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# Ozone Generation Properties using Pair-Pulsed Corona Discharge
# ペアパルスコロナ放電を用いたオゾン生成特性

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Pair-pulsed discharge under the atmospheric pressure was applied to ozone generation. The objective is to investigate the effect of residual active species such as vibrational exited state or metastable state on the ozone generation at the successive 2nd pulse. Two types of pulse duration of voltage pulse were used as 20 ns and 400 ns. Ozone yield was investigated changing the delay time of 2nd pulse from 1st pulse. As a result, the ozone yield property showed a peak value at the delay time of 10 μs in the long pulse application. On the other hand, the short pulse experiments showed a monotonous characteristic without forming any peaks.

## 1. Introduction

Gas treatment using non-thermal plasma generated by electric discharge under the atmospheric pressure has been widely studied for the removal of hazardous pollutants and ozone generation. Recently, extremely short pulse discharge of 2 ns duration was applied to NOx removal and ozone generation, and showed a high energy efficiency[1)].

In this paper, ozone generation using a pair-pulsed corona discharge was executed for the purpose of investigating the effect of residual active species on the ozone generation at the successive 2nd pulse discharge.

## 2. Experimental Setup

Voltage pulses were generated using MOSFET switch (Behlke HTS 80-12-UF) connected to high voltage power supply. The peak voltage was around 8 kV. Two types of pulse duration were used as 20 ns and 400 ns. Pair-pulsed corona discharge under the atmospheric pressure was repeated with the repetition rate of 250 set-pulse per second. The delay time $\tau_d$ which is defined as the delay time of 2nd pulse from 1st pulse was change from 1 μs to 2 ms. The dependence of ozone yield on $\tau_d$ was investigated, setting the input voltage of MOSFET to be constant at the turn-on timing of 1st pulse. The set voltage was 4.5 kV for long pulse and 5 kV for short pulse.

Two coaxial cylinders with parallel gas flow were used as a discharge reactor. The inner electrode was made of tungsten with a 0.3 mm diameter. The outer electrode was made of stainless steel with a 10 mm internal diameter. The discharge length was approximately 0.3 m for each cylinder. A positive, high-voltage pulse was applied to the inner electrode.

A gas mixture containing 80% $N_2$ and 20% $O_2$ was used with the flow rate of 2 l/min at room temperature and the pressure slightly above atmospheric pressure.

## 3. Results and Discussion

Figure 1 and 2 show sample waveforms of input voltage and current of 2nd pulse into the discharge reactor. The waveform of 1st pulse is almost same with that of 2nd pulse at $\tau_d$ of 2 ms. The voltage waveforms at $\tau_d$ of 1 μs are superimposed by the tail of the prior 1st voltage pulse. The second peak of the current waveform, which is the main part of discharge current, becomes lower with the decrease of $\tau_d$, especially in the long pulse waveforms.

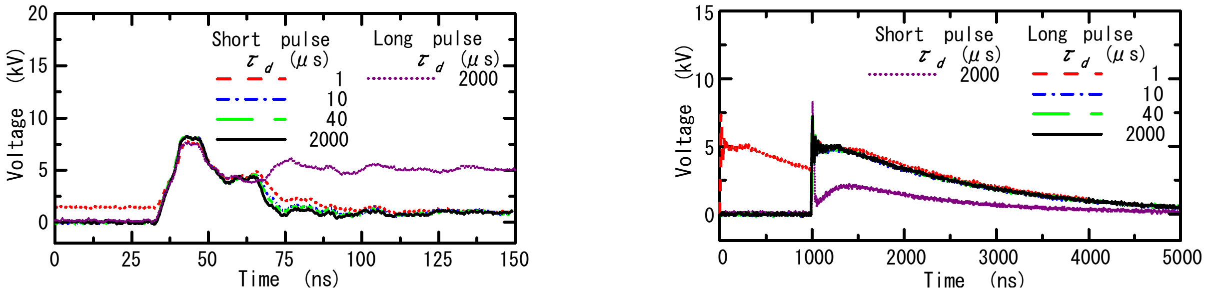
Figure 3 shows the dependence of input discharge energy on $\tau_d$. The energy input of 2nd pulse decreases in accordance with the decrease of $\tau_d$, and the tendency is remarkable for the long pulse application. It is presumed that the residual charge of 1st pulse is the main cause.

Figure 4 shows the ozone yield and ozone concentration at the outlet of discharge reactor. From Fig. 4(b), the ozone yield property of long pulse application has a peak value at $\tau_d$ of 10 μs. Since the production of low energy electrons are relatively large in the long pulse discharge, it is presumed that the peak of the ozone yield property is formed by the contribution of the reactions through the vibrational excited states or metastable states. Furthermore, it is also estimated that the amount of these active species decreases after 10 μs from 1st pulse discharge.

