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Implantation of Electrons into the Glass †

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Abstract: The objective of our work was to study the behavior of glass that is subjected to electronic bombing. In the context of this work, we first studied theoretically the establishment of electrons in a material—in this case, glass. We postponed the penetration of the electrons according to their acceleration and the density of the material, then we established the electric field within the material according to the fluence, thus referring to the conditions enabling the destruction of the material. However, for some materials this breakdown depends on several parameters. In the second step of the study we were interested in the realization of an electron cannon to provide a bundle of focused and energetic electrons; more precisely, we discuss this on basis of the practical design. In this instrument, the electrons are accelerated under high tension. We chose to postpone in this work the thermal current as a function of the tension, and we subsequently discuss the assembly chosen.

Keywords: electronic bombing; fluency; the implementation of electrons; thermionic current

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1. Introduction

Ionic implantation is among the techniques used to synthesize nanoparticles buried in a material [1]. This technique, therefore, consists in introducing a foreign species into material targets with a given energy during its passage in the matter.

As part of this work, we explore in the first part the theoretical study of the implantation of electrons in a material—in this case, glass.

Secondly, we are interested in the realization of an electron cannon to provide a bundle of focused energy electrons.

We are also interested in the study of the behavior of inorganic lenses subject to electronic irradiation.

Our problem is the behavior of the glass subject to electronic bombing, and the conditions of the destruction of this material.

For this, our purpose is the production of more powerful and energetic electrons which are able to penetrate the glass and cause damage inside this material.

The rest of this paper is organized as follows: in the second section, we present the proposed method with the result related to the thermal current. Finally, Section 3 summarizes the overall work in a conclusion and discusses some future directions.

2. Materials and Methods

2.1. Implementation Processing

The electrons are introduced into the glass, which is located in a system within the system; then, these electrons emitted via a filament with an electrical voltage are applied to the outlet of the room, allowing for the acceleration of the latter. This beam then crosses an electric field, which is focused and then accelerated to energies between 10 Kev and 100 Kev [2].

Thus, a homogeneous beam strikes the target. Then, we count the number of loads arriving on this target to determine the dose of the implants. To summarize this simple description, we can say in our case that the electronic barrel is the electronic gun that provides the electrons.

2.2. Canon A Electron Design

Practical Realization

The cannon is made in a tungsten-shaped, v-shaped filament (cathode). In practice, you can use a tungsten filament, formed as a hairpin, which is heated using an electric current via a Joule effect to a temperature of the order from 1900 to 3000 °C [3]. The electrons are extracted from the filament and, once out, these are attracted by the (positive) anode.

The Wheel cylinder has more negative potential than the cathode. Its role is to repel electrons on the axis. The emitted electrons passing through the Wehnelt cylinder are focused on the crossover between the cathode and the electrode. This crossover plays the role of being an electron source for the optics of the microscope.

The anode operates at a negative potential, creating a potential difference with the cathode (approximately 100 kV) responsible for the acceleration of electrons at the outlet of the filament.

Since the distance between the cathode and the Wheel cylinder is very critical, we have equipped the barrel with an axial displacement system from the cathode (Figure 1), which allows it to be easily put in place.

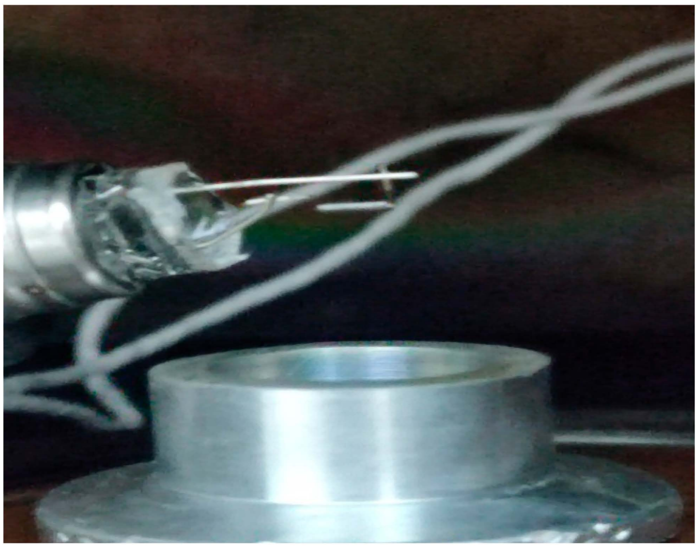

Figure 1. Canon A electron (the practical design of the latter is made up of three important elements: a Tungsten filament, Wehnelt cylinder, and anode).

2.3. Theoretical Calculation

Operation of Canon A Electron

Now we apply a potential difference V between the anode and the cathode. To do so, we direct part of the electrons which are located in the vicinity of the cathode toward the anode, thus creating a current, which is a fraction of JS [4]; the number of electrons available for the anodic current increases with the potential V. Their average speed V also increases with V.

