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.

MM 37.4 Di 12:00 TU H1058

Characterization of precipitates in aluminum based alloy AW 6016 — •N. Wanderka, R. Schiffmann, and J. Banhart — Hahn-Meitner-Institut Berlin, Glienicker Str. 100, 14109 Berlin, Germany

The aluminium based engineering alloy AW 6016 of nominal composition 98.44 Al - 0.45 Mg - 0.96 Si - 0.11 Fe - 0.034 Mn - 0.0054 Zn - 0.0038 Cr (at. %) was investigated. Heat treatment of solutionized and quenched alloys leads to an increase in hardness which is due to the formation of small precipitates of nanometer size. Two complementary high resolution methods, namely transmission electron microscopy (TEM) and three - dimensional atom probe (3 DAP), are used for investigations of the precipitate evolution after annealing at 185°C and 235°C. At very early stages, i.e. after 5 min at 185°C, Mg-rich, Si-rich and Mg-Si coclusters are observed. They are spherical and their diameter is between 1 and 3 nm. The number density of clusters as measured by 3 DAP is 9 x $10^{23}/m^3$. After ageing for 25 min and 90 min at 185°C GP zones needle-shaped β" phases are formed. Both are rich in Mg and Si. The concentration ratio of Mg to Si of the precipitates is approximately 1. The number density of all precipitates after 90 min annealing time at 185°C is 6 x $10^{23}/m^3$. The needle-like β" precipitates at this ageing stage are about 4 nm in diameter and longer than 10 nm. The precipitates formed at 235°C after 10 min are much larger compared to those at 185°C. They are rod-shaped and have an average size as measured by TEM, about 50 nm in length and 3-4 nm in cross-section. The concentration ratio between Mg and Si as measured by 3 DAP is about 1.

MM 37.5 Di 12:20 TU H1058

Untersuchung des Materialflusses beim Reibrührschweißen mit Synchrotronstrahlung basierter Mikrotomographie — T. Donath, F. Beckmann, R. Zettler, A. Schreyer, •T. Donath, F. Beckmann, R. Zettler und A. Schreyer — GKSS Forschungszentrum, Max-Planck-Str. 1, 21502 Geesthacht, Deutschland

Die Außenstelle des GKSS Forschungszentrums bei DESY, HASYLAB betreibt eine Apparatur für röntgenmikrotomographische Untersuchungen an der Synchronstrahlungsquelle DORIS.

Es wurden in Reibrührtechnik hergestellte Schweißnähte einer Aluminiumlegierung mit Hilfe dieser Apparatur untersucht. Der bei dieser Schweißtechnik auftretende plastische Materialfluss konnte durch das Einbringen von Ti-Pulver in den tomographischen Rekonstruktionen sichtbar gemacht werden. Die Mikrotomographie-Apparatur und die Untersuchungsergebnisse werden vorgestellt.