A comparison of methods for helium quantification via EELS

Walls, M.[1]

[1] LPS, Université Paris-Sud, CNRS, France

EELS has been used for decades to quantify the helium in bubbles forming in irradiated metals. The accuracy and precision of these measurements is limited by a number of factors, including the estimation of the bubble volume and the difficulty of isolating the helium signal from the much more intense excitation corresponding to the metal matrix plasmon, on which it is invariably superposed. Approaches applied up to now include the spatial difference method, modelling with Gaussians, Lorentzians and other functions, and multivariate analysis methods, in particular blind source separation via the methods of independent component analysis and non-negative matrix factorization. Here we will survey the current state of advancement in the field and compare these various approaches and combinations of them. We will introduce the first use, for this class of problem, of the "Samfire" fitting routine which greatly reduces the problem of diverging model parameters when fitting over large and variable datasets [1]. Our results show that a combination of MVA and modelling methods gives the most reliable estimates of the helium signal intensity and position. The examples we will use for illustration concern vanadium samples having undergone varying heat treatments, and other iron- or steel-based materials. In all cases the helium peak at around 21 eV is almost exactly at the maximum of the matrix plasmon, making the extraction particularly difficult. The densities encountered are comparable with those found in other similar metals in previous studies. The supposedly linear relation between the density and the shift in the helium peak is less clear, with considerable scatter in the data, but the values found for the proportionality constant between the helium density and the upwards shift in energy of this 1s-2p excitation are roughly consistent with those cited in the most recent studies by other groups.

Following the pioneering work of Walsh et al. [2] we will thus propose an up-to-date protocol describing how to obtain the most reliable measurements of these quantities, taking into account the instrumental and analytical developments having occurred since that publication.

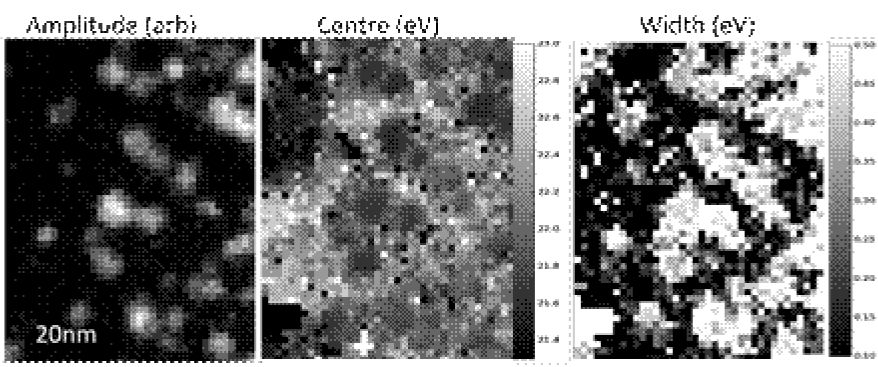

Figure: Amplitude, centre and width maps of the Lorentzian modelling the He signal in vanadium using Samfire [1]

[1] Hyperspy.org

[2] C. Walsh, J. Yuan and L.M. Brown, Phil Mag. **80**, No. 7, 1507-1543 (2000)

We are grateful to the French Agence Nationale de la Recherche (ANR) for funding the project EPIGRAPH