Speed for production electron:

$$\frac{1}{2}\mathrm{mv}^2 = \frac{3}{2}\mathrm{kT} \tag{1}$$

We deduce the speed expression to be:

$$v = \sqrt{\frac{3KT}{m}} \tag{2}$$

In this case, the value of the JS current density is:

$$JS = AT^2 \exp\left(-\frac{W_0}{KT}\right) \tag{3}$$

where

$$A = \frac{4mK^2 e\,\pi}{h^3} \tag{4}$$

Or, the electron acceleration speed value is given using the following relationship:

$$\frac{1}{2}mv^2 = eV \tag{5}$$

$$v = \sqrt{\frac{2eV}{m}} \tag{6}$$

We can deduce the density of the electrons to be:

$$n = \frac{j}{ev} = \frac{AT^2 \exp\left(-\frac{W_0}{KT}\right)}{e\sqrt{\frac{3KT}{m}}} \tag{7}$$

So

$$J = \frac{AT^2 \exp\left(-\frac{W_0}{KT}\right)}{e\sqrt{\frac{2eV}{m}}} e\,v \tag{8}$$

and

$$J = \frac{AT^2 \exp\left(-\frac{W_0}{KT}\right)}{e\sqrt{\frac{3kT}{m}}}\, e\sqrt{\frac{2eV}{m}} \tag{9}$$

In practice, we can show that:

$$I_C = BV^{1/2} \tag{10}$$

Or that B is constant.

This expresses the proportionality of the current to the power of 1/2 of the applied voltage, established for flat electrodes and still valid for any field of the form as soon as the emission of electrons is intense enough for the phenomenon of the space charge to be significant.

At the end of the process, we can find that the value of the practical IC current is proportional to the theory (see Table 1).

Table 1. Current values as a function of the voltage.

V	C1	C2	C3	C′1	C′2	C′3	C_T
3055	611	608.3	0.12	619	610	25.3	25.18
5150	613	612	0.21	621	620	26.8	26.59
8085	614	610	2.24	623	620	29.85	27.61
10600	612	609	4.43	628	625	32.32	27.89

V: tension V; C1: Current 1 without filament UA; C2: Current 2 without filament UA; C3: Current 3 without filament UA; C′1: Current 1 with filament UA; C′2: Current 2 with filament UA; C′3: Current 3 with filament UA; C_T: thermionic current UA.

The table shows the different values of the currents in two cases when the filament is light and extinguished (Figure 2).

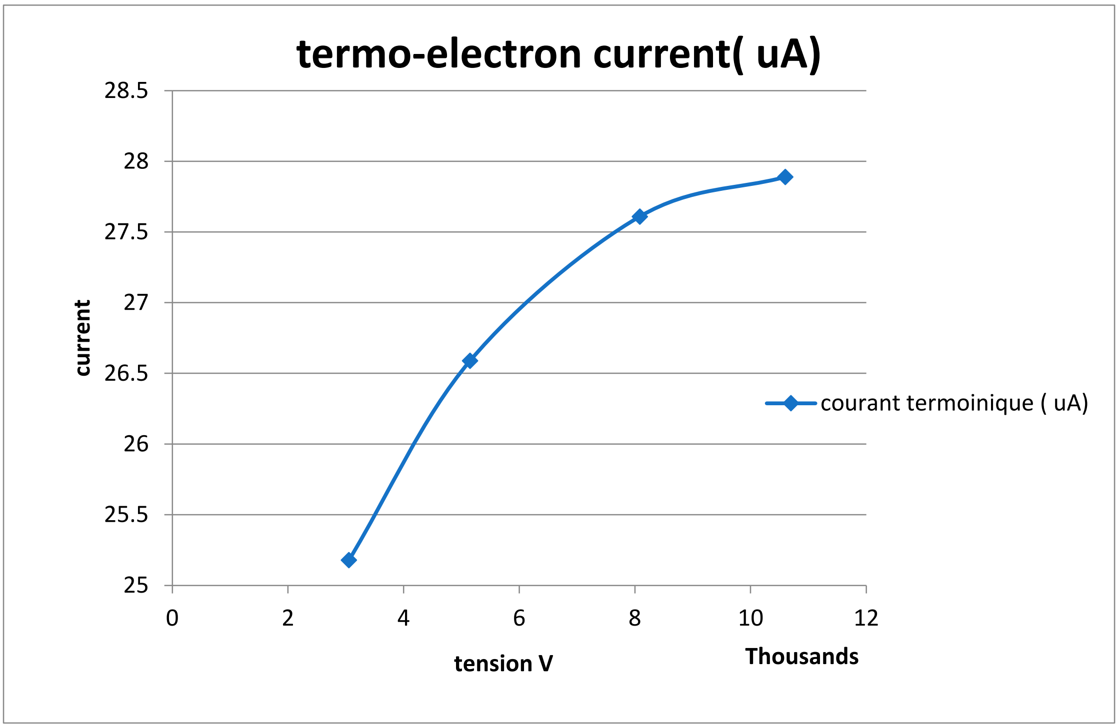

Figure 2. Thermo-electronic current representation of a different function of the voltage value.

3. Conclusions

In this article, we have studied the phenomenon of the insertion of electrons into glass, acknowledging the major problem of how the latter is created. To do this, we created an electron cannon that produced the electrons and accelerated them a way that could penetrate the glass briefly and with high tension.

The experimental results show that the creation of these electrons allowed us to obtain a thermo-electronique current which was of proper tension and on suitable for the moment in which we obtained the saturation.

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