VARIATION OF ELECTRON BEAM GENERATOR BASED ON OPEN DISCHARGE WITH RUNAWAY ELECTRONS ALLOWING FOR SUBSTITUTION OF PROCESSING MEDIUM INSIDE DISCHARGE CHANNEL [[1]](#footnote-1)\*)

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An electron beam (EB) generator based on steady-state anomalous high-voltage glow discharge, known as open discharge (OD), features a cylindric discharge channel with length and diameter of the order of the tens of a centimeter. The potential drop between the electrodes is usually in the range of units of kilovolts. The anode in such devices is either a mesh or a diaphragm with high geometrical transparency that allows for the majority of the accelerated electrons to leave the discharge channel without restriction. The produced electron beam forms a spatially nonuniform plasma as it decelerates in the processing medium. Operational aspects of these EB generators were extensively studied and presented in [1,2].

It is particularly advantageous for technical applications that EB generators based on OD are capable of forming highly energetic electron beams directly in the processing medium with no focusing or ejection systems involved, considerably reducing the weight-and-dimensional characteristics of the generator and its attendance. The energy efficiency of a stationary OD is usually in the 75-85% range, depending on the generator design and the processing medium of the choice [3]. Still, the area of application for currently existing devices stays limited due to a strong dependency of the EB generators operational efficiency on the processing medium parameters. Both the energy efficiency and the working pressure are at their maximum when the EB generator functions in the light noble gases free of air impurities, as shown in [4].

This report presents the results of the experimental investigations of the operational efficiency of the OD EB generators design variation that allows substituting the processing medium inside the discharge channel with another one by blowing a substituent gas through the channel. This addition to the design helps to achieve the highest possible energy efficiency of the beam, which indicates that the average kinetic energy of the accelerated electrons approaches the accelerating voltage. The substituent gas is considerably different, both kinetically and chemically, from the medium surrounding the EB generator where the electron beam decelerates and forms a plasma cloud. The report discusses the influence of the EB generator design variation on its operational efficiency. It also includes specific data on the discharge characteristics (the breakdown voltage, maximum pressure for both processing medium and substituent gas, current-voltage curves dependencies on the intensity of the substituent gas flow, and overall stability of the discharge) for the case when the processing medium is air and the substituent gas is helium. The report compares the current-voltage curves of the alternated EB generator (the substituent gas is up to 2500 Pa of helium) to the ones of a standard one in the same processing medium of air within the pressure range from 1000 to 2500 Pa.

References

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