Reduction of CO\textsubscript{2} over the TiO\textsubscript{2}/ZrO\textsubscript{2} composites covered with a very thin layer of water under solar irradiation

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With regard to reduction of CO\textsubscript{2}, there are many reports [1-4]. Reduction of CO\textsubscript{2} in air is extremely important because this research can not only reduce the concentration of CO\textsubscript{2} in the atmosphere but also can convert the CO\textsubscript{2} into useful compounds including CO, H\textsubscript{2} or low-molecular-weight organic compounds. Here, mini-review is described according to last year’s report [5] by author.

Method and experiments

The author devised composites consisting of nanometre-sized titanium oxide (TiO\textsubscript{2}) particles (a) and micrometre-sized zirconium oxide (ZrO\textsubscript{2}) particles (b), and, applied them using an original method. First, particles or molecules adsorbed onto the composite surface were removed by the elimination of static electricity using an ion blower. Next, after the composites were cooled in a refrigerator for more than 20 h, they were placed into a transparent gas-barrier plastic bag with room air. Cooling in a refrigerator enabled the whole surface of the composite to be covered with a very thin layer of water via the condensation of water vapour in the air. Cleaning of the composite's surface and formation of the thin water layer are extremely important.

Moreover, this method is unique because the reduction of CO\textsubscript{2} is performed in air.

Figure 1 shows SEM image of the composite. The image shows that numerous nanometre-sized TiO\textsubscript{2} particles are present on the top layer of the composite, and the core of the composite is composed of micrometre-sized ZrO\textsubscript{2} particle.

CO\textsubscript{2} was reduced under real solar light without the use of platinum as a co-catalyst.

The weight ratio (TiO\textsubscript{2}/ZrO\textsubscript{2}) of the composites was mainly 1:1. After (a) and (b) were mixed and pressed to form the composites, the composites were scattered onto an electric conducting material such as a copper plate. Figure 2 shows a typical photograph of the experiment under irradiation by real solar light. Experiments were performed under high room temperatures (approximately 30°C) and high humidity (60-80%). After irradiation, the concentration of formaldehyde and methanol in the bag was measured using gas-detecting tubes.

Results

The author obtained experimental results that reaction was catalytic, and, reaction site existed at interface of TiO\textsubscript{2} and ZrO\textsubscript{2}. Then, figure 3 shows plots of formaldehyde and methanol products (\mu mol/ (g×300 s)) as a function of the irradiation intensity of solar light (mW/cm\textsuperscript{2}). This shows that CO\textsubscript{2} reducing reaction was enhanced strongly by the photocatalytic effort.

Conclusion

The thin water layer on the composites provides a reaction medium for the catalytic reduction of CO\textsubscript{2}. And, author’s method is catalytic.
reaction enhanced by the TiO₂ photo-catalyst. Moreover, the fact that a large amount of reduced products was obtained from CO₂ and H₂O in air under irradiation of only real solar light at room temperature and atmosphere pressure is a novel and important finding.

References