High Energy µCT at HARWI-II and SEM of a Cobalt / Diamond Composite

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1 Introduction

By the combination of materials possessing different mechanical properties composites can be manufactured which are tailored with respect to macroscopical mechanical behaviour. For the prediction of the material behaviour and for the optimization of the composite micro deformation and micro damaging (like initiation and growth of micro defects) have to be understood. These micro processes take place in composites *under* load and precede a *macroscopical fracture*.

2 Materials and Methods

By water jet cutting plain dog bone shaped tensile specimens of Cobalt / Diamond were produced. This kind of composite is well-known in cutting edges for rotating tools. In order to deduce understanding about the mentioned micro processes *a* 2D analysis of the specimen's surface with SEM and a 3D analysis of real microstructure based on X-ray tomographic microscopy (XTM) at different stages of deformation with high spatial resolution were performed. At the new beamline HARWI-II CT measurements were carried out using monochromatic photons of 82 keV. The projection data set contains radioscopic images consisting of 1536x1024 pixels acquired at 720 rotation angles in the half-circle. The microstructure of the tensile specimens were imaged by tomography with a magnification $m \approx 2.4$ at different stages of deformation.

3 Results

By SR-based tomography the microstructure of a Co/Diamond composite was uncovered as depicted in fig. 1. The shape of diamonds in the bulk of the specimen can easily be recognized. A third phase was found by tomography which was afterwards identified as WC-inclusions by EDX-analysis. The specimen was deformed step-by-step and at each step a tomogram was created. The analysis of these tomograms by 3D data processing is currently in progress.

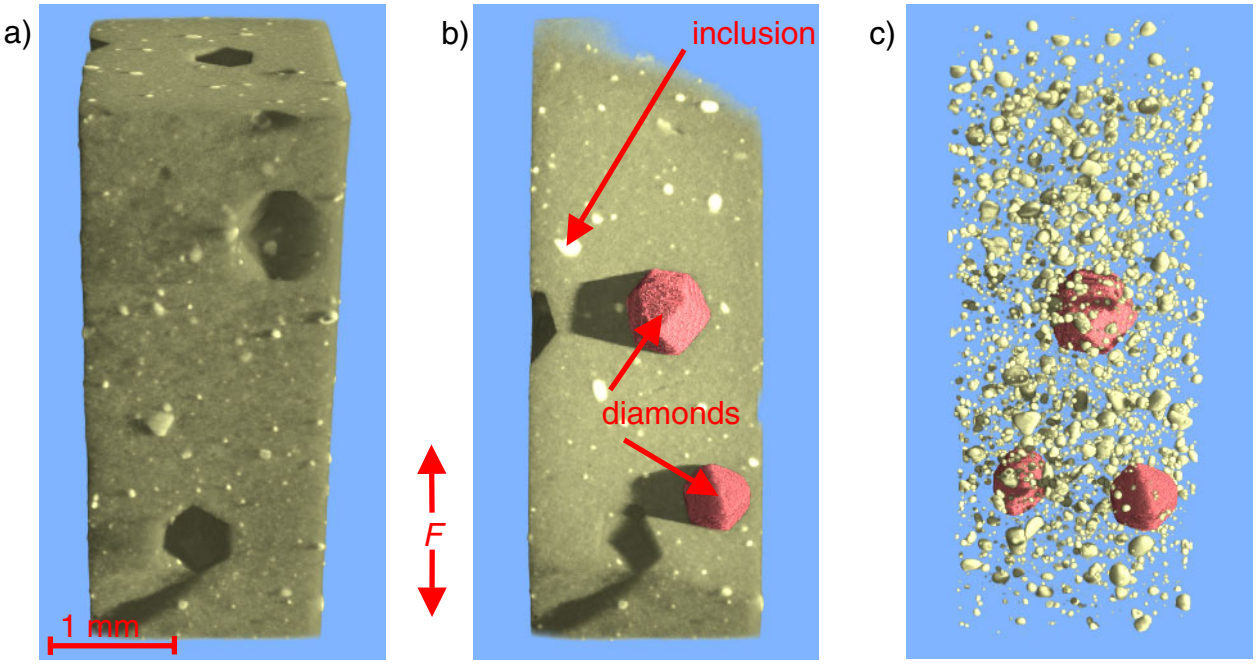

fig. 1: (a) 3D-representation of the tomogram in the undeformed stage (specimen gauge length), (b) 3D-representation of the virtually cut specimen after segmentation, diamonds cast shadows onto the cutting plane, (c) transparent representation of the Co-matrix, 3 diamond particles and tungsten carbide inclusions are visible

