MM 38: Diffusion and point defects III

Time: Thursday 14:45–15:45 Location: H6

MM 38.1 Thu 14:45 H6

Diffusion of Fe in intermetallic thin films — •Marcus Rennhofer[1], Daniel Kmiec[1], Bogdan Sepiol[1], Gero Vogl[1], André Vantomme[2], Johan Meersschaut[2], Bart Laenens[2], Daniel Merkel[3], Laszlo Bottyan[3], Svetoslav Stankov[4], and Rudolf Rüffer[4] — [1]Fakultät für Physik, Universität Wien — [2]Instituut voor Kern- en Stralingsfysica and INPAC, K.U.Leuven — [3]KFKI, Department of Nuclear Physics, Budapest — [4]ESRF, Grenoble, Cedex, France

Diffusion studies on the mesoscopic and macroscopic scale were done up to now via radio-tracer technique for a wide range of diffusivities. Nevertheless, the resolution of diffusion depths is limited by the detector efficiencies and sputtering resolving power. On the other hand scattering methods with atomic resolution [1] have very limited range of accessible diffusion coefficients. We advantageously applied grazing incidence nuclear resonant scattering of synchrotron radiation [2] for the study of iron self-diffusion in thin intermetallic films of $L1_0$-FePt, $L1_0$-FePd and B2-FeSi. It is possible to measure very low rates of diffusion of about $10^{-21}\,m^2s^{-1}$ to $10^{-25}\,m^2s^{-1}$. We will give a short introduction to the method, and present recent results.

[1] G. Vogl and B. Sepiol, eds. Heitjans and Kärger Diffusion in condensed matter, Springer, $p\,65$ (2005).
[2] M. Gupta, A. Gupta, J. Stahn, M. Horisberger, T. Gutberlet and P. Allenspach in Phys. Rev. B 70, 184206 (2004).

MM 38.2 Thu 15:00 H6

How to Measure Diffusion Lengths in the Sub-nanometer Range? — •Harald Schmidt[1,2], Thomas Gutberlet[2], and Michael Bruns[3] — [1]Institut für Metallurgie, AG Materialphysik, Technische Universität Clausthal, 38678 Clausthal-Zellerfeld — [2]Laboratorium für Neutronstreuung, ETH Zürich und Paul Scherrer Institut, 5232 Villigen, Schweiz — [3]Institut für Materialforschung III, Forschungszentrum Karlsruhe, 76021 Karlsruhe

The study of self-diffusion in metastable solids like glasses or nanomaterials necessitates the detection of extremely short diffusion lengths in order to prevent crystallization or growth processes during the measurement. This is especially true for covalently bound amorphous materials with their low atomic mobility. We demonstrate that it is possible to detect diffusion lengths down to 70 Å by neutron reflectometry. Such small values cannot be achieved by conventional methods of diffusivity determination (radiotracer technique, SIMS, NMR, QENS). The reflectivity measurements were carried out on magnetron sputtered amorphous $Si^{14}N_x/Si^{15}N_x$ isotope multilayers which were used as a model system. Due to the periodically modulated structure of the multilayers and the different neutron scattering lengths of the nitrogen isotopes, Bragg peaks occur in the reflectivity pattern. Self-diffusivities down to 5 x $10^{-25}m^2/s$ were determined from the decay of the Bragg peaks due to interdiffusion of the two nitrogen isotopes. The ability of the method to resolve a time dependence of the diffusivities due to short-time structural relaxation is demonstrated.

MM 38.3 Thu 15:15 H6

Eigenschaften struktureller Leerstellen in Fe_3C — •Volker Sluka und Torsten Staab — Helmholtz-Institut für Strahlen- und Kernphysik der Rheinischen Friedrich-Wilhelmsuniversität Bonn, Nussallee 14-16, 53115 Bonn, Germany

Eine Methode zur Untersuchung von Ermüdungserscheinungen in Materialien ist die Positronenannihilationsspektroskopie. Die Positronen reagieren dabei empfindlich auf leerstellenartige Kristallbaufehler. Um die Positronensignale aus reinen Kohlenstoffstählen besser zu verstehen, werden ab-initio Rechnungen mit dem SIESTA-Code durchgeführt. Ein solcher Stahl ist ein Gefüge aus einer Ferrit- und einer Perlitphase, wobei Letztere wieder aus Ferrit und Zementit (Fe_3C) besteht. Zunächst werden die Bildungsenthalpien von Leerstellen auf den einzelnen Untergittern des Zementits berechnet. Dabei erhält man die Positionen der um diese Defekte relaxierten Atome. Diese Daten lassen die Berechnung von Positronenannihilationsparametern zu, die dann mit dem Experiment verglichen werden können.

MM 38.4 Thu 15:30 H6

Element specific defect investigation on Mg-alloys by ion implantation with coincident Doppler broadening spectroscopy — •Martin Stadlbauer[1], Christoph Hugenschmidt[2], and Klaus Schreckenbach[1] — [1]TU Munich, ZWE FRM-II, Garching, Germany — [2]TU Munich, Department of Physics E21, Garching, Germany

Magnesium alloys experience an increasing interest for industrial applications due to their low specific weight, high elasticity and mechanical strength. For the high performance of these materials a homogeneous distribution of the alloy constituents is required. It is therefore of great interest to investigate the behaviour of the alloy constituents in the vicinity of open volume defects.

In order to investigate the influence of defects and their chemical surrounding, polished and annealed samples of pure magnesium and the alloy AZ31 (3 wt. % Al and 1 wt. % Zn) were irradiated with Zn-, Al- and Mg-ions. The energy of the ions was chosen between 1.4 MeV and 3.0 MeV according to 2.3 μm mean implantation depth. For every type of material a set of 4 samples was produced with doses between $3 \cdot 10^{13}$ and $3 \cdot 10^{16}\,cm^{-2}$. First, Doppler-Broadening measurements as a function of the positron implantation energy as well as lateral position with a resolution of 2 mm were recorded in order to image the ion beam spot on the sample. Secondly, coincident Doppler-broadening spectra were measured at different positron penetration depths according to the Makhov-profile. The relation between elemental signature and defect concentration in the sample are discussed.