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Surface Carbonization of Mo-La_2O_3 Cathode①

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Abstract: The carbonized structures of Mo-La_2O_3 cathode specimens have been investigated by means of FESEM and XRD, respectively. The substructure of carbonized layer in the Mo-La_2O_3 cathode has been found for the first time. The results showed that the carbonized layer with uniform Mo_2C was helpful to emission, while the demixing carbonized layer with a compact MoC outside layer was harmful to emission. The uniform Mo_2C layer consists of coarse particles with lots of grain boundary crevices as well as holes arranging perpendicular to the wire axle and up to surface, which was beneficial to the migration of activated rare-earth in activation and operating.

Key words: microstructure; cathodes; Mo-La_2O_3; carbonization; emission **Document code: A**

1 INTRODUCTION

Carbonization is very important to manufacturing direct-heating metallic cathode, which leads to lower the operating temperature and improve the stable emission. In the recent years, the molybdenum added with rare-earth oxides, such as La_2O_3, has been studied as a very hopeful cathode material to replace the radioactive Th-W[1~8] alloy. In carbonized Th-W filament, a W_2C layer forms on the tungsten wire surface and improves the emission[9~11], while there is no report on the microstructure of carbonized layer in Mo-La_2O_3 cathode. Therefore it is important to investigate the substructure of carbonized layer for correctly understanding the mechanisms.

In this paper, the microstructures of carbonized layer of Mo-La_2O_3 cathode have been studied by means of field emission high resolution scanning electron microscopy (FESEM) and X-ray *d* iffraction analysis, respectively. The effects of microstructures on emission property were discussed.

2 EXPERIMENTAL

The carbonized Mo-La_2O_3 cathode specimens used in X-ray diffraction analysis for phase constitution were *d*0.26 mm Mo-La_2O_3 wires with different degrees of carbonization. The SEM analyses were carried out by AMRAY-1910FE.

3 RESULTS AND DISCUSSION

The SEM micrographs in Fig.1 show the carbonized layer with different degrees of carbonization. A carbonized layer has formed on the surface of Mo-La_2O_3 cathode wire after carbonization. The carbonized layer was homogeneous and connected tightly with the matrix. There were lots of grain boundaries and holes arranging perpendicular to the wire axis in the carbonized layer with loose coarse particle structures. Fig.2 shows some holes and crevices of grain boundary on the surface. High resolution scanning microscopy observations indicate that lots of rare-earth oxide particles were concentrated in the holes and also on grain boundaries, as

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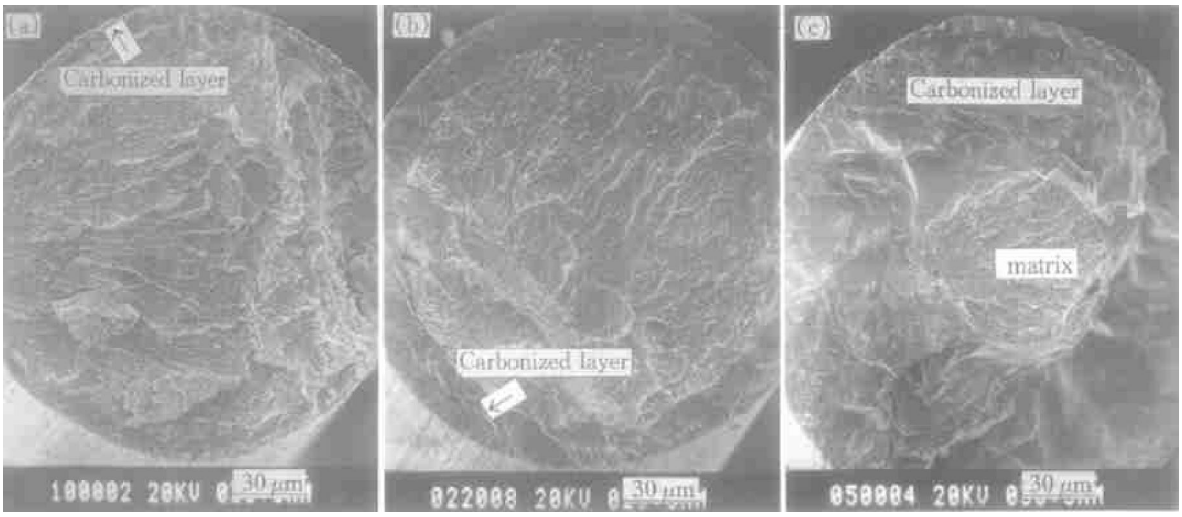

