# MM 18: Topical session: Interface-Controlled Microstructures: Mechanical Properties and Mechano-Chemical Coupling - Experimental Characterization

Time: Monday 17:30–18:45 Location: BAR 205

**Topical Talk** MM 18.1 Mon 17:30 BAR 205

**Experimental investigations on the relationship between crystallographic character of grain boundaries and their functional and mechanical properties in various engineering materials.** — •Stefan Zaefferer, Dayong An, Zhangqi Wang, Fady Archie, and Guillaume Stechmann — Max-Planck-Institut für Eisenforschung

Grain boundaries are important defects in crystalline solids because they influence a large number of properties, like strength of ductile materials, fracture resistance and corrosion resistance of various metals, or efficiency losses in polycrystalline solar cells. The exact correspondence between the properties and the crystallographic nature of grain boundaries is in many cases not well understood which is mainly due to the fact that grain boundaries are characterized by 8 degrees of freedom, namely 5 rotational parameters and 3 translational ones. The translational parameters are very difficult to measure and it is not clear whether they are independent of the others. The rotational parameters, that is the grain boundary misorientation (3 parameters) and the grain boundary plane, can however be measured using 3D or pseudo-3D orientation microscopy. With these techniques we are able to study the influence of all parameters on grain boundary properties. In the presentation we will introduce the various techniques and show application examples. In particular we will present results on the corrosion of grain boundaries of austenitic stainless steels in aqueous acid solutions and in salt melts, on fracture resistance in DP steels and on the influence on the performance of CdTe solar cells.

MM 18.2 Mon 18:00 BAR 205

**Mechanical Testing of Copper Alloy Micropillars Containing a Twin Boundary** — •Sebastian Krauss, Jan Philipp Liebig, Mathias Göken, and Benoit Merle — Department of Materials Science and Engineering, Institute I, Friedrich-Alexander-University Erlangen-Nürnberg, Germany

Nanotwinned metals are a promising class of modern materials combining a very high strength with a high ductility and excellent electrical properties. This remarkable strength is connected to the very good efficiency of twin boundaries as obstacles to dislocation motion. In order to further characterize these interactions, micropillars containing single twin boundaries with different orientations were compressed with a flat punch, and subsequently investigated in the scanning electron microscope. The investigations concentrated on copper and $\alpha$-brass, which is a low stacking-fault energy alloy exhibiting a high density of recrystallization twins. Coherent twin boundaries were selected from an EBSD orientation mapping of the sample and oriented by means of a custom sample holder. FIB-milling at these interfaces provided micropillar samples containing a single twin boundary. Single crystalline reference samples were obtained from the bulk of the grain located on both sides of the twin boundary. The microcompression tests allowed quantifying the influence of the twin boundary barrier on the strength of the sample. The activated glide systems were subsequently identified from slip trace analysis and STEM mapping of lamellas obtained by lift-off from the bulk of the tested micropillars.

MM 18.3 Mon 18:15 BAR 205

**Interface Nanolayer Analysis in Al-Cu FSW Lap Joints** — •Roland Marstatt[1], Markus Krutzlinger[2], Johannes Luderschmid[1], Ferdinand Haider[1] und Michael F. Zaeh[2] — [1]Chair for Experimental Physics 1, University of Augsburg, Universitaetsstraße 1, 86159 Augsburg, Germany — [2]Institute for Machine Tools and Industrial Management (iwb), Technical University of Munich, Boltzmannstraße 15, 85748 Garching, Germany

Friction Stir Welding (FSW) is a suitable technology to join dissimilar materials. The material does not exceed the solidus temperature during FSW and the heat effect is much lower compared to fusion welding processes. So FSW can produce high quality joints between dissimilar metals with a minimum of deleterious intermetallic phases. Interfacial phases can cause embrittlement, but also lower the electrical and thermal conductivity through the interface. While intermetallic nanometer scaled layers in friction stir welded dissimilar metal joints were mentioned in literature, the quantitative understanding of the correlation of process parameters and interface structure is still a subject of research. In this study, the formation and atomic structure of the nanometer scaled intermetallic layers at the bonding interface of aluminium copper lap joints were analysed. These layers play a key role for the joining mechanism. The thickness of an intermetallic layer highly depends on the process temperature, which can be controlled by the welding parameters. The obtained results lead to a better understanding of the correlations and therefore enable process control and predictability. *Supported by the DFG as part of SPP 1640.*

MM 18.4 Mon 18:30 BAR 205

**Experimental determination of interface strength and toughness in multi-layered thin films** — Ruth Konetschnik[1], Darjan Kozic[2], Ronald Schöngrundner[2], Hans-Peter Gänser[2], Roland Brunner[2], and •Daniel Kiener[1] — [1]Department Materials Physics, Montanuniversität Leoben, Austria — [2]Material Center Leoben Forschungs GmbH, Austria

In recent years, ongoing miniaturization has led to increasingly complex thin film combinations and geometries. As macroscale tests are not applicable, miniaturized tests are suggested to study the materials response in state of the art and future devices at small length scales. Here, we concentrate on the local determination of interface strength and toughness in layered thin films also taking into account the residual stresses. The materials investigated are sputter deposited Cu-W-Cu and W-Cu-W trilayer systems, with an individual layer thickness of 500 nm, on a Si substrate. Samples with different geometries such as notched bending beams, double cantilever beams, and miniaturized shear specimens are fabricated via cross section polishing and focused ion beam (FIB) milling to quantitatively test individual interfaces. Subsequently, miniaturized fracture experiments parallel and perpendicular to the interfaces are performed in-situ in the SEM to obtain comprehensive knowledge of the fracture and interface toughness. We emphasize the importance of elastic and plastic incompatibilities and residual stresses when addressing fracture mechanical quantities of multi-layered thin film systems and discuss challenges and benefits of our different approaches.