1st PLACE

Class 1

...lding of Novel High Carbon Bainitic Steel

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...re bainitic steels are known for their superior combination of mechanical properties, they are capable of achieving tensile strengths up to 2500MPa, while maintaining reasonable values of ductility and fracture toughness. Their use is somewhat limited due to welding difficulties which arise from the high carbon ... isothermal holding times required to regenerate the bainitic microstructure, within the welds and reaustenitized heat affected zones. Such treatments can last in the order of several hours or even days. Current microstructural analysis of a newly developed 0.8% carbon, aluminum containing bainitic steel welded ...ding process, have shown that the microstructure in the new steel, can be to a large extend regenerated during the cooling of the weld bead.

...M mosaic image of the weld, visible are the shapes and sizes of the weld beads and the penetration depth. The base ...d texture. There is a marked segregation at the fusion zone boundary, indicated by the change in the coloration.

Fig. 2. Polarized LOM mosaic image of the junction point of the welds, marked as region 1 in Fig. 1. Visible are the dendritic structure of the weld (A), and the heat affected zone (B).

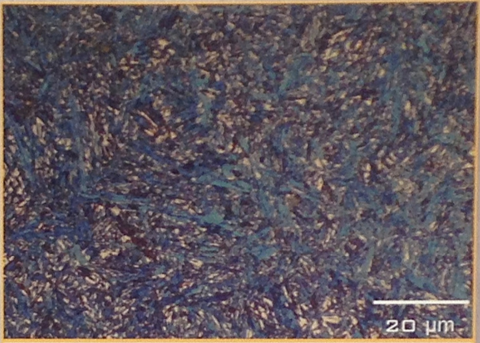

Fig. 3. Polarized LOM of initial bainitic microstructure before welding, we observe fine sheaves of bainitic ferrite separated by regions of retained austenite, (mag. 1000x).

Fig. 4. Polarized LOM mosaic image of region A in Fig. 2, showing dendritic structures within the weld bead. Bainite has been formed within the dendrites, whereas the interdendritic regions are enriched in alloying elements and therefore remain austenitic.

Experimental details

We decided to use the process of A-Tig welding, due to its advantage of not requiring a additive material, due to unavailability of commercial fillers. The base material was prepared by hot rolling to a final thickness of 4mm by a threefold reduction, and then heat treated to a fully bainitic microstructure, with a hardness of 660HV. Welding was performed by 2 single pass welds on both sides of the adjacent plates with a current of 150amp/15V at a speed of 6 cm/min, without preheating and post weld heat treatment. Samples were then EDM cut, prepared using standard metallographic techniques and observed with a optical microscope. In **Fig. 1**, the macrostructure of the weld and base material are visible. We determine the site of interest for a detailed analysis, which is depicted in **Fig. 2**. The initial microstructure before welding is shown in **Fig. 3**, whereas **Fig. 4.** and **Fig. 5.** depict the weld bead and heat affected zone respectively. The microstructures were revealed by tint etching with 7% aqueous sodium-metabysulfite ($Na_2S_2O_5$.). This etchant responds by coloring bainitic regions blue and martensite brown, whereas retained austenite etches white or in a slight purple.

Fig. 5. LOM mosaic image of the heat affected zone, denoted region B in Fig. 2. A appreciable fraction of martensite formed locally within the segregation bands.

Significance

We conclude from our observations that the initial bainitic microstructure regenerated successfully within the fusion zone and reaustenitized heat affected zone during A-Tig welding. Therefore no regeneration heat treatment or preheating are deemed necessary. The current welds achieve just under 60% of the tensile strength of the base material. We deduce from the current microstructural observations that this is mainly due to significant segregations, which were partially inherited from hot rolling. This enabled the localized formation of martensite within the HAZ (Fig. 5.). The relatively coarse scale of the dendrites produced within the welds (Fig. 4.). introduces comparably coarse regions of retained austenite. They are thought to have a comparably lower stability to their fine-grained counterpart, thereby transforming into brittle martensite at a lower stress. A reduction of the heat input or post weld heat treatment are necessary, to match the properties of the base material.

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