DESCRIBING THE MATERIAL BEHAVIOUR OF A TAILORED FORMED JOINING ZONE OF AN ALUMINIUM-STEEL HYBRID SOLID COMPONENT ON A MICROSCOPIC LENGTH SCALE

Martina Baldrich[1]*, Stefan Loehnert[2] and Peter Wriggers[1]

[1] Institute of Continuum Mechanics, Leibniz Universität Hannover,
Appelstr. 11, 30167 Hannover, Germany

* baldrich@ikm.uni-hannover.de, www.ikm.uni-hannover.de

[2] Institute of Mechanics and Shell Structures, TU Dresden,
August-Bebel-Straße 30, 01219 Dresden, Germany

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Tailored Forming is a technology in which two different metallic materials are joined before being formed together. This has the advantage of possible weight reduction of the engineering part and optimised material distribution with regard to the applied loads. One weakness of the technique however is the joining zone which due to the significant differences of the material properties of the joined materials may suffer from high stresses during the forming process that might lead to damage and failure. As a result, it is important to accurately predict the material behaviour of the joining zone. For this reason a micromechanically motivated material model needs to be developed so that the thermomechanical properties of the joining zone during and after the tailored forming process are represented.
Because of the strong dependence of the effective, macroscopic material behaviour on the thermomechanical and chemical influences on the microscopic level, the polycrystalline material is investigated on the microscopic length scale. Therefor, on the one hand the morphology of the joining zone and on the other hand the material behaviour of the different components, ferrite, pearlite and aluminium as well as the intermetallic phases, are considered in detail. The approach for the geometric model generates a volume element with non-convex grains of variable sizes with different orientations of the atomic lattice according to [1]. Based on [2] the microscopic material behaviour of the components with thermoplastic material behaviour is described considering the atomic lattice and its orientation, the slip systems and dislocation densities as well as the critical stresses and deformation rates. Due to the occuring diffusion caused by heat treatment and mechanical pressure, the material model is being extended to reflect the strongly coupled thermo-chemo-mechanical material behaviour by adding a diffusion term for the material concentrations. So it will be possible to capture the changes of concentration of the different components in the joining zone and the emerging modification of its properties.

References:

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