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Investigation of arc binding to the hafnium cathode at atmospheric pressure

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Our researchers present investigation of the argon and air arc binding to the hafnium cathode at atmosphere pressure. Working DC current is about several hundred amperes. Experiment was made on a plasmatron with a conical water-cooling cathode. Anode is presented by expanding copper channel. We assume that plasma of positive column is in LTE. It allows using the method of relative intensities for measurement of the electron temperature in positive column. Electron concentration is determined by the Stark broadening. Surface cathode temperature is measured by the high-speed camera which is used as a pyrometer. Obtained results are compared with the results for the pure tungsten, lanthanated tungsten (W-2% La_2O_3) and thoriated tungsten (W-2% ThO_2) cathodes.

Arc discharge is one of the widely used discharges in different areas such as metallurgy, surface treatment, welding etc. Understanding of plasma-physical processes creates opportunities for optimization of industrial plants [1, 2].

In this paper, we present results of the investigation of the arc binding to the hafnium cathode in argon and air at atmospheric pressure.

Experimental setup includes the cathode which is embedded in the copper water-cooling cathode holder and anode which is presented by the expending copper channel and vortex stabilization of the plasma torch [3, 4]. Working DC current was about several hundred amperes.

Assuming that plasma of positive column is in LTE creates an opportunity to use spectroscopy measurements for the electron temperature which is made by the spectrometer DFS-452. Electron temperature is determined by the method of relative intensities of the spectral lines from the same element and different ionization order. Electron concentration is determined by the Stark broadening. In argon plasma the spectral lines Ar II and Ar III were used with the wavelength 363.7 nm and 329.3 nm respectively.

Plasma parameters were measured at different distances from the cathode tip with the spatial step 0.1 mm.

A high speed black and white camera Phantom Miro M110 with the spatial resolution of about 25 micrometers was used for measuring the temperature distribution on the cathode surface. For the cancellation of the plasma stream we used an interface filter which is placed in front of the camera lens (for example for argon lens with an allowed bandwidth of 589 nm was used). Etalon tungsten lamp with a brightness temperature 2400 K was used to perform the calibrations.

All measurements were performed after some work time (tens minutes) of the plasma torch. Obtained plasma parameters are compared with the results (plasma temperature, electron concentration and cathode surface temperature) for the pure tungsten [4], lanthanated tungsten (W-2% La_2O_3) [3] and thoriated tungsten (W-2% ThO_2) [6] cathodes. Optimal plasma parameters for electric-arc technology can be obtained based on the comparison of the different results of particular discharge parameters.

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