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Addition Effects of Non-volatile Compounds on the Intensity of MBSL in Aqueous Solution Using 2.4 MHz Ultrasonic Atomizer

2.4 MHz 超音波霧化器を用いた水からの MBSL に対する不揮発性化合物添加効果

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1. Introduction

In recent years, an ultrasonic atomizer has received much attention for its well handling and practical applications. Former paper, we confirmed the illumination originates from cavitation during ultrasonic irradiation at 2.4 kHz [1]. The former paper, we have reported MBSL (multi bubble sonoluminescence) from water containing several dissolved gases and sonochemical reactivity [2]. In this presentation, dependence of the intensity of MBSL on additive in water will be discussed. The intensity of MBSL changes by addition of compounds in water. For example, it was decreasing when volatile compounds such as ethanol were added into water. [2] It is considered that the temperature of cavitation babble is decreasing with entering ethanol vapour and cavitation power is also decreasing. On the other hand, it is supposed that non-volatile compounds do not affect cavitation phenomenon.

2. Experimental

A Pyrex glass cylindrical tube (volume about 60 ml, solution volume 10mL, diameter 22 mm, and length 300 mm) was used as a reactor. **Figure 1** illustrates the reactor for present experiments. Ultrasonic irradiation was performed from the bottom of the tube attached with an ultrasonic oscillator, which is commercially provided as named ultrasonic atomizer (Honda Electric, HM-303N, 2.4 MHz, DC 24 V / 1.0 A). Reactants were potassium iodide (KI), potassium chloride (KCl), potassium sulfate (K_2SO_4), and ammonium chloride (NH_4Cl). All extra pure grade reagents (Wako) were used without further purification. Experiments were carried out in the air and in room-temperature. The composition of dissolved gas in the solution at the initial stage of observation was thought similar composition of atmospheric gas in the cylindrical reactor tube.

Intensity of sonoluminescence was measured in the dark box attached with photon counting head (Hamamatsu Photonics, H7360-02; diameter of optical window, 22mm; sampling time, 20ms; detectable wavelengths, 300-650nm). Detailed setup was shown in the former paper [2]. Chemical power was estimated by KI method (A Standard Method to Calibrate Sonochemical Efficiency of an Individual Reaction System recommended by Japan Society of Sonochemistry) [3]. Absorbance of I_3^- was monitored at 355 nm using a UV-Vis spectrophotometer (JASCO V-650).

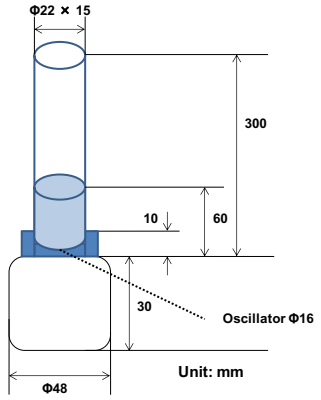

Fig. 1 Open-top Pyrex reactor for MBSL.

3. Results and discussion

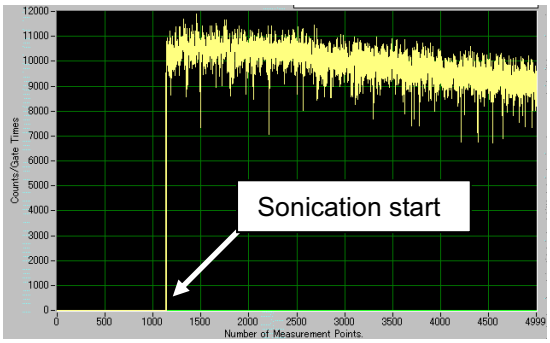

Fig. 2 Time dependence of the intensity of MBSL from pure water (10 mL).

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Multi bubble sonoluminescence (MBSL) from pure water was observed when sonication started as shown in **Fig. 2**.

