Newly Developed Low Silver Content Electrical Contacts for MCCB

MCCB（配線用しゃ断器）用省銀接点の開発

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Abstract

Electrical contacts for MCCB (Molded Case Circuit Breaker) are made of composite materials consisting of silver with high electrical conductivity and materials such as tungsten and tungsten-carbide with high melting point. In recent years, the cost of an electrical contact has become important in order to deal with escalating price of raw materials and international price competition. Our company developed electrical contacts with low silver content for cost reduction focusing attention on silver which occupies a great part of the raw material cost.

MCCB（配線用しゃ断器）用の接点には電気を通しやすい銀と、熱に強いタングステンや炭化タングステン、等の複合材料が使用されている。近年、原材料の高騰や、国際的な価格競争への対応のため、電気接点のコストが重要となっている。弊社では、ブレーカー用接点のコストダウンのため、材料費の大きい銀に着目し、銀量の少ない接点材料の開発を行った。

1. Introduction

Our Company manufactures composite materials consisting of silver with high electrical conductivity and tungsten or tungsten-carbide with high melting point for electrical contacts for MCCB, and those have been highly evaluated due to the excellent erosion-proof, deposition resistance and high electrical conductivity. In recent years, however, the cost of an electrical contact has become important in order to deal with escalating price of raw materials and international price competition. In order to reduce the cost, our company aimed to develop electrical contacts with low silver content which maintain properties required for MCCB focusing attention on silver which occupies a great part of the raw material cost.

If silver is reduced from existing composite materials, the erosion-proof and deposition resistance

would be improved, but the electrical conductivity would be deteriorated. Therefore, we decided to add nickel (Ni) with higher heat resistance than that of silver and higher electrical conductivity than that of tungsten-carbide (WC) instead of reducing silver. It is expected to maintain properties required for an electrical contact by using nickel and reducing silver.

2. Experimental

2-1) Experiment samples

We prepared samples using our company's conventional electrical contacts by adding nickel and reducing silver. Based on the composition of 60 mass% Ag-WC, "HS2", 79 mass% Ag-WC-Gr-X, "HD-8" and 85 mass% Ag-WC-Gr-X, "HD-8X", we prepared 45 mass% Ag-WC-Ni, "HS2α", 77 mass% Ag-WC-Gr-Ni-X, "HD-8α" and 83 mass% Ag-WC-Gr-Ni-X, "HD-8Xα", respectively. We conducted electric tests using these electrical contacts and compared the erosion and resistance with those of conventional materials.

Table 1 List of developed materials

	Conventional material		Developed material	
	Name	Content	Name	Content
Moving tip	HS2	60 mass% Ag-WC	HS2α	45 mass% Ag-WC-Ni
Fixed tip	HD-8	79 mass% Ag-WC-Gr-X	HD-8α	77 mass% Ag-WC-Gr-Ni-X
	HD-8X	85 mass% Ag-WC-Gr-X	HD-8Xα	83 mass% Ag-WC-Gr-Ni-X

＊) Gr : Graphite

2-2) Conditions of electric tests

2-2-1) Current breaking test

Voltage: AC230V Current: 3,000A (half wave lemgth)

Sample size: 2 x 5 x 5 mm (moving and fixed tips)

Measurement: volume loss (mm^3) after 5 times of interruption (Open operation)

2-2-2) Regular current inching test

Voltage: AC230V Current: 100A

Sample size: 2 x 8 x 8 mm (moving and fixed tips)

Power factor: 0.76 Frequency: 600times/hour

Measurement: volume loss (mm^3) after 10,000 times of switching and every 20 times of switching a resistance between terminals (m Ω)

2-3) Test results

2-3-1) Results of the breaking test

Fig. 1 shows the results of the breaking test. The erosion slightly decreases when using HS2α for moving tips and significantly decreases when using HD-8α /HD-8Xα for fixed tips.

