MM 23 Mechanical Properties I

Time: Wednesday 14:00–15:15 Room: IFW B

MM 23.1 Wed 14:00 IFW B

Deformation of laminated niobium and alumina: constraints from the interfaces — •Yonghe Liu[1,2] and Dieter Brunner[1] — [1]Max-Planck-Institut für Metallforschung, 70569 Stuttgart, Germany — [2]Institut für Physik und Zentrum für Mikro- und Nanotechnologien, Technische Universität Ilmenau, 98693 Ilmenau, Germany

The forming of thin metal sheets is highly constrained by interfaces between workpiece and dies. Constraints are usually treated as friction in a form of stiction, or coulomb friction depending upon lubrication. Our study of the deformation behavior of thin niobium sheets focus on the effects of constraints from interfaces. Polycrystalline niobium and sapphire joints were prepared by diffusion bonding in ultra high vacuum chamber to simulate the stiction, while the coulomb friction was simulated by stacking the niobium/sapphire pieces, or niobium/niobium pieces. We applied an optical full field strain mapping method to determine the strains on the side faces of the metal layers in in-situ deformations. In the case of stiction, the detected strain patterns are coupled with strain localization at interfaces and along the maximum shear directions. Once friction changes from stiction to coulomb friction through interface debonding, the strain localization at interface disappears. A ductile fracture model considering stress triaxiality was employed to understand the results. The results obtained by strain mapping can be directly compared with that obtained by finite element method.

MM 23.2 Wed 14:15 IFW B

Fatigue of highly strengthended Cu-Ag alloys — •J. Freudenberger[1], H.-J. Klauss[1], K. Heinze[1,2], A. Gaganov[1], M. Schaper[2], and L. Schultz[1,2] — [1]IFW Dresden, Institute for Metallic Materials, P.O.-Box 270116, D-01171 Dresden, Germany — [2]TU Dresden, Institute of Material Science, D-01062 Dresden, Germany

The fatigue behaviour of high strength Cu-Ag conductor materials which have undergone thermal treatments and subsequentially progressive strain hardening by repetitive cold drawing is reported. When a maximum load of 1 GPa and a minimum-to-maximum stress ratio of $R = 0.1$ is applied, the investigated materials show a similar behaviour and a fatigue lifetime in the range of $5 \dots 9 \times 10^3$ cycles to failure is observed. The fatigue lifetime of all investigated materials is sufficient with respect to the intended application, which the materials are developed for, i.e. conductors for pulsed high field magnets.

MM 23.3 Wed 14:30 IFW B

Friction and adhesion of selected bearing materials in vacuum — •Mikhail Kosinsky[1,2], Yonghe Liu[1], Wolfram Hild[1], and Juergen A. Schaefer[1] — [1]Technische Universität Ilmenau, Institut für Physik und Zentrum für Mikro- und Nanotechnologien, Postfach 100565, 98684 Ilmenau, Germany — [2]Bauman Moscow State Technical University, MT-11, BMSTU, 2nd Baumanskaya 5, Moscow, 105005, Russia

There is a strong interaction between the contact surfaces of bearings in vacuum. It may lead to high adhesion and high friction that can deteriorate the performance of positioning systems transported by bearings. We characterize the friction and adhesion of selected pairs of bearing materials including steel, copper, gold, sapphire and Si_3N_4 in high vacuum. A driving unit based on piezoelements were built in a vacuum (10^{-8} - 10^{-6} Torr) chamber, which can be refilled with various atmospheres (O_2, N_2). The load prescribed by the driving unit was applied to a glass cantilever through which a sphere was in contact with a specimen. We obtained the normal load and friction force by measuring the deflection of the cantilever in normal and lateral direction and multiplying the spring constants. A laser interferometer mounted outside of the vacuum chamber was employed to measure the deflection. The gas composition was monitored by an in-situ mass spectroscopy. The results were discussed with respect to the changes of normal load, velocity and gas composition.

MM 23.4 Wed 14:45 IFW B

Investigation of crack formation in single-crystal sapphire due to combined normal and lateral forces — •Maksim Karniychuk[1], Thomas Chudoba[2], Volker Linss[2], and Frank Richter[1] — [1]Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz, Germany — [2]ASMEC Advanced Surface Mechanics GmbH, Bautzner Landstr. 45, 01454 Radeberg, Germany

One difficulty in contact mechanics is the detection of crack formation and the evaluation of the critical tensile stresses responsible for this effect. Nanoindentation is a non-destructive method for in situ detection of mechanical failures for instance by the observation of pop-in events in normal force-displacement curves. However, a direct observation of indentation induced pop-in events for many materials such as single-crystal sapphire is often very difficult. Another problem is that there exist ambiguous failure reasons without application of additional methods for the investigation of the failure.

The failure formation in single-crystal sapphire was detected in situ during combined normal and lateral force-displacement measurements by using a new Lateral Force Unit together with a commercial UMIS-2000 nanoindenter. Further analysis allows to conclude that crack opening is the first failure after pure elastic deformation. Thus, the knowledge of the critical lateral and normal forces can be used for the calculation of the critical tensile stress for crack formation with the help of a theoretical model for elastic deformation. The critical tensile stress value was estimated 9.5-10.5GPa.

MM 23.5 Wed 15:00 IFW B

Initiation of microcracks with predefined slip planes and directions to investigate the interaction with micro-structural barriers — •Michael Marx, Wolfgang Schäf, and Horst Vehoff — Universität des Saarlandes, Werkstoffwissenschaft und Methodik, Geb. D23, 66041 Saarbrücken

It is well known that the propagation of microstructurally short cracks can be reduced as result of the interaction with microstructure elements like grain- and phase boundaries. This effect is exploited in materials like composites and multiphase materials with defined phase and boundary conditions to get an improved toughness and fatigue resistance. Further improvement can be expected from grain boundary engineering. Therefore it is necessary to investigate the interaction mechanisms between cracks and boundaries systematically on a microscopic scale. To do this a reproducible method to initiate artificial microcracks with predicted conditions like crack length and distance from the crack tip to the boundary is needed. It will be shown that with a Focused Ion Beam (FIB) such artificial microcracks can not only be initiated but even the direction of the propagation can be predefined. This is possible due to a combination of a complete crystallographic specimen characterization by electron back scatter diffraction (EBSD) and the locally precise adjustable ion beam. So cracks can be initiated directly on the preferred slip system. As a first result the interaction of microcracks with different grain boundaries in a directionally solidified nickel based superalloy will be presented.