On the other hand, the ozone yield property in Fig. 4(a) shows a monotonous characteristic without forming any peaks. It is presumed that low energy electrons do not have influence sufficient to form a peak because the produced amount is relatively small.

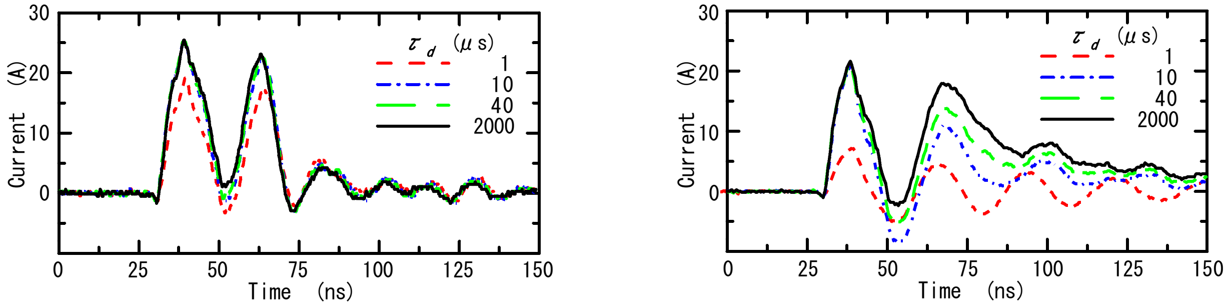
**References**


[1] T. Matsmoto, D. Wang, T. Namihira and H. Akiyama: Jpn. J. Appl. Phys. **50** (2011) 08JF14.

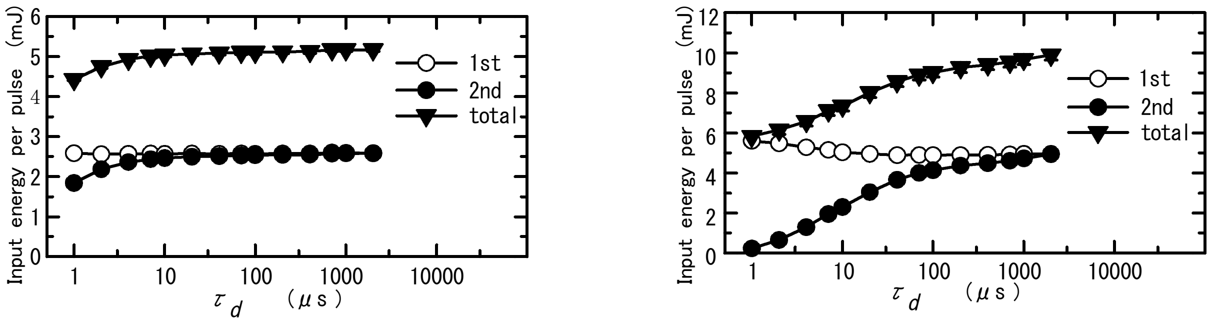

(a) Short pulse (b) Long pulse

Fig. 1 Voltage waveforms of 2nd pulse into discharge reactor.



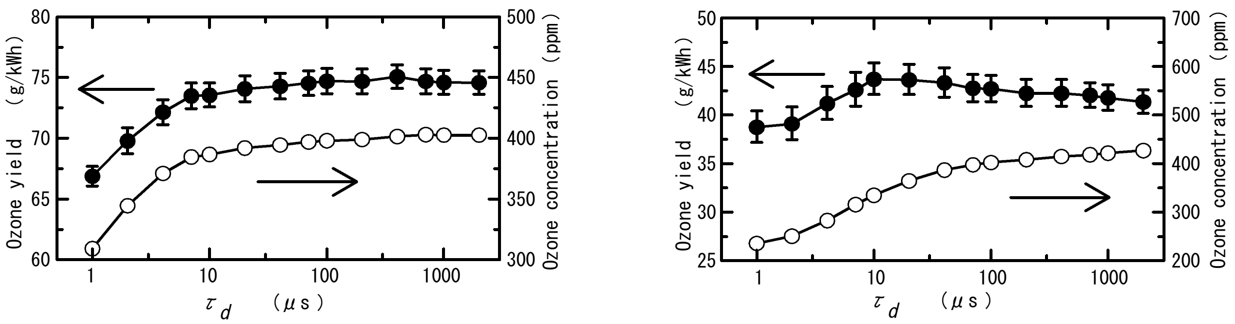

(a) Short pulse (b) Long pulse

Fig. 2 Current waveforms of 2nd pulse into discharge reactor.




(a) Short pulse (b) Long pulse

Fig. 3 Dependence of input energy on delay time of 2nd pulse.




(a) Short pulse (b) Long pulse

Fig. 4 Dependence of ozone yield and ozone concentration on delay time of 2nd pulse.