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Modeling of Thermionic Devices With Nonequilibrium Inert Gas Plasmas SERGEY MACHERET, MIKHAIL SHNEIDER, RICHARD MILES, Princeton University — Large temperature gradients occur between surfaces exposed to high temperatures associated with aircraft engines and external surfaces, and thermionic devices may offer a way of converting a significant portion of the heat flux into electricity. We theoretically study a possibility of operating thermionic devices with self-sustained or auxiliary nonequilibrium ionization in inert gas filled cells, without the conventionally used cesium vapor. Modeling of plasma kinetics shows that under certain conditions (low pressure, relatively high voltage and emitted current) the electric field-induced heating of plasma electrons can result in self-sustained ionization sufficient for the argon-filled device functioning without external ionization. The self-sustained nonequilibrium ionization regime is also characterized by oscillations of electron temperature and density, with the frequency determined by ion motion. At relatively low voltages or emitted currents, the heating of plasma electrons is not sufficient to sustain the ionization, and repetitive short pulses are shown to be capable of sustaining the plasma in an argon-filled device, with only a small fraction of the generated power spent on the auxiliary ionization.

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