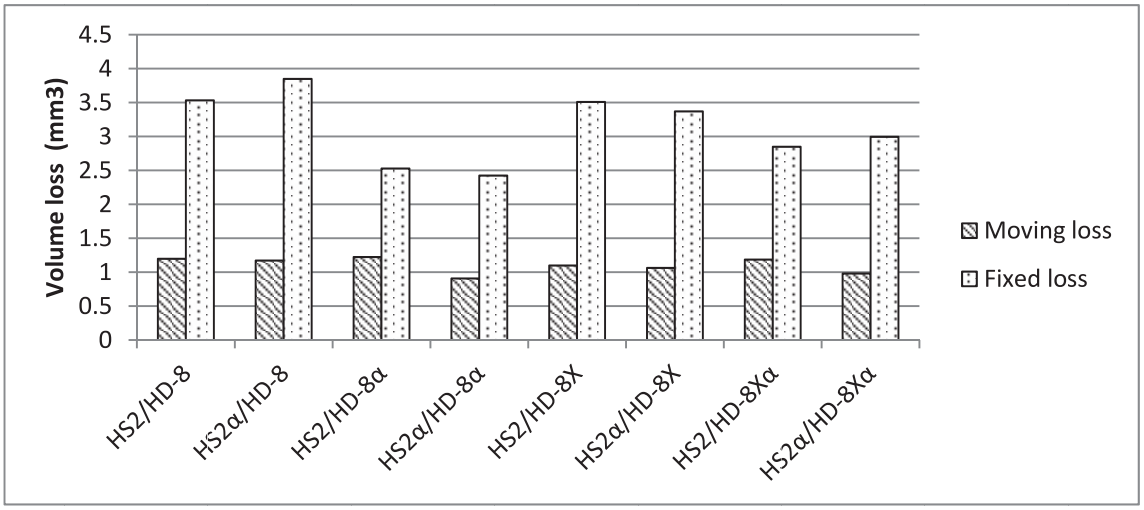

Fig. 1 The volume loss in the breaking test (moving/fixed)

2-3-2). Results of the inching test

Fig. 2 shows the results of the inching test. The erosion sometimes decreases at the moving tip side and that seems to be caused by the transfer from the fixed tip side, thus the erosion could not be measured correctly. At the fixed tip side, several combinations show decreased erosion while there are variations.

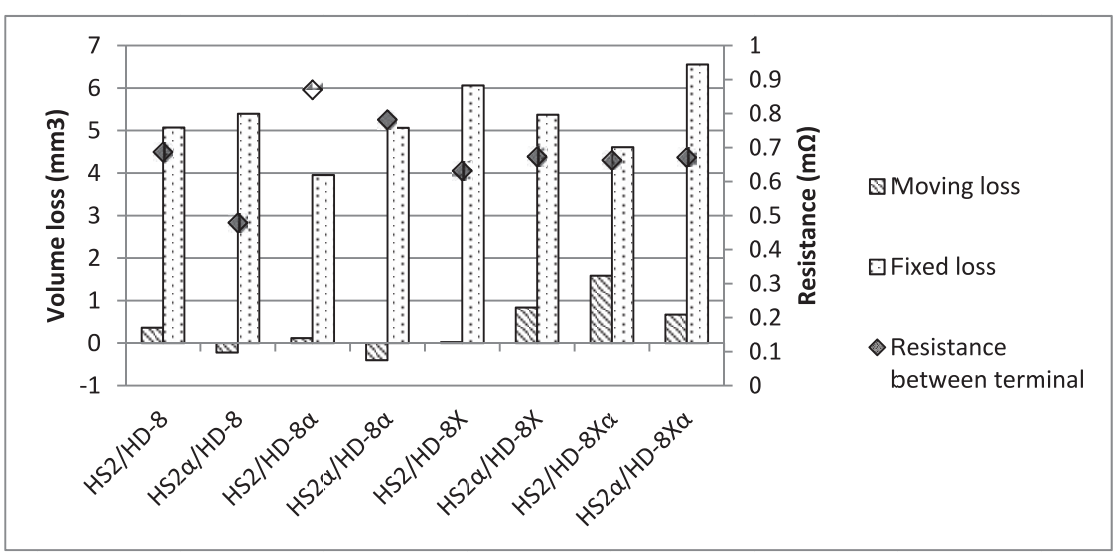

Fig.2 Volume loss and resistance between terminals in the inching test (moving/fixed)

3. Evaluation as electrical contacts

3-1) HS2 α and HD-8 α

Fig.3 shows comparative scores of experiment results of HS2α and HD-8α with a score of 100 % representing HS2/HD-8. The overall erosion decreases, particularly when using HD-8α in the breaking test and the inching test. With respect to HS2α /HD-8α , the erosion caused by interruption is significantly suggesting that this combination is resistant to high current load. With regard to HS2α /HD-8, the erosion at the fixed tip side slightly increases, but the resistance value decreases even though silver is reduced.