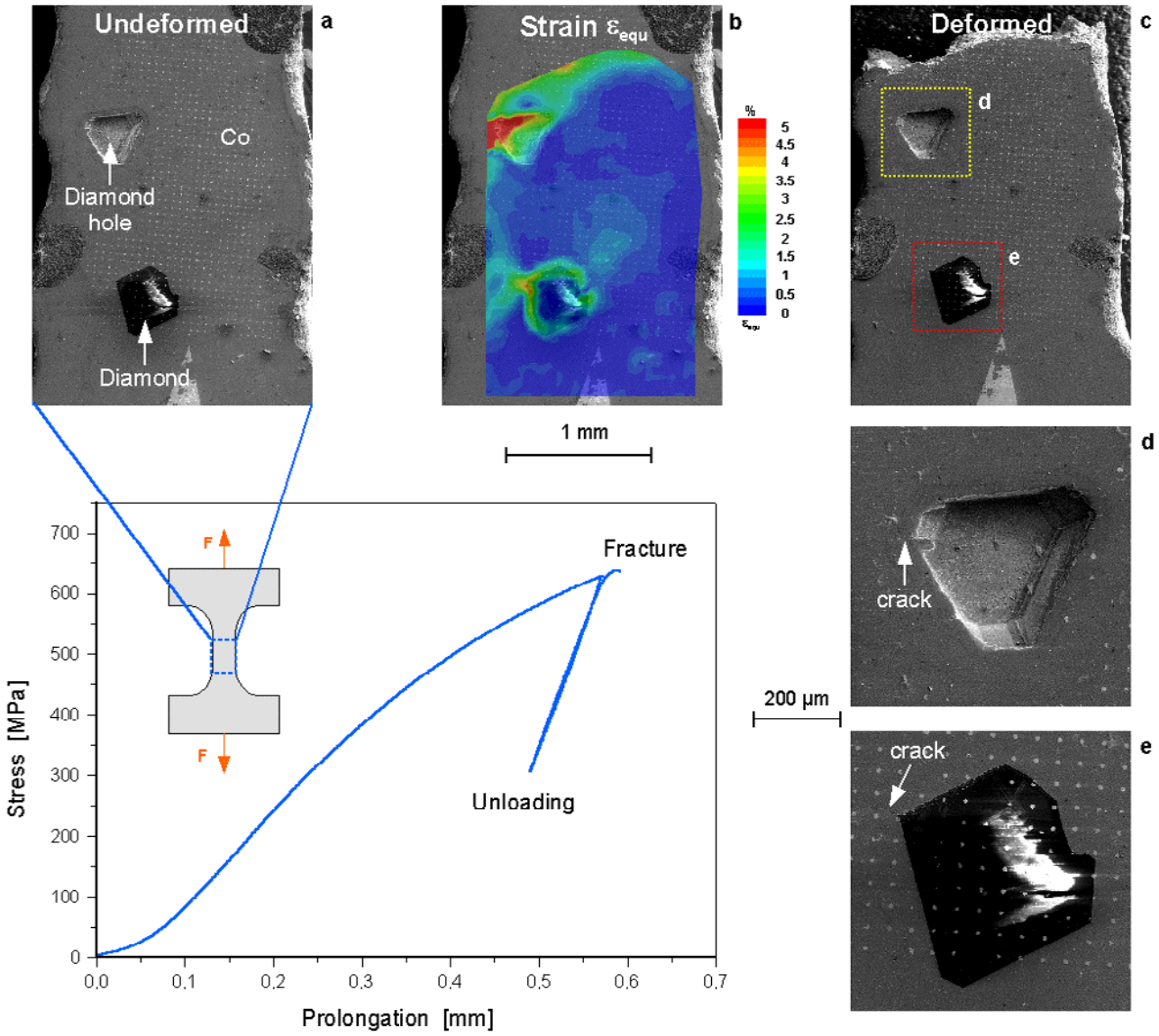

fig. 2: stress-prolongation curve and distribution of equivalent strain ε_{equ} at the specimen's surface after fracture (b) obtained by matching the SEM-images (a) and (c); relationship between high strain and cracking, see macro crack (c) and microcracks in the pictures (d) and (e)

With SEM the specimen's surface was recorded in the undeformed stage and after fracture. The surface reveals both diamonds and holes where diamonds sat (cp. fig. 2a, d, e). After fracture micro cracks orginating from diamonds resp. holes could be found (cp. fig. 2d, e). Before the tensile test the surface was artificially structured by an applied Gold dot grid as can be seen in fig. 2a and 2e to get additional gray level gradients in SEM-images. On the basis of the gray level edges an iterative matching of sub-images of different stages of deformation was carried out (image correlation). From the local transformation matrices describing this local mapping the field of equivalent strain was calculated. The field was overlaid semi-transparently on the SEM-image in fig. 2b. Strain concentrations emerge in areas of microcracks which are initiated in the neighbourhood of diamonds and holes. The results of 3D data processing on the tomographic data sets will be further fed into realistic FE-simulations (cf. [1]).

4 Acknowledgement

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5 Reference

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