Fig.1 SEM micrographs of Mo-La_2O_3 wires with different degrees of carbonization
(a) —7 %; (b) —22 %; (c) —50 %

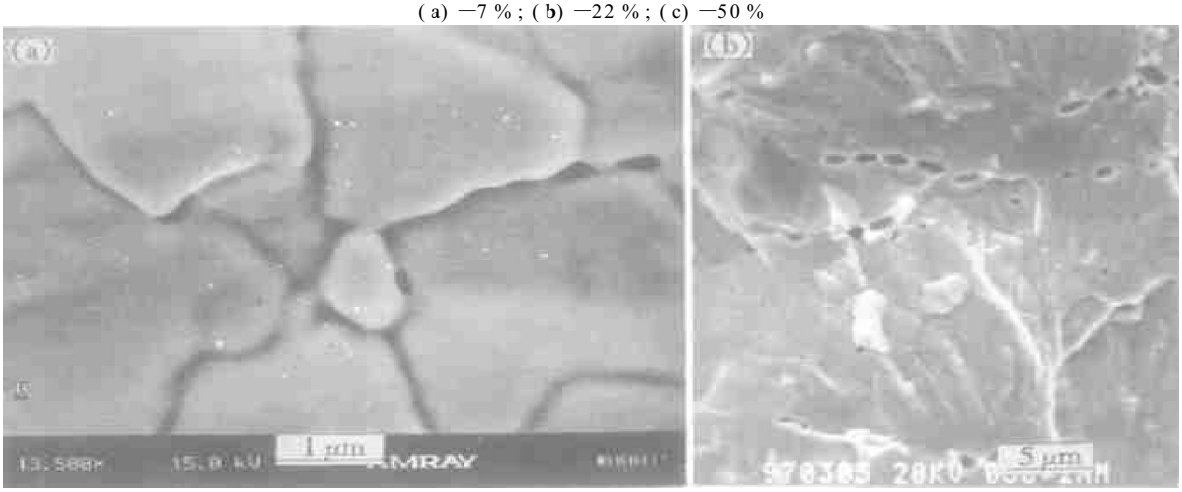

Fig.2 SEM micrographs of carbonized layer
(a) —Surface; (b) —Fracture

shown in Fig.3.

In operation, the effects of carbonization on cathodes were usually beneficial to the emission with higher carbonized percentages[12]. In our observations, a kind of carbonized layer with demixing structure could be seen in some badly carbonized filaments, as shown in Fig.4. By comparison, the outside layer was thinner and more compact than the inside layer. There were fewer holes and no coarse crevices of grain boundary or holes in the outside layer. In view of the appearance of fracture, the outside layer was flatter than inside; the particles were smaller and the structures were more compact in the outside layer.

X-ray diffraction analysis of the two kinds of carbonized filament samples shows that there were Mo_2C formed on the surface of Mo-La_2O_3 matrix in the samples of no demixing, and an additional MoC phase formed in the sample of demixing carbonized layer, as shown in Fig.5.

It may be concluded that a thinner MoC layer was formed on the surface of the Mo_2C layer when the carbonization process was

