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Influence of primary beam energy on localized surface plasmon resonances mapping by STEM-EELS

STEM-EELS has become a standard technique to map localized surface plasmon resonances (LSPR), which are collective oscillations of free electrons in metal nano- and microstructures. Despite that many works dealing with EELS measurement of LSPR have been published over the last 15 years, there has been no experimental work discussing the experimental conditions during the measurement. Therefore, we have experimentally studied the influence of the primary beam energy and the collection semi-angle on the localized surface plasmon resonances measurement by STEM-EELS to make an instructive overview for the beginners in the field [1].

We took a series of 3 rods and do the STEM-EELS measurement at the primary beam energy of 300 keV, 120 keV, and 60 keV. The best results in terms of the best signal-to-background ratio are obtained using a medium primary beam energy, in our case 120 keV. The primary beam energy should be high enough to suppress the scattering in the sample and at the same time should be low enough to avoid the appearance of relativistic effects. In the case of too high primary beam energy, for example 300 keV, the relativistic effects [2] in the supporting membrane play a non-negligible role and lead to a higher intensity of the background. However, the advantage of the 300 keV electron beam is a lower scattering probability resulting into a better signal to noise ratio in the case of spatial EEL maps of LSPR modes. We note that in the case of a better monochromatization of the primary electron beam (far below 0.1 eV), the elastic part of the background would be significantly reduced which should lead to much better signal to background ratio at lower primary beam energies.

References:

[1] M Horák and T Šikola, Ultramicroscopy **216** (2020), p. 113044.
[2] M Horák and M Stöger-Pollach, Ultramicroscopy **157** (2015), p. 73.

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