Automatic signal clasification of the Low-Loss Region in Electron Energy Loss Spectroscopy

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Localised Surface Plasmon Resonance (LSPR) is a non-propagating electron-density wave that is confined at the surface of a metallic nanoparticle. They can enhance the electromagnetic radiation, concentrating it into sub-wavelength volumes. Its resonance can be tuned by changing the surrounding medium and its geometry. This unique property opens a wide range of applications across various fields of applied research.

Electron Energy Loss Spectroscopy (EELS) within a Scanning Transmission Electron Microscope (STEM) has revealed remarkable capabilities in the analysis of plasmons at nanometric scale, as this technique achieves sub-angstrom spatial resolution and can excite the complete range of LSPR modes supported by the nanostructure. By employing EELS, the plasmonic properties can be correlated with geometric or structural characteristics, enabling a more comprehensive understanding of the plasmonic response.

In this study, based on the analysis of Silicon/Gold nanopillars samples, we demonstrate that clustering techniques can be used for detecting LSPRs in EELS. We propose a novel combination of unsupervised machine learning strategies that detect LSPRs in EELS spectrum images. To demonstrate the effectivity of this methodology, we studied Si/Au nanopillars. The detection of LSPRs is done by reducing the dimensionality of the data, clustering this low-dimensional space, and recuperate the spatial space. We demonstrate that using this methodology, it is possible to recover the LSPRs, among distinct spectra in a large EELS dataset, and easily make a plasmonic spatial map without the need for prior knowledge or labelling of the data.

Keywords:

EELS, Plasmons, Nanowires