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High efficient CO_2 decomposition by plasma (LAMP)

プラズマ（LAMP）による高効率CO_2削減

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We have studied the rate of decomposition of carbon dioxide using LAMP (Large Atmospheric Microwave Plasma) of 600W. CO_2 decomposition produces C and CO. And KH instability is produced in it. The results show the high efficient CO_2 decomposition over 50% by measuring of CO_2 content with LAMP on and off. The energy is estimated between 600W and CO_2 decomposition. Because of high density atmospheric microwave plasma and the turbulent effect, the energy estimation will be achieved in LAMP.

1. Introduction

While the synthetic revolutionary strategy for CO_2 decrease by green algae has been discussed as road map in Nagoya city [1], however there are many researches of CO_2 decomposition by plasma using DBD (dielectric barrier discharge) [2]. As industrial application, a cheap apparatus and high efficiency are required. So LAMP is developed, and the energy is estimated here. The fruitful result will be obtained with the high density plasma and the turbulent effect.

2. Experimental apparatus

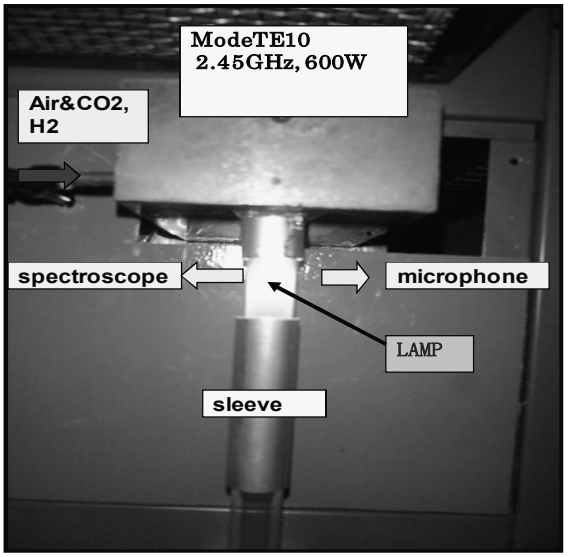

Fig. 1. Experimental apparatus（LAMP）.

Fig.1 is the photo figure of LAMP. As the electrical source, a magnetron 2M213 of mean power 600 W and frequency 2.45GHz was used on the market and cheap. The wave form was pulse modulated of 60Hz and the duty 50%. A spectroscope (Ocean optics usb2000+), a microphone, and a sleeve were mounted, by which the photo-spectra, the instability signal, and the length of LAMP were measured. The results were summarized in [3]. Large flow (~50L/m) of cheap air gas was introduced from the gas port with CO_2 gas. The high efficient decomposition will come from the high density plasma by atmospheric microwave plasma [4] and the turbulence [5]. LAMP was on-off according to magnetron on-off.

3. Energy estimation

Estimation is valued as follows.

CO_2 / mol is 44g and 22.4L. The decomposition value (D.V.) of CO_2 will be ¥2,000/ton [6]. So, the D.V. of CO_2/22.4L is,

$$\text{D.V. of } CO_2 = ¥0.088/22.4L \quad (1)$$

The electric value (E.V.) in industry will be ¥15/kWh. So, the E.V. of magnetron 600W is,

$$\text{E.V. of 600W} = ¥0.15/\text{min} \quad (2)$$

In the experiment of LAMP with the high density and the turbulence, when the large flow CO_2 gas of 44.8 L/m (two times of (1)) will be decomposed, the D.V. of CO_2 /44.8L exceeds the E.V. of 600W.

$$\text{D.V. of } CO_2/44.8L = ¥0.176 > \text{E.V. of 600W} = ¥0.15/\text{min} \quad (3)$$

4. High efficient CO2 decomposition

The efficiency is measured by high density CO_2 apparatus (XP3140). The results are shown in Fig.2 and Fig.3. Air flow is constant at 35L/m, CO_2 flow increases as 3, 6, 9 L/m. The efficiency decreases as 72.5, 67.8, 28.6%, respectively shown in Fig.2.

When Air flow changes, the results are shown in Fig.3. CO_2 flow is constant at 5L/m, Air flow increases as 20,

30, 40 L/m. The efficiency increases as 38.5, 39.0, 75.0 %, respectively shown in Fig.3.

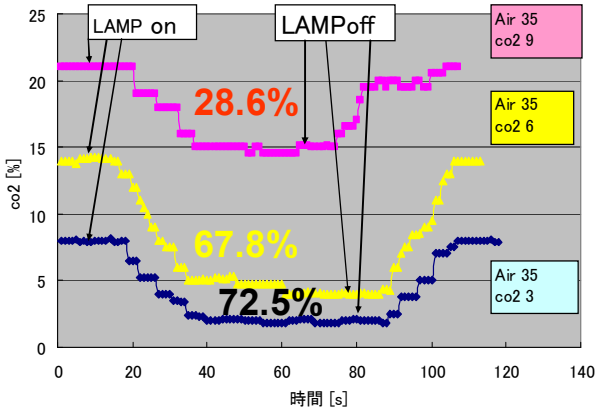

Fig.2 Change of CO_2 content in LAMP when CO_2 flow changes (decomposition efficiency : 28.6% , 67.8%, 72.5%)

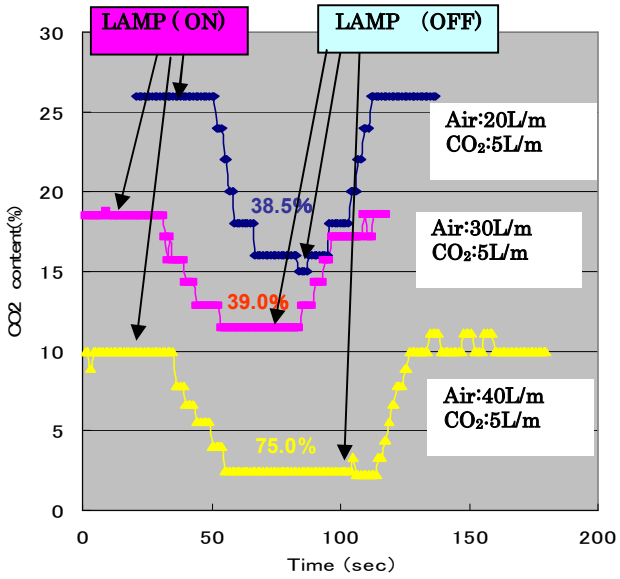

Fig.3 Change of CO_2 content in LAMP when Air flow changes (decomposition efficiency : 38.5 % , 39.0%, 75.0%)

5. Discussions and conclusion

LAMP is cheap and high efficient apparatus for CO_2 decomposition. The results in Fig.2 and Fig.3 are explained as flows.

When CO_2 flow increases with constant Air flow, the load of decomposition will increase, so, the efficiency decreases in Fig.2. When Air flow increases with constant CO_2 flow, the turbulent effect which will increases the effective collisions between atoms with St. numbers decreasing in Fig.3.

The energy estimation will be achieved when CO_2 flow is constant at 40L/m, and Air flow changes in large flow.

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