EXPERIMENTAL STUDIES ON COLD CATHODE MAGNETRON GUN

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Abstract

Experimental data on obtaining electron beam by the magnetron gun with a cold cathode are presented. Two possible emission mechanism such as electron secondary emission and explosive emission as well as methods of identifying it are discussed. Data on measuring amplitude and form of the beam current pulses and the beam diameter with variation of the electrical and magnetic fields are given. The final aim of these researches is production of the stable pulse beam with the currents nearly 100 amperes and the long life time of the gun. The research is carried out to create the magnetron injection gun for the high power cluster klystron for the Next Linear Colliders.

I. EXPERIMENT

This paper presents the experimental results of electron beam generation in a cold-cathode magnetron gun, operating in secondary-emission mode [1].

The research was performed on an experimental facility which contained a negative HV-pulse source, the pulse of the amplitude $U \leq 40$ kV and width 0.5-2.0 μs being fed on to a finger-like copper cathode, while the anode, made from a stainless steel tubing 35 mm in diameter, 250 mm long, was grounded via resistor. The gun was placed in a pulsed magnetic field of the strength $H \leq 0.5$ T. The beam current was measured using the resistor connected to an electron collector.

The above-device was used to measure the relationship of beam current amplitude vs. magnetic field strength H (Fig. 1) which has a threshold nature of beam current rise and disruption.

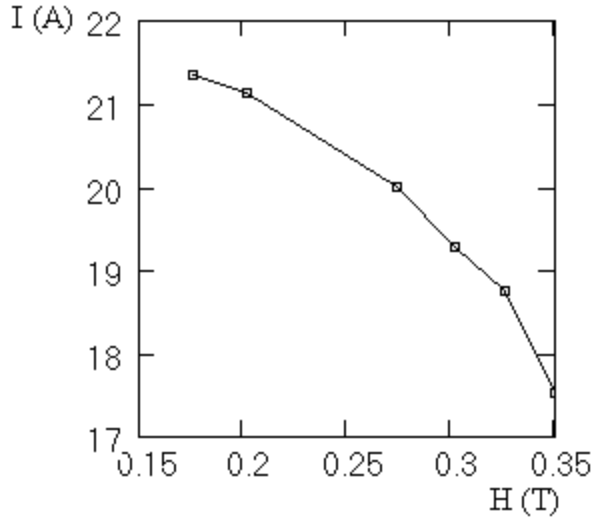

Fig. 1. $U \cong 40$ kV

Particle energy measurements were made using the technique of absorption of the particle energy in aluminium foil 10 μm thick. During the measurements the absorption coefficient was ≅0.1 corresponding to electron energy about 32 keV, the voltage pulse amplitude being 39 kV and magnetic field 0.2 T. The peculiarity of these measurements had to do with a decreasing longitudinal electron pulse caused by spiral-line electron motion in the magnetic field.

The beam dimensions were measured by producing its imprint on photo-film, photo-paper and thin metallic foil in two cases: 1) for cathode diameter 5 mm and 2) for cathode diameter 8 mm. The beam had annular transverse cross-section. In the first case, the beam outer diameter (OD) was 9.5 mm and its inner diameter (ID) 5.5 mm (U=40 kV, H=0.3), in the second one, its OD was 15 mm and ID - 9 mm (U=40 kV, H=0.25 T).

Upon increasing the voltage pulse duration, it was observed that current grew in the beam current pulse which exceeded the secondary emission current pulse amplitude by a factor of 1.5-2.0 and had a serrated top. Concurrently, the chamber pressure grew from $3.0*10^{-5}$Torr to $1.0*10^{-3}$Torr. From our view-point this is associated with gas desorption from electrode surfaces under the impact of bombarding electrons, and, as a consequence, with development of breakdown in the anode-cathode gap [2]. In order to preclude this undesirable phenomenon one has condition and heat the electrodes in vacuum.

In all our results demonstrate the feasibility on construction of a powerful cold-cathode electron gun with long pulse duration.

REFERENCES

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