Electron Compton Scattering and the Measurement of Electron Momentum Distributions in Solids

Alina Talmantaite
Michael R.C. Hunt
Budhika G. Mendis
Centre for Materials Physics, Durham University, Durham, DH1 3LE, United Kingdom
alina.talmantaite@durham.ac.uk

Recent advances in 2D materials, such as transition metal dichalcogenides and graphene, have triggered intensive research in their application in energy capture and storage devices. The successful operation and improvent of their performance relies on an in-depth understanding of the electronic band structure of constituent materials, which can be studied by probing the electron momentum distribution via Compton scattering in electron energy loss spectroscopy (EELS)[1,2]. In this work, electron Compton scattering profiles in simplified systems - amorphous holey carbon films - are examined[3]. A key assumption in extracting the momentum distribution is the so-called 'impulse approximation', i.e. the energy transfer to the atomic electron is assumed to be significantly above the binding energy in order to ignore any potential energy changes during the collision. However, here we confirm the suitability of the impulse approximation in the low energy transfer regime, in which only the valence electrons are Compton scattered. The low angle scattering provides a way for more efficient data collection and eliminates the need of the core electron background subtraction from the acquired electron momentum density profiles. In addition, the study of plasmon excitations at different Compton scattering angles has also enabled the development of a simplified plasmon background subtraction routine for samples resistant to beam damage.

References

[1] B G Williams, T G Sparrow, R F Egerton, Proc. R. Soc. Lond. A 393, 409-422 (1984).
[2] Z Feng, X Zhang, Y Sakurai *et al.* Sci Rep **9,** 17313 (2019).
[3] A Talmantaite, MRC Hunt, BG Mendis, Journal of Microscopy, (2020), doi:10.1111/jmi.12854

Figures

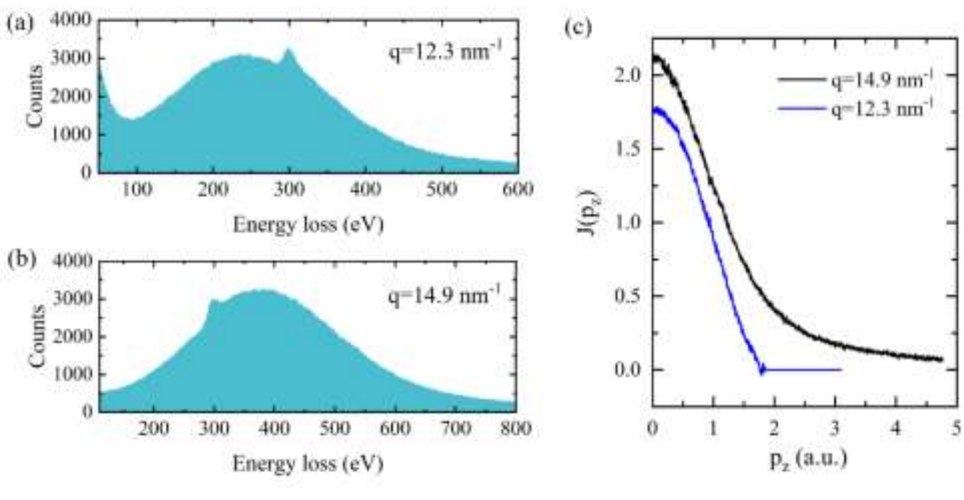

Figure 1: EELS spectra of amorphous carbon films in the low energy transfer, (a), and high energy transfer regimes, (b), and the corresponding Compton profiles in (c).