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Properties of CuCr contact materials with low chromium content and fine particles①

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Abstract: The voltage withstanding capability and electric conductivity of CuCr contact materials with low chromium content and fine Cr particles were studied. The results show that the withstanding voltage has little relation with the Cr content for the melted-casting CuCr alloy within 15%－29% Cr content, and that the electric conductivity of the alloy increases with the decreasing of Cr content.

Key words: contact materials; copper-chromium alloys; voltage withstanding capability
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1 INTRODUCTION

CuCr alloy has taken the place of CuBi alloy for its excellent electric properties and has been widely used in medium voltage, high current vacuum interrupter[1, 2]. Cu and Cr have very little solubility in each other. At room temperature, the solubility is approximately zero. In fact, Cu-Cr alloy is a pseudo-alloy with the mixture of Cu and Cr component. Cu-Cr contact materials reserve the excellent properties of Cu and Cr component, so the contact materials have excellent electric properties.

The optimal content of Cr in CuCr contact material has drawn lots of researchers' attention[3－7]. To lower the Cr content can make the resistance lower, the power loss lower, and the cost lower for the less expensive Cr used. However, the best Cr content is less subjected to systematic research. In practice, the lowest Cr content is 25% (mass fraction). This ratio is much related to the manufacturing method of the CuCr alloy. Infiltration can only prepare materials with Cr content higher than about 50% (mass fraction)[8]. The powder sintering method can make materials with low Cr content, however, the oxygen content will increase with the fining of Cr particles, which will make the properties of CuCr contact materials deteriorate[9－11]. Until now, the Cr content in CuCr alloy used as contact materials is higher than 25%.

With the development of melted-casting method, it's possible to prepare CuCr contact material with lower Cr content and fine particles[12]. So, the optimal Cr content becomes a critical problem. In this paper the properties of the CuCr contact materials prepared by melted-casting method are studied. The results show that electric conductivity of the alloy increases with the decrease of Cr content, while the voltage withstanding ability has little relation to the Cr content.

2 EXPERIMENTAL

CuCr alloys were prepared by melted-casting method in Jinchangpu Corporation, with the Cr content of 15%, 21%, and 29% respectively.

The electric conductivity was measured by WD-Z eddy current conductivity meter.

The voltage withstanding ability was measured in a TDR-40A single crystal furnace in Xi'an Jiaotong University. The specimens were machined to discs with diameter of 20 mm and thickness of 5 mm. Then they were fixed to the furnace as cathode, the anode was made of pure tungsten with diameter of 5mm. When the furnace chamber was out gassed to high vacuum, 8 kV DC voltage was applied across the cathode and anode. Then the cathode was drived to move toward the anode at a speed of 0.2 mm/min till breakdown occurred. By measuring the distance and dividing 8 kV by this value, the withstanding voltage of the specimen at this time was gotten. After driving the cathode far from the anode, 8 kV voltage was applied again. The procedure is repeated about 100－200 times.

Polish the specimens and observe the microstructure of the alloy with S360 SEM.

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3 RESULTS AND DISCUSSION

The microstructures of CuCr alloy with different Cr contents are shown in Fig. 1. When the Cr content is 15%, the Cr phase shows typical dendritic morphology. With the increase of Cr content, the dendrite becomes less. Cr particle distributes in Cu matrix randomly with average size of 20 - 30 μm, which is less than that made by infiltration or powder sintering method.

The electric conductivity of CuCr alloy is shown in Table 1.

Table 1 Relation between Cr content and electric conductivity

Cr content/ %	Electric conductivity/ ($MS \cdot m^{-1}$)
29	22.5
21	24.9
15	26.6

From Table 1 it can be seen that with the decrease of Cr content, the electric conductivity increases. When Cr content decreases from 29% to 15%, the electric conductivity increases by 20%.

The voltage withstanding ability is shown in Fig. 2.

From Table 1 and Fig. 2, it can be seen that with the decrease of Cr content, the electric conductivity increases, while the voltage withstanding ability changes a little. The results show that for CuCr alloy prepared by melted-casting method, Cr content have little influence on voltage withstanding ability but large influence on electric conductivity. The results are very similar to that by Rieder et al[13]. Rieder et al studied the CuCr alloys with Cr content of 25% - 75% prepared by powder sintering and vacuum infiltration. They found that the voltage withstanding ability and arc erosion were not influenced by the Cr content, and the average chop current and

