MM 21: Mechanical Properties I

Time: Tuesday 10:15–11:30 Location: H6

MM 21.1 Tue 10:15 H6

Plastische Verformungen und Schmelzerscheinungen beim makrospröden Bruch von Polyäthylenkörpern. — •Heinz Hans Walter Preuss — Hameln

Berichtet wird über eine bislang weitgehend unbeachtet gebliebene Entdeckung aus dem Jahre 1962 [1, 2, 3], die jünst bestätigt wurde [4]. Bei elektronenmikroskopischen Untersuchungen von Kohlenstoffabdrücken der Bruchfläche von Niederdruck-Polyäthylen-Proben waren morphologische Erscheinungen gefunden worden, wie sie nur nach dem Zerreißen einer zähflüssigen Substanz entstehen können, insbesondere Zapfen mit verdicktem abgerundeten Ende. Die Proben waren mit einer Biegevorrichtung mit Lastvorgabe bei Raumtemperatur und bei der Temperatur des flüssigen Stickstoffs gebrochen worden. Die der endgültigen Trennung vorausgehenden lokalen plastischen Deformationen führen dank der niedrigen Wärmeleitfähigkeit des Materials zur Erwärmung bis zur Schmelztemperatur (115oC), so dass die Trennung örtlich differenziert in zähflüssigen Phase erfolgt. Die ursprünglichen Abrissformen bilden sich nach der Trennung in abgerundete Formen und erstarren in der beobachteten Gestalt. Literatur: 1 H. H. W. Preuß, Plaste und Kautschuk, 10 (1963) Nr. 3, 161 2 H. H. W. Preuß, Plaste und Kautschuk, 10 (1963) Nr. 6. 330 3 H. H. W. Preuß, Dissertation, Leipzig, 1963 4 I. Brough, R. N. Haward, G. Healey, A. Wood, Polymer 45 (2004) 3115 - 3123

MM 21.2 Tue 10:30 H6

Deformation behavior of polycrystalline intermetallic compounds YAg and YCu — •Rolf Schaarschuch[1], Carl-Georg Oertel[1], Guanghui Cao[2], and Werner Skrotzki[1] — [1]Institut für Strukturphysik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Department of Materials Engineering, Shanghai University, Shanghai 200072, P.R. China

The influence of texture on the deformation behavior of YCu and YAg, intermetallic compounds with B2 structure, was studied by compression at room temperature on hot extruded polycrystalline material. The phase constitution and texture of the materials were determined by X-ray diffraction. The texture is characterized by a weak <110> fiber along the extrusion axis. The compression with a strain rate of about $10^{-4}s^{-1}$ was done parallel and perpendicular to the extrusion axis. The deformation experiments show a higher flow stress for YAg in comparison to YCu. This may be caused by a small amount of second phase YAg_2. Because of the weak fiber texture the flow stress perpendicular to the extrusion direction is slightly higher than parallel. The results are discussed with respect to the ductility of intermetallic compounds with B2 structure.

MM 21.3 Tue 10:45 H6

Dislocations in the Complex Metallic Alloy T-Al-Mn-Pd — •Marc Heggen, Lothar Houben, and Michael Feuerbacher — Institut für Festkoerperforschung, Forschungszentrum Juelich GmbH, D-52425 Juelich, Germany

The deformation mechanisms of complex metallic alloys - crystalline solids containing up to thousands of atoms per unit cell - are widely unknown. Due to the large lattice parameters of these materials, conventional dislocation mechanisms are prone to failure. We investigated the complex metallic alloy T-Al-Mn-Pd with 156 atoms per unit cell using aberration-corrected high-resolution transmission electron microscopy. We found a highly complex deformation mechanism, based on the movement of a dislocation core mediating strain and separate escort defects. Upon deformation, the escort defects move along with the dislocation core and locally transform the material structure. This mechanism implies the coordinated movement of hundreds of atoms per elementary glide step. Nevertheless it can be described by simple rearrangement of basic structural subunits.

MM 21.4 Tue 11:00 H6

Complementary Climb Systems: Deformation Mechanism in Complex Metallic Alloys — •Michael Feuerbacher, Stefan Roitsch, and Marc Heggen — Institut fuer Festkoerperforschung, Forschungszentrum Juelich GmbH, 52345 Juelich

Complex metallic alloys (CMAs) are hallmarked by a high number of atoms per unit cell and a cluster based substructure dominated by icosahedral atom coordination. Due to their large lattice parameters, conventional dislocation-based deformation mechanisms are prone to failure in these materials. In recent years we have experimentally characterized the plastic deformation mechanism of a number of CMAs. We find that in many instances, strain is mediated by dislocations moving by pure climb. In uniaxial compression experiments we find two sets of dislocations. One set is moving on planes perpendicular to the compression direction by positive climb. This leads to shortening of the sample by removal of atom planes and consumes vacancies. The second set has habit planes perpendicular to the compression direction. This set moves by negative climb and hence acts as a vacancy source for the first system. The complementary action of the two sets avoids vacancy depletion and breakdown of the plastic deformation mechanism. The measured dislocation densities lead to vacancy diffusion distances consistent with the applied deformation rates in our experiments. We demonstrate the action of this mechanism in a number of CMA phases.

MM 21.5 Tue 11:15 H6

Crack tip opening displacement and propagation rate of microstructurally short cracks in austenitic stainless steel — •Michael Scharnweber[1], Ingmar Roth[2], Martin Kübbeler[3], Carl-Georg Oertel[1], Wolfgang Tirschler[1], Hans-Jürgen Christ[2], Claus-Peter Fritzen[3], Ulrich Krupp[4], and Werner Skrotzki[1] — [1]Institut für Strukturphysik, Technische Universität Dresden, 01062 Dresden — [2]Institut für Werkstofftechnik, Universität Siegen, 57076 Siegen — [3]Institut für Mechanik und Regelungstechnik, Universität Siegen, 57076 Siegen — [4]Fakultät für Ingenieurwissenschaften und Informatik, Fachhochschule Osnabrück, 49009 Osnabrück

Austenitic stainless steel (X2 CrNiMo 18 14 3) has been cyclically deformed at RT in air under plastic strain control with an amplitude of $5*10^{-4}$ for N=10000 cycles to initiate microstructurally short cracks. Average crack propagation rates were measured with the scanning electron microscope (SEM) in steps of ΔN=5000 cycles. Additionally, the crack tip opening displacement (CTOD) was obtained via in-situ-deformation in the SEM. It is the aim of the present study to quantify the influence of grain boundaries on crack growth and determine the correlation between the two values measured. This may offer the possibility to replace time consuming measurements of the crack propagation rate by the much quicker measurement of the CTOD.