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SHORT COMMUNICATIONS

Thermograms of High-Frequency Capacitive Discharge Between Solid And Liquid Electrodes

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Abstract—We present the experimental results on thermograms and plots of temperature distributions along the streamer and spark discharges in a high-frequency capacitive field between solid and liquid electrodes for different electrode geometries.

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INTRODUCTION

There have been recent numerous studies of the characteristics and parameters of the discharge propagating above the surface of a liquid [1–16] due to practical application of such discharges, e.g., in the development of methods of lightning protection over water [1], material surface treatment [4, 5], water purification [6], and the obtainment of various electrolyte components, such as ozone, atomic oxygen, and hydroxyl groups [15, 16]. Low-temperature plasma of a high-frequency discharge at reduced pressures is used to obtain coverings [17], to improve the physicomechanical properties of metals, and to enhance their hardness [18]. The plasma microjet produced by a high-frequency electric discharge in a special electrode system is known to serve as a prototype of the plasma surgical apparatus; the possibility of its application has been proven [19].

Today, studies of the electrical discharge between a solid and a liquid, between a jet and a liquid, between a drop and a liquid, and between two jet electrodes are very promising due to their practical applications [3–15]. Even more attention is paid to studies of discharges with liquid electrodes, in particular, to the distributions of the electron concentration and temperature and the rotational and the vibrational temperatures based on spectral investigations [19], as well as to studies of the hydrodynamic processes taking place within the zone of discharge with liquid electrodes [20].

EXPERIMENTAL

The goal of the present work is to conduct experimental studies on the thermograms and (plotted on their basis) temperature distributions in the vapor-gas discharge between solid and liquid electrodes for different electrode shapes at $P = 10^5$ Pa, $f = 40$ MHz, and the interelectrode space L = 10–22 mm. The used assembly electrode consists of 40 plates, with a total length of the assembly package of 50 mm; the electrode material was steel and copper.

The experimental facility is described in [15]. We measured the temperature by infrared thermography on the electrode surface and with a FLIRA65005C thermal imager in the discharge burning zone, and we processed the data with the ALTAIP v5.91.010 software. The temperature distributions (in centigrade) are plotted with respect to the interelectrode spacing.

Figure 1 shows the thermogram (a) and the temperature distribution (b) along the streamer discharge channel. The arrow shows the direction from the assembly electrode to the electrolyte (technical water). The thermogram represents the infrared image of the temperature field distribution. The temperature at the edge of the surface of the copper plate assembly electrode is 14.8°C; at the direction to the electrolyte, the temperature increases and reaches its maximum (18.4°C) at a distance of 4 mm from the metal electrode. Further, in the direction to from the electrode to the electrolyte surface (from 4 mm to 22 mm), the temperature along the streamer discharge decreases to 14°C. In Fig. 1a, we see that the intensity of the streamer discharge glow is faint. With the used order of