Effect of the Crystalline Structure on the Thermally-activated Catalytic Properties of TiO_2

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TiO_2 has been utilized as photofunctional materials such as photocatalysts and solar cells. Moreover, TiO_2 has been expected as precious metal free oxidation catalyst due to its high thermally-activated catalytic property for the decomposition of volatile organic compound (VOC) with high concentration[1]. However, the effects of the crystalline structure and crystallite size of TiO_2 on thermally-activated catalytic property have not been clarified. In this study, the effect of the crystalline structure of TiO_2 (anatase, rutile and brookite) on the thermally-activated catalytic property for PM combustion was investigated.

TiO_2 catalysts (JRC-TIO-7, JRC-TIO-16 and brookite type purchased from KOJUNDO CHEMICAL LABORATORY CO., LTD.) were calcined at 800 °C. Characterization studies were performed by XRD, BET surface area measurements and SEM observation. The model PM (carbon black #2600, Mitsubishi Chemical Co., Ltd.) and TiO_2 catalysts (weight ratio of 1 : 9) was ground for 15 min in an agate motar (tight contact). Catalytic tests were performed in a fixed-bed reactor at atmospheric pressure under a gas flow (50 mL/min) containing 5 % O_2 from room temperature to 800 °C with a heating rate of 10 °C /min. The CO and CO_2 concentrations in the reactor outlet were monitored with a quadrupole mass spectrometer.

Characterization studies revealed that TiO_2 catalysts were found to be composed of anatase, rutile and brookite single phases, respectively, even after calcination at 800 °C. BET surface areas for TiO_2 catalysts after calcination at 800 °C were 20 - 30 m^2 g^{-1}. As shown in Fig. 1, the PM combustion is promoted by mixing TiO_2. The combustion temperatures of PM for TiO_2 catalysts are the following sequence, brookite < rutile < anatase, which means that thermally-activated catalytic property of TiO_2 depends on the crystalline structure. It was also found from H_2-TPR measurement that the amount of lattice oxygen released from brookite type TiO_2 was the lowest among three TiO_2 catalysts, despite being the most active for PM combustion. These results suggest that the PM combustion mechanism for TiO_2 catalysts can be different from those of other metal oxide catalysts such as CeO_2.

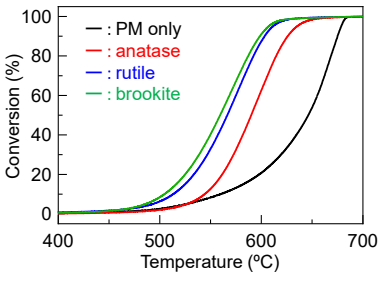

Fig. 1 PM conversion profiles as a function of temperature for TiO_2 catalysts.

1) T. Makino et al, *Jpn. J. Appl. Phys*. **2007**, *46*, 6037.