

Effect of Cr content on the micro structure and abrasion performance of high chromium cast Iron

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Abstract. In order to achieve the gradient metal high chromium cast iron which can fill the 3D network structure SiC porous ceramics, it was necessary to design cast iron materials with different performance by adjusting the experimental parameters. The cast iron material was fabricated by the molten casting method. Three group materials were executed by the addition of chromium with different content. Effect of chromium content on the impact toughness and micro-hardness was not obvious. The micro cutting mechanism was the mainly abrasive behavior for the high chromium cast iron.

1. Introduction

The metal/ceramic composites had more advantages than monophase materials, due to potential lower density than the metal, better fracture and damage resistance than the ceramic. Recently, the metal matrix composites reinforced SiC ceramics with 3-D network structure had aroused researcher's concern. This kind of the co-continuous composites possessed special mechanical properties and chemical properties. By designed different geometric shapes of ceramic, network structure increased the volume fraction of reinforced composites^[1-2]. It was difficult for wider application if the processing costs were too high for industrial production, which fabrication costs of advanced composites was considered at first. So for the co-continuous composites, the questions for processing costs and thermal expansion mismatch of the metal/ceramic co-continuous composite were put forward^[3-5]. For high chromium cast Iron with functional structure design which was applied into SiC porous ceramics with 3D network structure. In order to achieve the gradient metal high chromium cast iron which can fill the 3D network structure SiC porous ceramics, it was necessary to design cast iron materials with different performance by adjusting the material component and heat treatment. Based on the above consideration, effect of the Cr content on the micro-structure and abrasion performance of cast Iron was taken into consideration. The cast Iron with different Cr content was fabricated by casting process.

2. Material Fabrication and Measure

The cast iron material was fabricated by the molten casting method. The three group materials were executed by the addition of chromium with different content. The content of chromium was set as 18%, 21% and 24%. Other elements were carbon (3.0%), Mo (1.5%), B(0.2%), Cu(0.8%) and Mn(1.5%). The medium frequency induction furnace was utilized to fabricate the high chromium cast iron. The experimental samples was cut into 10mm×10mm×100mm bars, then the surface of high chromium cast iron was polishing treatment. The impact fracture test, hardness test and wear experiments were executed to Characterize mechanical properties of the high chromium cast iron. The phase composition and morphology observation were analyzed by XRD and SEM method. The

abrasive testing machine (ML-100 type) was utilized to abrasive behavior of the cast iron. The abrasive speed was set as 120 r/min and sandpaper was used as working face (SiC sandpaper 1000#). The 45 steel (HRC55) was chosen as counterpart. The dry sliding friction was executed and loading force was 100N. The abrasion mass loss was calculate by the mass difference after and before abrasion under different time.

3. Results and Discussion

XRD spectrum of the high chromium cast iron was listed in Fig.1. The cast iron materials was composed of M7C3 carbide, austenite phase and martensite phase, while the other phase was not detected. When the chromium content was low, the carbide with M7C3 type was less. The content of carbide with M7C3 type increased slightly as the chromium content increased. So it can be concluded that the addition of the chromium was favorable for the formation of the carbide with M7C3 type. With the increase of chromium in iron material, the diffraction peak of the martensite phase increased remarkably. Then addition of the chromium was benefit for promoting the formation of martensite phase. Within the scope of the designed chromium content parameter in this paper, the effect of the chromium content on the austenite phase content was not obvious.

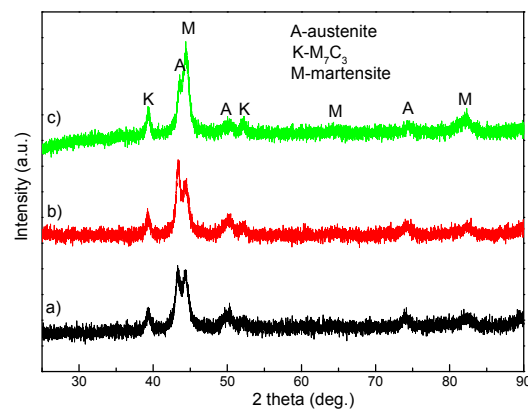


Fig.1 XRD spectrum of the high chromium cast iron with different Cr content., b) and c) represented the Cr content 18%, 21% and 24%.

Fig.2 showed the relationship curve of the impact toughness and microhardness of cast iron material with different contents chromium. The variation of the matrix composition would affect the micro-hardness of high chromium cast iron. The magnitude of martensite, carbon and secondary carbides affected the matrix strengthening impact. According to Fig.2, the impact toughness varied within the range 6.2~7.5J/cm² and micro-hardness changed within the range of 520~560HV. So the effect role of the chromium content on the impact toughness and micro-hardness was not obvious. The introduce of carbon content was about 3.0%, so the newly formed product of carbide would play an important role on the mechanical property of the high chromium cast iron. The synergistic effect of the primary carbide, eutectic carbide and matrix components influenced the hardness of high chromium cast iron. The typical fracture morphology of the cast iron under the different Cr content was listed in Fig.3. The conventional metal toughness nest structure can be detected even if Cr content was different. The differences of micro-structure is not obvious.

