Ernst Ruska-Centrum für Mikroskopie und Spektroskopie mit Elektronen ER-C

JÜLICH FORSCHUNGSZENTRUM

Spectral unmixing of localized surface plasmon resonances from an electron energy-loss spectroscopy dataset

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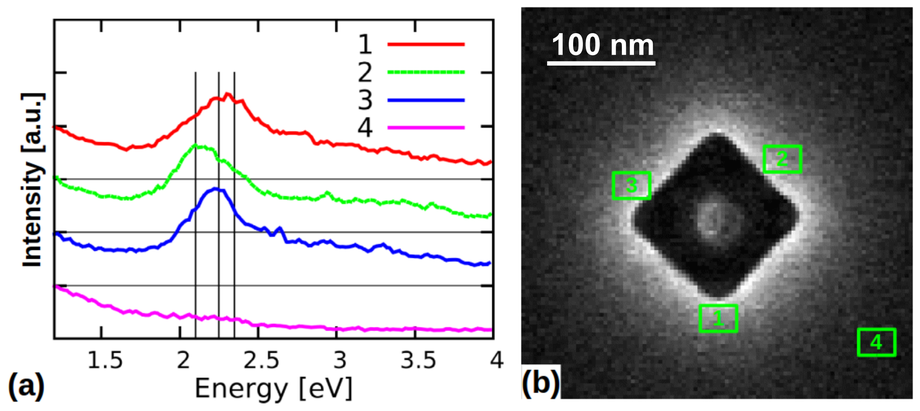
Introduction

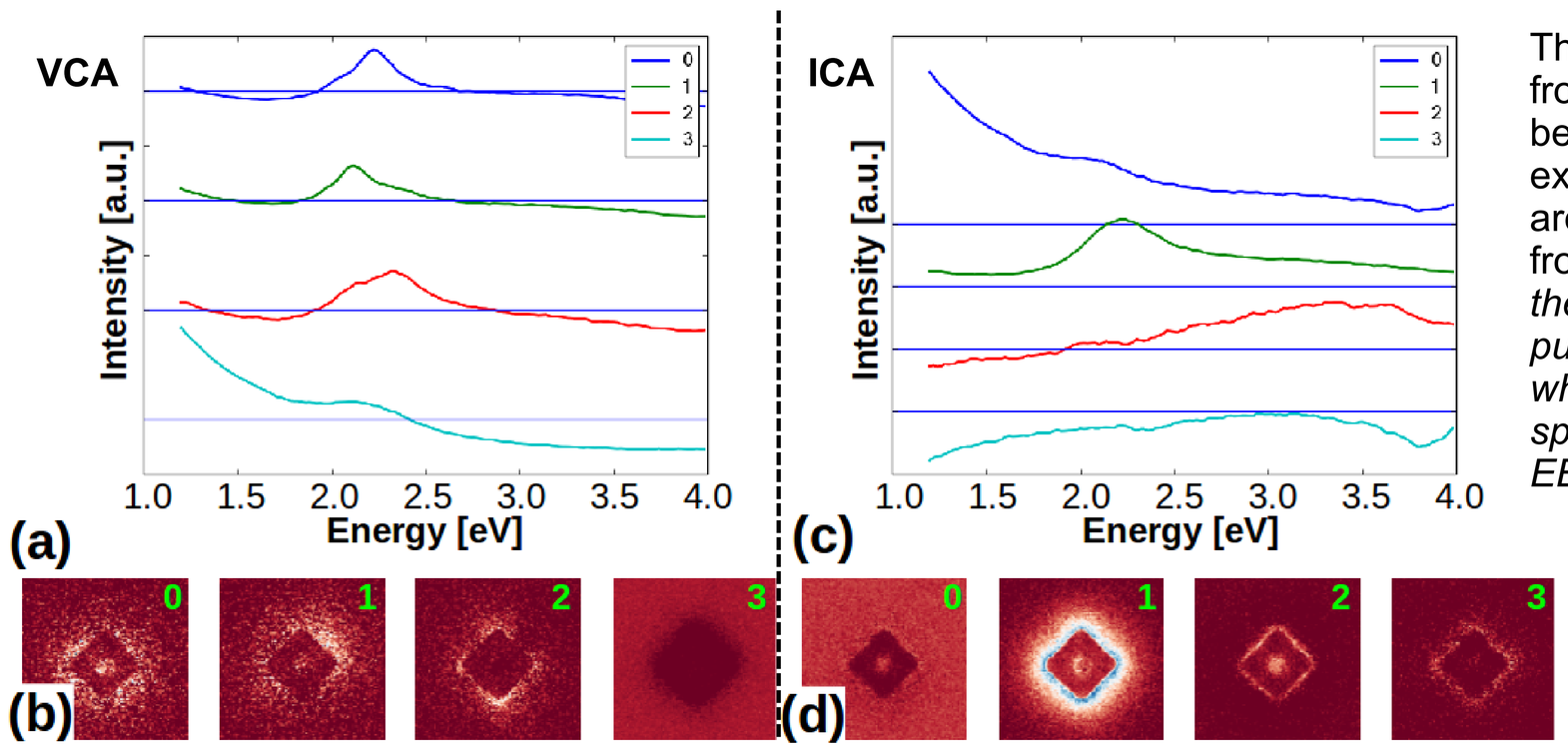
Monochromated electron energy-loss spectroscopy (EELS) imaging has recently been used to map localized surface plasmon resonances (LSPRs) in supported Au and Ag particles. Three-dimensional imaging of LSPRs has been demonstrated by combining multivariate statistical analysis, compressed sensing and electron tomography [1]. The application of algorithms based on spectral unmixing to low-loss EELS is promising for surface plasmon resonance mapping of complex structures, for which the direct calculation of LSPRs cannot be achieved. The robustness of SU-based algorithms for extracting spectral components from large datasets without introducing prior knowledge also promises to allow the direct reconstruction of three-dimensional information about the LSPRs of complex structures.

