

INFLUENCE OF CATHODE MATERIAL WORK FUNCTION ON SECONDARY EMISSION OF ELECTRONS INDUCED BY METASTABLE STATES IN GASES

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Abstract. Influence of work function of cathode material on time delay of electrical breakdown in argon-filled (at 6 mbar) diode has been investigated. The results obtained confirm that time delay of electrical breakdown increases with increasing of electrode material work function for complete "memory curves" in wide range of τ values.

1. Introduction

Metastable atoms or molecules have a significant influence on the duration of the breakdown time delay in gases. It was shown that for long time delays the breakdown is initiated by electrons released from the cathode by metastables impact. The study of time delay distributions makes possible the discrimination between electrons released from the cathode by positive ions from those released by metastable atoms [1].

For most gases secondary emission of electrons from the cathode due to the bombardment with positive ions is predominant. However, the influence of secondary emission induced by the bombardment with metastable atoms or molecules of some gases cannot be ignored. For example, for the argon-filled diodes with tantalum electrodes, coefficient of secondary emission of electrons due to the bombardment with positive ions and metastable atoms has the values of 0,023 and 0,022, respectively [2,3].

The purpose of this paper is to present the experimental results of an investigation of the influence of electrode material work function on the time delay of electrical breakdown in argon filled diode.

2. Experiment

The measurements of memory curves , i.e. time delay of electrical breakdown (t_d) as a function of a constant time between two successive measurements (τ) were performed on a diode with three pairs of electrodes of different materials (Al, Pb and Mo), with 5 mm gap length, filled with 6 mbar Ar with less than 1 ppm O_2 (Matheson Co) (Fig. 1).



Fig. 1 Argon-filled diode with a 5 mm gap

The time (τ) is the constant time interval between two successive measurements during which is no voltage at the diode.

Measurements of t_d as a function of τ have been carried out using circuit suggested in our previous papers [4,5], at an operating voltage (U_w) 20% higher with respect to the static breakdown voltage (U_g). Measurements were done with the diode in darkness in order to avoid the influence of the photoelectric or other effects. This made possible a more exact measurement of the time delays in case when breakdown is initiated by secondary electrons released by metastables.

3. Results and discussion

Figure 2 shows the results of measurements of t_d as a function of τ , for the diode with electrodes of Al, Pb and Mo (Fig.1). Each point on the curves represents the mean value of a set of 100 measurements of t_d . Work functions of Al, Pb and Mo are 3,74, 4,02 and 4,63 eV, respectively [1].

From Fig. 2 it can be concluded that for the conditions given in this experiment, time delay t_d increases with increasing of electrode material work function for all dependences of

$$t_d = f(\tau).$$

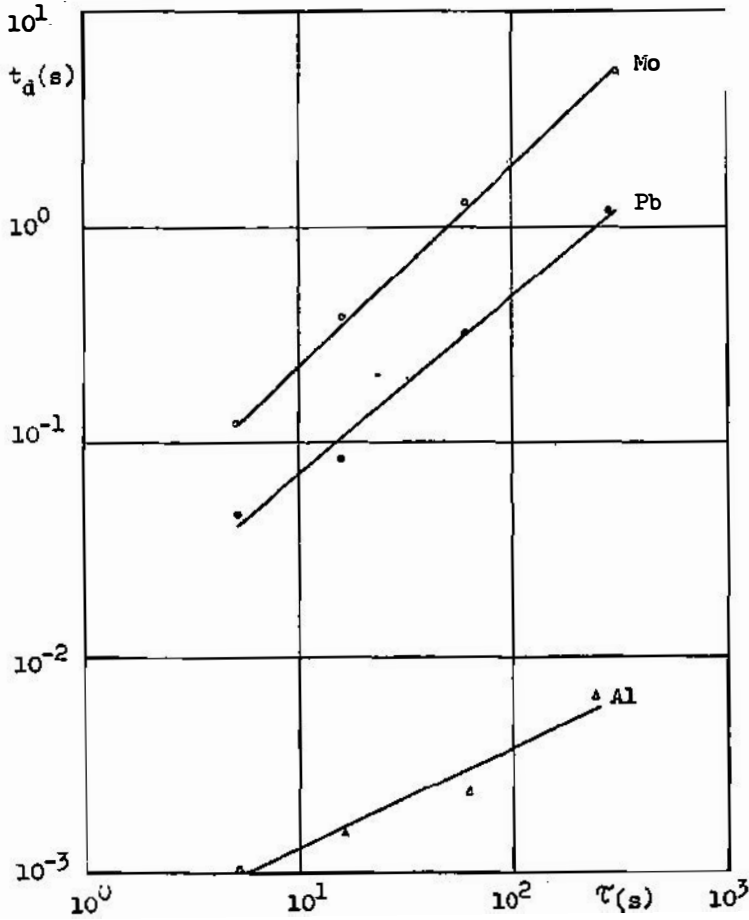


Fig. 2 Time delay (t_d) as a function of the time between two successive measurements (τ)

Figure 2 also shows that the saturation of the curves was not reached even at $\tau = 300$ s. The explanation for this phenomenon is the presence of some long living metastables responsible for secondary emission of electrons from the cathode.

For the first time, here are shown the results of the curve measurements of $t_d = f(\varphi)$ in an argon filled diode. The same functional dependences were also observed previously but for a nitrogen filled diode [3]. These similar dependences result in a conclusion that the time delay of the electrical breakdown depends, in a wide range of φ values, on the cathode material regardless of the kind of the gas.

4. Conclusion

From figure 2 it can be concluded that under given conditions the time delay t_d increases with increasing of electrode material work function.

These results confirm the previously reported fact [3], stating that the coefficient of secondary emission of electrons released by N_2 metastables ^{decreasing} with increasing of cathode material work function.

The described results are also in accordance with earlier papers [6,7,8] on experiments made in very different conditions, i.e. in dry air and at much higher voltages or under different other conditions.

We emphasize that the measuring of t_d can be utilised as a very reliable comparative method for the determination of material work function.

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