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EXPLOSIVE EMISSION IN GUIDED SLIDING DISCHARGES

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In [1] a method is proposed for controlling the development process of the discharge of a sliding spark along the surface of a film-type dielectric by the introduction into this surface of centers of emission consisting of chemical compounds with a low work function of the electrons.

The present article is devoted to an investigation of the nature of this means of control. Special experiments were set up which showed that the determining effect on the control is that of microexplosions of individual particles entering into the surface. The data of Fig. 1a (photograph of a sliding spark from the side) illustrate this assumption. The scattering of luminescing fragments of the emission centers (the visible diameter of the channel is approximately 0.5 mm) is clearly visible. The size of the fragments scattering with microexplosions is 10-100 μm. The size of the individual particles entering into the surface is ~200-500 μm. With projection of the axis of the channel of the discharge along the slit of the photorecorder (a streak camera), it is observed that microexplosions arise not only at the moment of the closing of the discharge gap (in Fig. 1b this moment is shown by an arrow), but also in incomplete stages of the discharge at moments corresponding to "surges" of the capacitance current [2] (Fig. 1b, 1 and 2).

It has been found that the visible intensity of the microexplosions depends to a considerable degree on the melting point of the metals of which the individual particles are made up. (Control is attained by the deposition of a surface film of varnish in which metallic powders are suspended). If part of the guiding band is deposited using titanium powder (T_{mp} = 1600°C), and if it is then prolonged using metallic calcium powders (T_{mp} = 850°C), then the development of a sliding spark in these sections differs in the intensity of the microexplosions. This is illustrated in Fig. 1c (the more intense region of luminescence relates to the part of the guiding band with calcium, while the less intense region relates to the part with titanium).

Up to the present time, microexplosions with metallic powders have been considered. As was shown in [1], there is guidance also with the use of dielectric powders. In this case, the microexplosions are more weakly expressed.

There is more effective guidance with the use of a mixture of barium oxide and graphite powders. In itself, graphite is not very effective for guidance (experiments with graphite have been made earlier [3]). In this mixture there is a sharp increase in the intensity of microexplosions from particles of graphite.

In our opinion, the explanation for this is the following. The presence of dielectric particles with a low work function (barium oxide) leads to a large number of electron cascades and streamer channels near the head of the developing leader. The graphite particles are current-collecting or conducting jumpers between the cascades. As a result, a large current flows through the graphite particles. This current leads to explosion of the conducting particles. The easier the material of the wire melts and the greater the current flowing through it, the more intense the explosive processes.

We must note one more special characteristic. As experiments have shown, a particularly high efficiency of the guidance can be obtained if the guiding band is bounded on both sides by bands with powders whose emission is minimal (for example, copper oxide Cu_2O). In this case the development of a sliding spark takes place at the boundary between the two bands. The set of data obtained allows of the following hypothesis.

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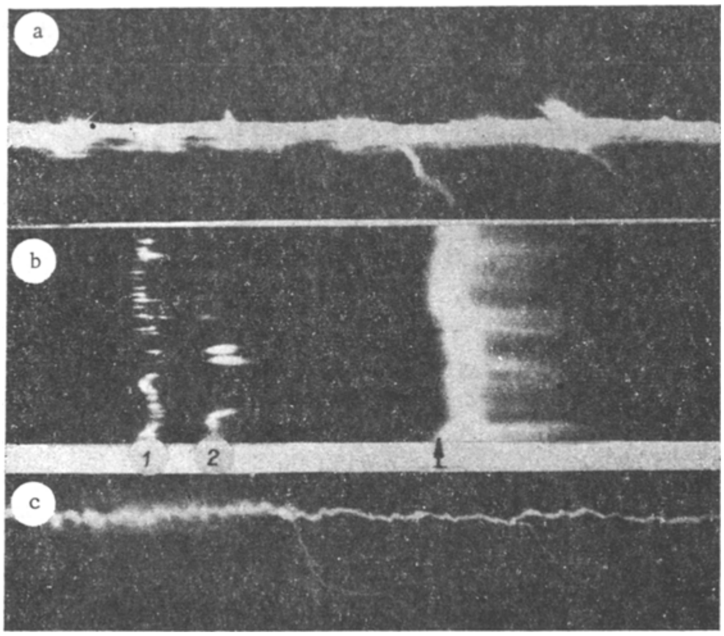

Fig. 1

The development of the breakdown takes place along the interface between two inhomogeneous regions having different ionization capacities. In the field of the head of the approaching leader there arise intense ionization processes, which set up a larger gradient of the field between these regions, the sharper the spatial differentiation between them. The greater the values of the longitudinal gradient of the field, the more effective the control of the development of the length of the spark.

From the point of view of this hypothesis, an explanation can be given of the fact that ionizing radiation [3], used as an "initiator" of special form [4] (a metallic wire located under a layer of dielectric, along whose surface a sliding spark is developing), and other methods for the control of the preferential direction of the development of a discharge are found to be not very effective. In these cases, there is not formed so sharp a boundary between regions with a different intensity of the ionization as in the case of the use of two bands with different emitting powers.

We note also that the proposed method of control makes it possible to lower considerably the breakdown voltages of a sliding spark.

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