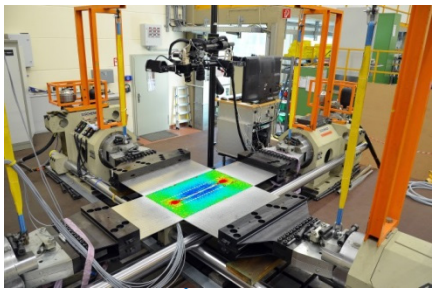
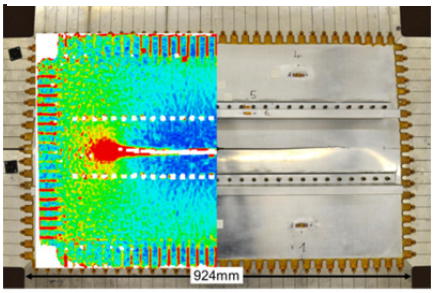
Fatigue and Fracture Mechanics of Metals



Biaxial test of an aluminum alloy with an effective size of 924 x 560 mm², overlapped with the deformation field obtained by Digital Image Correlation



Biaxial test sample with stiffeners and a long central crack, overlapped with deformation field obtained by Digital Image Correlation at the end of a fatigue test.

Fatigue is one of the most common causes of failure of structural components and systems. Cracks can form and grow under the effect of cyclic mechanical loads and finally lead to catastrophic failure.
The institute investigates the fatigue and fracture behaviour of metallic materials for the aeronautics and space sectors. The activities encompass the experimental determination of material parameters, their correlation with the microstructure as well as the development and application of models and simulation tools to rationalize and describe the fatigue behaviour of alloys and components.

Crack propagation in structural alloys
Damage tolerance of structural alloys constitutes one of the main research areas of the institute in the field of fatigue and fracture mechanics. Digital image correlation (DIC) tools are utilized for the characterization of crack propagation in metals to determine deformation fields in the investigated structures and locally at the crack tip. This allows for a straightforward detection of the load condition around cracks and, moreover, the calculation of fracture mechanical parameters as well as the validation of numerical models.
The fundamental knowledge obtained with these tools is used for the evaluation of the crack behaviour in aircraft and spacecraft structures as well as the corresponding interaction of the cracks with structural elements such as stringers, frames or rivets.

Propagation of large cracks in fuselage-relevant structures
Actual cracks in fuselage structures can have large dimensions and, consequently, the stress conditions around cracks are significantly different from those that can be achieved using conventional fracture mechanics approaches. A large biaxial testing machine is available at the institute to investigate and quantify the propagation behaviour of long cracks in fuselage-relevant structures under realistic static and cyclic loading conditions. This allows the experimental determination of the influence of structural elements, e.g. rivets, welding joints, window frames, etc., on crack propagation.

The methodologies developed at the institute give end-users the chance to carry out fast and cost efficient assessments of fuselage configurations in the stages of design, development and testing.

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