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H-10

APPLICATION OF SiC ELECTRODE SYSTEMS IN ELECTROCHEMICAL LASERS

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An important element of electrochemical lasers is the electrode system, which should ensure stable long term operation of the laser in a chemically aggressive environment [1, 2]. It is known that the use of cathodes made of semiconductor or anisotropic-resistive materials can significantly increase the homogeneity and stability of the volume discharge [3]. The report presents an analysis of the results of studies of applications of a SiC cathode in electrochemical non-chain HF lasers and repetitively pulsed oxygen-iodine lasers. The problems of increasing the stability of a volume discharge by using a SiC cathode were investigated. Particular attention is devoted to the physical and technical aspects of the formation of small scale inhomogeneities on the SiC cathode, which are necessary to obtain a uniform volume discharge in gas mixtures based on SF_6 without the use of special preionization devices [2], as well as to the issues of degradation of the surface of the SiC cathode under pulse periodic operating mode.

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H-11

INFLUENCE OF CONDITIONS FOR INITIATION OF AN APOKAMPIC DISCHARGE ON THE EXPANSION DYNAMICS OF ITS PLASMA PLUME

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This work continues the cycle of our studies of a new discharge phenomenon – the expansion of the glowing structure at a bend in the channel of a pulsed high voltage discharge in air. In [1], it was called the apokamp discharge, and the structure was called the apokamp. The apokamp consists of a bright offshoot and a long plume. We have shown experimentally and theoretically that the plume is a positive streamer starting from the bend of the plasma channel with a characteristic speed of tens and hundreds of km/s, depending on the applied voltage, pressure and type of gas [2, 3]. The bending of the canal provides a local amplification of the field, which sets the starting orientation of the expanding streamer canal.

In this work, we compare the development rates of a positive streamer starting from a plasma channel (option 1) and from a charged capacitor (option 2) under the same conditions (in terms of air pressure, frequency and amplitude of voltage pulses). In particular, at a pressure of 150 Torr, in the first case, a maximum speed of 267 km/s was recorded, and in the second – 520 km/s. Moreover, in the second case, the length of the offshoot increases. Analysis of the spectra of the offshoot revealed additional ionic lines. This indicates an increase in the field gradient at the place of initiation of the plasma plume, which significantly affects the dynamics of its expansion.

An interpretation of the obtained data is given to explain the differences in the formation of the transients of the middle atmosphere, which, as shown in [2], are their laboratory analogs. This work was supported by the state assignment for IHCE SB RAS, Project No. 13.1.4.

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H-12

FORMATION OF A MICROCHANNEL STRUCTURE AND SHOCK WAVES IN THE INITIAL PHASE OF A SPARK DISCHARGE IN AIR IN THE TIP–PLANE GAP

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The results of experimental studies of the dynamics of the initial phase of a spark discharge in air at atmospheric pressure in the tip (cathode) – plane gap with an interelectrode gap of 1.5 mm are presented. The breakdown of the gap in the discharge circuit resulted in a damped oscillatory process with a period of 1 μs. The current amplitude and its decay time were 1.5 kA and 2 μs, respectively. Using a two-frame technique of shadow photography, the spatial structure of the discharge at different points in time relative to the onset of breakdown is investigated. The registration system provided a spatial resolution of 5 μm per 3 pixels [1]. The source of probe radiation was a laser with a wavelength of 532 nm and a pulse duration at half maximum of 6 ns.

Earlier data on the dynamics of the discharge at times from the instant of breakdown to 100 ns were confirmed. The visually homogeneous channel is a bundle of a large number of microchannels. The dynamics include: the development of microchannels from the tip into the depth of the discharge gap, the expansion of the microchannels, the formation of a common front of the cylindrical shock wave of the spark, and its radial movement.

The dynamics of the formation of the microstructure of the channels in the near cathode region was recorded, including the sequential formation of channels of a smaller diameter and an increase in their number. The diameter of the initial channel is 10–15 μm, the diameter of the subsequent channels is 5–10 μm, while a doubling of the number of channels is observed on a time scale not exceeding 5 ns. It was suggested that the recorded pattern of changes in the spatial structure of the discharge is the result of the instability of the ionization front.

In the near-cathode zone, narrow extended regions were found that propagate from the surface of the tip and are interpreted as near cathode shock waves. Such waves were recorded, as a rule, in the time interval from 10 to 50 ns after breakdown, and their propagation velocity was 1–3 km/s. It was found that the onset of near-cathode shock waves is accompanied by the formation of cathode plasma torches. Areas torches conjugate with microchannels and have similar transverse dimensions 10–15 μm.

Thus, besides the cylindrical shock wave generated during the expansion of the discharge channel, the data obtained enable us to establish the feasibility of the two other types of shock waves in the initial phase of a spark discharge in the air in the geometry of the point-plane:

– near cathode, presumably generated by cathode torches on the surface of the pointed electrode;