MM 35 Hauptvortrag Karl Maier

Zeit: Dienstag 09:45–10:15 Raum: TU H1058

Hauptvortrag

MM 35.1 Di 09:45 TU H1058

Prediction of material fatigue — •Karl Maier — Helmholtz Institut für Strahlen und Kernphysik, Nußallee 14-16, 53115 Bonn

About 30 years ago positron annihilation became a useful tool in basic metal research eg. vacancy formation enthalpies of nearly all metals could be measured with high precision in thermal equilibrium. In the meantime the experimental techniques and the theoretical understanding developed to a high standard. Position resolved measurements with a resolution of a few microns are now possible in a standard laboratory.

The consequent next step is to take laboratory techniques and knowledge into an industrial environment. There are many relevant material problems which can be solved with positron annihilation. Without any sample preparation, plastic zones in front of fatigue cracks are visible in a non-destructive way. First precursors of material failure at extremely low concentrations can be used to estimate the fracture within only 1% of cycles in a Wöhler experiment. Examples in light alloys, ferritic and austenitic steels are discussed.

MM 36 Symposium Tomographic Methods in Materials Research Hauptvortrag Astrid Haibel

Zeit: Dienstag 10:30–11:00 Raum: TU H1058

Hauptvortrag

MM 36.1 Di 10:30 TU H1058

Synchrotron X-ray microtomography: principles and applications — •A. Haibel, A. Rack, S. Zabler, and J. Banhart — Hahn-Meitner-Institut Berlin, Abteilung Strukturforschung, Glienicker Str. 100, 14109 Berlin

Synchrotron tomography images the interior structure of real objects three-dimensionally, non-destructively, and with a high spatial resolution. This allows for a detailed microstructural analysis of many different kinds of materials or small engineering components. The wide field of applications of synchrotron microtomography will be presented by means of several examples, i.e. metallic foams, thixotropic alloys as well as further components and materials. Our research topics aim at the understanding of the structural and chemical nature of these objects. Moreover, by in-situ experiments, reorganization processes, e.g. the discharge process inside an alkaline battery or the accumulation of SiC particles on the pore surfaces in metallic foams during the foaming process will be visualized and characterized quantitatively. All presented results were measured at the tomographic facility of the BAMline at the BESSY II synchrotron.

MM 37 Symposium Tomographic Methods in Materials Research

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

MM 37.1 Di 11:00 TU H1058

3D-Atom Probe investigation of carbide dissolution in a pearlitic steel subjected to severe plastic deformation. — •Yu. Ivanisenko[1], X. Sauvage[2], H. Rösner[1], and H.-J. Fec ht[1,3] — [1]Institut für Nanotechnologie, Forschungszentrum Karlsruhe, 76021 Karlsruhe, Germany — [2]Institut des Matériaux de Rouen, Université de Rouen, BP 12, 76801 Saint-Etienne-du-Rouvray, France — [3]Abt. Werkstoffe der Elektrotechnik, Universität Ulm, 89081 Ulm, Germany

Pearlitic steels find a wide application in industry mainly as a material for rails and tyre cords. Phenomenon of decomposition of carbides occurring either during the exploitation of rails, or during the cold drawing of wires is very important because it decreases the ductility, and consequently leads to the loss of mechanical properties.

The application of 3D Atom Probe to study the process of strain induced cementite dissolution in pearlitic steels is very promising because it allows to detect the concentration of the elements in alloys with atomic resolution. Here we report our results on 3D AP investigation of pearlitic steel (Fe - 0.76 wt. % C - 1.2 wt. % Mn) following the room temperature severe plastic deformation by high pressure torsion. We show that decomposition of carbides starts already in the beginning of straining with a gradual decrease of the carbon concentration and formation of transitional non-stoichiometric phases with carbon contents of 8-16 at. %. A parallel HRTEM investigation has demonstrated that these phases, still keeping the lamellar shape, are partially amorphous. Increasing the strain further leads to a considerable decrease of size and amount of such carbon-rich areas and formation of carbon segregations on grain boundaries of nanocrystalline ferrite and along the dislocations.

MM 37.2 Di 11:20 TU H1058

Stability and Thermal Reaction of GMR NiFe/Cu Thin Films — •Constantin Buzau Ene[1], Guido Schmitz[2], and Reiner Kirchheim[1] — [1]Institut für Materialphysik, Friedrich-Hund-Platz 1, D-37077 Göttingen — [2]Institut für Materialphysik, Wilhelm-Klemm-Str. 10, D-48149 Münster

Giant magneto-resistance (GMR) model systems of NiFe/Cu multilayer stacks with 2 nm single layer thickness were deposited onto needle-shaped W tips using ion beam sputtering and analyzed by atom probe tomography (TAP) after appropriate heat treatments.

Owing to the outstanding sensitivity of the method, even minor chemical modifications on the nanometer scale can be detected. Although annealing treatments at temperatures up to 250°C result already in a dramatic decrease of magneto-resistivity, no major structural or chemical transformation of the initial layer system is found. Instead, a slight decrease of the concentration slope at the interfaces is observed, which is attributed to short range interdiffusion induced by non-equilibrium point defects. Annealing at higher temperatures up to 500°C/40 min still preserves a clear layer structure. However, appreciable amounts of Ni are dissolved inside the Cu layers. In presence of grain boundaries, the onset of significant grain boundary diffusion is at about 350°C.

According to the nanoanalysis, the low temperature breakdown of the magneto-resistivity in NiFe/Cu systems is related to the short range interdiffusion of Ni in Cu on a mixing width of about 1nm, which happens homogeneously along the interfaces without destroying the clear layer structure.

MM 37.3 Di 11:40 TU H1058

Tomographic characterization of magnetic sensor materials — •Guido Schmitz[1], Constantin Ene[2], and Mario Kuduz[2] — [1]Institut für Materialphysik, Westf. Wilhelms-Univ., Wilhelm-Klemm-Str. 10, 48149 Münster, Germany — [2]Institut für Materialphysik, Univ. Göttingen, Friedrich-Hundt-Platz 1, 37077 Göttingen, Germany

Atomprobe tomography provides a 3D local chemical analysis with atomic sensitivity. Due to the 3D chemical information, atomic transport processes can be determined even in complex nanocrystalline materials. The application of the method to thin film multilayers is demonstrated at the example of magneto resistive sensor devices. Investigations of {NiFe/Cu/Co/Cu}, {Cu/Py}, {Co/Al_2O_3/NiFe} systems are presented. These structure are severely unstable from a thermodynamic point of view, so that their thermal stability and reaction gets an important issue for any technical application. Based on the 3D volume reconstruction, different mechanisms of atomic transport are identified and their relative importance for the degeneration of the giant magneto resistance effect or the electrical stability of tunnel barriers determined. According to the nano-analysis, volume diffusion induced by non-equilibrium point defects seems to be the dominant factor in GMR systems. In oxide tunnel barriers, a thermal treatment leads to zones of local enrichment of metallic impurities, which probably induces electrical breakthroughs.