X-ray diffraction analysis of residual stresses in TWIP steels subjected to plastic strain

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Owing to the global trend of weight reduction in automotive metal structures, the development of high strength steels arises as an important factor for the competitiveness and sustainability of the metallurgical industry, in addition to user security. TWIP Steels (*Twining Induced Plasticity*) arise from the deformation mechanism based on mechanical twining, which is provided by purely austenitic Fe-Mn-C alloys with high Mn-contents (i.e. > 20%). Those steels combine high mechanical strength with high ductility and enable an effective cost reduction in the manufacturing process due to its reduced processing time, without the need for thermomechanical controlled processing and/or particular heat treatments.

Mechanical components made from Fe-Mn-C steels develop macro- as well as micro residual stresses as a result of inhomogeneous plastic deformation and temperature distributions during manufacturing processes, such as rolling or deep drawing. Particularly the impact of micro residual stresses on the failure mechanisms, corrosion processes or hydrogen-induced crack formation in Fe-Mn-C steels was not clarified so far. Significant strain-induced micro-stresses shall occur in TWIP steels as a result of the elastic and plastic anisotropy (i.e. crystallographic orientation dependence of the Young modulus and yield strength) of the austenite during and after forming processes.

Thus, this work aims at investigating the effect of uniaxial plastic strain on the formation of macro as well micro residual stresses in a Fe-22%Mn-0.6%C TWIP steel. To this end, X-ray diffraction analysis was applied to separate the macro- and micro stress contributions in specimens subjected to different tensile strains. The evolution of the twin probabilities was also assessed by line broadening analysis and correlated to the formation of III. order micro residual stresses.