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Short Communication

Effect of Mo addition on the microstructure and wear resistance of in situ TiC/Al composite

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ABSTRACT

In this work, Mo was investigated as an additive for in situ preparation of TiC/Al composite using a casting route assisted by self-propagating high-temperature synthesis (SHS). Experimental results show Mo improves the wettability between TiC phase and aluminium melt due to the formation of a Mo-rich shell around the formed TiC particles, which is a kind of good modificator. Compared with the composite without added Mo, 1.0 wt.% Mo addition developed finer matrix structure, significant refinement of TiC particles and more uniform distribution of TiC particles in the matrix. Meanwhile, both wear and tensile properties of TiC/Al composite were improved with 1.0 wt.% Mo addition and then deteriorated with the further increase of Mo content due to the formation of fragile phase Al_5Mo.

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1. Introduction

TiC/Al composite belongs to the new generation of particulate reinforced aluminium alloy based metal-matrix composites (MMCs) [1]. The aluminium based metal-matrix composites have attracted increasing interest in the automobile and aerospace industries as potential advanced engineering structural materials by virtue of high specific strength, stiffness and modulus, as well as high wear resistance, excellent elevated temperature resistance, low fabrication costs and good isotropic properties [2–4].

Recently, in situ synthesis of TiC reinforcement in molten alloys has received more and more attention worldwide due to the following advantages comparing with conventional techniques [5]: First, the dimensions of the TiC reinforcement generated in situ tend to be finer, the surfaces of the TiC particles remain uncontaminated, and the TiC phase integrates with matrix metallurgically. Furthermore, in situ technology directly combined with conventional casting provides the opportunity for producing near-net-shape final components.

Various ceramic particles such as, SiC [6], TiB_2 [7], B_4C [8], ZrB_2 [9] and TiC [4] have been used as in situ reinforcements in aluminium matrix. As a good reinforcement candidate in aluminium matrix composites, TiC ceramic exhibits many desirable features, such as high hardness, high melting point, high elastic modulus and low heat-conductivity coefficient [3,10,11].

There are reports [12–14] that use some active additives in reinforcements for the TiC/Al composite, such as Mg, rare earth and mixture of $KAlF_4$ and K_3AlF_6; however, none has mentioned Mo as the additive. In this study, the aim of the investigations here is to investigate the influence of the Mo addition on the microstructure and wear resistance of TiC/Al composites. An optimal addition amount of Mo is determined in accordance with the experimental results.

2. Experimental procedures

Five alloys based on 6A02 were prepared with a constant level of 10 wt.% TiC and 0, 1.0, 3.0 and 5.0 wt.% Mo contents and the compositions were listed in Table 1. TiC particles were introduced to alloys by adding preformed blocks of titanium, carbon, molybdenum and aluminium powders into the melt. The purpose of adding aluminium is to restrain the intensity of the SHS reaction between titanium and carbon. The particle sizes of carbon, titanium, molybdenum and aluminium powders were about 10, 90 and 100 μm, respectively. To make these preformed blocks, titanium, carbon, molybdenum and aluminium powders were mixed and subsequently compacted in a mould with the size of 30 × 30 × 10 mm.

After the stock of the base alloy 6A02 had been melted in a vacuum medium frequency induction melting furnace, the preformed blocks were introduced into the melt. The SHS reaction between titanium powders and carbon powders soon occurred, producing TiC particles. The melt with TiC particles was held at 1100 °C for several minutes and then poured into steel moulds. The ingots were hot extruded at 480 °C into bars with the diameters in 30 mm and then cut into all samples. All samples were T6 heat treated condition (solution treating at 525 °C followed by ageing at 180 °C for 8 h).

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