Modelling the thermoplastic material behaviour of a tailored formed joining zone on a microscopic length scale.

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ABSTRACT

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 optimized 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 stiffnesses 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 physically 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 (whose basis is described in [1]) and on the other hand the material behaviour of the different components, ferrite, pearlite and aluminium, are considered in detail. Based on [2] the microscopic material behaviour of the steel components ferrite and pearlite are described investigating the atomic lattice and its orientation, the slip systems and dislocation densities as well as the critical stresses and deformation rates. In order to develop the material model for the aluminium phase analogously, the differences between the mechanisms of the aluminium and ferrite material behaviour are emphasized.

In a future step, due to the occuring diffusion caused by heat treatment and mechanical pressure, the material model will be extended to reflect the strongly coupled thermo-chemo-mechanical behaviour by adding a diffusion term for the material concentrations. Then, 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. Finally, to obtain the material behaviour on a macroscopic length scale, the micromechanical material model will be homogenized and embedded in a specialized macroscopic cohesive zone element.

REFERENCES

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