Materials and Design 32 (2011) 2028–2033

Contents lists available at ScienceDirect

Materials and Design

journal homepage: www.elsevier.com/locate/matdes

Enhancement of wear resistance of ductile iron surface alloyed by stellite 6

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ARTICLE INFO

Article history:
Received 20 July 2010
Accepted 25 November 2010
Available online 1 December 2010

Keywords:
A. Ductile iron
C. Surface alloying
I. Wear

ABSTRACT

This paper deals with the improvement of the wear resistance of ductile iron surface alloyed by a hypoeutectic stellite 6 alloy. In this regard, the surface alloyed layer with 3 mm thickness deposited on ductile iron using tungsten inert gas (TIG) surface processing. The microstructure, hardness and wear resistance of surface alloyed layer were investigated using optical microscopy, scanning electron microscope (SEM), energy dispersive spectroscopy (EDS), X-ray diffraction analysis, Vickers hardness (HV0.3) and pin-on-plate tests. The results showed that the microstructure of the surface alloyed layer consisted of carbides dispersed in a Co-based solid solution matrix with dendritic structure. This microstructure was responsible for the improvement of the hardness and wear resistance of the coating. Further investigations showed that the dominant mechanism of the wear in the coated and uncoated samples was delamination wear.

1. Introduction

The use of ductile iron (DI) has increased constantly since its introduction in the market in the 1950s, due to its excellent mechanical properties and low production costs [1]. The application of ductile iron in manufacturing of components like gears, pinions, crankshafts and similar parts requires improved wear resistance. Therefore, there has been a growing interest in the improvement of wear behavior of ductile iron in recent years [2–4].

Cobalt-based alloys are widely used in wear applications [5–7]. A group of typical cobalt hardfacing alloys are known as ‘Stellite’. These alloys are known to have high corrosion resistance, high hardness at high temperatures and high wear resistance under high pressure conditions. It has been demonstrated that the mechanical properties of these alloys depend on the chemical composition, microstructure and manufacturing processes [8].

Among the different existing stellite alloys, stellite 6 is widely used in industry. It has an approximate composition of Co–28Cr–4.5W–l.lC (in wt.%) [9]. The typical microstructure of the stellite 6 alloy consists of α-Co (Co-rich matrix) dendrites with a face centered cubic (f.c.c.) crystal structure surrounded by lamellar mixture of the Co-rich phase and carbide phase resulting from the eutectic reaction into interdendrite during solidification. In this alloy (stellite 6), Cr provides oxidation and corrosion resistance, as well as strength by the formation of M_7C_3 and $M_{23}C_6$ carbides. Refractory metals such as Mo and W are responsible for strengthening not only via solid solution strengthening but also via precipitation hardening by the formation of MC and M_6C carbides and intermetallic phases such as Co_3(Mo,W) [8].

In the present work, the wear resistance of ductile iron surface alloyed by stellite 6 using tungsten inert gas (TIG) surface processing was studied.

2. Experimental details

2.1. Materials and welding procedure

The tungsten inert gas (TIG) welding process was performed using a MAGIC WAVE 2600 apparatus. The deposition conditions for the TIG process used in this research are listed in Table 1.

Ductile iron was used as the substrate material. The dimensions of the substrate were 120 mm × 20 mm × 10 mm. Stellite 6 alloy wire (2 mm diameter) was used as cladding material. The chemical composition of stellite 6 alloy is shown in Table 2. Prior to cladding, the top surface of the sample was flattened and cleaned by acetone to remove all surface contaminants.

2.2. Microstructural characterization

For Microstructural investigation, as-welded samples were first cut in cross section. The cross section of the coating was polished using 0.3 μm alumina polishing powder suspended in distilled water and was etched by 2% nital solution. Then, the microstructure of the coating was studied by optical microscope and scanning electron microscope (SEM). The microstructure of worn surfaces

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doi:10.1016/j.matdes.2010.11.060