/4$ and 6π phase limits. (b) Zemlin ableau of 21 diffractograms taken at different incident beam tilts.

Distortions introduced by the intermediate and projector lens system of the JEOL 2200MCO were independently measured to give a maximum value of 0.5%.

The monochromator, which is located between the extraction anode of the ZrO/W emitter and the accelerating tube, is composed of two Wien filters with an adjustable width slit for energy selection

located at the symmetric plane of the two filters. The electron trajectories in the monochromator are symmetric with respect to the slit plane. The upper filter forms a spectrum of the electron source at the slit plane and the energy selected electron beam, having passed through the slit, enters the lower filter element. The lower Wien filter cancels the energy dispersion of the electron beam and forms an achromatic and stigmatic focus at the exit plane of the monochromator.