EELS measurement of the Optical gaps on individual Boron Nitride single and multiwalled nanotubes

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In order to determine the optical band-gap of boron nitride individual nanotubes, spatially resolved EELS experiments have been performed in a STEM on several individual single, double and triple-walled nanotubes, whose diameters and number of shells have been carefully measured. In particular, collections of low-loss spectra have been acquired while scanning the electron probe across isolated tubes allowing to retrieve the spatial dependency of the different induced electromagnetic excitations. To get access to the gap energy-region, a procedure of deconvolution and subtraction by the zero loss peak has been applied to every individual spectra of the line scans. An example of such a series of deconvoluted spectra across a double-walled nanotube is shown on the figure. The spectra have been analysed within the framework of the continuum dielectric theory. The good agreement between the experimental results and the calculations shows that:

1. The optical response of BN nanotubes is dominated by in-plane excitations.
2. It is not experimentally affected by the interlayer coupling, nor by the curvature.
3. No out of plane (plasmonic) response is experimentally detected.
4. No low-dimensional quantum effects are observed.

The gap has been measured to be independent to the nanotubes geometry and close to the in-plane gap value of hexagonal BN (5.8 ± 0.2 eV).

FIG. 1. A series of deconvoluted spectra when the electron beam is moved across a BN TWNT. Different spectral features are indicated by letters (A to D), and the two main excitation bands by number I and II. Inset: Scheme of the experiment, indicating the positions of the probe corresponding to the spectra of the main panel.