MM 33: Topical session: In-situ Microscopy with Electrons, X-Rays and Scanning Probes in Materials Science III - Atomic structure and defects II

Time: Wednesday 11:45–13:15 Location: H38

Topical Talk MM 33.1 Wed 11:45 H38

Deformation mechanisms of grain boundaries in Al and TiAl from atomistic simulations — •Rebecca Janisch — ICAMS, Ruhr-Universität Bochum, Germany

Interfaces in metallic micro- and nano-structures play a role during plastic deformation in many respects. Besides accommodating part of the plastic strain by means of grain boundary sliding and migration they can act as sources, sinks, or barriers for dislocations, as well as as crack nucleation sites. These processes are not independent, and often several of them occur at the same time. To isolate the intrinsic deformation mechanisms of grain boundaries we have carried out molecular statics and molecular dynamics simulations of bi-crystal shear at different interfaces in Al and TiAl. Four distinct mechanisms could be identified, namely rigid grain sliding, grain boundary migration, coupled sliding and migration, and dislocation nucleation and emission. Depending on the loading direction different mechanisms can occur at one and the same grain boundary, i.e. there is a pronounced anisotropy in the interfacial shear behaviour. This anisotropy is suggested as the explanation for seemingly contradicting experimental results on the role of grain boundary sliding during creep of lamellar TiAl alloys.
By varying the geometry and chemistry of the interfaces we could relate the observed mechanisms to structural features of the grain boundaries as well as to physical properties of the material. The influence of external factors such as strain and temperature will be discussed in the presentation.

MM 33.2 Wed 12:15 H38

X-ray microdiffraction Laue experiments to understand plasticity at interfaces — •Christoph Kirchlechner[1,2], Nataliya Malyar[1], Peter Imrich[2], and Gerhard Dehm[1] — [1]Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf, Germany — [2]University of Leoben, Leoben, Austria

The deformation behavior of metallic single crystals is size dependent, as shown by several studies during the last decade (Uchic et al. 2009, Greer and De Hosson 2011). Nevertheless, real structures exhibit different interfaces like grain, twin or phase boundaries. Due to the possibly higher stresses at the micron scale, the poor availability of dislocation sources and the importance of diffusion in small dimensions the mechanical behavior of samples containing interfaces can considerable differ from bulk material. In the talk we show the first in situ microdiffraction Laue compression experiments on micron sized, bi-crystalline samples. Three different grain-boundary types will be presented and discussed (i) Large Angle grain Boundaries (LAGBs) acting as strong obstacle for dislocation slip transfer; (ii) LAGBs allowing for easy slip transfer and (iii) coherent sigma3 twin-boundaries. The talk will focus on pile-up of dislocations at the boundary, slip transfer mechanisms, storage of dislocations and dislocation networks at the LAGB.

MM 33.3 Wed 12:45 H38

Quantitative measurements of grain boundary excess volume from HAADF-STEM micrographs — Yulia Buranova, •Harald Rösner, Sergiy Divinski, and Gerhard Wilde — WWU Münster, Institut für Materialphysik, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany

A novel approach for quantitative measurements of grain boundary excess volume has been developed combing several electron scattering signals and successfully demonstrated for several simulated symmetrical [100] tilt GB configurations as well as for the experimental case of an Al bicrystal containing a near $\sum 13$ GB with an additional twist component. The reliability and precision of this new approach is analyzed and the limitations are discussed.

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MM 33.4 Wed 13:00 H38

In-situ investigations with high-energy X-ray diffraction of the diffusion brazing process of γ-TiAl alloys — •Katja Hauschildt, Andreas Stark, Norbert Schell, Ursula Tietze, Helmut Eckerlebe, Florian Pyczak, and Martin Müller — Helmholtz-Zentrum Geesthacht, Max-Planck-Straße 1, 21502 Geesthacht

Diffusion brazing is a promising method to close cracks (in noncritical or not highly loaded areas) in parts made of TiAl alloy, as for example aero engine vanes. In this work the phase constituents, phase distribution, and microstructure of the joint zone of diffusion brazed Ti-45Al-5Nb-0.2B-0.2C (in at. %) alloys are investigated. Two brazing alloys based on Ti-Fe and Ti-Ni are used.

The phases and their distribution in the brazing zone were determined time and space resolved by high-energy X-ray diffraction (HEXRD) using the materials science beamline HEMS at the PETRA III synchrotron radiation facility at DESY in Hamburg, Germany.

Therefore, the brazing zone was scanned in several steps over the joint while heating.

The results show, that different phases occur over time in the Ti-Ni joint. In contrast the phase constitution in the Ti-Fe joint shows only little change over time. In comparison, scanning electron microscopy was used to characterize the microstructures of the two systems after brazing.