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MICROSTUCTURAL AND HARDNESS VARIATION IN POST WELD HEAT TREATED FIBER LASER WELDED DUAL PHASE STEELS

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ABSTRACT

Dual Phase (DP) Steels have gained importance in the current times to meet requirements of environmental legislations, passenger safety without compromising continuous improvements in design aspects. Ferrite and Martensite are the main microconstituents of this steel and the proportion of these phases, morphology, distribution, and grain size of ferrite decide the mechanical properties of these steels. Welding is inevitable in the automobile manufacturing process. Laser welding has pioneered over the other welding techniques for automobile manufacturing due to its flexibility to focus the beam with minimum weld zone and Heat Affected Zone, ability to produce minimum weld zone dimensions, and its high speed.

The present study is aimed to understand the variationof microstructure and Hardness across the weld bead with varying the Post Weld Heat Treatment temperatures on Dual Phase Steel 590 grade. Nd: YAG fiber laser source was used to produce butt joint with 2.5 kW Laser Beam Power and at a welding speed of 4m/min. Due to the rapid solidification of fusion zone, the liquid metal was transformed into lath martensite upon solidification. The hardness in the fusion zone was increased to 350 $HV_{0.5}$ from 200 $HV_{0.5}$ of the base material. This high hardness in the weld zone may be the potential source for the failures. To decrease the hardness of the fusion zone, Post weld Heat Treatments were given to Laser Welded samples. Post Weld Heat Treatments were carried out at the upper critical temperature (830^0C) and between the critical temperatures ($775\ ^0$C) of this steel followed by rapid quenching, and below the lower critical temperatures ($600\ ^0$C) followed by air cooling. Microstructural investigation resulted Higher proportion of martensite due to rapid quenching from Austenite region. Though uniform hardness was achieved in the base material and weld zone, the hardness was increased to 325 ± 10 $HV_{0.5}$. The hardness of samples heat treated below critical temperature maintained the hardness profile of base material but the hardness in the weld zone and base material was decreased due to the transformation of martensite into Iron carbides and ferrite. The austenite formed in the intercritical region was transformed to martensite upon quenching and resulted in the combined microstructure of Ferrite and Martensite. Hardness in the weld zone was decreased due to the 275 HV 0.5 from 375 $HV_{0.5}$.

Keywords: Dual Phase Steel, Fiber Laser Welding, Fusion Zone, Post weld Heat treatment, Lath Martensite