Stress- and strain-affected transformation and transformation plasticity of low alloy steels

Abstract of the Ph.D.-Thesis of Dipl.-Ing. Uwe Ahrens

This study identifies key material phenomena that affect the resulting material's properties of heat treated components. Focus is on aspects relating to transformation behaviour in low alloy steels. Specifically, experimental data are presented on (i) the stress-stain response of supercooled austenite prior to transformation, (ii) the effect of externally applied loads on the kinetics of the phase transformation and (iii) the magnitude and progress of transformation plasticity. The data obtained demonstrate a substantial stress-induced as well as a strain-induced acceleration of the transformation, which has to be accounted for in modelling of heat treatments of steels. Consequently, the resulting microstructures were characterised both by optical and electron microscopy in order to shed light on the relevant microstructural processes that have to be accounted for in developing improved models. Moreover, stress-strain response of the supercooled austenite was found to be drastically different from that estimated based on the behaviour of stable austenitic steels. The results also point out that transformation plasticity can contribute significantly to distortion of heat treated components. Moreover, some of the assumptions widely used in modelling transformation plasticity are clearly incompatible with the experimentally obtained data, and these discrepancies are discussed based on microstructural observations.