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Short Communication

Fabrication of high chromium cast iron and medium carbon steel bimetal by liquid–solid casting in electromagnetic induction field

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ABSTRACT

The high chromium cast iron and medium carbon steel bimetal was fabricated by liquid–solid casting in electromagnetic induction field. The interfacial structure and mechanical properties were investigated. The results show that the microstructure is refined obviously and mechanical properties are improved significantly. The electromagnetic stirring can refine effectively the microstructure, and profit the diffusion of elements and obtaining of the desirable microhardness transition. The electromagnetic induction heating is beneficial to achieving metallurgical interface bonding and improving the mechanical property. Furthermore, the electromagnetic stirring compels the molten metal to scour continuously the surface of medium carbon steel, resulting in the oxides and impurities being melted or broken away from the surface.

1. Introduction

Bimetallic material has been extensively employed as an advanced functional material in many fields because of unique physical and mechanical properties, which can be fabricated by bonding two materials, similar or dissimilar. Currently, there are several fabrication methods of bimetal, including casting [1], diffusion bonding [2,3], rolling [4], extrusion [5], cladding [6,7] and powder metallurgy technology [8], etc. Among them, the liquid–solid casting has been confirmed as a simple, economical and effective method for fabricating bimetal [1].

In order to achieve the metallurgical bonded interface, the solid metal should be preheated to a design temperature [9]. Usually, the oxygen tube heating [1] and electric resistance furnace [9] as the preheating method were employed during preheating. The low heating rate by the methods above will yield serious surface oxidation. The electromagnetic induction heating, one of rapid heating process, is widely used for improving rapidly surface temperature [10]. The rapid heating process is favorable for decreasing the surface oxidation and improving interfacial quality. Furthermore, the electromagnetic induction stirring as an important technology has been used wildly in material science field to fabricate high property castings, due to its advantage of refining microstructure, reducing shrinkage porosity and segregation, and minimizing the inclusion. However, this technology was employed scarcely in fabrication of bimetal field from available literatures. In the present paper, an innovative technology for fabricating high chromium cast iron (HCCI) and medium carbon steel (MCS) bimetal was presented. This innovative technology utilizes the electromagnetic induction heating to rapid preheat solid metal, and the electromagnetic induction stirring to refine microstructure, minimize the inclusion and optimizing interface. The objectives of the present study are to investigate the effects of this technology on the interface binding, microstructure and mechanical properties, and to achieve the significant information for fabricating HCCI and MCS bimetal.

2. Experimental procedure

The HCCI and MCS were selected as raw materials to fabricate bimetal by liquid–solid casting technology. The chemical compositions of HCCI and MCS were given in Table 1. The solid MCS was cut into 20 × 20 × 50 mm, and each surface was processed by grinding and polishing, subsequently cleaned using alcohol. The HCCI was weighed according to the liquid HCCI–solid MCS volume ratio of 10:1, and melted in induction furnace. A sand mould with the preset MCS sample was placed into induction coil connected with the 1400 Hz alternating-current source. When the MCS sample was preheated for 80 s to about 600 °C, the molten HCCI at 1500 °C was poured into the sand mould. After the pouring, the electromagnetic induction stirring was employed on the molten metal for 10 min. The bimetal was cooled to the room temperature in sand mould. This bimetal was also fabricated by conventional

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