MM 43: Mechanical Properties II

Time: Thursday 18:00–19:00 Location: IFW D

MM 43.1 Thu 18:00 IFW D

In-situ micro-cantilever tests to study the fracture properties of NiAl — •Farasat Iqbal, Johannes Ast, Karsten Durst, and Mathias Göken — Institute of General Materials Properties, Department of Materials Science & Engineering, University of Erlangen-Nürnberg, Germany

In recent years the nanomechanical testing of materials becomes an important tool to test the materials at micron or even sub-micron scale with the help of different methods. In order to understand mechanical behavior of the bulk materials at micron or sub-micron scale different existing methods including nanoindentation , micro-tensile, bulge test , micro-compression and micro-cantilever fracture test are used on different material systems. In order to understand the relation between micron scale fracture toughness to that of the bulk materials, we carried out in-situ micro-cantilever tests on anisotropic NiAl-single crystals. The reason for choosing NiAl is its brittle nature and the macroscopic fracture toughness using ASTM E399 standard has been already investigated and reported in literature. NiAl possess two orientation namely hard <101> & soft <100> and the macroscopic fracture toughness measured using ASTM 399 standard ranges 3-4 MPa m1/2 for soft orientations and 5-7 MPa m1/2 for hard orientations. Hence the micro cantilever method was used to investigate the orientation dependent fracture toughness of NiAl at micron scale and its possible relation to the macroscopic fracture toughness is also discussed.

MM 43.2 Thu 18:15 IFW D

The fracture toughness of silicon nitride thin films of different thicknesses as measured by bulge tests — •Benoit Merle and Mathias Göken — Department of Materials Science and Engineering, Institute I, University Erlangen-Nürnberg, Germany

A bulge test setup was used to determine the fracture toughness of amorphous low pressure chemical vapor deposited (LPCVD) silicon nitride films with various thicknesses in the range of 40 to 108 nm. The method used for this measurement relied on a special sample preparation with a Focused Ion Beam (FIB), in which a crack-like slit of a defined length was introduced in the center of a rectangular freestanding membrane. The membrane was then deformed in the bulge test until failure occurred, and the fracture toughness KIC of the film was calculated from the pre-crack length and the stress at failure. It was shown that the membranes were in a transition state between pure plane-stress and plane-strain, which however had a negligible influence on the measurement of the fracture toughness, because of the high brittleness of silicon nitride and its low Young's modulus over yield strength ratio. The fracture toughness KIC was measured to be constant at 6.3 +/- 0.4 MPa m1/2 over the whole studied thickness range, which compares well with bulk values. This means that the fracture toughness, just as the Young's modulus, is a size independent quantity for LPCVD silicon nitride. This presumably holds true for all amorphous brittle ceramic materials.

MM 43.3 Thu 18:30 IFW D

Mechanical Behaviour of Layered Nanocomposites — •Inga Knorr[1], Susanne Seyffarth[1], Tobias Liese[1], Nicolas Cordero[2], Hans-Ulrich Krebs[1], and Cynthia A. Volkert[1] — [1]Institut für Materialphysik, Universität Göttingen — [2]Centre des Matériaux, Mines Paris, Paristech

Multilayer thin films with dimensions at the nanometer scale represent a technologically important class of materials which can offer improved mechanical properties as a result of composite, interface and size effects. Here, sample series composed of polycrystalline metal and amorphous layers are investigated, with the goal of understanding the size-dependence of the layer mechanical properties as well as the deformation and failure modes of nanoscale composites. The specific samples have layer thicknesses between 5 and 300 nm and consist of Cu/Polycarbonate, Ti/amorphous ZrO_2, and Cu/amorphous $Pd_{78}Si_{22}$ layers. Mechanical characterization is performed using Berkovich nanoindentation as well as micro-compression tests. Sample morphologies in the undeformed and deformed states are investigated with SEM and TEM. The three sample sets show some common trends in the mechanical behavior. For example, the metal layers show a slight increase in strength with decreasing thickness and grain size, but the effect is much weaker than expected. In addition, the samples often fail by localized shear band formation, which may be attributed to plastic strain induced weakening at the layer interfaces. Explanations for these trends as well as possible tactics for improving the mechanical performance of multilayer films will be discussed.

MM 43.4 Thu 18:45 IFW D

Micro- and Nanostructure Characterization Imaging of TWIP Steels — •Leonardo Batista, Ute Rabe, and Sigrun Hirsekorn — Fraunhofer IZFP, Campus E3 1, 66123 Saarbrücken, Germany

New design concepts for the construction of advanced light-weight and crash resistant transportation systems require the development of high strength and supra-ductile steels combined with enhanced energy absorption and reduced specific weight. TWIP (Twinning Induced Plasticity) steels have excellent mechanical properties combining high strength levels (Rm > 1000 MPa) with a large uniform elongation (Au > 50%). These properties are a direct consequence of intensive mechanical twinning resulting in a high sustained degree of strain-hardening. The mechanisms and the interaction of the mechanical twinning with the microstructure which leads to such outstanding mechanical properties are, however, not well understood. In order to characterize the microstructure and probe the local material properties combined studies using EBSD (Electron Backscattering Diffraction) and AFAM (Atomic Force Acoustic Microscopy) as well as TEM (Transmission Electron Microscopy) have been used.