

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 RENNHOFFER¹, DANIEL KMEC¹, BOGDAN SEPIOL¹, GERO VOGL¹, ANDRÉ VANTOMME², JOHAN MEERSSCHAUT², BART LAENENS², DANIEL MERKEL³, LASZLO BOTTYAN³, SVETOSLAV STANKOV⁴, and RUDOLF RÜFFER⁴ — ¹Fakultät für Physik, Universität Wien — ²Instituut voor Kern- en Stralingsfysica and INPAC, K.U.Leuven — ³KFKI, Department of Nuclear Physics, Budapest — ⁴ESRF, 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 L1₀-FePt, L1₀-FePd and B2-FeSi. It is possible to measure very low rates of diffusion of about $10^{-21} \text{ m}^2 \text{ s}^{-1}$ to $10^{-25} \text{ m}^2 \text{ s}^{-1}$. 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 GUTBERLET², and MICHAEL BRUNS³ — ¹Institut für Metallurgie, AG Materialphysik, Technische Universität Clausthal, 38678 Clausthal-Zellerfeld — ²Laboratorium für Neutronstreuung, ETH Zürich und Paul Scherrer Institut, 5232 Villigen, Schweiz — ³Institut für Materialforschung III, Forschungszentrum Karlsruhe, 76021 Karlsruhe

The study of self-diffusion in metastable solids like glasses or nano-materials 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 Si¹⁴N_x/Si¹⁵N_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 $5 \times 10^{-25} \text{ m}^2/\text{s}$ 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 Fe₃C — ●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 Positronenannihilationspektroskopie. 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 (Fe₃C) 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 STADLBAUER¹, CHRISTOPH HUGENSCHMIDT², and KLAUS SCHRECKENBACH¹ — ¹TU Munich, ZWE FRM-II, Garching, Germany — ²TU 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 $3 \cdot 10^{16} \text{ cm}^{-2}$. 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.

MM 39: Mechanical properties I

Time: Thursday 16:15–18:15

Location: H6

MM 39.1 Thu 16:15 H6

Tribological performance of WC/C coatings on rough substrates — ●MIKHAIL KOSINSKIY¹, YONGHE LIU¹, MAIK GUBISCH², LOTHAR SPIESS², and JUERGEN A. SCHAEFER¹ — ¹Institut für Physik und Zentrum für Mikro- und Nanotechnologien, Technische Universität Ilmenau, Germany — ²Institut für Werkstofftechnik und Zentrum für Mikro- und Nanotechnologien, Technische Universität Ilmenau, Germany

The available measurements on the tribological behavior of WC/C multilayer coatings are mainly performed on atomically smooth Si surfaces. In this work, we study the influence of surface roughness on the friction and wear of WC/C coatings. Chromium steel samples cut from linear bearing were polished to surface roughness (Ra) in the range of 3 nm ~ 700 nm, and subsequently deposited with 700 nm thick WC/C coatings. The measurements were performed by using a reciprocating microtribometer at different normal load and velocity in normal atmospheric conditions. As a comparison, bare samples (without coating)

were also tested. We find a roughness, on which the coefficient of friction (COF) is minimum for bare samples, but is maximum for coated samples. The reduction of COF by applying the coating is ~200%.

MM 39.2 Thu 16:30 H6

Evaluating creep behaviour of thin wall structures at high temperatures - method and first results — ●RAINER HÜTTNER, RAINER VÖLKL, and UWE GLATZEL — Rainer Hüttner, Metals and Alloys, University of Bayreuth, Ludwig-Thoma-Straße 36b, D-95447 Bayreuth, Germany

The knowledge of creep behaviour of structural materials for high temperature applications is prerequisite for life-time predictions. In order to optimize both the cooling efficiency and the weight of fast rotating turbine blades a general trend to reduce the wall thicknesses of the hollow investment castings is observed. This work deals with a method for evaluating creep behaviour of thin wall structures. The test equipment uses resistive heating to achieve fast heating and cool-