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Characterization of microstructure, mechanical properties and corrosion resistance of dissimilar welded joint between 2205 duplex stainless steel and 16MnR

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ABSTRACT

The joint of dissimilar metals between 2205 duplex stainless steel and 16MnR low alloy high strength steel are welded by tungsten inert gas arc welding (GTAW) and shielded metal arc welding (SMAW) respectively. The microstructures of welded joints are investigated using scanning electron microscope, optical microscope and transmission electron microscopy respectively. The relationship between mechanical properties, corrosion resistance and microstructure of welded joints is evaluated. Results indicate that there are a decarburized layer and an unmixed zone close to the fusion line. It is also indicated that, austenite and acicular ferrite structures distribute uniformly in the weld metal, which is advantageous for better toughness and ductility of joints. Mechanical properties of joints welded by the two kinds of welding technology are satisfied. However, the corrosion resistance of the weldment produced by GTAW is superior to that by SMAW in chloride solution. Based on the present work, it is concluded that GTAW is the suitable welding procedure for joining dissimilar metals between 2205 duplex stainless steel and 16MnR.

1. Introduction

Duplex stainless steel (DSS) consists of approximately equal amounts of austenite and ferrite, which results in the favorable mechanical properties and corrosion resistance. The higher strength properties allow weight savings, which reduce fabrication costs and enable lighter support structures to be used. The higher corrosion resistance, in particular against stress corrosion cracking, makes them preferably applied in certain environments such as chemical tankers, pressure vessels, pipes to heat exchangers, paper machines and ocean engineering [1–3]. With the growing application of new materials and higher requirements for materials, a great need occurs for component or structure of dissimilar metals. However, the joining of dissimilar metals is generally more challenging than that of similar metals, which is usually due to several factors such as the differences in chemical compositions and thermal expansion coefficients, resulting in different residual stresses situation across the different regions of weldments as well as the migration of carbon element from the steel with higher carbon content to the steel with relatively lower carbon content. If the welding process is not well controlled, some weld defects such as dilutions and cracks will generate in the weld metal and lead to great decrease of properties of the welded joint. There are some researches about failure analysis or mechanical performance for dissimilar metals joints. Ul-Hamid et al. [4] have addressed that carbon diffusion in the dissimilar joint between carbon steel pipe and type 304 stainless steel elbows resulted in cracking after a relatively short period of usage. Lee et al. [5] have also reported creep–fatigue damage of dissimilar weldment of modified 9Cr–1Mo steel (ASME Grade 91) and 316L stainless steel in a liquid metal reactor. In order to overcome the technical problems and take full advantage of the properties of different metals, it is necessary to pay more attention to the joining of dissimilar metals, so as to produce high quality welded joints between them.

At present, some investigations have been conducted on welding of duplex stainless steel, almost all common fusion welding techniques can be used to weld duplex stainless steel through selecting appropriate filler metals and parameters such as heat input [6,7]. Explosive welding can be thought as a feasible method to produce composite plates. Kaçar and Acarer [8] have addressed that explosive welding process can be used successfully for cladding duplex stainless steel on the vessel steels without losing properties such as corrosion resistance and mechanical properties. However, compared to the welding of similar metals, there is limited information about microstructure/property relationships in dissimilar material welds between duplex stainless steel and low alloy high strength steel. Increasing application of these steels will

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