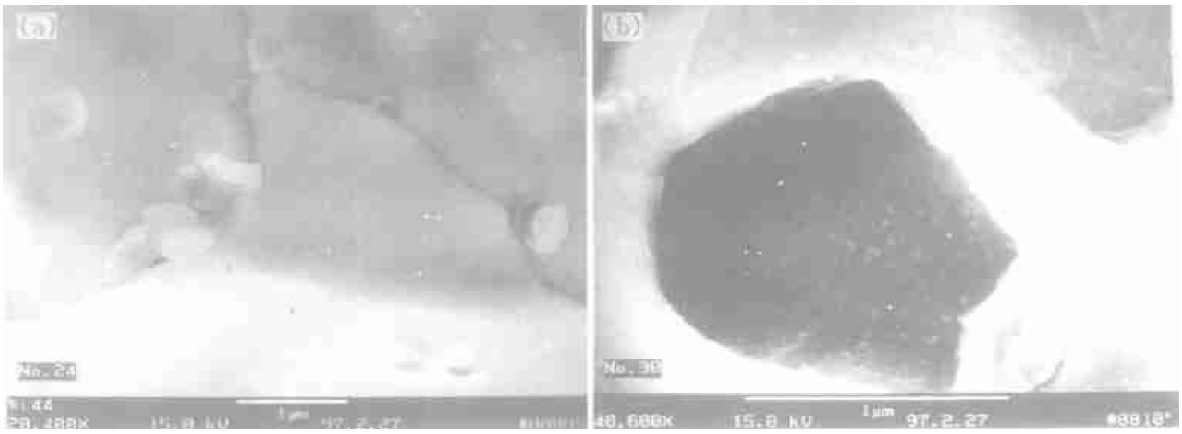

Fig.3 Rare-earth oxides concentration in carbonized layer
(a) —On grain boundary; (b) —In hole

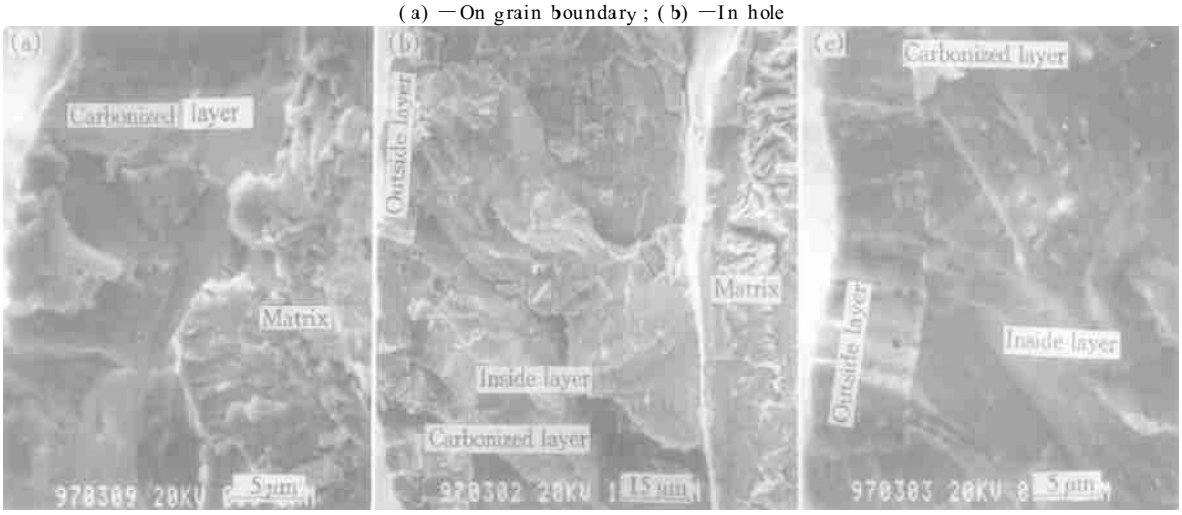

Fig.4 SEM micrographs of carbonized layer
(a) —No demixing; (b) —Demixing structure; (c) —Enlargement of (b)

Fig.5 X-ray diffraction spectra
(a) —No demixing carbonized filaments;
(b) —Demixing carbonized structure filaments

unsuitable, which leads to a hindrance to the migration of rare-earth oxides from inner to surface for its more compact structure. This is harmful to emission.

4 CONCLUSIONS

(1) A carbonized layer has formed on the surface of Mo-La_2O_3 cathode wire after carbonization, which was homogeneous and connected tightly with the matrix.

(2) The carbonized layer with uniform Mo_2C was helpful to emission, while the demixing carbonized layer with a compact MoC outside layer was harmful to emission.

(3) The uniform Mo_2C layer consists of coarse particles with lots of grain boundary crevices as well as holes arranging perpendicular to the wire axle and up to surface.

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