

Mapping of vibrations in graphene nanostructures

Momentum-Resolved Electron Energy-Loss Spectroscopy

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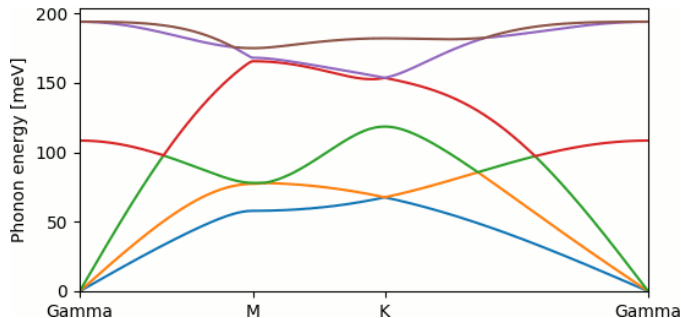
AP3252 - Electron Microscopy - TU Delft

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Content

- ▶ Goal of the paper
- ▶ Microscope modifications
- ▶ Sample
- ▶ Results

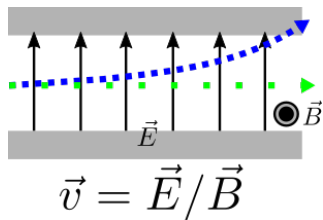
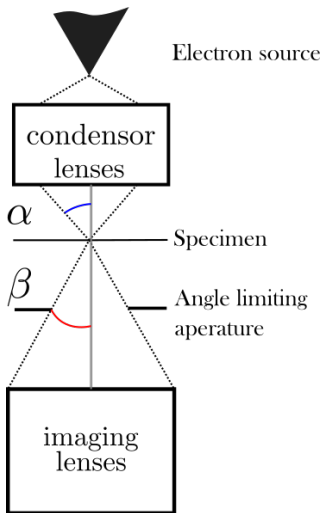
Goal of the paper



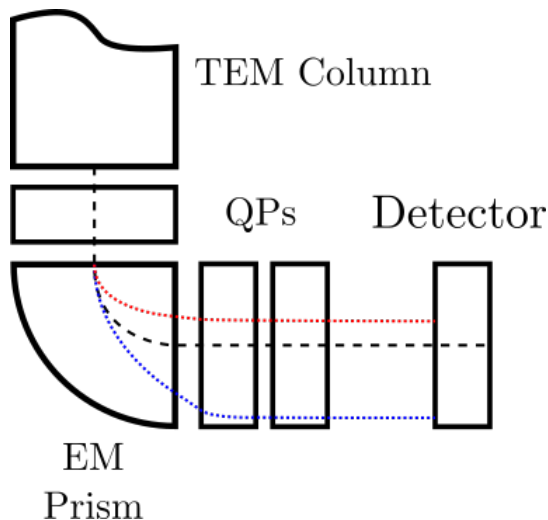
Shows:

- ▶ different bands \rightarrow different modes
- ▶ dispersion, set energy-momentum relation
- ▶ crystallographic direction

Microscope set-up, Monochromator

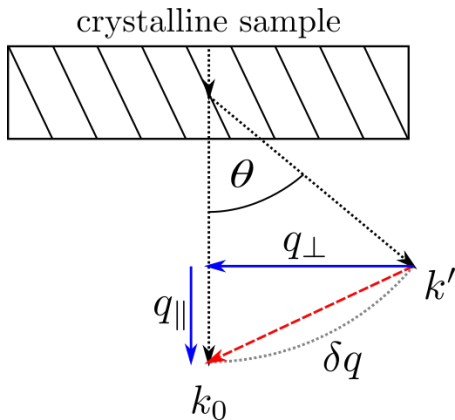
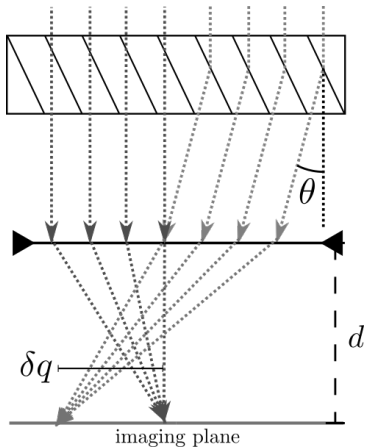


Microscope set-up, Spectrometer

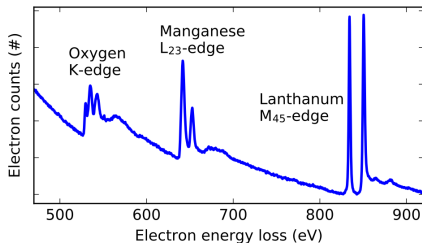
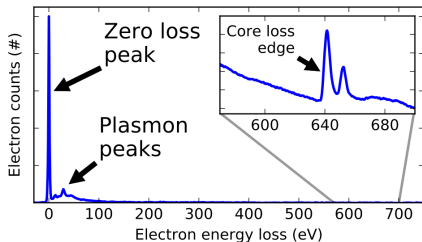


