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Material model for a composite with ductile and brittle constituents

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Tailored Forming is a manufacturing process where two metallic materials, here aluminium and steel, are joined and formed subsequently [1]. This processing order allows for new designs of hybrid material components. However, the joining zone is heavily loaded during forming. To evaluate the possibly occurring damage in a coarse scale simulation, a material model has to be developed that captures the complex microstructural behaviour effectively on a macroscopic length scale.

In the case of an aluminium-steel compound, a brittle intermetallic phase develops in the joining zone as a thin layer between the two metals. It is surrounded by ductile steel on one and ductile aluminium on the other side. Due to this inhomogeneous structure, a specialised anisotropic material model is required. Partial delamination between the materials has to be taken into account. This is done in a Lemaitre like approach by means of effective areas [2]. Furthermore, cracking of the brittle intermetallic phase and subsequent deformation causes void generation and growth. Gurson like terms in the yield condition consider this behaviour [3]. The damage evolution and modeling approaches will be presented.

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