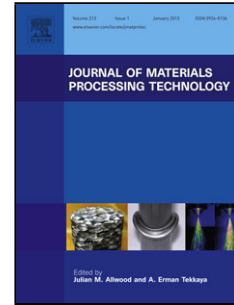


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Laser-arc hybrid welding of thick HSLA steel

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Abstract

A standard laser-arc hybrid welding (S-LAHW) and LAHW with preplaced cut wire inside the groove before welding were studied and compared. The S-LAHW setup revealed problems with filler wire delivery to the root, resulting in substantial hardness increase due to bainitic-martensitic transformation. The applied finite element modelling confirmed significant cooling rate increase in the root area for deep penetration welds. Preplacement of cut wire prior to welding reduced hardness providing improved welds with higher homogeneity. This method was subsequently applied for multi-pass welding that revealed insufficient nucleation of acicular ferrite on non-metallic inclusions (NMIs). It is implied that a critical cooling rate has been exceeded where the NMIs become inactive, resulting in a microstructure consisting of a martensite and bainite mixture. This kind of microstructure is clearly harmful for the weld metal toughness.

Keywords: Hybrid welding; Fiber laser; Acicular ferrite; Inclusions; Toughness; Numerical simulation

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