DC excited plasma with dielectric covered metal electrode in water.

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Underwater discharges have been intensively studied in view of the potential environmental applications [1]. However, the physics of plasma in liquids or in bubbles inside liquids is still largely unknown. Studies of discharges generated by dc voltages in fluids use typically the capillary (or diaphragm) geometry [2]. In this contribution the discharge is generated between a point electrode and a plane counter electrode as in pulsed corona systems in water [3]. By placing the point electrode inside a dielectric tube, the discharge can be generated by dc excitation, which makes pulsed high voltage supplies with small rise times unnecessary. In this geometry the plasma is generated at the end of the capillary and extends to the bulk of the fluid, which is more advantageous for treatments of liquids than the strongly encapsulated plasma in the case of the standard capillary discharge geometry. Another benefit is that external gases can be fed through the tube when using a hollow needle metal electrode. This is especially interesting to control the plasma chemistry for applications.

Although the plasma is excited by high dc voltages, it is self-pulsing in nature. The discharge exhibits different regimes depending on the power. The intermitting plasma at low power is correlated with bubble dynamics. At higher power, a continuous plasma is formed which resembles a small plasma jet at the exit of the capillary.

The different regimes are investigated by time dependent electrical and optical diagnostics in order to explain the shape of the time-averaged current voltage characteristics. The continuous plasma mode (with typical currents between 7-30 mA) is investigated by optical emission spectroscopy. The main contributions in the emission spectrum of the water vapour plasma are due to OH, atomic hydrogen (Balmer lines), the oxygen radical and H_2 (Fulcher band). A Boltzmann plot of the OH(A-X) (0-0) transition exhibits non-Boltzmann behaviour. A significant over-population of high rotational states is found. Time-averaged atomic electron excitation temperatures of hydrogen are typically in the range of 4400 K. Time-averaged electron densities measured by stark broadening of the hydrogen β Balmer line is of the order of 5×10^{14} cm^{-3} and almost independent of the current.

Changes of the plasma properties when external gas is fed into the reactor will be discussed. Argon, helium, nitrogen, oxygen, N_2O and hydrogen have been used. Also the influence on the gas flow rate and the pressure of the reactor will be addressed.

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