MM 24: Transport & Diffusion II

Time: Tuesday 11:45–13:00 Location: H26

MM 24.1 Tue 11:45 H26

Diffusion and microhardness in ultrafine grained nickel produced by high-pressure torsion — •Simon Trubel, Sergiy Divinski, Martin Peterlechner, Gerrit Reglitz, Jörn Leuthold, Matthias Wegner, Christian Simon, and Gerhard Wilde — Institut für Materialphysik, Wilhelm-Klemm-Str. 10, 48149 Münster

Ultrafine grained and nanocrystalline materials produced by methods of severe plastic deformation have roused a growing interest in science and technology due to their unusual property combinations. Here, tracer diffusion is used as a sensitive probe to determine how the internal interfaces in a material are affected by severe deformation. Nanoindentation was applied to obtain information about the local mechanical properties of the material and their evolution with annealing temperature. EBSD (electron backscatter diffraction) and TEM (transmission electron microscopy) were utilized for microstructure examination. Nickel material of 99.6 wt. % purity was subjected to high pressure torsion (HPT), performing several rotations under a quasi-hydrostatic pressure of 2 GPa. By this treatment, ultrafine grained Ni is produced. Subsequently, grain boundary self-diffusion was measured at several temperatures applying the radioactive isotope 63Ni. The measurements indicate that the specific grain boundary diffusivity is significantly enhanced. The results of the complementing methods are discussed in the context of grain boundary structure modifications through severe plastic deformation.

MM 24.2 Tue 12:00 H26

Thermal stability of fast diffusion pathways in ECAP-deformed Ag — •Jochen Fiebig[1], Sergiy Divinski[1], Werner Skrotzki[2], and Gerhard Wilde[1] — [1]Institute of Materials Physics, University of Münster, Münster, Germany — [2]Institute of Structural Physics, Dresden University of Technology, Dresden, Germany

We performed a systematic study of grain boundary self-diffusion in ultrafine grained silver produced by equal channel angular pressing (ECAP) using the radiotracer method (^{110m}Ag-tracer solution) in combination with parallel sectioning by microtome slicing. The grain boundary diffusion was measured depending on the deformation state and the resulting profiles unambiguously revealed the existence of grain boundaries with enhanced excess energy density, i.e. 'high-energy' grain boundaries. Based on this result, we focused on the thermal stability of these specific grain boundaries. Therefore, the diffusion properties after different heat treatments were studied and the microstructure was analyzed with respect to structural elements that survived the heat treatment. Additionally, calorimetric measurements were performed. Applying Borisov's formalism [1] the excess energy of high-energy grain boundaries was determined. The energy of general high-angle grain boundaries was measured to be about 0.5 J/m^2. The grain boundary energy of high-energy grain boundaries is about 10 % to 20 % higher.

[1]V.T. Borisov, V.T. Golikov, and G.V. Shcherbedinsky, Phys. Metall. Metallogr. 17, 881 (1964)

MM 24.3 Tue 12:15 H26

Effect of UFG structure on grain boundary diffusion in an Al-Mg-Sc-Zr alloy produced by ECAP — •Anna Mogucheva[1,2], Sergiy Divinski[2], Rustam Kaibyshev[1], and Gerhard Wilde[2] — [1]Belgorod State University, Pobeda 85, Belgorod, 308015, Russia — [2]Institut für Materialphysik, Universität Münster, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany

An aluminum alloy 5024 (Al-4.6%Mg-0.35%Mn-0.2%Sc-0.09%Zr) was subjected to equal channel angular pressing (ECAP) with the back pressure of 20% ram pressure using rectangularly shaped channels. Processing to the strain of 8 at a temperature of 300oC resulted in the formation of a fully recrystallized structure with a grain size of $1\mu m$. The kinetic properties of grain boundaries after this treatment were investigated by the radiotracer technique using the 65Zn isotope. The impact of the microstructure on the mechanical properties at elevated temperatures and on the mechanisms of grain boundary diffusion is discussed in detail. A correlation between the superplastic behaviour of the 5024 aluminum alloy and the diffusion properties of the interfaces is also analysed.

MM 24.4 Tue 12:30 H26

Contact resistance and field effects of graphene field effect transistors probed by Kelvin Probe Force Microscopy — •Carlos Alvarado[1], Gerd Bacher[1], Wolfgang Mertin[1], and Daniel Neumaier[2] — [1]Werkstoffe der Elektrotechnik and CENIDE, Universität Duisburg-Essen, 47057 Duisburg, Germany — [2]AMO GmbH, 52074 Aachen, Germany

A promising route for large area, high quality graphene sheets suitable for electronic applications is the CVD growth through cooper foils. On its way to become the new material of choice in high frequency electronics, transistors based on CVD grown graphene have to be fabricated and their electrical properties have to be understood on a microscopic scale.

Here, back gate field effects transistors based on CVD grown graphene have been prepared. By spatially resolved Kelvin Probe Force Microscopy (KPFM) on an operating device, the voltage drop profile at the contacts and the potential distribution along the graphene channel are directly measured. Our results show how defects like contaminations or vacancies alter the voltage drop profile and the contact resistance, which is confirmed by 4-probe measurements. We are able to visualize the changes in the potential distribution due to back-gated field effects by KPFM imaging, which opens the possibility to relate the macroscopic I-V characteristics with the distribution of the electrical potential in the device on the nanoscale

MM 24.5 Tue 12:45 H26

Coulomb drag in bilayer graphene — •Jonathan Lux — Institut für theoretische Physik, Universität zu Köln

Coulomb drag measurements provide an interesting possibility to study interaction effects between two adjacent layers. If a current is driven in one of the layers, called the active layer, via Coulomb interaction, momentum can be transferred to the other layer, called the passive layer. This can induce a voltage drop in the passive layer, which can be measured. The ratio of the voltage drop in the passive layer and the current in the active layer is called the drag resistance.

We have calculated the drag resistivity in bilayer graphene (BLG) using Boltzmann kinetic theory, taking into the relevant mode for both particles and holes in each layer. In the Fermi liquid (FL) regime of BLG, the drag resistivity is, up to numerical prefactors, identical to the one in the 2 dimensional electron gas, and independent of the impurity configuration.

Near charge neutrality, Coulomb interaction is able to relax the current, due to the particle–hole symmetry of the low energy theory of BLG. This defines a new regime, which is not accessible in FLs. We found that here the result depends on the ratio of the scattering times of Coulomb and impurity scattering. Special attention is paid to the differences and similarities to the drag in monolayer graphene.