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TWO-SCALE MECHANISM-BASED MODELING OF RESIDUAL STRESSES IN DUPLEX STEELS

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In the talk, the mechanism-based modeling of deformation induced residual stresses is discussed. The modeling is realized by a two-scale approach, which combines a classical mean field theory [1] with the principle of maximum entropy [2]. The mean field theory is used to estimate the total strain, the plastic strain and the eigenstrain on the grain level based on macroscopic stress, strain and stiffness data. In addition, the maximum entropy estimate is applied to derive an explicit formula for the covariance of stress within the phases. This approach allows the micromechanical modeling of residual stresses of first, second and third kind in single-phase and double-phase structures. In comparison to full-field approaches the computation time is reduced significantly. This allows for an application of the model approach at the integration point level of three-dimensional finite elements. The aforementioned methods are applied to a duplex steel (X2CrNiMoN22-5-3), which consists of a ferritic phase and an austenitic phase both with the same volume fraction. The predicted residual stresses are compared to experimental data from bending experiments for which the phase-specific residual stresses have been determined by neutron diffraction over the bending height of the specimen.

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