MM 30 Symposium Tomographic Methods in Materials Research

Zeit: Montag 11:00–12:40 Raum: TU H1058

MM 30.1 Mo 11:00 TU H1058

Quantitative Field Determination for Magnetic Recording Heads — •Robert Ferrier[1] and Pat Ryan[2] — [1]Department of Physics and Astronomy, The University of Glasgow, Glasgow G12 8QQ, UK — [2]Advanced Transducer Development, Seagate Technology Inc., 7801 Computer Av. - M.S. NRW102, Bloomington MN 55435, USA

The magnetic recording industry is constantly striving to increase the areal density of information storage and currently 170Gbits/inch2 has been demonstrated. Track widths are now approaching 120nm and the high coercivity media employed require writing fields in excess of 0.4T and head flying heights of the order 20nm. Thus to assess the modelling of inductive head writing fields we must measure the field distribution at this distance or closer to the air bearing surface (ABS). The technique employed is electron beam tomography and the input data for the real space back projection method is obtained from orthogonal components of differential phase contrast image intensity obtained using a FEGSTEM instrument. The construction of the recording head combines the inductive writer in combination with a GMR reading head. The magnetic shielding poles for the latter are substantially longer than the width of the writing pole and if shadowing effects due to misalignment of the ABS in the microscope are to be minimised then only a small region (2.0x0.5μm2) around the writing polegap must remain in the original ABS plane. This is achieved by a combination of mechanical polishing, chemical etching and FIB milling. The determination of absolute field distributions for heads with writing pole widths 0.33μm and 0.22μm will be described and the future use of the method will be assessed.

MM 30.2 Mo 11:20 TU H1058

Electron Tomography for Materials Research and Indsutrial Applications — •Christian Kübel — FEI Company, Application Laboratory, Achtseweg Noord 5, 5651 GG Eindhoven, The Netherlands — Fraunhofer Institut für Fertigungstechnik und Materialforschung, Wiener Straße 12, 28359 Bremen, Germany

In recent years, the limitations of 'classical' electron microscopy in materials science characterization have become increasingly apparent. Especially in areas such as nanotechnology and the IC industry, accurate analysis and measurements for metrology are difficult to obtain as different features overlap in a single 2D projected (S)TEM image. Electron tomographic methods provide a way around these limitations and are capable of delivering nanometer resolution in 3D for relatively 'large' volumes. BF-TEM tomography techniques, traditionally used in life sciences, are only of limited use in materials science due to diffraction contrast. Therefore, we have developed an automated acquisition for HAADF-STEM tomography, which is easy to use for a wide range of (crystalline) materials. The possibilities of electron tomography for materials science will be demonstrated using catalyst, nanocrystal, and semiconductor materials. Important aspects of the tomography analysis will be determination of particle size distributions, analysis of morphologies and imaging of surface variations in 3D. Finally, the advantages and limitations of both BF-TEM and HAADF-STEM tomography for materials sciences will be discussed.

MM 30.3 Mo 11:40 TU H1058

Investigation of orientation gradients around particles and their influence on particle stimulated nucleation in a hot rolled Fe_3Al based alloy by applying 3D EBSD — •Joachim Konrad, Stefan Zaefferer, and Dierk Raabe — Max-Planck-Institut für Eisenforschung GmbH, Max-Planck-Str.1, 40237 Düsseldorf

The optimization of the mechanical properties of Fe_3Al based alloys requires the increase of room temperature ductility and of high temperature strength. Both can be achieved, inter alia, by the addition of particles, for example of Laves phase. On the one hand these particles influence recrystallisation by particle stimulated nucleation (PSN) or inhibition of boundary movement. On the other hand particles lead to strengthening of the matrix at high temperatures.

The occurrence of PSN is correlated with the size and the mechanical properties of the precipitates. The larger the particles are and the harder they are compared to the matrix the larger the orientation gradients in the matrix around these particles become. 3D EBSD investigations by serial sectioning using a scanning focused ion beam - electron microscope (FIB-SEM) reveal the spatial distribution of the orientation gradients and their influence on the nucleation behaviour. Furthermore, the orientation gradients provide information on the active slip systems in these areas.

MM 30.4 Mo 12:00 TU H1058

Electron Tomography of Nanoparticles: towards atomic resolution? — •Sara Bals[1], Christian Kisielowski[2], Mihail Croitoru[1], and Gustaaf Van Tendeloo[1] — [1]EMAT-University of Antwerp, Groenenborgerlaan 171, Antwerp B-2020, Belgium — [2]National Center for Electron Microscopy, Lawrence Berkeley National Laboratory, One Cyclotron Road, Berkeley CA 94720, USA

The use of bright field imaging for electron tomography in physical sciences is often hampered by the presence of Bragg diffraction. Reconstructions of Pt nanoparticles (5-7 nm) show that the morphology is not remarkably hampered, but artificial cavities are observed inside the particles. To understand the formation of these artifacts, we have used multislice calculations to simulate the different projections in a tomography series. From this we can conclude that strong scattering and channeling effects are possible reasons for the formation of the cavities. One of the experimental possibilities to overcome this problem is to combine electron tomography with annular dark field TEM. Here, the central beam and all electrons scattered up to a certain semi-angle are excluded from imaging by an annular objective aperture. In this manner, a mass-thickness contrast is generated that depends exponentially on sample thickness. Using this technique, we have successfully obtained a 3D reconstruction of CdTe tetrapods, which also allows us to locate the CdSe seed that is used during growth.

MM 30.5 Mo 12:20 TU H1058

Nanotomography with Scanning Probe Microscopy — •Robert Magerle — Institut für Physik, Technische Universität Chemnitz

Nanotomography [1] is a novel procedure for high-resolution volume imaging based on scanning probe microscopy (SPM). The method is similar to an excavation on the nanometer scale: With suitable etching of polishing techniques the specimen is eroded step by step and the chemical composition of each freshly exposed surface is imaged with scanning probe microscopy. From the resulting series of images, separated in depth by only a few nanometers, the specimen's three-dimensional microstructure can be reconstructed. I will present examples of volume images with 10 nm resolution of block copolymers, semi-crystalline polymers, and Ni-based superalloys; limitations and perspectives will also be addressed. With the success of SPM in mind, volume imaging with SPM promises new insights into the physics of materials on the nanometer and even atomic scale. [1] R. Magerle, Phys. Rev. Lett. 85, 2749 (2000); EP 1144989; U.S. Patent 6,546,788.