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PRACA DOKTORSKA

Wpływ szybkości odkształcenia na przemianę martenzytyczną w stalach wielofazowych z austenitem szczątkowym

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ABSTRACT

Effect of strain rate on martensitic transformation in multiphase steels with retained austenite

The aim of this work was to determine the effect of strain rate on the martensitic transformation of retained austenite and the relationship between the microstructure and mechanical properties in high-strength multiphase steels with retained austenite. Two steels with different manganese concentrations of 3 and 5 wt.% were tested. The literature part of the thesis contains a review of multiphase steels with retained austenite of different matrix and manganese content. The influence of various factors on the stability of the retained austenite, which determines obtained mechanical properties during plastic deformation was determined. The work focuses on aspects related to high strain rates and accompanying phenomena. In order to verify the hypothesis, mechanical properties and detailed microstructural tests were performed. The results obtained using the XRD, EBSD and TEM methods, which allowed for quantitative and qualitative assessments of the stability of the retained austenite, were of fundamental importance for the conducted research.

The martensitic transformation of the retained austenite was tested in the range of tensile strain rates of 250, 500 and 1000 s^{-1}. Detailed microstructural studies were carried out and the change in the share of retained austenite as a function of the applied strain rate was determined. Determining the amount of retained austenite before and after plastic deformation, as well as determining the influence of manganese content on the mechanical properties and evolution of the microstructure of the tested steels, was essential for the implementation of the objective of the work.

It was found that the use of high strain rates (250 ÷ 1000 s^{-1}) intensifies the martensitic transformation of almost whole retained austenite amount, which was confirmed by quantitative methods. A small amount of austenite identified by TEM was too mechanically stable and had no effect on the mechanical properties of the steel. A significant increase in the mechanical properties of both steels in relation to static deformation conditions was revealed. The 3Mn steel was characterized by a greater elongation compared to the 5Mn steel; however obtaining significantly lower strength. The microstructural analysis showed the presence of heat activated processes such as dynamic recovery in 3Mn steel and local dynamic recrystallization in 5Mn steel. It was found finally that the mechanical stability of austenite is determined by the Mn content grain size and a type of phases adjacent to it.