Next Generation High-Temperature and High-Current Switching Converters

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Nowadays cosmic and earth-based nuclear power industry specifies stringent requirements to the research and development sector in view of its necessity for the total control over the current density, smooth failure-free operation of energy-generating plants under extreme conditions at high radiation levels and temperatures above 1000 K. The application of high-current thermionic cesium-barium switching devices meets one of those requirements. The results of the research into plasma’s electro kinetic parameters of Knudsen high-current diode and triode switching devices are presented below.

- Unique regimes of effective grid discharge quenching were attained: the increase in the modulated power is accompanied by the decrease in the power consumption – this is of particular importance for the purpose of current control in triode switching devices.

- Unprecedented energy parameters were obtained: stable frequency modulation in the range from 1 to 10 kHz, an anode potential of 50 V, the electric power density of 5 kW/cm² and the resultant efficiency is above 95%.

Experimental results, obtained with the grid-less modulator based on the thermionic diode:

- The current modulation is produced as a result of plasma structure generation in the electrode gap without applying any external forces. Such structures are developed due to electron instabilities in plasma.

- The experiments with the Cs-Ba Knudsen diode testify to demonstrate the feasibility of creating a full current modulation at an ignition voltage of 5…6 V and a discharge current density of ~10 A/cm². At a gap of 0.2…2 mm, a stable current and voltage modulation of 5…20 kHz is maintained under Cs pressure range from 1.5·10⁻³ to 3.5·10⁻³ Torr.

- The possibility of the modulation process control via additional external forces (auxiliary discharge, electric and magnetic fields) was discovered; which is definitely promising in terms of widening the range of parameters and functionality of the diode-modulator.