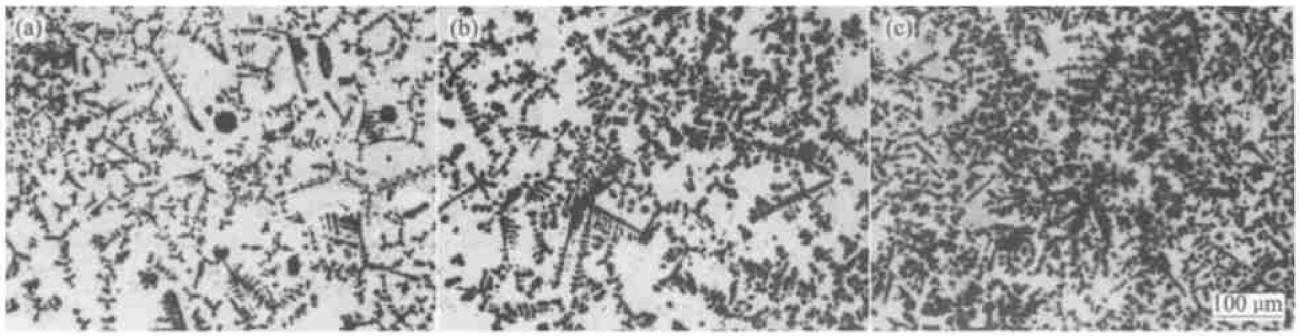

Fig. 1 Microstructures of CuCr alloy with different Cr contents
(a) —15% Cr; (b) —21% Cr; (c) —29% Cr

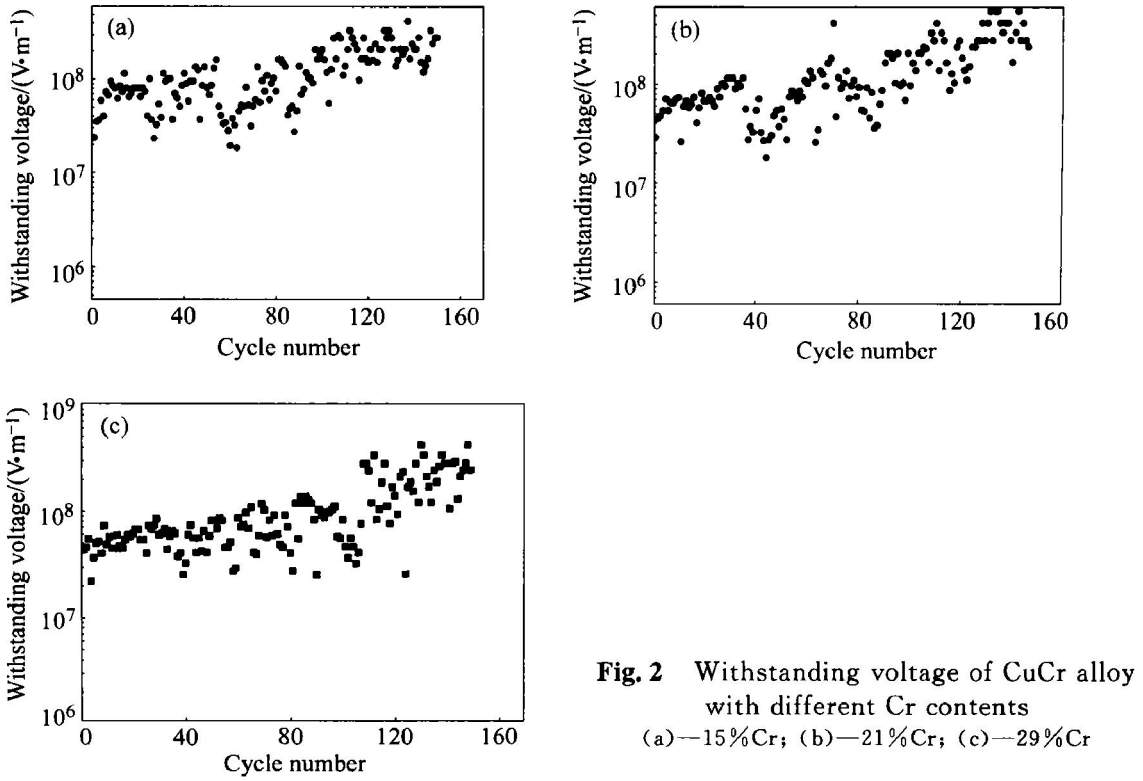

Fig. 2 Withstanding voltage of CuCr alloy with different Cr contents
(a)—15%Cr; (b)—21%Cr; (c)—29%Cr

its statistical distribution were not influenced, either. Some properties, such as the maximum chop current and the contact resistance, were enhanced. Our work indicated that it's possible to lower the Cr content of CuCr alloy prepared by melted-casting method without deteriorating its voltage withstanding ability

4 CONCLUSIONS

1) The voltage withstanding ability of CuCr alloy prepared by melted-casting has little relation to Cr content in the range of 15% - 29% (mass fraction), while the electric conductivity increases with the decrease of Cr content.

2) It is possible to prepare CuCr contact material with low Cr content, which will reduce the cost.

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