Abstract

Low carbon low-alloy '***TR**ansformation **I**nduced **P**lasticity* (*TRIP*)' aided multi-phase steels were selected for the work. Retained austenite (≈ 5 – 20%) in the microstructure transforms gradually to martensite under the influence of stress (TRIP effect) resulting in improved strength and formability. The work is carried out to explore the effect of '*Phase Transformations*' and '*Thermo-mechanical Treatment*s' on the mechanical properties.

Phase transformation studies were accomplished in a dilatometer. A new method of quantitative analysis of dilatation data was developed and used specifically to (i) explain an 'unusual' expansion observed during the formation of austenite on heating, (ii) formulate equations for the lattice parameters of martensite that include the effect of substitutional alloying elements, and (iii) obtain the carbon concentration of bainitic ferrite formed during continuous cooling. It has been observed that the carbon concentration of bainitic ferrite formed during continuous cooling could be as high as that of the parent austenite, indicating the transformation to be 'displacive'. Isothermal experiments reveal that when carbon concentration of the parent austenite is high and the transformation temperature is low, solubility of carbon in bainitic ferrite would also be high, and vice-versa. This has been attributed to the formation of bainitic ferrite with body centred tetragonal (BCT) structure. Bainite transformation below the martensite start temperature of parent austenite is also discussed. It is suggested that the stress generated by prior martensite transformation may assist bainite transformation in the subsequent stage.

Work on thermo-mechanical treatments showed that strength – ductility balance increases with the increase in the volume fraction and carbon concentration of retained austenite. The carbon content of retained austenite is typically ≥ 0.7 wt% C. On the application of stress, retained austenite transforms to high carbon martensite. It is usually believed that such martensite would cause brittle failure in TRIP aided steels. However, samples showed considerable post-uniform elongation even when the TRIP effect was absent during tensile tests due to prior transformation of retained austenite to martensite by quenching the samples in liquid nitrogen. This indicates that premature transformation of retained austenite to martensite (or absence of TRIP effect) would not necessarily lead to brittle failure of the material.

Keywords: TRIP aided Steel, Bainitic ferrite, Retained austenite, Martensite.