MM 5: Diffusion and Point Defects I

Time: Monday 10:15–11:15 Location: H6

MM 5.1 Mon 10:15 H6

A Novel Approach to Identify the Mechanism of Gold Diffusion in Lead — •Nico Stolwijk and Dirk Böckmann — Institut für Materialphysik, Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

Fast impurity diffusion in metals has been extensively studied in the 1960s and 1970s, with Pb:Au serving as a prototype system. In particular, it was concluded from measurements of self-diffusion enhancement factors in Pb(Au) alloys that the high Au diffusivity cannot be reconciled with the vacancy mechanism. Alternative models interpreted Au transport in terms of fast moving interstitial-type defects including conventional interstitials Aui, Aui-vacancy pairs, or Au-Au diplons (dumbbells), however, without providing convincing evidence. Specifically, the role of substitutional Aus was not sufficiently clarified. Our experiments aim at identifying the Au diffusion mechanism by closely looking at the evolution of the Au penetration profiles in a regime of short-term isothermal annealing. To this aim, we utilise the suitability of the Pb:Au system for neutron activation analysis, which allows for the detection of diffusion profiles on an absolute concentration scale. The results are evaluated within the framework of the dissociative mechanism involving Aui-Aus exchange with the aid of vacancies.

MM 5.2 Mon 10:30 H6

The influence of Au on the decomposition of Al-Cu — •Benedikt Klobes[1], Osman Balarisi[1], Meng Liu[1], Karl Maier[1], and Torsten Staab[2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik, Nußallee 14-16, 53115 Bonn — [2]Fraunhofer ISC, Neunerplatz 2, 97082 Würzburg

Al alloys based on the binary Al-Cu system are important structural materials since they combine light weight with high strength. Their favourable mechanical properties are induced by precipitates of nanometer size which are formed due to the vacancy driven transport of solute atoms. Usually, this precipitation process is significantly influenced by other microalloying elements, e.g. the addition of Mg accelerates and amplifies the hardness increase during ageing. In contrast, microalloying additions of Au inhibit the decomposition and age hardening of the alloy. By means of positron annihilation and x-ray absorption spectroscopy, with which the essential ingredients of age hardenable alloys, namely vacancies and solute atoms, can be probed, we show that Au atoms trap quenched-in vacancies. Since the vacancy mechanism of diffusion is surpressed this way, no age hardening can occur.

MM 5.3 Mon 10:45 H6

Zerstörungsfreie Abschätzung der Restlebensdauer an Proben des ICE-Achsstahls — •Patrick Eich[1], Reinhard Sottong[1], Matz Haaks[1], Karl Maier[1] und Hartmut Hintze[2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik, Nussallee 14-16, 53115 Bonn — [2]Deutsche Bahn AG Bahntechnikerring 74, 14774 Brandenburg-Kirchmöser

In den letzten Jahren ist das ermüdungsbedingte Versagen von Radsatzwellen im Schienenverkehr ausführlich in der Tagespresse diskutiert worden. Die heutzutage eingesetzten und an das 150 Jahre alte Wöhler-Verfahren angelehnten Methoden zur Abschätzung der Restlebensdauer erfordern sehr zeit- und kostenintensive Experimente. Aus der zerstörungsfreien Beobachtung erster Gefügeänderungen als Vorboten des Ermüdungsprozesses lässt sich vergleichbare Information mit nur ca. 1% des experimentellen Aufwandes gewinnen. Die physikalische Ursache für die Ermüdung von metallischen Werkstoffen ist die Akkumulation von Gitterfehlern, wie Versetzungen, und durch Versetzungsbewegung erzeugte Defekte. Der Aufbau der Defektdichte wird mit der Positronen-Annihilation-Spektroskopie (PAS) gemessen und so die Restlebensdauer von Stählen und Aluminiumlegierungen zerstörungsfrei bestimmt [1]. Diese Methode wurde auf Proben des ICE-Achsstahls A4T übertragen. Die Ergebnisse zeigen, dass sich aus den Frühstadien der Ermüdung die Restlebensdauer mit zu Wöhlermethoden vergleichbarer Genauigkeit abschätzen lässt.

[1] M.Haaks, K. Maier in V. Jentsch et al. "extreme events", Springer 2005

MM 5.4 Mon 11:00 H6

Fluid transport in one dimensional channel systems — •Ramona Baum, Florian Hibbe, Sergej Naumov, Jörg Kärger, and Rustem Valiullin — Department of Interface Physics, University of Leipzig, Germany

Interference microscopy (IFM) is a well-suited experimental technique for studying transport of guest molecules in nanoporous materials [1]. A sufficient spatial resolution, which is in the range of micrometers enables the monitoring of the evolution of concentration profiles under non-equilibrium conditions. The transient concentration profiles, which are the result of a change in the ambient pressure, therefore allow the study of the adsorption and desorption kinetics. L-zeolite represents an important model system to study molecular transport in nanopores. It is a crystal with a length of 7 to 8 μm with one dimensional channels arranged in a hexagonal pattern. Such organization of the pore structure allows most unambiguous verification of theoretical predictions about the diffusion process [2]. In this work, we present the data on molecular transport of propane in L-zeolite assessed using IFM. The results obtained, revealing the one dimensional character of the diffusion process, are in good correlation with the crystallographic structure of this material.

[1]L.Heinke,D.Tzoulaki, C.Chmelik, F.Hibbe, J.M.van Baten, H.Lim, J.Li, R.Krishna, J.Kärger, Phys.Rev.Lett. 102, 065901 (2009)

[2] J.Kärger, R.Valiullin, S.Vasenkov, New Journal of Physics 7 (2005) 1-15.