ICCDU XVI
27-30 August, 2018
Rio de Janeiro, Brazil

16th INTERNATIONAL CONFERENCE ON CARBON DIOXIDE UTILIZATION

Investigation on Reductants and Layout of Cu/TiO_2 for Improvement of CO_2 Reduction Performance

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Keywords: Photocatalyst, CO_2 Reduction, Reductant, Layout

TiO_2 is the principle catalyst for almost all types of photocatalysis reaction. It is well known that CO_2 can be reduced into fuels, for example, CO, CH_4, CH_3OH and H_2 by using TiO_2 as the photocatalyst under ultraviolet (UV) light illumination. However, the CO_2 reduction rate using pure TiO_2 is very low, that is, the fuel concentration in the products is very low. In addition, pure TiO_2 is only photoactive at a wavelength below 400 nm due to its relatively large band gap energy (~3.2 eV). Reductants like H_2O or H_2 which provide H^+ are necessary to convert CO_2 into fuel by TiO_2. However, the effect of combination of reductants on CO_2 reduction is not investigated well.

This study developed TiO_2 film doped with Cu (Cu/TiO_2) coated on netlike glass fiber and investigated the overlapping layout of two Cu/TiO_2 coated on netlike glass fiber. It is known that Cu can absorb the visible light and emits the free electron. Since electron and H^+ are used during the CO_2 reduction process, doping Cu influences the CO_2 reduction performance of $CO_2/H_2/H_2O$ reaction. However, there is no report investigating the relationship.

This study investigated the effect of reductants and layout of Cu/TiO_2 to improve the CO_2 reduction performance of photocatalyst. TiO_2 film is coated by sol-gel and dip coating process on net glass fiber. Then, Cu is loaded on the TiO_2 coated netlike glass fiber by pulse arc plasma method which can emit nanosized Cu particles. The CO_2 reduction characteristics of Cu/TiO_2 coated on net glass fiber with H_2 and H_2O under the condition of illuminating Xe lamp with or without UV light were investigated.

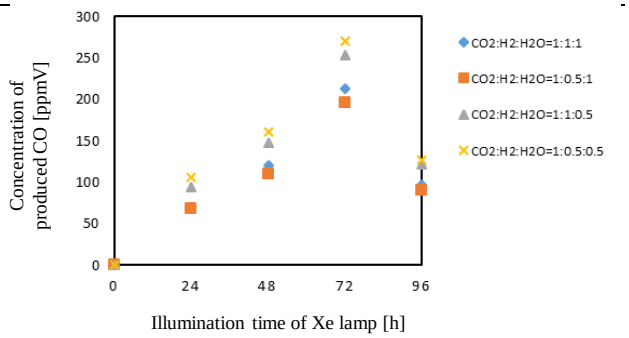

Figure 1. Comparison of CO_2 reduction performance of Cu/TiO_2 film under illumination conditions without UV light.

Figure 1 shows the comparison of concentration of produced CO along the time under the Xe lamp without UV light for double overlapping Fe/TiO_2. The molar ratios of CO_2:H_2:H_2O are changed for 1:1:1, 1:0.5:1, 1:1:0.5 and 1:0.5:0.5. From this figure, the concentration of produced CO for CO_2:H_2:H_2O = 1:0.5:0.5 is the highest. Since the reaction mechanism of $CO_2/H_2/H_2O$ reaction is not clarified well, this study refers to the reaction scheme of CO_2/H_2 and CO_2/H_2O. Then, CO is produced under the molar ratios of CO_2/H_2 and CO_2/H_2O of 1:1 theoretically. Under the molar ratio of CO_2:H_2:H_2O=1:0.5:0.5, the molar ratio of CO_2:total reductants is 1:1, resulting that the highest concentration of produced CO is obtained. This result is also confirmed under illumination condition with UV light.

Acknowledgments

The authors would like to gratefully thank JSPS KAKENHI (Grant no. 16K06970) and joint program of the Institute of Materials and Systems for Sustainability, Nagoya University, for the financial support of this work.