NON-EQUILIBRIUM PLASMA IN LIQUID WATER - DYNAMICS OF GENERATION AND QUENCHING*

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In most cases, the electric breakdown of liquids is initiated by the application of high electric field on the electrode, followed by rapid propagation and branching of plasma channels. Typically plasma is only considered to exist through the ionization of gases and typical production of plasmas in liquids has generated bubbles through heating or via cavitation and sustains the plasmas within those bubbles. The question appears: is it possible to ionize the liquid without cracking and voids formation?

To answer this question we used a pulsed power system with 32 kV pulse amplitude, 12 ns pulse duration, 200 ps rise time. Discharge cell had point to plate geometry with a tip diameter of 100 μm. These parameters allow us to observe the non-equilibrium plasma generation. The measurements were performed with the help of 4Picos ICCD camera. It was found that discharge in liquid water forms in picosecond time scale. Emission intensity increase and plasma formation took 200-300 ps. Diameter of excited region near the tip of the high-voltage electrode was ~ 1 mm. After this initial stage emission rapidly decreased and plasma region becomes almost invisible in 500 ps. The absence of the emission during the rest of the pulse is explained by electrical field decrease on the boundary of conductive zone.

Thus we have demonstrated possibility of formation of non-equilibrium plasma in liquid phase and investigated the dynamics of excitation and quenching of non-equilibrium plasma in liquid water.