MM 37: Mechanical Properties I

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

MM 37.1 Wed 11:45 H26

γ' Hardened Cobalt-Base Superalloys - A New Class of High Temperature Materials — •Steffen Neumeier, Christopher Zenk, Alexander Bauer, and Mathias Göken — Lehrstuhl Allgemeine Werkstoffeigenschaften, Department Werkstoffwissenschaften, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Deutschland

Conventional Co-based alloys are suitable materials for use in corrosive environments at high temperatures. However, the classic Co-based alloys with high Chromium contents cannot compete with γ' (Ni3Al) hardened Ni-base superalloys in terms of strength as they are only carbide and solid solution hardened. Accordingly, these alloys are only used as materials for static parts in gas turbines for energy conversion, for example. However, this situation could change in the future due to the discovery of the ternary compound Co3(Al,W) in 2006. This stable intermetallic phase with L12 crystal structure is in equilibrium with the face centered cubic Co solid solution and therefore γ/γ' Co-base superalloys with microstructures similar to Ni-base superalloys can be generated. This new class of high temperature materials shows promising properties but is still in its early stages of development. In this talk the positive aspects of Co as base material will be discussed and the microstructures as well as the thermo-physical, mechanical and oxidation properties of these new γ/γ' Co-base superalloys will be presented and compared with Ni-base superalloys.

MM 37.2 Wed 12:00 H26

Microstructure and mechanical properties of the ductile multicomponent Ti-based alloys — •Ilya Okulov[1,2], Simon Pauly[1], Uta Kühn[1], Tom Marr[1,2], Jens Freudenberger[1,3], Juliane Scharnweber[3], Carl-Georg Oertel[4], Werner Skrotzki[4], Ludwig Schultz[1,2], and Jürgen Eckert[1,2] — [1]IFW Dresden, 01171 Dresden, Germany — [2]TU Dresden, Institute of Material Science, 01062 Dresden, Germany — [3]TU Bergakademie Freiberg, Institute Of Materials Science, 09599 Freiberg, Germany — [4]TU Dresden, Institute of Structural Physics, 01062 Dresden, Germany

The decreasing volume fraction of intermetallic phases in nano/ultrafine-grained Ti-based alloys results in significant changes of the plasticity in tension. The Ti-based alloys were designed based on Ti66Nb13Cu8Ni6.8Al6.2 reported by Kuhn[1] and prepared by non-equilibrium processing under high cooling rates. The microstructure of these alloys consists of a dendritic bcc β-Ti solid solution and fine intermetallic phases, which precipitate in the interdendritic regions. The volume fraction of the strong but brittle intermetallic compounds significantly decreases with slight decreases in the Cu and Ni content. Consequently, the failure mechanism in tension changes from cleavage to shear fracture. The Ti71.8Nb14.1Cu4Ni3.4Al6.7 alloy demonstrates already in the as-cast state a pronounced tensile ductility of about 5.2%.

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[1] Kühn, U. et al., Journal of Applied Physics 98, (2005).

MM 37.3 Wed 12:15 H26

Kinetic processes in copper bi- and tricrystals — •Isabelle Binkowski[1], Jörn Leuthold[1], Matthias Wegner[1], Martin Peterlechner[1], Shashank Shekhar[2], Alex King[2], Sergiy Divinski[1], and Gerhard Wilde[1] — [1]Institut für Materialphysik, Universität Münster, Wilhelm-Klemm-Str. 10, D-48149 Münster, Germany — [2]School of Materials Engineering, Purdue University, 501 Northwestern Avenue, West Lafayette, IN 47907-2044, USA

Grain boundaries (GBs) and their junctions often define properties of polycrystalline materials and have a dramatic influence on diffusion and plastic behavior. Owing to the high density of grain boundaries included in polycrystalline materials and especially nanocrystalline materials, investigation of kinetic processes in this type of defect are of fundamental interest. Heading towards nanostructured materials one has to focus also on triple junctions (TJs) since their volume fraction and thus their influence on materials' properties rise. In the present investigation, a near special $\Sigma5{:}\Sigma5{:}\Sigma25$ copper tricrystal is utilized for examining the properties of a triple junction with defined orientations of grains and defined misorientations across the grain boundaries. The mass transport properties of the tricrystal are investigated using the radiotracer method with the 110mAg isotope. The kinetics of out-diffusion from the triple junction into the neighboring grain boundaries are carefully measured by preparing proper bicrystal samples. Additionally, tensile tests including plastic deformation of several percent are performed and the digital image correlation technique is applied to measure the strain fields in the immediate vicinity of GBs and TJs.

MM 37.4 Wed 12:30 H26

Homogeneity and time dependent behavior of high pressure torsion processed copper — •Jörn Leuthold, Matthias Wegner, Sergiy Divinski, Martin Peterlechner, and Gerhard Wilde — Institute of Materials Physics, University of Muenster, 48149 Münster, Germany

The presence of a high defect density in the form of dislocation networks and high and low angle grain boundaries affects the plastic behavior of materials processed by severe plastic deformation . With a decrease of grain size into the sub-micrometer range, dislocation-grain boundary interactions are of increased significance for the accommodation of externally applied stresses. For this study several samples were produced by high pressure torsion, where, under a hydrostatic pressure of several GPa, large shear strains can be employed by a rotating die. Characteristic for this process is a non uniform plastic flow, since shear strain and velocity depend on the distance from the axis of rotation. As a result, an inhomogeneous microstructure is produced. After preparation, the samples were tested by nanoindentation, where, in addition to the hardness, the time dependent properties were analyzed by implementing a holding phase of 300 sec at the maximum load. Electron back-scatter diffraction was used to link the observed features of the microstructure to the results of the nanoindentation measurements.

MM 37.5 Wed 12:45 H26

Size effects of the mechanical properties of copper thin films investigated by bulge tests — •Jan Philipp Liebig, Benoit Merle, and Mathias Göken — Department of Materials Science and Engineering, Institute I, University Erlangen-Nürnberg, Germany

Plane-strain bulge testing was used to study extrinsic as well as intrinsic size effects on the mechanical behavior of thin copper films. Films of various thicknesses ranging from ~ 100 to 1000 nm were magnetron sputter deposited on freestanding silicon nitride membranes. After heat treatment under vacuum a highly twinned microstructure is obtained. Reactive ion etching was used to remove the silicon nitride layer, in order to produce free-standing Cu-membranes. Freestanding as well as passivated Cu-films were investigated in the bulge test. From the load-deflection data, equivalent uniaxial stress-strain diagrams were calculated, allowing a reliable measurement of the yield strength and work hardening coefficients of the specimens. The relative influences of the film thickness, presence of a substrate, and microstructure as characterized by Focused Ion Beam (FIB) and Electron Backscatter Diffraction (EBSD) will be discussed in the presentation.