OH radical and a drizzling water jet production from the Ball-lightning discharge in water

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Plasma treatments using powerful oxidizing agents such as ozone and OH radical are promising procedure for a decomposition of persistent chemical materials. Because of a small reaction area and a time duration of conventional discharges along a water surface or under water, both expansions of its volume and a high repetitive operation are necessary for a large scale processing. The ball lightning, or fireball discharge using the typical electrode configuration[1][2] is reported to produce long-living spherical plasmoids with radius exceed 10 cm at atmospheric pressure. In this study, we measured the relationship between an optical output emitted from OH radicals and discharge conditions of the ball-lightning electrode configuration and discussed the possibility to the water treatment process.

The electrode configuration of this study is same as that of B.Juettner, et.al.[2], and is shown in Fig.1, where top level of the central rod electrode and its surrounding dielectric material is a same as that of the water surface. As a results, in both polarity of the charged voltage $V_0$, a ball-lightning discharge can be generated where still higher voltage is required in the case of positive polarity for the rod electrode $V_0 < 0$. Furthermore, an intensive upward water jet from the rod electrode is observed in case of $V_0 < 0$, which is composed of drizzling water drops near the rod electrode as shown in Fig.2. The optical output of $\lambda = 309$ nm originating from OH radical can be observed in each polarity. And its signal strongly depends on the conductivity of a liquid water, which is modified by adding NaCl in it. In conclusion, the plasma source using the fireball discharge configuration are suited for a water treatment processing because of large volumetric one and OH radical. And the configuration with positive polarity has a additional property of active water drop supply to the reaction field.

Fig 1: Experimental setup

Fig 2: Photographs of the initial discharge phase