MI 3: Analytical Scanning Electron Microscopy

Time: Monday 15:00–16:45 Location: EMH 225

Invited Talk MI 3.1 Mon 15:00 EMH 225

Orientations, texture, properties - applications of electron backscatter diffraction — •Karsten Kunze — ScopeM, ETH Zürich, Switzerland

Electron Backscatter Diffraction (EBSD) is the most widespread method for crystallographic characterisation at the microscale in the scanning electron microscope (SEM). The EBSD pattern contains information about the crystallographic phase and orientation as well as on the defect content of the material. Automated acquisition and analysis of EBSD patterns allows to map crystal orientations and phases, intergranular and intragranular microstructures, grain boundary misorientations, all at size scales between some ten nanometers to some ten millimeters. Crystallographic preferred orientations (CPO or texture) give rise to anisotropy in bulk tensorial properties. The presentation will review some of the recent developments with applications in Earth and materials sciences.

MI 3.2 Mon 15:45 EMH 225

Monte Carlo Simulations for Transmission Kikuchi Diffraction — •Nathanael Jöhrmann and Michael Hietschold — Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz

Transmission Kikuchi Diffraction in a Scanning Electron Microscope is an interesting modification of Electron Backscatter Diffraction to get information about crystalline structures with high spatial resolution. However, it is not easy to decide about optimal parameters for sample thickness, sample tilt, working distance or acceleration voltage. In addition, for each new sample material it might be necessary to choose a completely different set of parameters. Since the sample preparation for Transmission Kikuchi Diffraction is difficult, it is desirable to know beforehand, if the lateral resolution would improve significantly in comparison to Electron Backscatter Diffraction.

To avoid time consuming experiments, we use Monte Carlo simulations to predict the influence of sample thickness, sample position and acceleration voltage on the detector signal, exposure time and expected lateral resolution.

MI 3.3 Mon 16:00 EMH 225

A Mirror-Corrected Scanning Electron Microscope — •Peter Gnauck and Markus Boese — Carl Zeiss Microscopy, Oberkochen, Germany

In materials science and biological research the Scanning Electron Microscope (SEM) has a long tradition. In recent years the interest in the imaging of sensitive samples and the material contrast at a high lateral resolution has grown. Lowering the primary electron energy helps to reduce the sample damage. On the other hand the interaction volume is decreased, thus increasing the lateral information from the backscattered electron signal.

However, the low primary electron energy is extremely demanding to the electron optics, if not too much of the lateral resolution should be lost due to the increased wavelength of the electrons. In a suitable instrument typically the spherical and the axial chromatic aberration have to be corrected. Additionally, innovative detector schemes can provide enhanced analytic capabilities and can avoid limitations by signal noise and residual instrumental instabilities.

We will discuss a mirror-corrected SEM, offering high-resolution analytics with efficient productivity to visualize even the most sensitive materials by use of electrons with energies far below 1keV. At these energies the resolution of conventional instruments is very poor, but compensating for the primary aberrations of the objective lens can overcome this obstacle. The aberration correction by means of an electron mirror significantly increases the resolution especially for low energies; this has been proven in a unique spectro-microscope.

MI 3.4 Mon 16:15 EMH 225

Detecting the chemical shift of X-ray lines of Lithium, Boron and Carbon using a novel wave-length dispersive X-ray spectrometer — •Jürgen Heindl — JEOL (Germany) GmbH; Oskar-v.-Miller-Str. 1a; 85386 Eching; Deutschland

A novel parallel detecting wave-length dispersive x-ray spectrometer was developed by JEOL Ltd. Tokyo, Japan. This Soft X-ray Emission Spectrometer (SXES) is sensitive to extreme soft X-ray like the Li-K-line and opens access to qualitative as well as quantitative analysis of Li-alloys and Li-ion batteries e.g. The energy resolution of this spectrometer is high enough to observe the line shift induced by different chemical environment of the individual element (chemical shift) as well as the line shape of selected x-ray lines.

Recent application examples will be shown of Li quantification, the chemical shift of B-K- and C-K-line and the chemical dependency of the line shape of the Si-L-line in different Si compositions.

MI 3.5 Mon 16:30 EMH 225

Quantitative EDS with focus on the nanometer scale for combinations of light and heavy elements. — •Meiken Falke, Igor Nemeth, Andi Kaeppel, and Ralf Terborg — Bruker nano GmbH, Am Studio 2D, 12489 Berlin, Germany

Quantitative spatially resolved chemical characterization of mixtures of light and heavy elements in the electron microscope is a challenge. Complicating factors are e.g. preparation artefacts, radiation damage and signal absorption. Energy dispersive X-ray spectroscopy (EDS) is one technique for composition analysis of bulk and electron transparent samples. For bulk analysis sophisticated absolute EDS quantification methods have been developed. Multiple detector arrangements at high solid and take-off angles speed up and simplify the analysis in case of complex topography or beam sensitivity and limit the need for sample preparation. For quantitative analysis of electron transparent objects the Cliff-Lorimer method is widely used and can provide data on the accuracy level of a few at%. Using large solid and take-off angles, even the ppm level can be accessed. The results are valid only relative to a suitable standard of similar thickness and composition though. An alternative is the Zeta-factor method, Ref 1. It additionally includes information on the beam current and accommodates the use of any standard with known composition, thickness and density. This method can deliver absolute quantification while accounting e.g. for absorption effects. Examples for all techniques mentioned above will be shown. Ref.1 Watanabe M. & Williams D.B, J. of Micr. Vol. 221, 2006, 89.