MESA+
INSTITUTE FOR NANOTECHNOLOGY
NanoLab Twente

SEM EXAMPLE

CHEMICAL ANALYSIS IN THE SEM

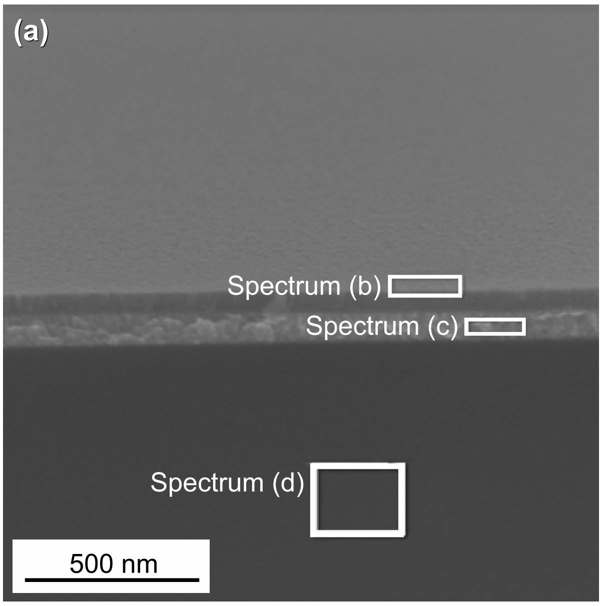
Introduction to Energy Dispersive X-ray Analysis

The best known and most widely used technique for chemical analysis in the Scanning Electron Microscope is the Energy Dispersive x-ray analysis system or in short, the EDX. Our HR-SEM is equipped with a state of art system from Oxford Instruments which allows chemical analysis of a material down to the sub-micron scale. It is able to analyse light elements starting from Boron up to large atoms such as Uranium, and if the sample symmetry allows can even quantify the chemical spectra, very accurately.

The technique uses the x-rays which are released upon interaction with the electron beam in the SEM. These x-rays have a specific wavelength according to the element that has been excited and this wavelength is then converted into a characteristic energy scale representing an energy unique to that particular element. The peaks have a Gaussian shape and form a spectrum which reveal the composition of the material analysed. Using the accompanying software the exact composition of the material can be determined. There are limitations to the technique due to overlap of the peaks, but it is possible to extract accurate results using peak synthesis. See, e.g., Ref. [1].

EDX is a fast and reliable technique for analyzing materials down to sub-micron level.

Thin film deposition using sputtering techniques



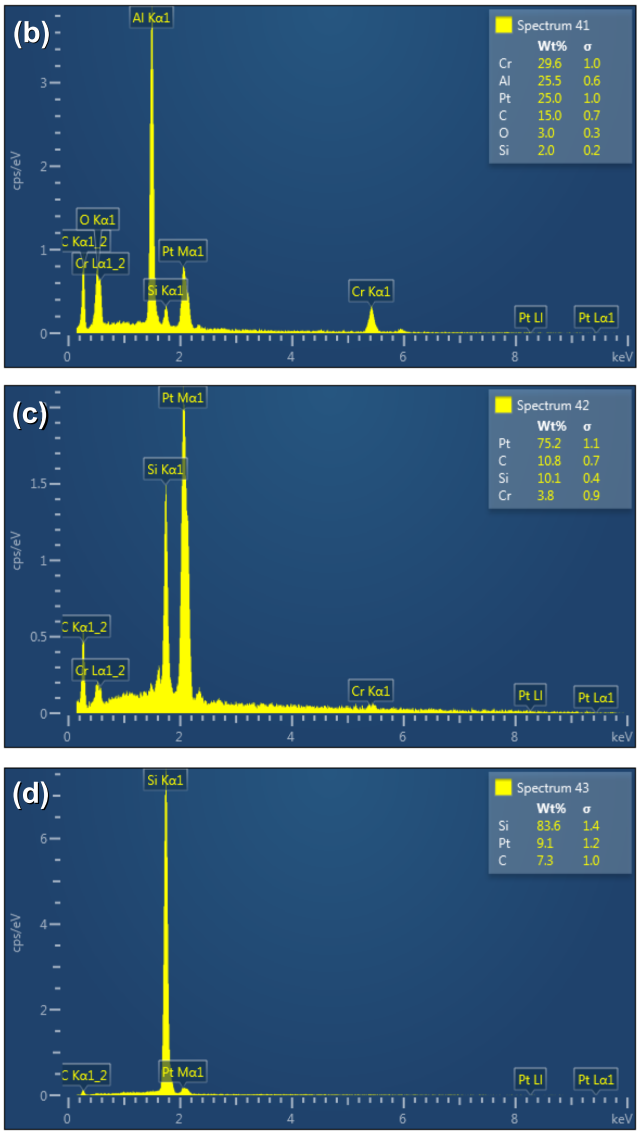


Fig. 1: Compositional EDX analysis on the cross-section of a thin Chromium film deposited on a sputtered Platinum barrier layer on top of a Silicon wafer.

(a) SE image of the cross section
(b) EDX spectrum of the top layer
(c) EDX spectrum of the barrier layer
(d) EDX spectrum of the substrate

Notice the appearance of Pt and Al peaks in the Chromium top layer. The Al peak is due to beam scatter from the SEM sample holder, whereas the Pt peak originates from the barrier layer underneath.

