New insight into the fundamental physics of low-dimensional and self-assembled materials using electron microscopy

Transmission electron microscopy has been revolutionised in recent years, both by the introduction of new hardware such as field-emission electron guns, aberration correctors, monochromators, imaging filters and in situ stages and by the development of new techniques, algorithms and software. Chromatic aberration correction, in particular, promises to provide improved spatial resolution and interpretability when compared with the use of spherical aberration correction alone, especially at lower accelerating voltages. It also promises to allow magnetic information about materials to be recorded with a spatial resolution of better than 0.5 nm with the conventional microscope objective lens switched off.

In this talk, I will present a selection of recent results obtained in both high-resolution and Lorentz modes from a recently installed Titan Ultimate field emission gun transmission electron microscope equipped with a combined spherical and chromatic aberration corrector on the objective lens. I will show how such studies can be used to obtain unique information about the fundamental physical properties of low-dimensional materials, including graphene, as well as to measure the local magnetic properties of self-assembled materials, including arrays of closely-spaced sub-10-nm ferromagnetic nanoparticles.

I will conclude with a personal perspective on directions for the future development of transmission electron microscopy. Such developments may ultimately lead to approaches for characterising the positions, chemical identities and magnetic moments of individual atoms in three dimensions.

References

Controllable atomic scale patterning of freestanding monolayer graphene at elevated temperature, Q Xu, M Y Wu, G Schneider, L Houben, S Malladi, C Dekker, E Yucelen, R E Dunin-Borkowski and H W Zandbergen, ACS Nano, in press (available online 23 January 2013).

Direct observation of dipolar magnetism in low-dimensional nanoparticle assemblies, M Varón, M Beleggia, T Kasama, R J Harrison, R E Dunin-Borkowski, V F Puntes and C Frandsen, Scientific Reports, in press (available online 06 February 2013).