



# NOTE ON THE SELF-SUSTAINING CREEP DISCHARGES IN GAS AT THE DIELECTRIC SURFACE

J. Klobukowska, J. Brzosko

► To cite this version:

J. Klobukowska, J. Brzosko. NOTE ON THE SELF-SUSTAINING CREEP DISCHARGES IN GAS AT THE DIELECTRIC SURFACE. Journal de Physique Colloques, 1979, 40 (C7), pp.C7-469-C7-470. 10.1051/jphyscol:19797228 . jpa-00219210

**HAL Id: jpa-00219210**

**<https://hal.science/jpa-00219210>**

Submitted on 4 Feb 2008

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

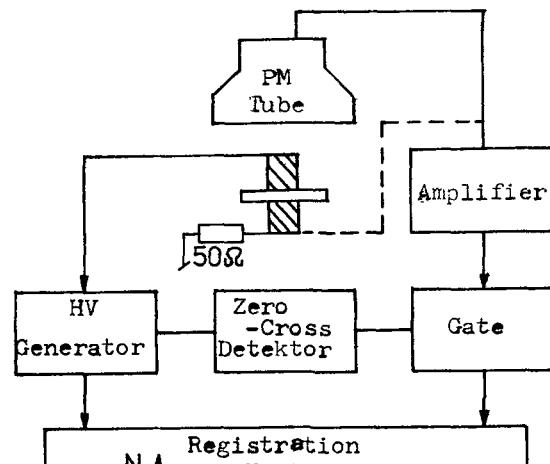
## NOTE ON THE SELF-SUSTAINING CREEP DISCHARGES IN GAS AT THE DIELECTRIC SURFACE

J. Kłobukowska and J.S. Brzosko.

*Institute of Physics, Warsaw University Branch, Białystok, Poland.*

When a thin dielectric specimen is placed between flat cylindrical electrodes of a diameter much smaller than that of the specimen and alternating voltage,  $V = 50$  Hz is applied, creep discharges take place in the gas phase near the surface. The discharges concentrate in narrow channels oriented radially with respect to the electrode and may be registered by means of a photomultiplier (flashes) or charge amplifier (apparent charge). Study of the conditions in the plasma channel requires investigation of the discharge self-sustenance. In this note the preliminary results are given which provide a basis for checking the validity of Paschen's law as the self-sustenance criterion. The electric field intensity near the electrode edge can be approximated by the quasi-uniform field up to the critical distance  $R_0$ . The calculations based on the equivalent circuit method [1], [2] reveal that  $R$  is strongly dependent on the damping parameter

which strongly depends on the effect of injection of carriers into the specimen [3]. The discharges were detected by means of a high sensitivity and low noise level photomultiplier or a charge amplifier working in the pulse regime. The electronic set-up (Fig. 2) allowed us to measure the voltage characteristic of the discharge intensities and to determine the inception voltage  $U_0^{inc}$ .



$$U_0^{\text{inc}} = p R_0 B \ln^{-1} [A p R_0 \ln^{-1} (1 + \frac{1}{\gamma})]$$

where  $p$  is the pressure of the specimen ambient gas,  $R_0$  is equivalent distance between flat electrodes for the discharge channel fitted to best agreement with experimental data.

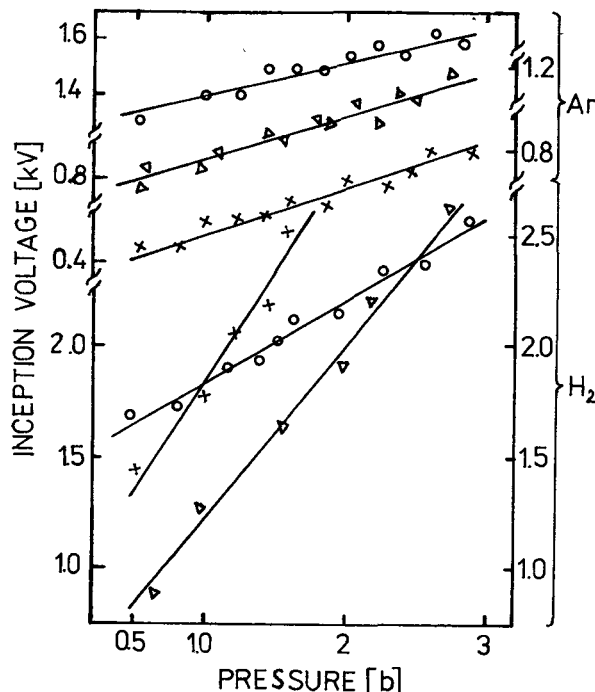


Fig.3

The coefficients  $A$ ,  $B$  and  $\gamma$  were taken from the literature for plane geometry and the investigated gases for example from ref. [4]. The values of  $R_0$  obtained as a result are of the order of  $4 \times 10^{-3}$  cm for argon,  $2 \times 10^{-2}$  cm for air, and  $5 \times 10^{-2}$  cm for hydrogen. The values of  $U_0^{\text{inc}}$  are 1 - 3 times smaller than the measured ones. Additionally the dependence of  $R_0$  on the thickness of the sample was checked. An increase of the specimen thickness induced an increase of the range of the effective electric field, due to the lowering of the damping parameter  $\alpha$  (see Fig.1). As a result longer sparks are allowed, what corresponds to the experimental results;

$$h = 0.22 \text{ mm} \quad \text{and} \quad R = 4 \times 10^{-3} \text{ cm},$$

$$h = 1.3 \text{ mm} \quad \text{and} \quad R_0 = 6 \times 10^{-3} \text{ cm}.$$

The results of our measurements allow us to draw the following conclusion:

1. Paschen's law is qualitatively fulfilled for the creep sparks for pressure as well

as for spark length variation, which suggest that the discharges are self-sustaining

2. The spark length  $R_0$  is of the order of  $10^{-2}$  cm, which corresponds to the field intensity of the order of  $10^5 \text{ Vcm}^{-1}$  and damping parameter  $10 - 100 \text{ cm}^{-2}$ . As a result our quasi-uniformity assumption of the electric field is fulfilled, see Fig.1.

3. No dependence on the polarity of the electrode has been observed for the untransparent bakelite BC, see Fig.3.

4. The absolute values of  $U_0^{\text{inc}}$  are strongly dependent on the specimen material even for similar  $R_0$  magnitudes (see Fig.3).

Taking into account that the discharge time is of the order of  $10^{-8}$  s even for sparks 1 cm in length [5] and that  $U_0^{\text{inc}}$  is independent of polarity of the electrode we can suggest that self-sustenance is based on photoionization effects as well as exchange of carriers between the plasma channel and the specimen surface.

## References:

- [1] Busch K., Raport Elektrot.Z., A 92, 1971 604
- [2] Brzosko J.S., Grudziński J., Konarzewski A., Wojewódzka A., Żukowski E., J.Phys.D:Appl.Phys. 10 1977 1583
- [3] Brzosko J.S., Żukowski E., Grudziński J., Żukowski W., Konarzewski A., I.E.E.E. Transactions 1979, accepted for publication
- [4] Babikow M.A., Komarow N.S., Siergiejew A., Technika Vysokich Naprażeń, Gosenergozdat, Moskva-Leningrad 1963
- [5] Kärkkäinen S., 1974 Finland Tech. Res. Centre Rep. vol.6