THE INFLUENCE OF PRE-DEFORMATION ON THE FRACTURE TOUGHNESS OF CHROMIUM, STUDIED BY MICROCANTILEVER BENDING

Stefan Gabel, Institute I: General Materials Properties, FAU Erlangen-Nürnberg, Erlangen, Germany
stefan.s.gabel@fau.de
Benoit Merle, Institute I: General Materials Properties, FAU Erlangen-Nürnberg, Erlangen, Germany
Erik Bitzek, Institute I: General Materials Properties, FAU Erlangen-Nürnberg, Erlangen, Germany
Mathias Göken, Institute I: General Materials Properties, FAU Erlangen-Nürnberg, Erlangen, Germany

Key Words: Fracture Toughness, Microcantilevers, Pre-deformed, Brittle-to-ductile-Transition

Cr is bcc metals, which has a high melting point and high strength. However, its fracture toughness at room temperature is low. This is due to their rather high ductile to brittle transition temperature. At room temperature the fracture toughness is limited by dislocation mobility or by the inability to activate nucleation sources. While this behavior is well characterized for W, there are only few studies for Cr.

FIB milled cantilevers were used to investigate the facture toughness of Cr on the microscale and to study the influence of the loading rate and the initial dislocation density of the sample. In order to introduce dislocations into the material by pre-deformation, Vickers indentations were performed on the sample surface prior to testing. An FEM-based estimation of the resulting strain field was used to select positions corresponding to different amounts of pre-deformation, where cantilevers were fabricated. Subsequent testing was performed with a G200 nanoindenter. The dynamic mode (CSM) allowed tracking the stiffness change of the cantilever, which can be correlated to ongoing crack growth.

The measurements showed that an increase of the dislocation density leads to a toughening of the sample (Figure 1). This toughening effect is saturates around 14% pre-deformation. The dependence of the brittle to ductile transition on the availability of dislocations and activity of dislocations sources was investigated via TEM-lamella lift-outs and Transmission Kikuchi Diffraction mapping.

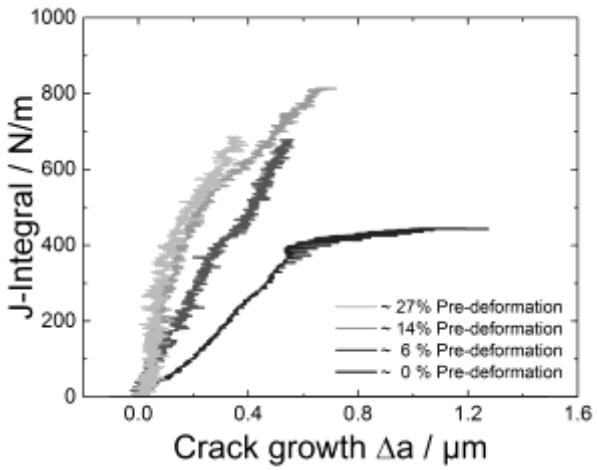

Figure 1 – Increase of the crack-resistance behavior by an increase of the pre-deformation in Cr microcantilevers.