A comparative study of customized and standard STEM electronics

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The STEM technique is required for many applications where it is necessary to image material properties that are difficult to obtain with TEM, or it is required to reduce beam damage. Sensitivity to incoherently scattered electrons, and thereby to the atomic number is a major benefit of STEM equipped with a High Angle Annular Dark Field (HAADF) detector. Further, STEM is simultaneously less sensitive to diffraction effects and to thickness variations, which enables characterization of nanoparticles on rough or porous supports and thus fulfills many requirements specific to catalytic applications. These unique benefits for the characterization of catalysts have justified the upgrade of our 200 kV LaB_6 TECNAI TEM to STEM.

In this work, we present the upgrade process of a conventional TEM to a STEM using custom accessories. Custom systems are required for microscopes from previous generations because it is difficult to obtain original STEM equipment, and the alternative of complete electronics update is prohibitively expensive. In collaboration with specialized suppliers for custom electron microscope electronics, an up-to-date scan unit is installed to the already existing scan coils of the TEM. The custom electronics allow pixel dwell times down to 200 ns/pixels and an image resolution of up to 16k x 16k pixels. A BF / ADF / HAADF sensor is also installed in a custom detector housing designed specially to attach to the existing CCD-camera mechanics. To expand the opportunities for elemental mapping, parts of the EDX-System were also upgraded to deliver a common interface with the scan control.

The initial version of the system allowed for simultaneous acquisition of BF and HAADF signals, alongside the EDX signal. A further upgrade adds access to all 12 quadrants of the ADF detector in order to create a synthetic objective aperture, and thus obtain orientation information for the sample investigated. For this paper, we compare the performance of this custom system to that of a standard 200kV LaB_6 TECNAI equipped with original STEM, and present feedback in terms of handling and stability. Figure 1 displays images and an EDX linescan acquired by the original STEM TECNAI LaB_6 200kV, showing SiC nanoparticles embedded in a polycrystalline Mg matrix. Since the SiC particles have a size distribution between 5 and 200 nm, the atomic numbers are moderate (compared to Au on C), and the specimen thickness is practically constant, this specimen acts very well as a reference material.

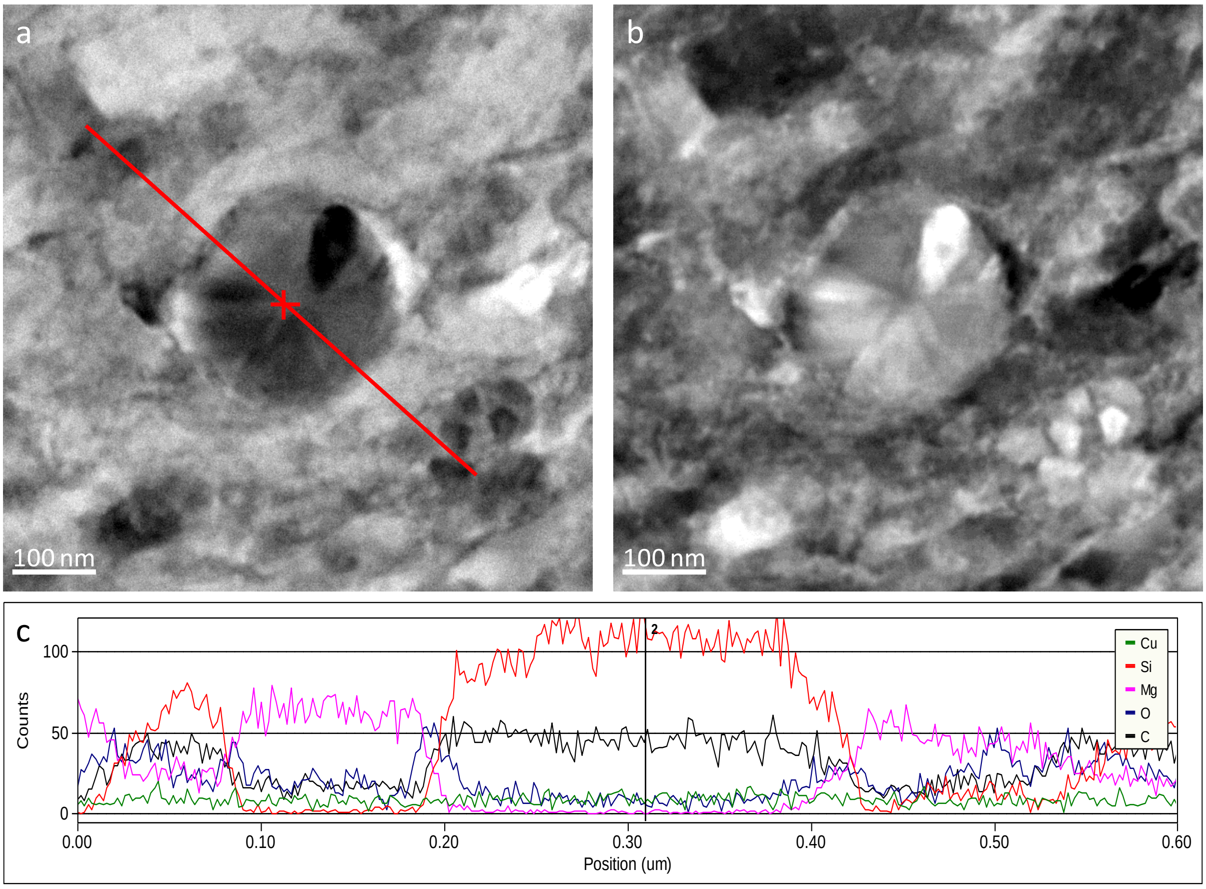

Figure 1: a) Bright Field STEM image of SiC particles in polycrystalline Mg, b) corresponding Dark Field STEM image, c) EDX linescan with a length of 600 nm, steps of 2 nm and dwell time of 5 sec/step.

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