MM 47: Topical Session Modern Atom Probe Tomography III - Functional and Nanostructured Materials

Time: Thursday 10:15–11:45 Location: H 0107

Topical Talk MM 47.1 Thu 10:15 H 0107

Methods in Correlative Tomography for the Nanometer Regime — •Stephan S.A. Gerstl Gerstl, Elisabeth Mueller, Miriam Lucas, and Roger Wepf — EMEZ Center for Electron Microscopy, ETH Zurich, Switzerland

Tomographic methods in materials science have experienced a surge in interest, since observing nature including the third spatial dimension provides significantly more insight than techniques interrogating surfaces or viewing projections of materials. In this paper we discuss a variety of methods we are investigating not only to correlate 3-D images between microscopes, but extend combinatorial techniques to including the correlation between analytical information of chemistry and crystallography. Basic correlations between Atom Probe Tomography (APT) and HRSEM images can reveal geometric input for reconstructions. More direct chemical correlations are feasible between STEM and APT. Methods we will discuss to achieve the spatial and chemical correlations involve modified TEM specimens and well known pillar geometries. Examples from both nanostructured metal and semiconductor type materials will be presented.

MM 47.2 Thu 10:45 H 0107

Laser-assisted atom probe tomography of self-organized surface layers — Andreas Stoffers, Martin Lütkemeier, and •Guido Schmitz — Institut für Materialphysik der Westf. Wilhelms-Universität, Münster, Germany

The availability of femtosecond lasers opened analysis of new material classes by atom probe tomography (APT). Laser-assisted APT has even the potential to give microstructural and chemical information on organic materials at an atomic scale. We investigated the model cases of polyelectrolyte multilayers (PEM) and self-assembling monolayers (SAM). PEMs are deposited step by step as a multilayer of poly-anions and poly-cations to sharp gold tips. SAMs are adsorbed in a self-assembling process to the apex of gold tips, but offer only a limited volume for analysis.

We could successfully analyze multilayers of the polyions poly(acrylic acid), poly(diallyldimethyl-ammonium chloride), poly(styrene sulfonate) and poly(allylamine hydrochloride). Also the chemical structure of perfluorodecanethiol and alcanethiolate SAM was studied. In all cases, mass spectra are complex, indicating different molecular fragments. We could determine the polyanion/polycation stoichiometry in polyelectrolytes, also the amount of counterions. Mass spectra of fluorinated SAM are easily identified. Even the evaporation sequence of molecule fragments could be determined in this case. It appears to be remarkably different to that of structurally similar alcanethiolate monolayers.

MM 47.3 Thu 11:00 H 0107

On the influence of interfaces, local composition and microstructure on the magnetic properties of Nd2Fe14B — •Catharina Wille[1], Torben Boll[1], Tala'at Al-Kassab[1], Manfred Ruehrig[2], and Joachim Wecker[2] — [1]King Abdullah University of Science and Technology, Division of Physical Sciences, Thuwal, Kingdom of Saudi Arabia — [2]Siemens AG, Corporate Research and Technologies, 91058 Erlangen, Germany

In this contribution results on the chemical and microstructural characterisation of a Nd2Fe14B bulk magnet will be reported. As the magnetic coercivity strongly depends on the grain boundary phases, their chemical composition is explored by means of atom probe tomography (APT) in the LAWATAP instrument at King Abdullah University of Science and Technology. Additionally the distribution of Nd in the microstructure and the presence of trace elements like Dy, Ga and Nb has been analysed.

The bulk magnet (MQ2) was prepared by hot pressing from rapidly consolidated powders resulting in an anisotropic microstructure which has been investigated by means of X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS).

Special emphasis was put on the determination of the spatial gradient of the microstructure both parallel and orthogonal to the deformation direction.

MM 47.4 Thu 11:15 H 0107

On the pulse of time: Atom Probe Tomography of nanostructured materials — •Tala'at Al-Kassab, Catharina Wille, and Torben Boll — King Abdullah University of Science and Technology, Division of Physical Sciences,

In the last decade, Nano-materials have been gaining considerable interest for their various properties and applications. Particularly, designed nano-structured materials are largely characterized by their numerous internal interfaces. Since the quested physical properties of this material class are closely related to the thermal stability of their internal interfaces, the investigation of the chemical reactions at these interfaces is of a great importance to understand and optimize the desired properties for prospective future applications. Owing to their grain size of some tens of nanometers, such materials can only be analyzed via high resolution methods such as modern atom probe tomography. This contribution aims at showing by examples, what challenges such atom probe tomographers are able to solve when utilized to explore these nano-structured materials. Results obtained with the laser assisted wide angle tomographic atom probe LAWATAP and the local electrode atom probe LEAP HR4000, which are both newly installed in our laboratory at King Abdullah University KSA, will be presented and compared in this study.

MM 47.5 Thu 11:30 H 0107

Triple junction and grain boundary diffusion in the Ni/Cu system — •Mohammed Reda Chellali, Zoltán Balogh, and Guido Schmitz — Institut für Materialphysik, Westfälische Wilhelms Universität Münster; Münster (Germany)

A topological defect of the grain boundary structure, the so called triple junction, plays a dominant role for grain growth and atomic transport in nano-crystalline materials. By means of atom probe tomography measurement of atomic transport along triple junctions and grain boundaries became possible recently [1]. Heat treatment was chosen in the kinetic C-B regime according to generalized Harrison categories for the hierarchy of volume, grain boundary and triple junction transport. A significant dependence of the thickness of the grain boundaries on the annealing temperature in the range of 563-643 K is detected and taken into account to determine the activation energy along triple junctions. The determined energies are found to be 120 KJ/mol and 82kJ/mol along the grain boundaries and triple junctions respectively. Thus, triple junctions represent a significantly faster diffusion route than grain boundaries.

[1] M-R. Chellali, Z. Balogh, L. Zheng and G. Schmitz Scripta Mater. 65/4 (2011) 343