Entrance aperture of $q = 0.2 \text{\AA}^{-1}$ for beam size of 10 nm

Momentum-Resolved EELS



MR Electron energy-loss Spectroscopy



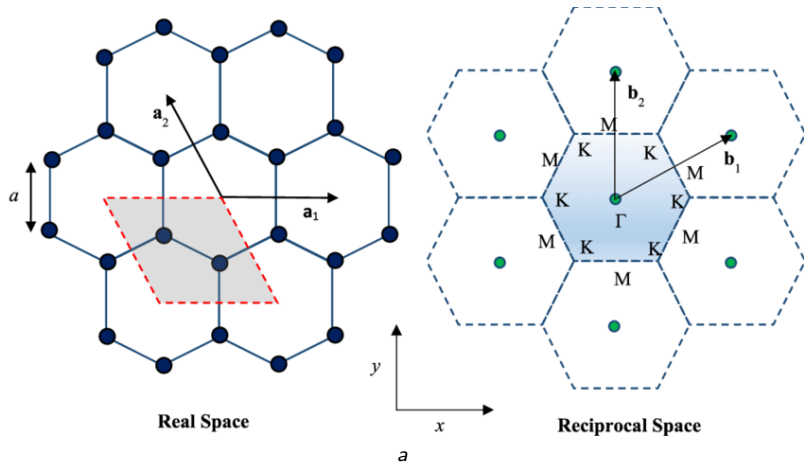
Scattering:

- ▶ Dissimilarity in mass
→ elastic scattering
- ▶ Similar mass
→ inelastic scattering

EELS use cases:

1. sample thickness measurement
2. electron properties
3. elemental analysis

Graphene



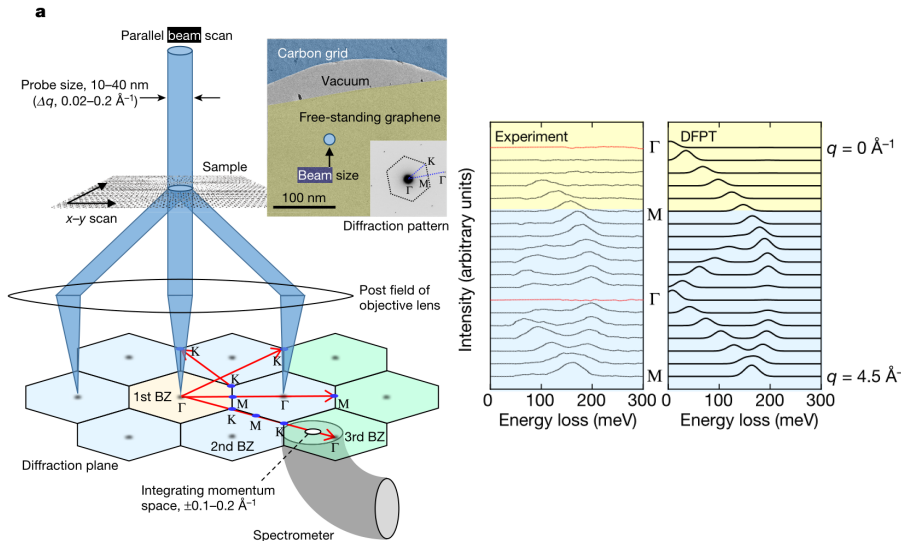
^a Raj, Anant & Eapen, Jacob. (2019). Phonon dispersion using the ratio of zero-time correlations among conjugate variables: Computing full phonon dispersion surface of graphene. Computer Physics Communications. 238. 10.1016/j.cpc.2018.12.008.

Sample preparation

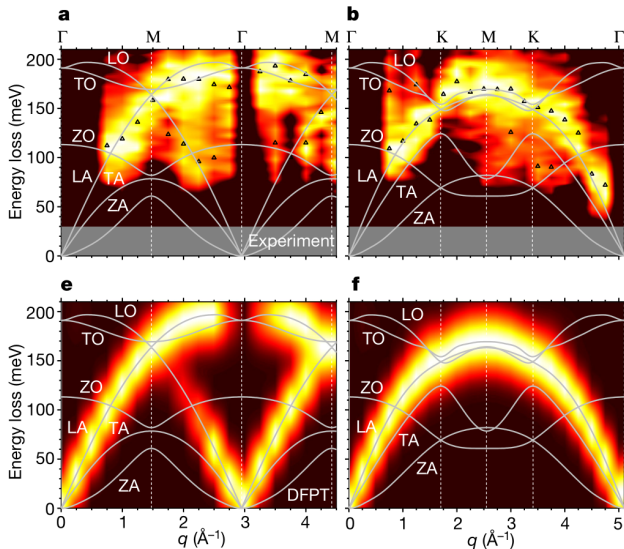
Graphene easy sample

1. Mechanically exfoliated from bulk graphite
2. Transferred onto TEM grids
3. Baked at 500°C for 12 h in the transmission electron microscope
→ remove contaminants

Setup / Results



Results



1. many EELS spectra recorded per q
2. ordered side-by-side
3. peaks in spectra were tracked across q

appendix

a

