Formation of residual stresses in hot bulk formed parts with subsequent cooling due to austenite-to-martensite phase transformation

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ABSTRACT

In current research, the focus lies on the induction of targeted residual stress states during the manufacturing process of a component. Instead of minimizing or preventing residual stresses, one aims at improving certain properties of the component by introducing residual stresses into a component. For example, hardness can be increased, lifetime extended or wear resistance improved. In the course of this, hot bulk forming processes with subsequent cooling offer various options. Here, process parameters such as deformation state, temperature profile or cooling media can be modified and thus influence the final component properties through the induction of specific residual stress states. Therein, metallurgical, thermal and mechanical interactions play an important role. In addition to experiments, advanced numerical simulation models can be used for the modeling of this process, see [1].

During cooling of a hot bulk formed part, phase transformation takes place which is one reason for the evocation of residual stresses inside the material, see [2]. The description of this complex physical process requires an appropriate material model which considers the resultant change of material properties, volume change and further influences. Thus, in this contribution, a numerical simulation of the cooling process, which takes into account thermo-elasto-plastic material modeling as well as the phase transformation is presented, cf. [3, 4]. This enables an investigation of the residual stress development in the component itself, but also of phase specific residual stresses on the microscale. Different approaches are compared to each other: a phenomenological material model on the macroscale and a two-scale FE² calculation which additionally resolves the microscale.

REFERENCES


