MM 36: Nano structured materials IV

Time: Thursday 14:45–16:15 Location: H4

MM 36.1 Thu 14:45 H4

Intrinsic Microstrain in Nanocrystalline Metals — •Jürgen Markmann[1], Vesselin Yamakov[2], and Jörg Weissmüller[1,3] — [1]Universität des Saarlandes, FR 7.3 Technische Physik, 66123 Saarbrücken — [2]National Institute of Aerospace, Hampton, Virginia 23666, USA — [3]Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Institut für Nanotechnologie, 76344 Eggenstein-Leopoldshafen

Microstrain is often observed as a consequence of plastic deformation of metals and its appearance is usually contributed to the increase of dislocation density after deformation. Interestingly almost all nanocrystalline metals show already a high amount of microstrain in their as-prepared state independent of their synthesis route. This leads to the assumption that microstrain could be an intrinsic property of nanocrystalline metals. To investigate this, defect-free nanocrystalline 3-dimensional microstructures containing between 16 and 1024 grains were thermally relaxed at 300 K by molecular dynamics simulation. X-ray diffractograms were calculated out of the atom positions and the x-ray peak broadening was analysed to determine the average grain size and microstrain. The evaluated grain size is in excellent agreement with the grain size of the starting microstructure. Nevertheless there is a large the amount of microstrain in the relaxed samples. These findings support an intrinsic nature of microstrain in nanocrystalline metals because no extrinsic sources for microstrain in these "samples" exist. A simple model will be presented which can explain this intrinsic microstrain as a function of the grain size.

MM 36.2 Thu 15:00 H4

The effect of grain size on strain rate sensitivity and activation volume — •Kerstin Schüler, Delphine Lemaire, Thomas Waschkies, Bo Yang, and Horst Vehoff — Werkstoffwissenschaft und Methodik, Universität des Saarlandes, 66123 Saarbrücken, Deutschland

The strain rate sensitivity of nanocrystalline (nc) nickel (Ni) was studied at different temperatures in tensile tests and with a nanoindenter in order to examine the effect of grain size on the different deformation mechanisms of nc materials. The experiments yielded, depending on temperature and strain rate, the strain rate sensitivity, the activation volume and the creep exponents as a function of stress and grain size. From the creep experiments the transition between grain boundary sliding and dislocation climb as a function of temperature was obtained. The strain rate jump tests gave extremely small activation volumes, nearly a factor of 100 smaller than in conventional Ni as a function of grain size. For understanding this behaviour the strain rate sensitivity of single grains was tested with a nanoindenter. The results clearly showed that the primary interaction of dislocations with grain boundaries is the reason for the observed strong rate effects and small activation volumes.

MM 36.3 Thu 15:15 H4

Basic investigations of the precipitation behaviour of AlMgSi alloys — •Ingmar Wieler, Nelia Wanderka, and John Banhart — Hahn-Meitner-Institut Berlin, Glienicker Str. 100, 14109 Berlin

AlMgSi alloys are widely used in aerospace applications and in increasing quantity for car body panels. Their beneficial mechanical properties are achieved by precipitation of nanoscaled metastable precursors of Mg_2Si during heat treatment. A room temperature storage after solution heat treatment often results in a slowered and decreased hardening during subsequent artifical aging - the so called negative effect.

Two high purity alloys AlMg0,6Si0,8 and AlMg0,8Si0,6 were produced and subjected to natural as well as artificial aging with and without previous natural aging and a pre-aging step. Certain states have been characterized by hardness and in situ electrical resistivity measurements. Qualitative and quantitative TEM investigations have been made to associate the properties with the microstructural evolution.

The room temperature storage before artificial aging at 180°C gave rise to a distinct delay and reduction of the hardness growth especially for the Si-richer alloy. The resistivity of artificial aged samples was increased by the room temperature storage until about peak hardness was reached. The TEM investigations proved a low-density, coarse precipitate structure to be the reason for the negative effect.

