ESRF	**Experiment title:** Local stress distributions during crack growth in reinforced Mg alloy AE42	**Experiment number**: MA-1456
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Report:

The local stress distribution during crack growth in the reinforced Mg alloy AE42 (10 % Saffil (Al_2O_3) short fibres and 10 % SiC particles) was measured at beamline ID11. The principal aim of the investigation is to gain new insights into the role that reinforcing ceramics play for the rate and direction of crack growth. To pursue this the unique data set of grain positions, sizes, orientations and grain resolved stresses of both metal matrix and reinforcements around the crack tip were measured during *in-situ* tensile loading and complemented by absorption contrast tomography of the crack front and nearby reinforcements.

The beam energy was calibrated to the Ce edge at 40.44 keV. The notched sample was mounted in an *in-situ* tensile devise, and 3DXRD grain centre mapping was performed at the following nominal loads: preload, 111 MPa, 136 MPa, 155 MPa and after unload. W wires were glued onto the face of the sample at the top and bottom of the gauge volume, and the macroscopic strain was determined from the distance between these as measured by optical microscopy. Two different scans were performed, one optimized to map the large Mg matrix grains (~150 microns) and the other to measure the strain in the small reinforcing particles of SiC (~10 microns) – the Saffil fibres only gave the faintest powder signal that cannot be analysed. The Mg scans were performed with an unfocused beam confined with slits to be 0.5 mm vertically and 1.3 mm horizontally. Three layers covering a total of 1.5 mm along the tensile z-axis were mapped within 100 minutes. The SiC scans were performed with a focused beam slit down to 0.1 mm vertically and 0.8 mm horizontally. A total of eight layers covering 0.8 mm along the tensile *z*-axis in front of the notch tip were mapped within 18 hours.

The diffraction spots of the Mg phase were indexed and the elastic strain tensors and corresponding type-II stresses were then refined. The lattice constants fitted at the preload were used as d_0, and the resulting stresses of the ~400 Mg grains in the volume of interest at the maximum load can be seen in Figure 1. The number of simultaneously illuminated SiC grains is very large, and some of the diffraction rings overlap with those of Mg. In order to speed up the indexing process only data from two well-separated SiC diffraction rings combined with very strict cuts were used for indexing. In the next step only SiC grains with at least 80 reflections (50% completeness over all diffraction ring up to $2\theta_{max}$) were considered for further refinement. The number of these throughout the mapped 0.8x0.8x0.8 mm is roughly 11,000.

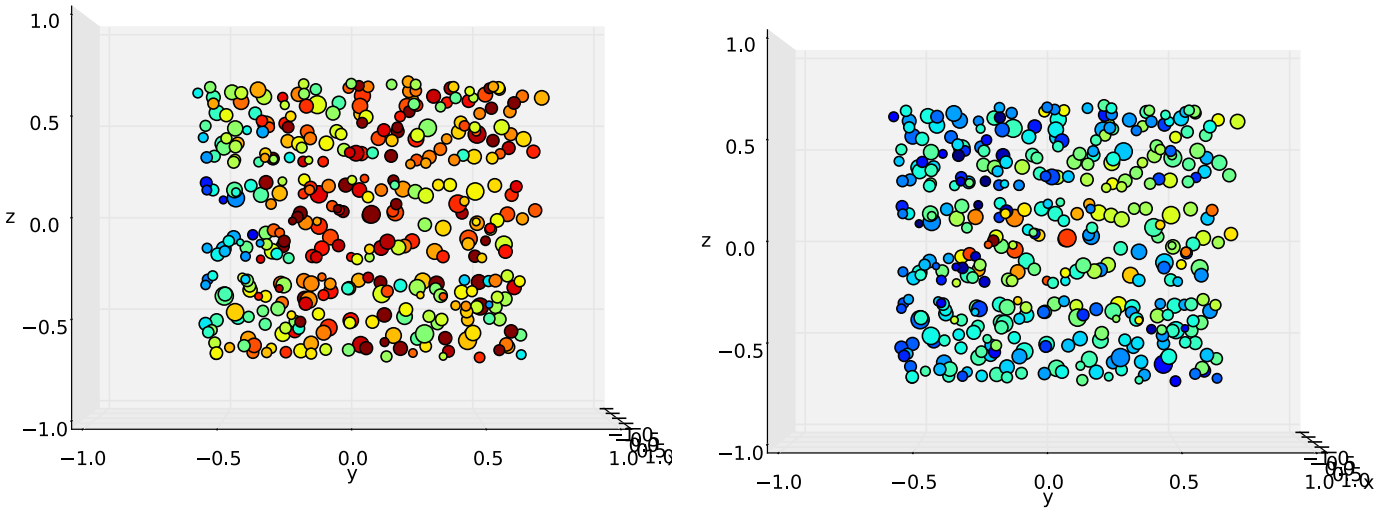

Figure 1 Mg grains in the volume of interest at the maximum load with the notch to the left and the tip at z = −0.25. The left figure is colour coded according to the axial stress along the tensile *z*-axis, while the right is colour coded according to the stress along the *y*-axis – the growth direction of the crack.

A set of radiographs for tomographic reconstruction was collected after each 3DXRD experiment. This was done after the mapping in order to minimize sample movements due to relaxation. The beam was opened to 2×2 mm^2 and the sample was rotated [0°; 180°] in 1200 steps to make 3 s/radiograph exposures on a high resolution detector with a pixel size of 1.92 µm. Standard reconstruction software was used to reconstruct the volume of interest around the notch. In Figure 2 the longitudinal section of the reconstructed volume at 136 MPa is shown indicating the notch, notch tip and a crack with its multiple crack tips. The longitudinal section has the same dimensions in the *y*- and *z*-directions as shown in Figure 1. The starting point of the crack at the notch tip and its bifurcation can be clearly at seen the load of 136 MPa.

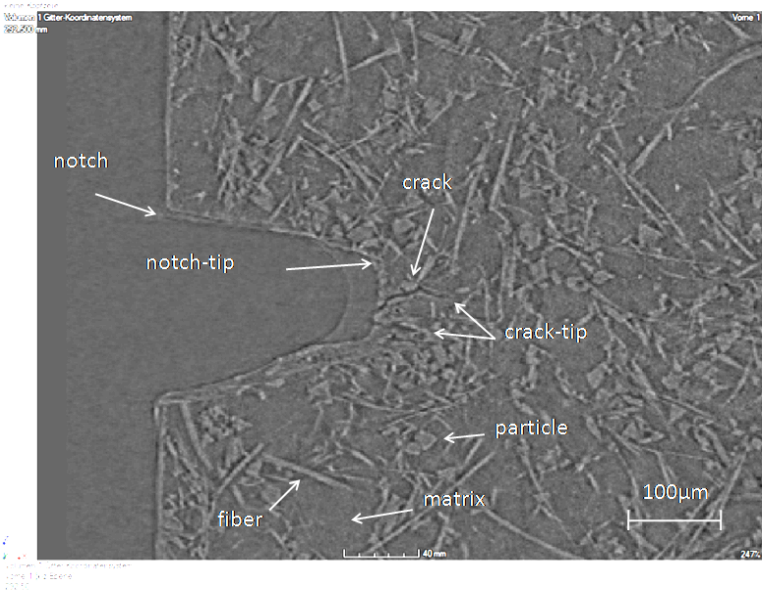

Figure 2 Longitudinal section of the tomographic recontruction at 136 MPa.