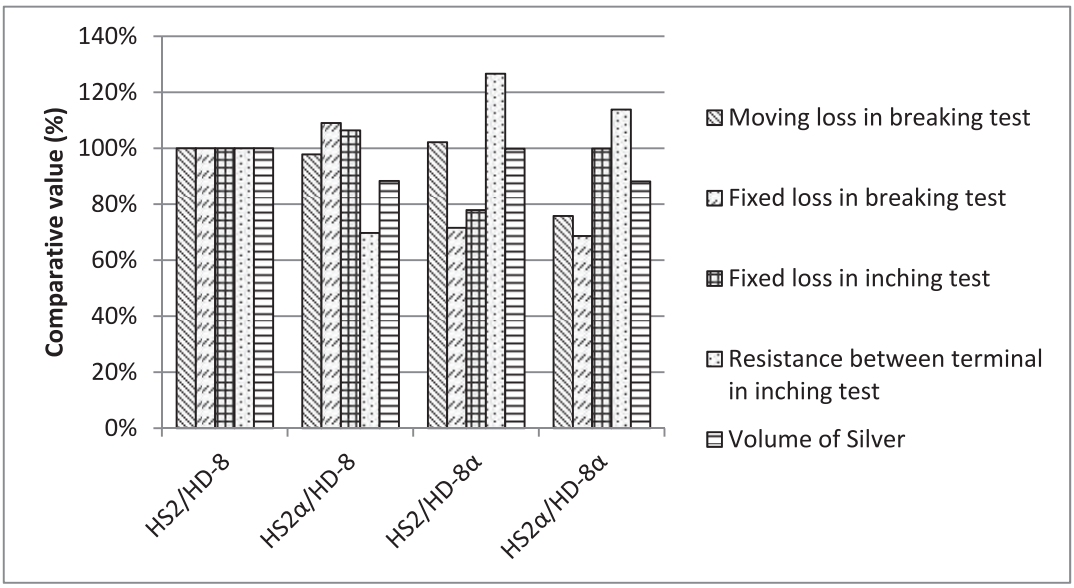

Fig.3 Comparative scores of experiment results of HS2α and HD-8α with a score of 100 % representing HS2/HD-8 (moving/fixed)

3-2) HS2α and HD-8Xα

Fig.4 shows comparative scores of experiment results of HS2α and HD-8Xα with a score of 100 % representing HS2/HD-8X. The resistance slightly increases because of reduced silver, but the overall erosion decreases. In particular, the overall erosion of HS2α /HD-8X is suppressed in the breaking and inching test. With respect to HS2α /HD-8Xα , the erosion under high current load decreases at both moving and fixed tip sides. This also tells that this combination is resistant to high current like HS2α / HD-8α .

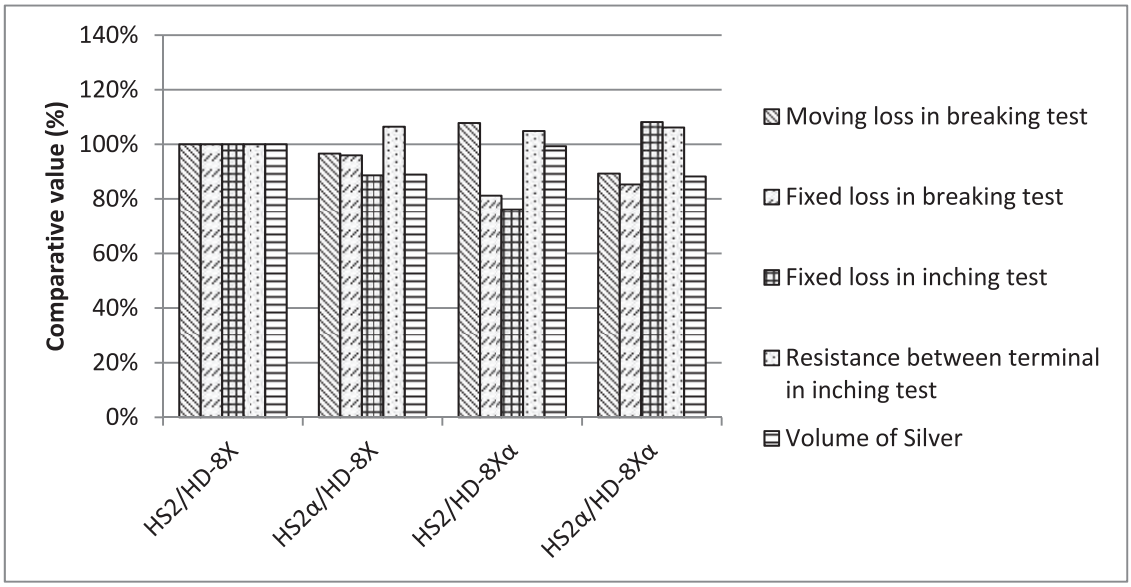

Fig.4 Comparative scores of experiment results of HS2α and HD-8Xα with a score of 100 % representing HS2/HD-8X in electric tests (moving/fixed)

4. Conclusions

In this experiment, we prepared electrical contacts by reducing silver and adding nickel and used them for electric tests.

As a result, we successfully prepared electrical contacts with low silver content having performances close to conventional materials while the performances slightly vary depending on the combination. These electrical contacts seem to be applied to a wide range of applications by using appropriately according to the properties of MCCB.