Simulation of the Plasma Generated in a Gas Bubble

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Abstract

Introduction: Investigations of plasma water treatment have been widely carried out [1,2]. The plasmas generated in water involve various physical phenomena such as flows agitated by bubbles, high electric fields for breakdown, discharges in bubbles with the size variation, and so on. In order to clarify the complicated phenomena, the numerical simulation technique will be a powerful tool because many unknown factors exist in experiments. In this work, the simulation of the plasma generated in bubbles is performed. The time evolution of bubble size [3] is traced and its effect on plasma properties is examined.

Use of COMSOL Multiphysics: In this work, we used the Plasma Module in COMSOL Multphysics® 4.3a, for which the DC Discharge Interface is applied.

Results: The simulations are performed for 1D model in a 100%H2O gas bubble at atmospheric pressure. The bubble radius is varied from 1 to 10.4 mm. The duration for the variation of bubble size is chosen T = 0.8, 1.6, or 2.4 ms. The DC voltage of -1 kV is applied and the ballast resistor is 10 kohm. The plasma species taken in account include the ions: H2O+, O2+, H2+, the neutrals: H2O, H, OH, H2, O(1D), O, O2, O3, HO2, H2O2, and also electrons. The moving mesh is used to trace the variation of solved domain. Figure 1 shows the electron densities at the different times for T = 1.6 ms. The gas heating induced by plasma discharges is also depicted.

Conclusion: The simulation of the plasma generated in a gas bubble is performed by using COMSOL Multiphysics. The present research provides a useful method to study the plasma generated in water, especially in bubbles.

Keywords: Atmospheric Pressure Plasma, Gas Bubble, Gas Heating, COMSOL Multiphysics.

Reference

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Figures used in the abstract

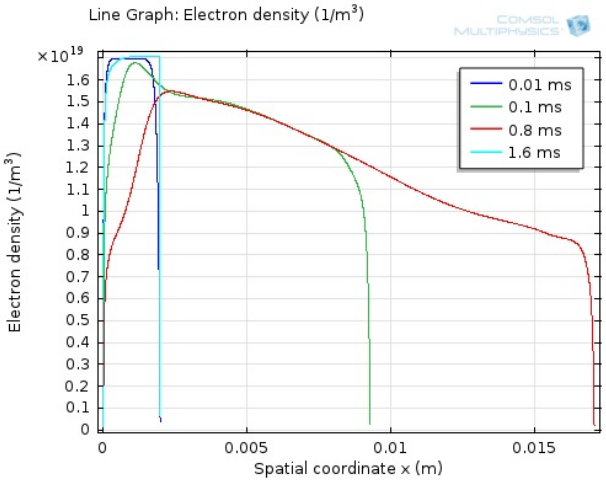

Figure 1: Electron densities at the different times for T = 1.6 ms.