

Effect of prior annealing on the microstructure and mechanical properties of thermo-mechanically treated TRIP steel

Corresponding author:

Ludmila Kučerová, skal@rti.zcu.cz, University of West Bohemia, Regional Technological Institute, Univerzitní 8, 301 00 Pilsen

Co-authors:

Klára Hrdá, Adam Stehlík

Abstract:

Low alloyed TRIP (Transformation induced plasticity) steels are typically used for an automotive application and the final products are processed mainly from thin sheets. Most of the researches pay attention to optimisation of dedicated heat or thermo-mechanical treatment of the product, using cast ingots, which are first re-forged or pre-rolled and annealed to provide an input material for TRIP steel processing. In this work aims to evaluate the effect of different initial microstructure, created by different annealing treatment, on the final microstructure and mechanical properties after subsequent thermo-mechanical treatment.

Low carbon low-alloyed high strength steel 0.2C-1.5Al-0.5Si-2Mn-0.06Nb (in weight %) was forged into bars and annealed at 1050 °C with either 2 hour hold and furnace cooling to room temperature or 20 min hold with controlled cooling by 1 °C/s. This created two different initial microstructures, banded ferritic-pearlitic one for the longer hold and bainitic-ferritic for a short hold and quicker cooling. Samples with those microstructures then underwent the same thermo-mechanical treatment (TMT) typical for TRIP (transformation induced plasticity) steels. Light and scanning electron microscopy was used to characterise obtained microstructures and tensile test for determination of mechanical properties.

Even though fully austenitic state was achieved during the soaking, traces of the original microstructure were not completely erased and banded original microstructure resulted in banded final microstructure after the thermo-mechanical processing. The same parameters of thermo-mechanical processing applied to homogeneous original microstructure resulted in also homogeneous distribution of the final microstructure. This difference was reflected by mechanical properties as well, the banded

microstructures generally achieved higher strengths and lower total elongations than microstructures produced by the same processing parameters applied to homogeneous input microstructure. The highest tensile strength of 1031 MPa was achieved after solution annealing with longer hold at 1050 °C and slow furnace cooling with subsequent thermo-mechanical treatment with 20 min hold at the temperature of 350 °C. The highest total elongation was on the other hand obtained for the sample with shorter hold at 1050 °C and controlled cooling at 1 °C/s, followed by thermo-mechanical treatment with 20 min hold at 450 °C.

Key words:

TRIP steel, annealing, thermo-mechanical treatment, initial microstructure