Chair of Metal Forming and Casting (*utg*)
TUM School of Engineering and Design
Technical University of Munich

Hydrogen-induced cracking

Influence of the cutting strategy on the embrittlement tendency

Motivation

The potential for the use of ultra-high-strength steel materials for sheet metal structures produced by forming technology is currently only being exploited to a limited extent. One reason for this is the susceptibility of these materials to hydrogen-induced failure. Hydrogen-induced failure describes a time-delayed failure mechanism that occurs below the tensile strength determined in the tensile test and is based on the interaction of material, hydrogen content and mechanical load. The extent to which hydrogen-induced failure is influenced by the residual stress state introduced by the cutting process, the strain hardening and the microstructural damage to the shear zone is still unexplored.

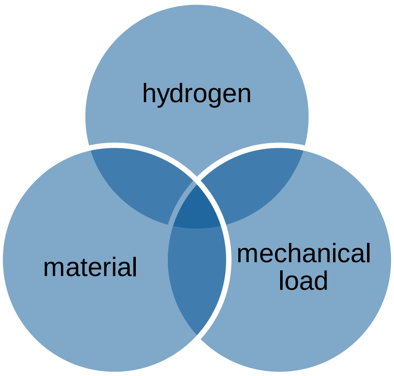

Figure 1: Factors influencing the hydrogen embrittlement tendency

Research objective

The research objective is to characterize the influence of the cutting strategy and individual cutting parameters as well as the properties of the resulting shear influence zones on the hydrogen-induced embrittlement tendency of ultra-high-strength steels. Thereupon, material-specific cutting strategies are developed which reduce the hydrogen embrittlement tendency and thus enable the increased use of ultrahigh-strength materials. The materials to be tested include a dual-phase steel with a tensile strength of 1200 MPa, which has already been shown to be particularly sensitive to hydrogen in previous investigations.

Solution strategy

The hydrogen content is initially specified based on the hydrogen introduced during industrial production processes and then simulated under laboratory conditions on the shear-cut samples. The effusion of the introduced hydrogen is prevented by applying a zinc coating. Afterwards, the material is tested by means of SSRT (slow strain rate test). Figure 2 summarizes the procedure for identifying the influence of the cutting strategy on the failure behaviour.

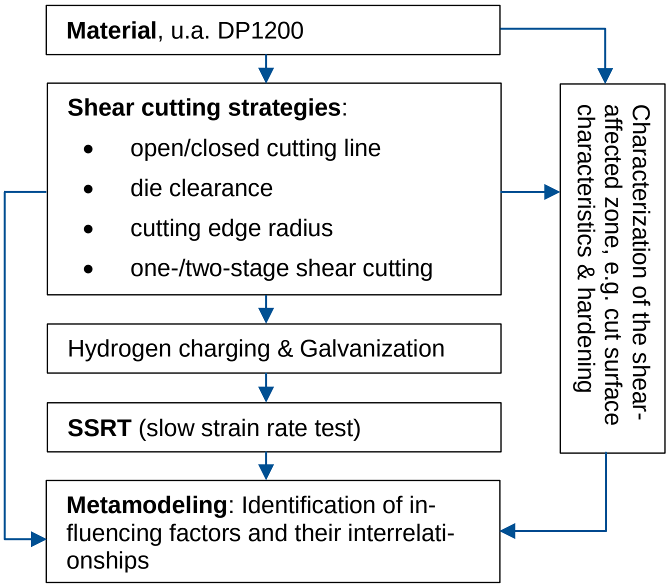

Figure 2: Solution strategy to identify the influence of cutting strategy on the hydrogen embrittlement tendency.

The result is a metamodel, which reflects the interrelationships between the cutting operation, the characteristics of the shear zone, the hydrogen content and the hydrogen-induced embrittlement tendency of the test materials. The aim of the project is, to be able to select an optimum cutting strategy on the basis of the generated metamodel.

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