Understanding the Wear Mechanism of Current Collecting Materials

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1. Introduction

In electric railways, contact wires and pantograph contact strips, which are both current collecting materials, slide in electric contact with each other to supply the vehicles with high power fed from the substation. The lives of these current collecting materials are mainly determined by wear. Therefore, research and development of wear measuring technologies and wear reduction measures are important.

2. Occurrence factor of maximum wear of contact wire

RTRI researchers have worked on the development of a wear tester (Fig.1) capable of capturing the transitional phenomena of wear modes. In order to understand the wear mechanism we think it is better to focus on the transitional phenomena of wear modes, instead of reproducing a wear volume which has been the traditional approach.

We performed a wear test on a combination of a hard-drawn copper contact wire and an iron-based sintered alloy contact strip. The result of the test indicates that there are three distinct wear modes dependent on the contact force and current (Fig.2). This chart shows the maximum wear rate of the contact wire for this test occurs when the contact force is around 10 N. Fig.2 also shows that the wear rate of the contact wire decreases under the condition of arc discharge occurrence (when the contact force is under 6 N in the chart), which traditionally has been considered the cause of maximum wear.

We also have found that, as shown in Fig.3 the wear mode changes when the maximum contact temperature, estimated from the contact voltage, reaches the melting point of each material, i.e., the hard-drawn copper contact wire and the iron-based sintered alloy contact strip. It can be concluded from the above that the maximum wear of the contact wire occurs when only the contact wire melts and forms a “melting bridge” between the contact wire and the contact strip. If the contact strip (Fe) is melted under a certain condition, the wear mode becomes a contact strip melting wear mode, in which case the surface of the contact wire (Cu) has not melted. In this case, the contact wire’s wear rate decreases because the “melting bridge” behavior of the contact wire has been suppressed.

3. Conclusion

In this research, we have found that the increase in the wear of the contact wire is highly dependent on the “melting bridge” phenomenon on the surface of the wire. It has been expected that, in addition to the maximum contact temperatures that we have discussed in this article, there are other factors which affect the “melting bridge” phenomenon. Therefore, we have continued further research into this phenomenon, and at the same time, have been exploring the optimum combination of materials for contact wire and strip, taking into consideration of the other influential factors.

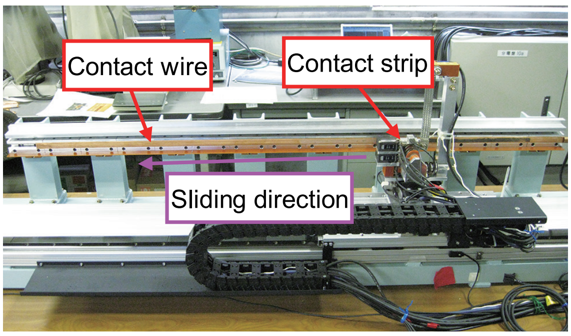

Fig.1 Linear wear test apparatus

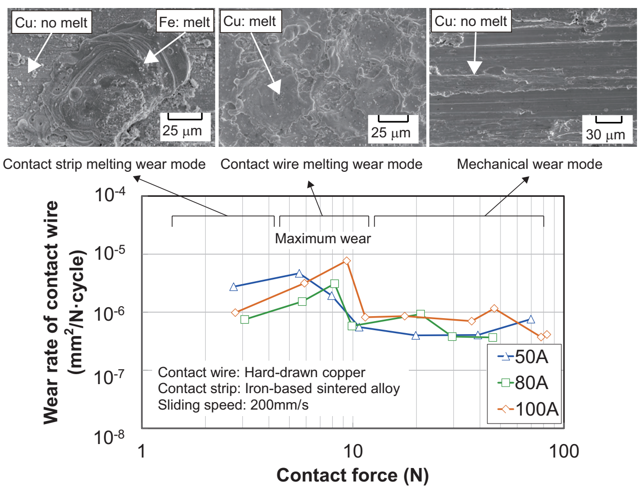

Fig.2 Wear rate and wear surface of contact wire

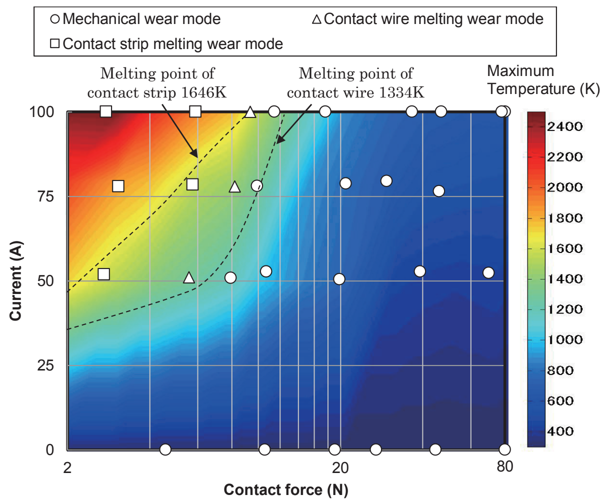

Fig.3 Correlation between wear mode and maximum contact temperature