PREPARATION OF DISPENSER CATHODES BY FAST SINTERING METHOD

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ABSTRACT

Dispenser cathodes are the most widely used cathodes in the vacuum electron devices. B type cathode, M type cathode and scandate cathodes are the main kinds of cathodes, which covers the development history of dispenser cathodes[1]. In these cathodes, porous tungsten matrices were usually prepared by a traditional sintering method in a flow of hydrogen, which usually takes several hours. In this work, we used fast sintering methods to prepare the dispenser cathodes matrices.

This paper introduced our recent advances in dispenser cathodes with the matrices prepared by selective laser melting method and microwave sintering method. It was found that the tungsten matrices prepared by selective laser melting had a certain porosity and high roughness. After impregnating with the traditional 411 barium calcium aluminates and 2.5%wt Scandia added 411 impregnations, the cathodes surface were machined. Compared with the untreated surface, the Space Charge Limited current density of machined cathode increased apparently and reached to 10A/ cm^2 at the temperature of 1050^{o}C, which was similar to that of traditional B-type cathodes. On the other hand, the cathode impregnated with the 2.5wt% Scandia added barium aluminates exhibited much higher emission capabilities, about 4 times higher than that without Scandia addition, indicating that Scandia plays an important role in the improvement of thermionic emission. However, its emission property is much lower than the nano-Scandia doped cathode[2,3].

W-Ir alloys matrices with uniform grain size could be obtained by microwave sintering. It was observed that temperature had a great influence on the microstructure of as obtained compacts. At low sintering temperature of 1470 ℃, the grains with average size of 2.5 μm were obtained, and partly formed metal skeleton. The matrix has a high porosity of 37.5% and poor binding strength between the grains. With the sintering temperature increased to 1500 ℃, the grain size grows up to around 3 μm and exhibits a fully inter-connected metal skeleton. Meanwhile, a high bulk porosity of 28.5% was obtained. With further increasing temperature to 1530 ℃, unusual coarsening of the grains took place in the obtained compact and the porosity was down to 17.5% due to the overgrowth of the grains. XRD pattern of compact indicates that IrW compound has formed together with the existence of W and Ir. After impregnation of barium calcium aluminates, Ba_2CaWO_6 and Ba_2CaIrO_6 phases were detected, indicating the reaction was occurred between the matrix and active substances during the annealing process. The current densities of W-Ir cathode were 10.18 A/cm^2, 17.30 A/cm^2 and 20.23 A/cm^2 at the temperature of 1000 ℃$_b$, 1050 ℃$_b$ and 1075 ℃$_b$, respectively, superior to those of the M type cathodes coated with Ir and Ir-W films. These results indicates the greatly improved emission performance of W-Ir MM-type (mixed matrix) cathodes fabricated by microwave sintering.

References

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