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Mechanical properties of a warm-forged twinning induced plasticity steel

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The mechanical behavior of a 30Mn-3Al-3Si twinning induced plasticity (TWIP) steel in warm forging and annealing states was investigated in the present study. It is found that the steel in the forged state exhibited extremely fine grains together with extended coarse ones. After annealed at relatively low temperature, e.g. 750 °C, the fine grains almost disappeared but the coarse grains were increased. When further increasing the annealing temperature to 850 °C, all the grains were transformed to equiaxed grains with an average size of about 50 μm. Depending on the microstructures, the tensile strength of samples decreased from 793 MPa to 666 MPa while the elongation increased from 46.8% to 81.4% as the annealing temperature was elevated. As expected, there were high dense dislocations and piles-ups but very few twins in the as forged samples. The dislocations were significantly increased at the yielding point and predominantly distributed around the grain boundaries. These increased dislocations strongly impeded the motion of dislocations and thus led the yield and tensile strengths of samples to increase. In comparison of annealing at 850 °C with 750 °C, not only the number but also the complexity of dislocations were pronouncedly decreased and the twins were obviously increased. It is believed that decreased dislocations and increased twins should contribute to weakened strength and increased plasticity. The present results would be helpful for tailoring the mechanical properties of TWIP steels.

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