Decomposition of Environmental Pollutants by Microwave-Induced Plasma in an Aqueous- and Gas-Phase under Atmospheric Pressure

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Behavior of microwave-induced (MI) plasma generated from highly conductive materials as a trigger upon irradiation of 2.45 GHz microwave in an aqueous- and gas-phase under atmospheric pressure and decomposition behavior of environmental pollutants involved in both phases have been investigated.

When SiC ceramics or carbon block (C.B.) was employed as a trigger, the trigger itself was decomposed partially in aqueous solutions and a considerable amount of CO_2 was produced during the plasma generation, whereas conversion of dichloroacetic acid (DCAA) and β-naphthol reached almost 100% within short time. Among the triggers examined, $La_{0.8}Sr_{0.2}CoO_3$ was found to be the most suitable candidate from the viewpoints of DCAA conversion, the amount of partial decomposition products from DCAA and long-term stability as a trigger (see Fig. 1). However, $La_{0.8}Sr_{0.2}CoO_3$ was less effective for complete decomposition of β-naphthol.

Behavior of MI plasma generated from several SiC-based triggers has been studied under atmospheric flowing Ar and N_2 containing monochlorobenzene (MCB) and O_2. All the triggers tested generated plasma under flowing Ar, but plasma could be generated from only three triggers of porous SiC ceramics, SiC-Al_2O_3 honeycomb coated with SiC and cylindtical SiC ceramis, under the flowing Ar containing 3.0% O_2 and 0.16% MCB. MCB in the flowing Ar could be decomposed completely by the plasma generated from these three triggers upon irradiation of microwave at a power higher than 120 W. In flowing N_2, however, plasma could be generated stably only from the porous SiC ceramics among the triggers tested. The porous SiC ceramics showed the ability for decomposing MCB even in flowing N_2, and the complete oxidation of MCB could be achieved with increasing the O_2 content in the flowing N_2 along with a decrease in CO concentration generated (see Fig. 2).

Generation of MI plasma in an O_2-N_2 mixture gas resulted in the formation of a considerable amount of NO_x. Especially, NO_2 concentration was superior to that expected from the thermodynamic equilibrium between NO and NO_2 at elevated temperatures. The NO_2 generated by the MI plasma was effective for promoting the oxidation of diesel particulate matters (DPM) at lower temperature than its thermal decomposition temperature (see Fig. 3).

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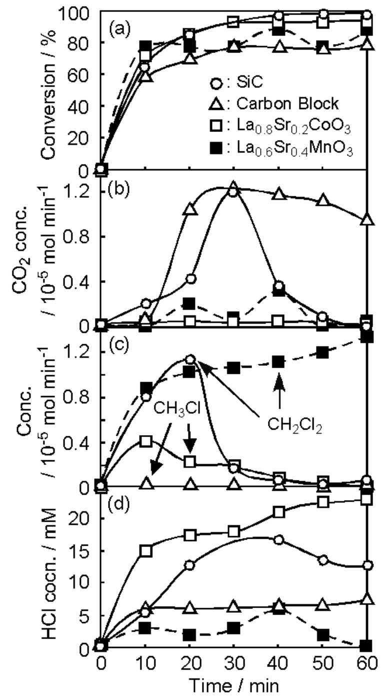

Fig. 1 Decomposition behavior of DCAA with time by MI plasma generated from several triggers in aqueous solution (Microwave power: 150 W).

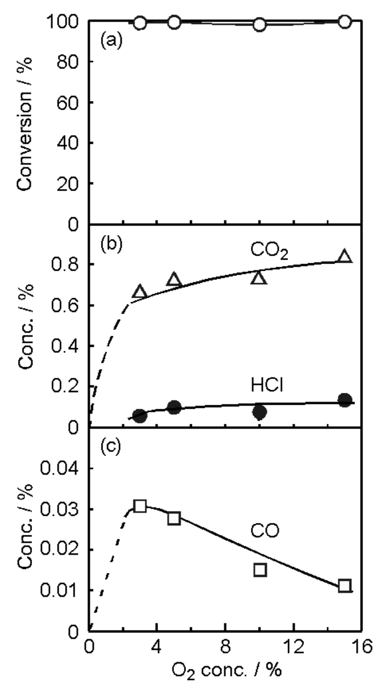

Fig. 2 Decomposition behavior of MCB with O_2 concentration by MI plasma generated from porous SiC ceramics under atmospheric pressure (Feed gas: 0.16% MCB - x% O_2 - N_2, microwave power: 190 W)

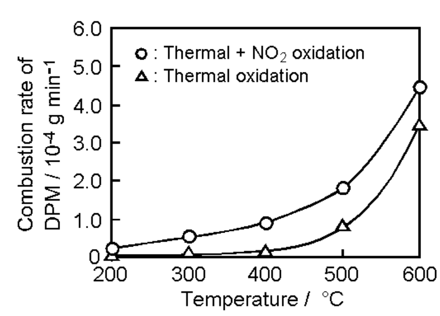

Fig. 3 Thermal and NO_2-assisted thermal decomposition behavior of DPM (NO_2 was produced by MI plasma generated from porous SiC ceramics under 0.1% NO - 10.0% O_2 - N_2 at a microwave power of 180 W).