PAPER ID:106

MICROSTRUCTURE EVOLUTION IN MEDIUM M_n (14 WT.%) HIGH Al (13 WT.%) LOW-DENSITY STEEL

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ABSTRACT

Automobiles are the second largest source of greenhouse gas emissions in the world because of which stringent environmental regulations to control emissions have been incorporated globally in recent years. There is call for weight saving in the body-in-white (BIW) of conventional vehicles and also to compensate the weight of batteries/cells in upcoming Electric/Hybridvehicles. A weight saving of 10% results in 6-8% improvement in fuel economy and eventually reduces emission. As steel comprises, 50-70% weight of vehicle, an approach that can be adopted, is to make the steel lighter without compromising the required mechanical properties. In this context, Al (density=2.7 g/cc) has emerged as the chief alloying element for density reduction in steel. For every 1% addition of Al there is a decrease in density of 1.3% due to combined effect of lower atomic weight and lattice dilatation. An attempt was made to design a suitable steel composition consisting of high Al along with Mn, Ni, C and Si through thermodynamic study in ThermoCalc software and was taken up for the study. The objective of the present work is to investigate the microstructure evolution in Fe-14 Mn-13Al-4.5Ni- 0.8C-0.5 Si wt.% steel after quenching and aging treatment. Heat making and casting of the alloy was done at 10 kg scale in vacuum induction melting furnace. The alloys were homogenized at 1200 ^oC for 3 hours followed by air cooling to room temperature. Thereafter, it was re-heated to 1200 ^oC and quenched to room temperature followed by aging at different temperatures of 400,500,600,800 ^oC. The microstructure of the samples was investigated through optical microscopy, scanning electron microscopy (SEM), energy dispersive spectrometry (EDS), X-ray diffraction (XRD), electron back scattered diffraction (EBSD) and transmission electron microscopy (TEM). The microstructure after the aging treatment comprised primarily of elongated δ-ferrite, austenite (45-50%) along with *k*-carbides [$(FeMn)_3AlC$]. A very fine precipitates of *k*-carbides (in austenite matrix) and B_2-FeNiAl (in δ-ferrite matrix) was obtained in the sample aged at 600 ^oC. Formation of fine precipitates in the sample aged at 600 ^oC can contribute significantly to precipitate strengthening of the alloy.

Keywords: low density steel, k-carbide, retained austenite, δ-ferrite