How an ASEM Workshop led to a successful quantification for atomic-scale EELS maps

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With this abstract, we reflect on how ASEM workshops bring together researchers from different Austrian electron microscope facilities producing important scientific research results.

At the 9th ASEM workshop (2019) the corresponding author of this abstract, a dedicated PhD student, presented her work on elemental analyses at atomic resolution of the second order Ruddlesden-Popper ferrite $Ba_{1.1}La_{1.9}Fe_2O_7$. This ceramic exhibits promising properties for future applications in protonic ceramic fuel cells, electrolyser cells or membranes for hydrogen separation. Fundamental research on such materials is therefore needed in order to correlate mass and charge transport properties with the crystal structure of the material. At the particular time of the original presentation, we had already acquired high-resolution EDX and EELS maps of $Ba_{1.1}La_{1.9}Fe_2O_7$, which suggested that Ba and La were not equally distributed but have preferred crystal sites. Unfortunately, acquiring elemental maps at atomic-scale is always prone to channeling effects, which lead to additional intensity stemming from neighbouring atomic columns – a circumstance which renders a straightforward, reliable quantification impossible. After her presentation, an assistant professor and expert in EELS simulations from the USTEM (TU Wien) approached the speaker and offered to perform inelastic multislice simulations in order to overcome the problem with unknown neighbouring off-axis intensities. With sound knowledge of the channeling behavior, we then were able to paint a fuller picture, combining visually graspable, colourful EELS elemental maps and the actual composition of each atomic column. Through subtracting the additional off-axis intensity we successfully performed a column-by-column quantification for La and Ba [1]. The outcome of this collaboration will now be presented at this ASEM workshop.

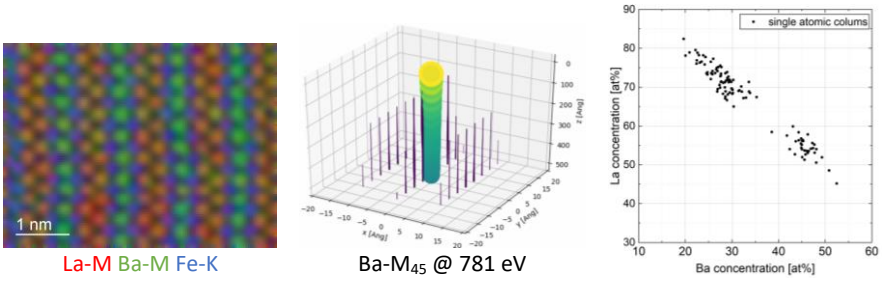

Figure 1. Left: Experimental EELS elemental map of barium lanthanum ferrate. Centre: simulated EELS Ba-M intensity showing contributions from on-axis atoms (green/yellow) and neighbouring atomic columns (blue/purple). Right: scatter plot of Ba and La concentrations per atomic column.

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