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Monitoring the dynamics of Kirkendall effect in Cu nanoparticles with LSPR spectroscopy in ETEM

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Studying the oxidation process in Cu nanoparticles is relevant for a number of applications, including microelectronics, catalysis, plasmonics and photovoltaics. Here we use environmental transmission electron microscopy (ETEM) to monitor in-situ the changes occurring to Cu nanoparticles and their localised surface plasmons (LSPRs) during oxidation. Annular dark-field scanning TEM (ADF STEM) imaging is employed to closely examine the dynamics of metal to oxide conversion and electron energy-loss spectroscopy (EELS) is employed to follow the evolution of the LSPRs of the particles.

Summary and future work

• **In-situ STEM imaging of Cu nanoparticles during oxidation reveals the details of their Kirkendall oxidation mechanism.**
• **In-situ monitoring of the LSPR shows red-shift of the peak energy followed by broadening and splitting of the LSPR peak into two before complete loss of the signal at the final stage of oxidation.** The extent of these features shows dependence on the position of the electron probe relative to the nanoparticle. This implies the possibility of using the LSPR energy, intensity and line-width of Cu nanoparticles at different light polarisations to predict their morphology and composition during oxidation.