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ICAMS Seminar room UHW 11/1102

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Nanoscale testing of interfaces using nanoindentations and in-situ bending experiments

Many material systems are influenced in their mechanical properties by interfaces. Grain boundaries i.e. dominate the materials response in the case of nanocrystalline metals, while the interfacial strength of hard protective coatings on metallic substrate is crucial for the performance of these systems in load bearing application. This talk will focus on the testing of interfaces for hard carbon films on soft metallic coatings as well as on an approach for testing of the local strain rate sensitivity in nanocrystalline materials.

Nanocrystalline materials, like electrodeposited Ni exhibit extraordinary properties in terms of their deformation behaviour. Besides a high uniaxial strength due to grain boundary strengthening, also a rate dependency is found for their deformation resistance, which is unusual at room temperatures for fcc metals. This rate dependency is one of the reasons discussed for the relatively large uniform elongation of these materials, besides their high strength. Here, a new nanoindentation approach for testing the local strain rate sensitivity using nanoindentation strain rate jump test is presented. By changing the indentation strain rate during the indentation, the local strain rate exponent is measured and this allows i.e. the analysis of thermally activated processes on a local scale.

Interfaces are also of importance for hard coatings, since they provide the adhesion between coating and substrate. During deformation of the substrate, stresses are transferred to the coating, until fracture or delamination of the coating occurs. However strong interfaces are not easily damaged and testing their properties is difficult. For understanding what qualifies a strong interface in diamond like coatings (DLC), two systems were processed with small modification in the interface between the Cr bond layer and the coating. The different deformation behaviour of these coatings, one having poor and one having very good adhesive strength is discussed in terms of microstructure and local hardness and chemical gradients. For testing of the interface thin bending beams consisting of a 1.5 m thick DLC coating have been fabricated by Focused Ion Beam (FIB) and were tested in-situ in a SEM using a nanoindenter. With this approach, damage is localized at the interface and the bending strength can be assessed.

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