MM 36.4 Thu 15:30 H4

Microstructure Analysis of Al-Mg-Si alloys with respect to its influence on strength — •Cynthia Chang, Nelia Wanderka, and John Banhart — Hahn-Meitner-Institut Berlin, Glienicker Str. 100, 14109 Berlin

Al-Mg-Si - based alloys are widely used in automotive industry owing to their high strength, good formability and low density. During paint baking of car bodies at 180°C the metal alloy hardens. The increase of hardness is due to the formation of small needle-like precipitates.

In the present work the influence of different Mg and Si contents is investigated. Alloys with compositions Al-0.4Mg-0.4Si and Al-0.4Mg-1.0Si were characterized after different heat treatments using TEM and microhardness measurements. The strengthening by natural ageing of the both alloys is different. In the case of the Al-0.4Mg-0.4Si alloy the natural aging increases the microhardness after subsequent artificial aging at 180°C, while in case of the Al-0.4Mg-1.0Si alloy it decreases. Preceding natural aging has a positive influence on the strength of Al-0.4Mg-0.4Si and a negative one on Al-0.4Mg-1.0Si alloy.

TEM analysis showed that the small needle-like precipitates of both alloys are oriented parallel to the <001> directions of the Al matrix. While the Al-0.4Mg-0.4Si alloy shows a large number of dislocations beside the needle-like precipitates, no dislocation in the Al-0.4Mg-1.0Si alloy were observed. The number density and the size of needle-like precipitates of both alloys are different too.

The different strengthening behaviour of both materials is discussed with respect to their different microstructure.

MM 36.5 Thu 15:45 H4

Mechanically alloyed nanocrystalline Fe-Cu-powders investigated by Atomprobe Tomography (APT) — •Catharina Wille[1], Taláat Al-Kassab[1], Pyuck-Pa Choi[2], and Reiner Kirchheim[1] — [1]Georg-August-Universität Göttingen, Institut für Materialphysik — [2]Korea Institute of Science and Technology, Nano-Materials Research Center

Atom Probe Tomography (APT) has been applied systematically to characterize mechanically alloyed powders chemically and microstructurally. Such powders are interesting from a technical point of view owing to their outstanding macroscopic properties and their frequent application as feed stock for powder metallurgical processing routes. Fe-Cu serves in this study as a binary model system representative for immiscible systems, characterized by a positive heat of mixing. Powders with concentrations between 2.5 and 10at% Cu were prepared by high energy ball milling applying milling times between 2 and 50h. In addition to the APT, Field-Ion-Microscopy- (FIM) and X-Ray-Diffractometry (XRD) -investigations are performed as well. Thus detailed nanoscale information on the local concentration of the minority component, segregation effects and the distribution of impurities can be gained. In this contribution results on the extension of the solubility limits and on the homogeneity of the alloy - both in dependency on the composition and milling time - are presented, discussed and compared to earlier works. Financial support from the Deutsche Forschungsgesellschaft under contract KI-230/33-1 is gratefully acknowledged.

MM 36.6 Thu 16:00 H4

Microstructural investigations of the carbon free stainless maraging steel Corrax — •Stefan Höring, Nelia Wanderka, and John Banhart — Hahn-Meitner-Institute Berlin, Glienicker Str. 100, 14109 Berlin

Stainless maraging steels are highly alloyed precipitation hardened martensitic steels. Glass and plastic press-forming is one potential application due to their good combination of high toughness and high ductility and the absence of carbides. Precipitates of nanometre size are the reason for the high hardness of these steels. The hardening phase of the commercial alloy Corrax was chemical analysed using the 3D atom probe. The investigation after different aging times at 475°C show only one type of precipitates enriched in Ni and Al. They grow from spherical shaped particles with a size of about 3nm to plates with increasing aging times. The crystallographic structure of these precipitates was investigated with TEM/SAED. These measurements

showed an ordered B2-structure. The changes in the microstructure during aging was analysed by X-ray diffraction. The content of reverted austenite in Corrax which influences the mechanical stability was analysed with diffraction methods after different heat treatments. The results are discussed with respect of the mechanical properties.