MM 4: Mechanical Properties I

Time: Monday 10:15–11:30 Location: H 0106

MM 4.1 Mon 10:15 H 0106

In-situ TEM mechanical testing of nanocrystalline Cu — •Matthias Funk[1], Claiare Chisholm[3], Anna Castrup[2], Daniel Kiener[4], Andrew Minor[3], and Christoph Eberl[1] — [1]KIT, Institute for Applied Materials, Kaiserstrasse 12, 76131 Karlsruhe, Germany — [2]KIT, Institute of Nanotechnology, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany — [3]Department of Materials Science and Engineering, University of California, Berkeley, USA — [4]Austrian Academy of Science, Erich Schmid Insitute of Materials Science, Jahnstrasse 12, 8700 Leoben, Austria

For nanocrystalline (nc) materials deformation seems to be governed by processes at the grain boundaries. Therefore, it is necessary to observe the microstructural changes during deformation to fully understand the mechanisms involved. In-situ TEM tensile and cycling tests were conducted on sputtered nc Cu thin films with a thickness of 60 nm. The sputtered films were transferred onto a Push-to-Pull device to test it with an in situ Picoindenter. The continuous films were milled into an hour glass shape by the use of a FIB tool with a gage width and length of roughly 3 and 4 um. Videos were taken of the single cycles in combination with micrographs at the end of each cycle. The strain of up to 9% was analyzed with digital image correlation globally over the whole sample as well as locally. The ultimate tensile strength reached 2 GPa and the Youngs modulus round about 50 GPa. During cycling, grain coarsening was observed. The high observed strength and ductility will be discussed in the light of the microstructural changes during tensile and fatigue testing and the small testing volume.

MM 4.2 Mon 10:30 H 0106

Strain Relaxation Kinetics in Thin Nano-Crystalline Platinum Films — •Wolfgang Gruber[1], Carsten Baehtz[2], Christian Kübel[3], Wolfram Leitenberger[4], and Harald Schmidt[1] — [1]TU Clausthal, Institut für Metallurgie — [2]Helmholtz Zentrum Dresden Rossendorf, Institute of Ion Beam Physics and Materials Research — [3]Karlsruher Institut für Technologie, Karlsruher Micro Nano Facility — [4]Universität Potsdam, Institut für Physik und Astronomie

Thin metal films with a thickness in the nanometer to the micrometer range are important for various areas of science and technology. Residual stresses, which are commonly assumed to be bi-axial in thin films, result from different thermal expansion coefficients of substrate and film (thermal stress) and/or from stress formation during film deposition (grown-in stress). During isothermal annealing, residual stresses relax as a function of annealing time and temperature. We used thin nano-crystalline Pt films deposited on oxidized silicon wafers to investigate the role of vacancies for relaxation of strain resulting from compressive stress. We applied a method which is based on the fundamental concept of dilatometry. We modified this basic concept and used synchrotron based combined in-situ X-ray diffractometry and reflectometry. From the experimentally determined relative changes of the lattice parameter and of the film thickness the modification of vacancy concentration and residual strain was derived as a function of annealing time. The results indicate that relaxation of strain is accompanied by the creation of vacancies at the free film surface [1].

[1] W. Gruber et al., Phys. Rev. Lett., in print.

MM 4.3 Mon 10:45 H 0106

Accumulative roll bonding and differential speed rolling of ultra fine grained Al-Ti composites — •Jan Romberg[1,2,3], Juliane Scharnweber[4], Jens Freudenberger[1,5], Hiroyuki Watanabe[6], Tom Marr[1,2], Carl-Georg Oetrel[4], Werner Skrotzki[4], and Ludwig Schultz[1,2] — [1]IFW Dresden, Institute for Metallic Materials, Dresden, Germany — [2]Dresden University of Technology, Institute for Materials Science — [3]Dresden University of Technology, ECEMP International Graduate School, Germany — [4]Dresden University of Technology, Instute for Solid State Physics — [5]Freiberg University of Technology, Institute of Materials Science, Freiberg, Germany — [6]Osaka Munipial Technical Research Institute, Osaka, Freiberg

Roll bonding of aluminium and titanium sheets was performed accumulatively. Due to the differences in formability of the metals initially used necking of the titanium is observed. Hence this process would not be expected to generate sheets consisting of layers from titanium and aluminium with a homogeneous thickness. This study examines the conditions under which roll bonding of titanium and aluminium is feasible and how necking can be suppressed. The use of cold worked aluminium sheets and recrystallised titanium sheets enables accummulated roll bonding with up to four cycles and faultless deformation. In addition the potential of differential speed rolling with respect to increasing the ductility of the roll bonded metals is shown. Both processes were combined to assess the relationship between processing and properties of fine-grained laminar sheets from titanium and aluminium.

MM 4.4 Mon 11:00 H 0106

The new Shock-Wave-Laboratory at the TU Bergakademie Freiberg — •Thomas Schlothauer[1], Gerhard Heide[1], and Edwin Kroke[2] — [1]TU Bergakademie Freiberg, Institut für Mineralogie, Brennhausgasse 14, 09599 Freiberg — [2]TU Bergakademie Freiberg, Institut für Anorganische Chemie, Leipziger Strasse 29, 09599 Freiberg

The new subterranean Shock-Wave-Laboratory at the TU Bergakademie Freiberg (established 2007, extended 2011) opens new vistas for the material synthesis and the investigation of material properties under dynamic loading. Dynamic pressures of >1 Mbar (100 GPa) are a matter of routine. Loading of the samples along the Hugoniot-EOS are as much possibble as the so called "quasistatic loading" or the "reflection method". This opens enhanced possibilities for the material research under extreme conditions. Because this laboratory is localised in the Research- and Teaching Mine "Reiche Zeche", a part of the university, the German mining law for this laboratory is valid. This law together with the status of the university as a research facility ensures contemporary experiments and fast changes of the charge geometries. Cylindrical charges, advanced plane wave generators and hollow explosive charges are possible. Currently this laboratory has experiences in the shock wave synthesis of nano scaled nitrides, shock loading of metals and alloys and the investigation of the results.

MM 4.5 Mon 11:15 H 0106

Severe deformation twinning in pure copper by cryogenic wire drawing — •Alexander Kauffmann[1,2], Jens Freudenberger[1,3], David Geissler[1,2], Song Yin[1,2], Wolfram Schillinger[4], V. Subramanya Sarma[5], Mohsen S. Khoshkhoo[1], Horst Wendrock[1], Jürgen Eckert[1,2], and Ludwig Schultz[1,2] — [1]IFW Dresden, P.O. Box 270116, 01171 Dresden, Germany — [2]TU Dresden, Institute of Materials Science, 01062 Dresden, Germany — [3]TU Bergakademie Freiberg, Institute of Materials Science, 09596 Freiberg, Germany — [4]Wieland-Werke AG, Graf-Arco-Straße 36, 89079 Ulm, Germany — [5]Dept. Metallurgical and Materials Engineering, IIT Madras, Chennai 600036, India

The effect of deformation at 77 K on the activation of deformation twinning in pure copper during wire drawing was investigated. For this purpose, cryogenic wire drawing was performed utilizing molybdenum disulfide lubrication. Microstructural investigation and texture analysis reveal severe twin formation with broad twin size distribution.

This result is discussed by means of the orientation dependence of deformation twinning in fcc metals and the applied state of stress during wire drawing. Remarkable differences compared to cryogenic rolling with its limited contribution of twinning to grain refinement are highlighted.