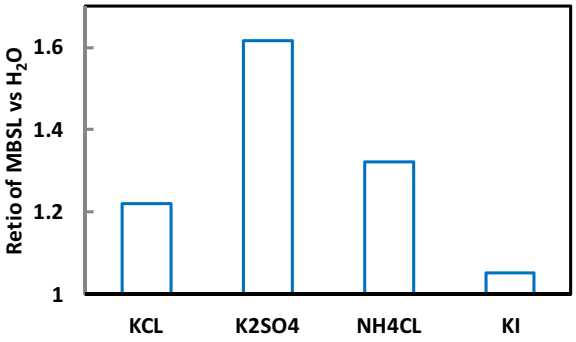

Fig. 3 Addition effects of 0.5M non-volatile compounds on the intensity of MBSL.

Figure 3 indicated addition effects of some inorganic salts on the intensity of MBSL. Intensities increased with addition of them. In particular, potassium sulfate was effective. Potassium or potassium ions illuminate under sonication. [4] Ammonium ions also contributed to increase intensity. In the case of KI, oxidized iodide ions (I_3^-) absorb photons. KI solution would be examined in the later part of this report. In addition, similar atomization was observed in all cases.

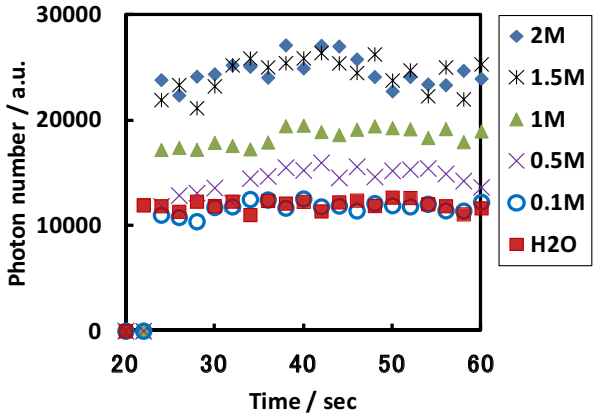

Fig. 4 Dependence of the intensity of MBSL on KCl concentration.

Figure 4 shows the intensity increased with increasing concentration of KCl. A small difference of the intensity between water and dilute solution (0.1M) was observed. Those behaviours were also confirmed for other additives.

In the case of KI, it is known that solution is coloured with sonication time. We confirmed the absorbance at 355 nm as shown in **Fig. 5.** Colorization was also improved with increasing concentration. It is considered that this behaviour means improvement of chemical power.

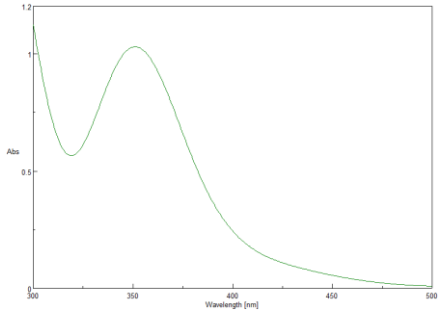

Fig. 5 UV-Vis spectrum of 0.1 M KI solution after 5 min sonication.

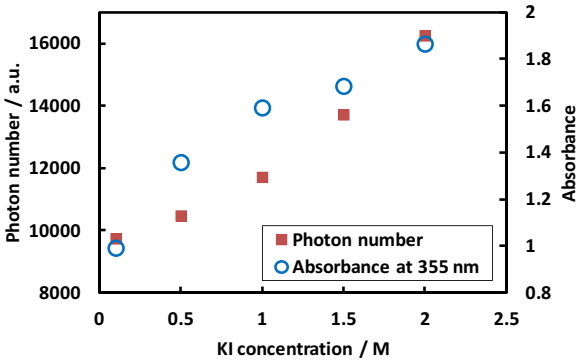

Fig. 6 Relationship between the intensity of MBSL and oxidative power.

To examine the relation between the intensity of sonoluminescence and chemical power, photon number with sonoluminescence and absorbance at 355 nm were plotted in **Fig. 6**. Well relation was confirmed.

References

1. H. Harada, H. Yoshida, and H. Kato: 11th Meeting of European Society of Sonochemistry (2008, France).
2. H. Harada, N. Iwata, and K. Shiratori: Jpn. J. Appl. Phys. **48** (2008) 07GH01.
3. S. Koda, T. Kimura, T. Kondo, and H. Mitome: Ultasonics-Sonochem. **10**(2003)149.
4. P.-K. Choi: *Theoretical and Experimental Sonochemistry Involving Inorganic Systems* (Springer, 2011) 337.