Research Progress in new types of Thermionic Cathodes

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ABSTRACT

Thermionic cathodes serve as electron sources in numerous vacuum electron devices, including traveling wave tubes, klystrons and magnetrons et al. These devices use in military, space applications and commercial, for which the requirement to thermionic cathode is different. Space traveling wave tubes emphasize a long and reliable operating lifetime with several hundred thousand hours, high power klystrons require high emission current density and ten thousand hours lifetime, and high power continuous wave magnetrons think a lot of low operating temperature and good secondary electron emission coefficient.

According to the requirement of the above different vacuum electron, various thermionic cathodes are developed, such as directly heated metal cathodes [1], oxide cathodes [2], impregnated coating Ba-W cathodes [3,4] and Sc series Ba-W cathodes et al [5]. At present, oxide cathodes and impregnated coating Ba-W cathodes are most widely used in klystrons, traveling wave tubes and part magnetrons, and directly heated metal cathodes are used in high power magnetrons [6, 7].

In order to satisfy the further development of the vacuum electron devices to high power, high frequency and long lifetime, various new types of thermionic cathodes have been developed in IECAS which including directly heated Re-W / W-ThO_2 alloy cathode, Y-Gd-Hf-O W base directly heated cathode, plasma-sprayed oxide cathode, ammonium perrhenate impregnated W matrix Ba-W cathode and nanometer tungstate cathodes.

The ThO_2-W cathode is applied in 20kW continuous wave magnetron which lifetime is beyond 6000 hours. The dc emission current density of the Y-Gd-Hf-O W base cathode is 3.7A/cm^2 *at 1500 ℃br*, and the Secondary electron emission yield of W doping Y-Gd-Hf-O W base cathode reaches 3.1 at room temperature. The PC emission current density of plasma-sprayed oxide cathode is reached 118 A/cm^2 at 850 ℃. The work function measuring results shows that the initial practice work function of the ammonium perrhenate impregnated W matrix Ba-W cathode is 1.75eV. After 41571h lifetime at a temperature of 1000 ℃br～1010 ℃br and a dc load of 3.0 A/cm^2, the practice work function increase to 1.84eV. And also the PC emission current density of nanometer tungstate cathode is reached 60 A/cm^2.

References

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