MM 31: Mechanical properties II - Characterisation mechanics

Time: Tuesday 15:45–17:00 Location: IFW D

MM 31.1 Tue 15:45 IFW D

Problems of understanding defect-related mechanical loss spectra in aluminium — •Hans-Rainer Sinning and Jens Bernhardt — Institut für Werkstoffe, Technische Universität Braunschweig

Aluminium is one of the most thoroughly studied materials with respect to basic mechanisms of internal friction and anelastic relaxation, such as low-temperature intrinsic dislocation relaxation (Bordoni relaxation), various kinds of dislocation - point defect interactions, grain-boundary sliding, and high-temperature dislocation processes. Although these mechanisms and related phenomena are usually treated separately, they are often overlapping or even physically connected, e.g. by common rate-controlling processes like bulk or short-circuit diffusion. This makes their identification and understanding sometimes difficult, particularly in technical Al-based materials. On the other hand, such understanding is highly desirable because of pronounced effects and high sensitivity of the spectra observed. Here we will discuss some characteristic modifications recently observed mainly in the high-temperature parts of the spectra (around the well-known "grain-boundary peak"), as introduced e.g. by ceramic reinforcements (particles or BN nanotubes), or by severe plastic deformation.

MM 31.2 Tue 16:00 IFW D

Observation of dislocation - related damping mechanisms in Al - based materials — •Jens Bernhardt and Hans-Rainer Sinning — Institut für Werkstoffe, Technische Universität Braunschweig, Germany

Damping features in Al based alloys between 100 K and room temperature are due to dislocation dynamics. In metal matrix composites (MMCs) formation of micro plastic deformation zones take place during thermal cycling at the interface between metal matrix and reinforcing phase. As we have shown before a broad damping structure in mechanical loss spectra of annealed AA 6061 based MMC (22 % Al2O3) could be assigned to free dislocations generated at the interface between metal matrix and reinforcing particles.

To understand the nature of this broad damping structure we measured damping spectra of Al(99,99), and an Al(99,7) + 10 % B4C composite. In deformed Al(99,99) we observed the Bordoni-Peak around 150 K at 1 kHz. This peak is due to interaction of dislocations with crystal lattice. In Al(99,7) + 10 % B4C a further peak in damping was observed at temperatures between 250 K and room temperature. He is embedded in a broad damping structure comparable to the one observed in AA 6061 + 22 % Al2O3. The mechanism of this peak is most likely dragging of dislocations by point defects (PD) with some enhanced diffusion involved. We will show that this damping peak is depending on heating rate, amplitude of measurement and frequency as well. Properties of Bordoni-Peak, PD-Dislocation Peak and also of the broad damping structure are being discussed for all materials.

MM 31.3 Tue 16:15 IFW D

Ambiguity filtering for quantitative data analysis of ACOM-TEM imaging of nanocrystalline metals — •Aaron Kobler[1,2], Edgar Rauch[3], Christian Kübel[1], and Horst Hahn[1,2] — [1]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany — [2]Technische Universität Darmstadt (TUD), Darmstadt, Germany — [3]SIMAP laboratory, Saint Martin d'Hères Cedex, France

Automatic Crystal Orientation Mapping for the Transmission Electron Microscope (ACOM-TEM) still is a new technique. It allows investigating nanocrystalline (nc) metals with crystal sizes <100 nm where Electron Backscattering Diffraction reaches its limitations. Recently, we combined ACOM-TEM (Nanomegas) imaging with in-situ straining inside the TEM using Hysitron's TEM Picoindenter to follow up the deformation processes of nc PdAu alloys. After recognizing grains/crystallites in crystal orientation maps using Mtex we tracked individual crystallites through straining series. This allowed us to separate grain rotation from an overall sample bending. However, this tracking fails if the grain recognition is misled by the famous 180° ambiguity of the crystal orientation data. 180° ambiguity arises for certain crystal orientations if the underlying spot diffraction pattern show only a limited number of diffraction spots from the zero order Laue zone. As a result of it twin noise is visible. This kind of noise leads to failure of the crystallite tracking and a reduced reliability of quantitative data analysis. Here we present a simple approach to correct for this ambiguity, further some results on in-situ straining of nc PdAu using this filter.

MM 31.4 Tue 16:30 IFW D

Energetic Structure of micro Laue Peaks from Plastically-Deformed Cu Micro-Beam Revealed by a Three-Dimensional X-ray Detector — •Ali Abboud[1], Christoph Kirchlechner[2], Lothar Strüder[3], Jozef Keckes[4], and Ullrich Pietsch[1] — [1]University of Siegen FKP — [2]Max Planck Institut für Eisenforschung GmbH — [3]PNSensor GmbH — [4]Material Center Leoben Forschungs GmbH

Energy dispersive micro-Laue diffraction is used to analyse morphology and energetic structure of circular and streaked Cu 711 and 511 reflections collected during a position-resolved experiment on a plastically deformed Cu micro-beam with dimension of 6 x 6 x 30 umˆ3. The synchrotron experiment was performed at the BM32 beam line of ESRF using polychromatic radiation of 5-27keV and beam size of 0.5x0.5 umˆ2. The diffraction signal was recorded using an energy-dispersive two dimensional detector; pnCCD. Whereas the Laue reflections obtained from undeformed sample regions remain sharp and diffract at distinct X-ray energies, streaked reflections originating from plastically deformed regions possess an energy gradient which is interpreted by lattice rotation caused by geometrically necessary dislocations stored in the crystal. The novel approach represents a milestone in the structural analysis of materials and will be used to analyse (i) strains in elastically deformed samples without the need of sample rotation and (ii) dislocation structures as well as local strains in plastically deformed metals.

MM 31.5 Tue 16:45 IFW D

The influence of dissolved hydrogen in palladium on the pop-in load — •Martin Deutges[1], Christine Borchers[1], and Reiner Kirchheim[1,2] — [1]Institut für Materialphysik, Georg-August Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]International Institute for Carbon-Neutral Energy Research (WPI-I2CNER), Kyushu University, Japan

The transition of elastic to plastic deformation in an initial defect free material is accompanied by the creation of a new dislocation loop. Nanoindentation allows to observe this event and the load at which this happens is called pop-in load.

It is well known that hydrogen affects defect formation. As an example, dissolved hydrogen in palladium facilitates the formation of dislocations, leading to an increase in dislocation density [1].

The palladium-hydrogen system was chosen to analyze this effect with nanoindention. For this purpose an in-situ setup is used to keep a defined hydrogen concentration within the α-phase of the palladium-hydrogen system.

These experiments can be analyzed using the defactants concept [2], the basis of which is the assumption that a decrease of the overall free energy by the segregation of solute atoms to a defect can be ascribed to a decrease of the defect formation energy.

[1] Y.Z. Chen et al., Scripta Mater. 68 (2013) 743.
[2] R. Kirchheim, Acta Mater. 55 (2007) 5129.