MM 41: Mechanical Properties II

Time: Wednesday 15:00–16:15 Location: H26

MM 41.1 Wed 15:00 H26

Investigation of residual stress in straightened steel pipes with diffraction methods — •Sascha Raatz[1], Heike Oppermann[1], Peter Staron[2], Michael Hofmann[3], Michael Kaack[4], and Katharina Theis-Bröhl[1] — [1]University of Applied Sciences Bremerhaven, 27568 Bremerhaven — [2]Helmholtz-Zentrum Geesthacht (HZG), 21502 Geesthacht — [3]Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II) , 85747 Garching — [4]Salzgitter Mannesmann Forschung GmbH (SZMF) , 47259 Duisburg

In our study we compare several non-destructive evaluation methods to determine the residual stress in steel components due to a demand from the industry for reliable on-site testing. The chosen samples are low-alloy steel pipes with different levels of a straightening process which leaves a visible helix on the surface. We used synchrotron diffraction at the HEMS beamline at DESY and neutron diffraction at STRESS-SPEC at the FRM II to get absolute values for the residual stress in the bulk of our samples. The samples have a wall-thickness of 4 mm and the measurements show the highest residual stresses approximately 1 mm under the surface. The residual stresses correlate with the levels of straightening and change their values up to 400 MPa through the wall-thickness.

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MM 41.2 Wed 15:15 H26

Influence of hydrogen on the defect structure in metals subjected to plastic deformation — •Martin Deutges[1], Inga Knorr[1], Hans Peter Barth[1], Yuzeng Chen[2], Christine Borchers[1], Cynthia Volkert[1], and Reiner Kirchheim[1,3] — [1]Institut für Materialphysik, Georg-August Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]State Key Lab of Solidification Processing, Northwestern Polytechinical Univeristy, Xi'an, China — [3]International Institute for Carbon-Neutral Energy Research (WPI-I2CNER), Kyushu University, Japan

The interaction between dissolved atoms and crystal defects can be studied on specific model systems.

Hydrogen enhances the formation and the mobility of dislocations. This can be demonstrated by palladium which is cold rolled with and without hydrogen content. The presence of hydrogen markedly increases the dislocation density. TEM investigations show that the arrangement of dislocations changes with hydrogen concentration.

Another experiment is the deformation of vanadium micropillars. At low hydrogen concentrations, the pillars deform on a few discrete slip planes generating serrations, and at higher concentrations the pillars deform to a barrel-like shape.

These experiments can be analyzed using the defactants concept. The basis of the defactants concept is the assumption that a decrease of the overall free energy by the segregation of solute atoms to a defect can be ascribed to a decrease in the defect formation energy.

MM 41.3 Wed 15:30 H26

Structure and thermal stability of severe plastically deformed Cu84Al16 — •Nazar Ibrahim, Martin Peterlechner, Sergiy Divinski, and Gerhard Wilde — Institute of Materials Physics, Muenster, Germany

Severe plastic deformation (SPD) is an effective tool for production ultrafine grained materials with extraordinary mechanical properties. High strength and relatively good ductility are attributed to their fine microstructure. In this work, structure modification by high pressure torsion (HPT) and the thermal stability of the resulting microstructure are investigated for the Cu*16 at.% Al alloy . For this alloy, a propensity for the formation of five-fold twinning has recently been reported [X.H. An, et al., Scripta Materialia 64 (2011) 249]. Disks of thickness of 0.8 mm and diameter of 10 mm were processed via HPT for 2,5,10 and 20 revolutions at room temperature using an imposed pressure of 6.0 GPa and rotational speed of 1 rpm. Structural and thermal analyses were carried out using X-ray diffraction, transmission electron microscopy (TEM) and differential scanning calorimetry (DSC). The DSC experiments using constant heating rates showed two exothermic peaks in the temperature range from 30°C to 450°C. After HPT a highly distorted structure was observed, including dislocations, fragmented grains and twins. The twin thickness in Cu84Al16 has been determined from TEM observation to be in the range of 2 to 6 nm. These small thicknesses are in agreement with the low stacking fault energy of the alloy. The results are discussed with respect of the reported five-fold twinning in this alloy.

MM 41.4 Wed 15:45 H26

Mechanical Spectroscopy on deformed Al-Mg-Si (AA6061) alloy: Characterization of interactions between solute atoms, precipitates and dislocations — •Jens Bernhardt and Hans-Rainer Sinning — Institut für Werkstoffe, Technische Universität Braunschweig, Germany

Industrially used alloy AA 6061 shows a great variety of microstructural effects. In homogenized samples formation of solute clusters starts during storing at room temperature (RT). At higher temperatures a complex precipitation sequence takes place changing microstructural state and therefore mechanical properties of the alloy. In addition mobility of solute atoms is increasing with increasing temperature. Since dynamics of dislocations are governed by microstructural material state and by interaction with solute atoms, characteristics of dislocation dynamics are changing with temperature. In order to investigate the interaction of dislocations with precipitates and solute atoms, temperature dependent internal friction (TDIF) between 80 and 292 K was measured, after different thermal treatments and plastic deformation at 80 K and 292 K respectively, using the vibrating-reed technique with small strain amplitudes between about 10^{-6} and 10^{-5}. Interaction between solute atoms and dislocations can also be affected by these small strains, hence TDIF was measured at both high (10^{-5}) and low (10^{-6}) strain amplitude. The results are discussed regarding applied deformation, strain amplitude and thermal treatment in order to characterize the dynamics of dislocations in AA 6061 and related aspects of the Portevin-Le Chatelier effect.

MM 41.5 Wed 16:00 H26

The influence of different Equations of State on the calculation of elastic properties — •Claudia Loose and Jens Kortus — TU Bergakademie Freiberg, Fakultät für Chemie und Physik, Leipziger Str. 23, 09599 Freiberg

Equations of state (EOS) describe the behavior of solids under compression and are widely used in geophysics and high-pressure research. However there is no general thermodynamic basis for the correct form of a solid state EOS, hence there are many different EOS in use. Here we present density functional calculations of different AlN and SiO_2 phases up to very high compressions V/V_0=0.58. We use seven different EOS to fit the equilibrium volume V_0, the bulkmodulus B and pressure derivative of the bulkmodulus B' using the obtained energy-volume data. A comparison of the elastic properties obtained from these fits revealed significant dependence on the regarded EOS.