Impact Fracture Behaviour of the Dissimilar Alloy 316L – Hastelloy C276 Joint

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ABSTRACT

Nickel alloys are commonly used in oil-refining industries, heat exchangers, chemical industries and seawater services due to their high corrosion resistance and high-temperature strength. These alloys are known to be expensive and several methods can be used in order to decrease cost. A Ni-rich deposit layer can be formed on the metal surfaces by several coating technologies in order to obtain a protective layer; however, some constructions make the coating technology limited. A joint consisting of a nickel based alloy and a less expensive material is also considered more economical and several studies concluded that steels can be good candidates as substrate materials for dissimilar joints [1-4]

In this study, it was aimed to obtain a dissimilar alloy joint between a stainless steel grade (AISI 316L) and a nickel based superalloy (Hastelloy C276) by using GTAW and its impact fracture behaviour was investigated. Initially, V-type welding mouth was opened and the welding was performed by multi-pass. In welding procedure, ERNiCrMo4 material used as a filler metal and the heat input was varied between 1.05-1.56 kJ/mm depending on welding parameters. Both welding pool and root zone were protected by an argon atmosphere. The microstructural features of welded parts were studied in detail and it was observed that (i) Weld metal (ERNiCrMo4) had both fine cellular structure (Figure 1a) and columnar dendrites (Figure 1b), (ii) heat affected zone (HAZ) of nickel based alloy exhibited typical coarsened grain structure (Figure 1c) and (iii) a partially melted zone was observed in the HAZ of 316L (Figure 1d).

Multi notched impact tests were performed at -30ºC and the fracture surfaces of tested joints were studied as a function of notch region. Fractographical and cross-sectional examinations revealed out that (i) the fracture surface of weld metal had several dimples indicating the plastic deformation capability of the matrix and also had several oriented cracking paths due to its solidified structure (Figure 2a), (ii) both transgranular and intergranular fractures were observed in the fracture surface of HAZ of C-276 alloy (Figure 2b) and (iii) although the fracture surface of HAZ of 316L alloy exhibited ductile characteristics, elongated delta ferrite phases caused crack propagation under impact loading (Figure 2c).

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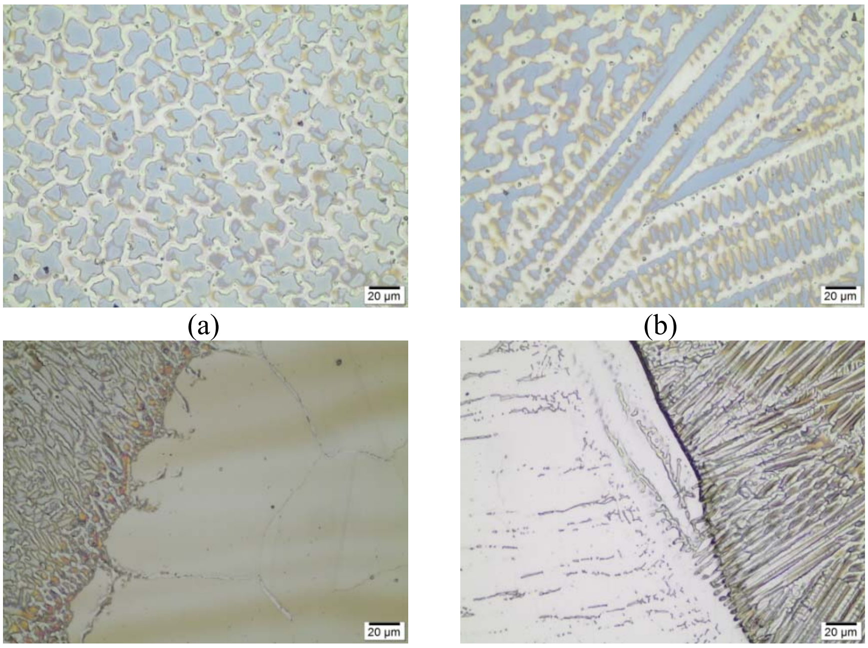
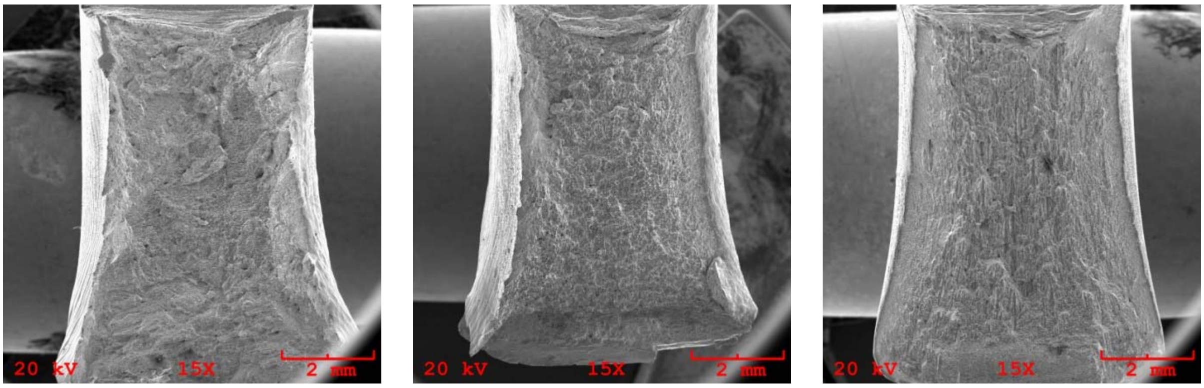


(a) (b)

(d) (e)

Figure 1: Images showing the microstructures of weld metal (a and b), HAZ of C-276 alloy (c) and HAZ of 316L alloy (d).



(a) (b) (c)

Figure 2: Fractographs showing the general fracture morphologies of weld metal (a), HAZ of C-276 alloy (b) and (c) HAZ of 316L alloy.

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