[1] "Scanning Electron Microscopy and X-ray Microanalysis", by Goldstein, J., Newbury, D.E., Joy, D.C., Lyman, C.E., Echlin, P., Lifshin, E., Sawyer, L., Michael, J.R., Springer Publishers, 3rd ed. 2003, XIX, 690 p. With online files. ISBN 978-1-4615-0215-9.

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The EDX elemental mapping technique is used to allow a quick overview of the elemental distribution in the area of interest providing direct visual impact, while the Secondary Electron image (SE2) at the same time provides an insight into the surface morphology.

EDX elemental mapping of a fibre in a superconducting cable

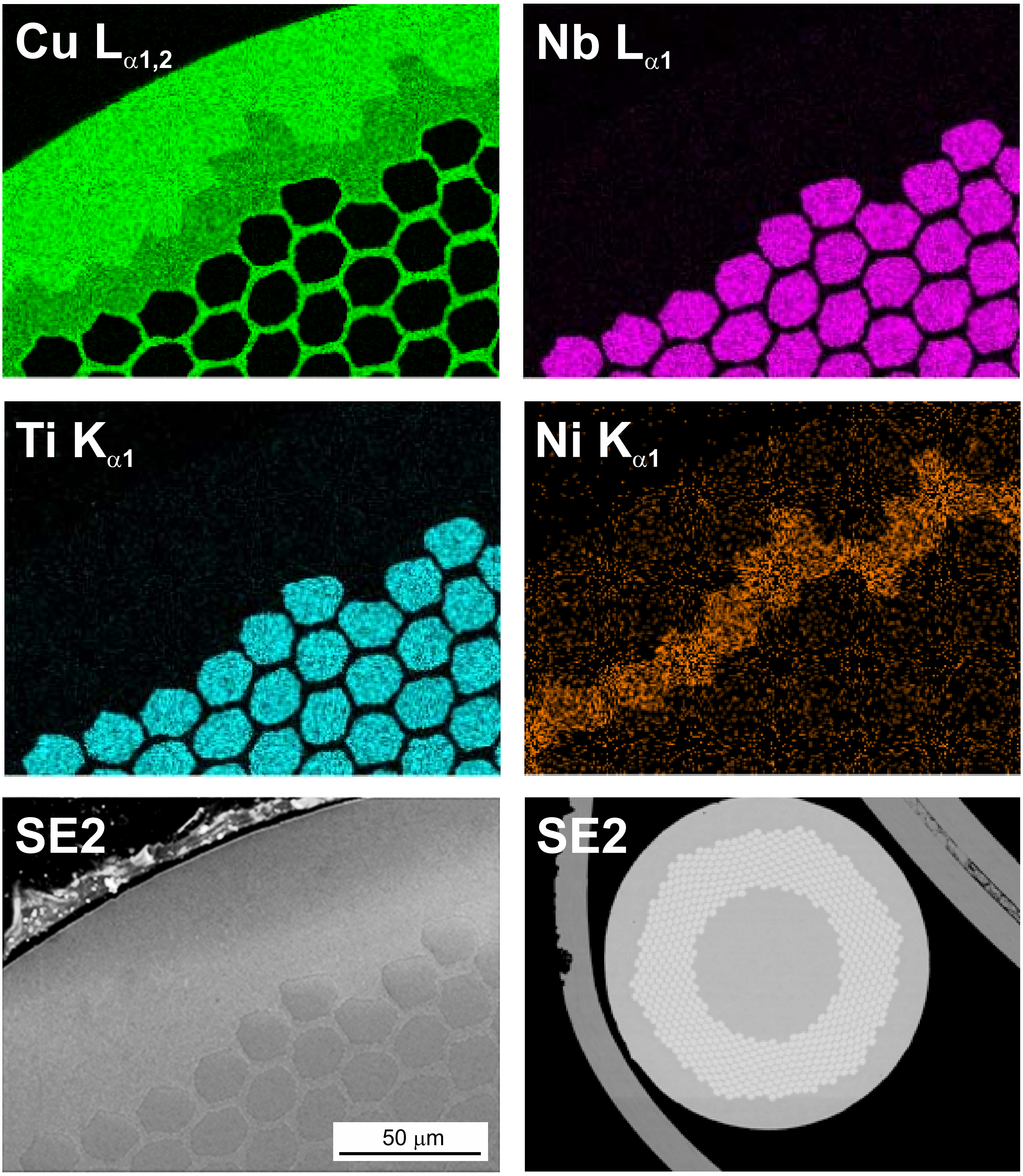

Fig. 2: EDX mapping illustrating the element distribution in a flat polished superconducting cable. Each colour represents a different element as shown. The lower two photos are secondary electron images of the sample.The lower left image shows the cable structure relative to the position of the x-ray maps. The lower right SE2 image is an overview of a cross sectional polished cable.

[1] "Scanning Electron Microscopy and X-ray Microanalysis", by Goldstein, J., Newbury, D.E., Joy, D.C., Lyman, C.E., Echlin, P., Lifshin, E., Sawyer, L., Michael, J.R., Springer Publishers, 3rd ed. 2003, XIX, 690 p. With online files. ISBN 978-1-4615-0215-9.