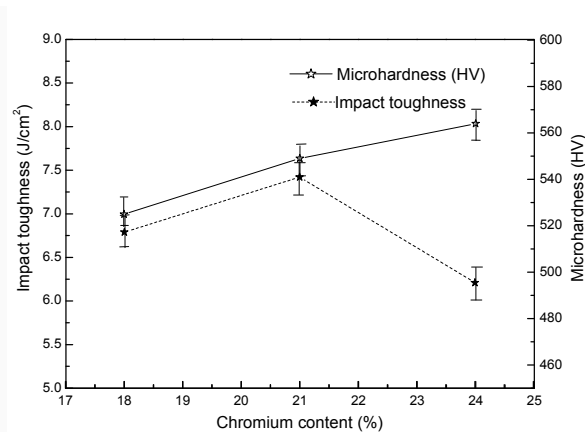


Fig.2 Impact toughness and micro-hardness for the cast iron with different Cr content.

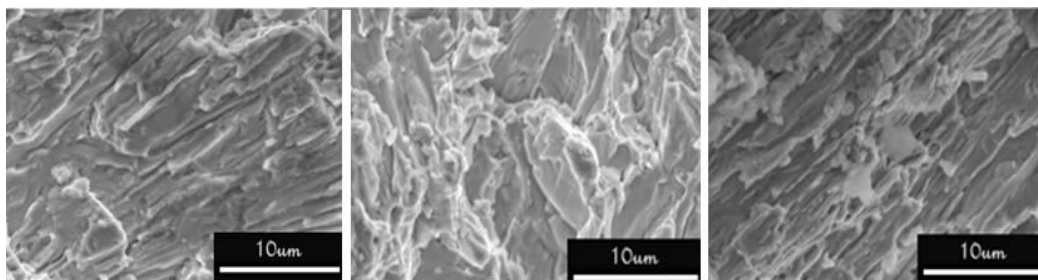


Fig.3 Typical fracture photos of cast iron under the different Cr content.

The relation curve between abrasion mass loss and time of the high chromium cast iron under different chromium content was listed in Fig.4. As chromium content was constant, abrasion mass loss increased with abrasion time prolonged. When the abrasion time was same, the higher chromium content was, the less the abrasion mass loss was. Especially when chromium content reached 24%, abrasion mass loss reached minimum figure. The abrasive performance was closely related with its micro-structure.

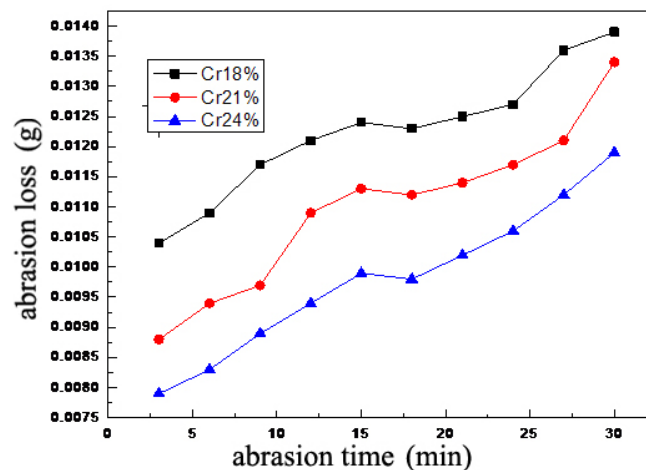


Fig.4 The relation curve between abrasion mass loss and time of the high chromium cast iron

The micro-structure morphology of the high chromium cast iron under 100N load after 30 minutes was enumerated in Fig.5. When chromium content was low, the abrasion of experimental materials was more serious. Wear scratches was evident, as shown in Fig.5 a). The high chromium cast iron matrix was composed of martensite with high hardness and the hard phase (carbide) was dispersedly distributed among the matrix. From the Fig.5, so we concluded that micro cutting mechanism was the mainly abrasive behavior.

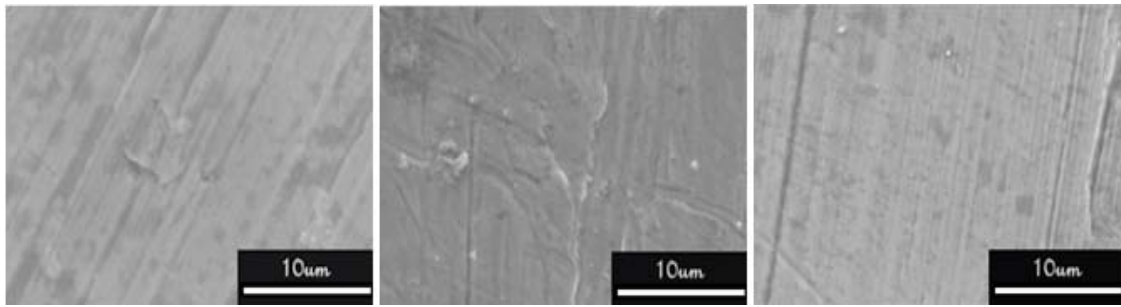


Fig.5 morphology of high chromium cast iron under 100N load after 30 minutes

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