Method



(a) Averaged EELS spectra from the marked positions in (b).
(b) 2.0-2.5 ev-loss image of a AuAg nanobox.

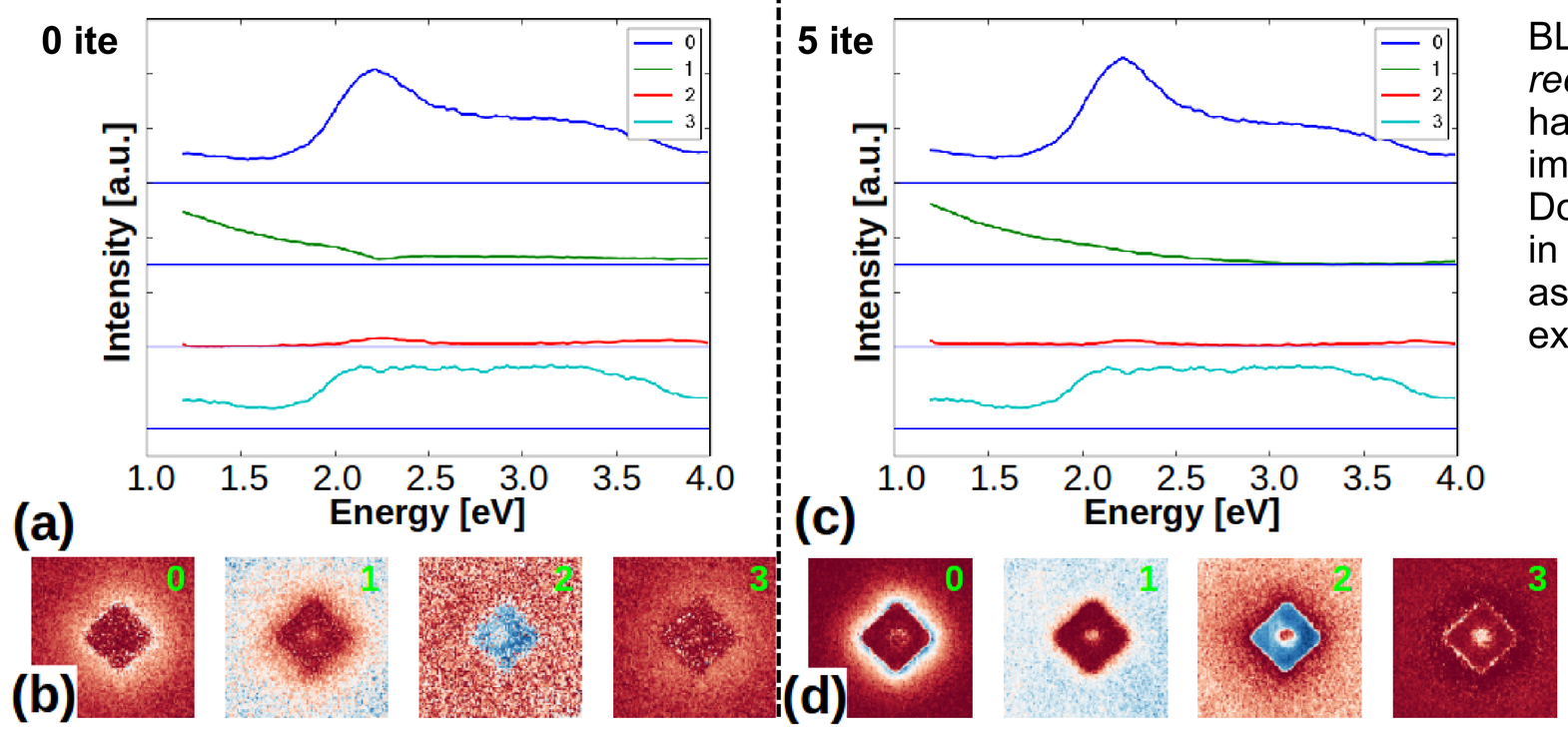
Vertex and independent component analysis decomposition



The spectral signatures obtained from VCA decomposition [2-3] are in better agreement with the spectra extracted from the raw dataset than are the spectral signatures obtained from ICA [4]. *However, VCA requires the assumption of the presence of pure pixels in the analyzed image, which limits its ability to recover spectral plasmonic signatures from EELS datasets.*

Spectral components extracted by (a) VCA and (c) ICA from the AuAg nanobox shown above. The corresponding maps are depicted in (b, d).

Bayesian linear unmixing (BLU) for 0 and 5 iterations



BLU decomposition, *which does not require the pure pixel assumption*, has been performed using the implementation proposed by Dobigeon et al. [5]. An improvement in the spectral signatures and the associated maps is visible (see, for example, background component 1).

(a, c) Spectral components extracted by BLU after 0 and 5 iterations of the BLU decomposition from the AuAg nanobox shown above. The corresponding maps are depicted in (b, d).

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