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EFFECT OF CATHODE GEOMETRY ON MODES OF CURRENT TRANSFER TO CATHODES OF HIGH-PRESSURE ARC DISCHARGES*

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The general pattern of stable steady-state modes of current transfer to thermionic cathodes of high-pressure arc discharges has been established previously[1,2] for a cathode in the form of circular cylinder with a flat front surface. It comprises a diffuse mode that exists at all currents and a spot mode that exists at low currents. In this work we study a general pattern and stability of steady-state modes of current transfer to thermionic cathodes of complex geometries which are closer to ones of real devices. Axially symmetric tungsten cathodes of two shapes have been considered: rod cathodes with a hemispherical tip and with a spherical protrusion on top; rod cathodes with variable curvature of the front surface.
No 3D steady-state modes of current transfer have been found. For a cathode with a protrusion on its top, there are two separate axially symmetric modes. One of the modes (mode *a*) exists only at low currents and comprises two branches separated by a turning point. The stable branch of this mode is diffuse and there seems to be something that can be identified as a poorly pronounced spot on the unstable branch. The other mode (*b*) exists at all currents, is S-shaped, and manifests a smooth transition from a thermal regime characteristic of the spot mode (at low currents) to a thermal regime characteristic of the diffuse mode (at high currents).
There is a certain current range in which the mode *b* is spot-like while the mode *a* does not exist. In other words, there is a current range in which only a spot mode exists. As the cathode radius decreases (at a constant height of the cathode and a constant radius of the protrusion), this pattern is gradually transformed into the above-described one typical for a cylindrical cathode with a flat surface.
In the case of a cathode with variable curvature of its front surface, only mode *b* was found in the whole current range investigated, from very low to very high currents.
Thus, variations of geometry of a thermionic arc cathode may dramatically change the pattern of steady-state modes of current transfer. In particular, the diffuse mode at low currents may disappear. This effect may play a role in operation of cathodes of arc devices.

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FORMATION OF $CaPO_4$ AND SUPPRESSION OF Ni LEACHING IN NITINOL USING OXYGEN AND SODIUM PLASMA IMMERSION ION IMPLANTATION

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Clinical applications of nitinol have been hampered by the high toxic nickel content. Our previous studies demonstrate that oxygen plasma immersion ion implantation (PIII) can mitigate nickel leaching and enhance the corrosion resistance. However, the oxygen-implanted layer does not bond well to bones *in vivo*, thereby leading to potential mechanical failure at the bone-implant interface. Sodium and titanium PIII may enhance the surface bioactivity of titanium and this study investigates the feasibility of apatite formation and enhancement of corrosion resistance of nitinol using combined Na and O PIII. Nitinol discs are implanted with oxygen plasma at 40 kV and 100Hz for 2 hours and some samples are subsequently treated by sodium plasma at 15 kV at 200 Hz for 3 hours. The elemental depth profiles and chemical composition are determined by X-ray photoelectron spectroscopy, and the bioactivity and cytotoxicity are assessed by immersion tests in simulated body fluids and cell cultures respectively. The SEM and EDS spectra indicate that the Na&O-PIII and Na-PIII samples are capable of attracting Ca and P rich deposits onto their surface after SBF immersion. The corrosion potential increases from 300 mV on the untreated nitinol to 850 mV on the Na&O-PIII sample and so the corrosion resistance is significantly improved. The quantitative results of the cell attachment tests indicate the cells seeded onto both surface modified nitinol spread more compared to the untreated nitinol. The amount of calcium phosphate deposited on the surface of the Na-PIII sample is lower than that on the Na&O-PIII sample and the reason appears to be directly correlated to the amount of sodium implanted to the surface. In our experiments, energetic Na ions are implanted, thereby changing the chemical composition and surface morphology of the nitinol substrate. The number of osteoblasts attached on the Na&O-PIII sample is significantly higher than that on the untreated one. Both plasma implanted nitinol samples show better osteoblast adhesion, suggesting that Na plasma ion implantation contributes to the enhanced biological performance.

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