Separation of redox site by utilizing the nanostructure of ZnS stratified photocatalysts

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1. Introduction

Photocatalysts can generate hydrogen from various reactants, such as water and/or hydrogen sulfide, by utilizing solar energy. Thus, hydrogen synthesized by photocatalytic reaction can be recognized as environmentally friendly fuel. However, it is well known that photocatalytic activity is not satisfied for practical application of hydrogen production.

We reported the synthesis of sulfide type photocatalysts with specific morphology which has nano-sized and capsule-like form, called as stratified photocatalysts[1]. These materials show extremely high catalytic activity, because of specific morphological characteristics, such as nano-hetero junction between oxide and sulfide within the wall. These natures induce the effective separation of the photo-excited electron hole pairs, consequently photocatalytic activity become extremely improved[1]. However, for the industrial application of stratified photocatalysts, their activity should be 10 times enhance, nevertheless it is 8-10 times higher than that of traditional photocatalysts.

Needless to say, photocatalytic reaction is redox reaction, and it is well known that Pt can act as reduction site[2], while RuO_2 can act as oxidation site[3]. Thus, photocatalytic activity can be increased by the co-deposition of Pt and RuO_2. To achieve this, prevention of physical contact between Pt and RuO_2 is considered as important factor[4], nevertheless it is not easy in the case of usual photocatalysts. On the other hand, stratified photocatalysts has the nano sized capsule like morphology, which can induce the separation of Pt and RuO_2 site.

Therefore, in this study, two co-catalysts, Pt and RuO_2, separated deposition method at inside and/or outside of the wall of ZnS stratified photocatalyst(s-ZnS) is developed.

2. Experimental

To achieve the deposition of Pt at inside of the wall, Pt was deposited on the ZnO which is precursor material for synthesis of s-ZnS as follows. ZnO powder (200 mg) was added into purified water containing K_2PtCl_4 was used as Pt precursor (0.1-1 at.% against to Zn amount, pH6) and stirred for 24 h. Then, Pt was photo-deposited by using 500 W Hg lamp irradiation. Finally, to give the stratified morphology, Pt/ZnO was sulfurized and acid treated as in previous report[5]. Samples were analyzed by TEM (Hitachi, HF-2000).

3. Result and discussion

Figure 1 shows TEM images of Pt/ZnO after sulfurization and acid treatment. At the samples deposited small amount of Pt(0.1, 0.2 at.%), capsule-like form which was specific feature of s-ZnS was observed. On the other hand, at the samples deposited large amount of Pt(0.5, 0.9 at.%), it was not clearly observed. Thus, it confirmed that capsule-like form was disappeared with increasing Pt deposition on ZnO. These result suggested that Pt deposition on ZnO was not suitable for Pt deposition at inside of the wall because of preventing the formation of stratified morphology.

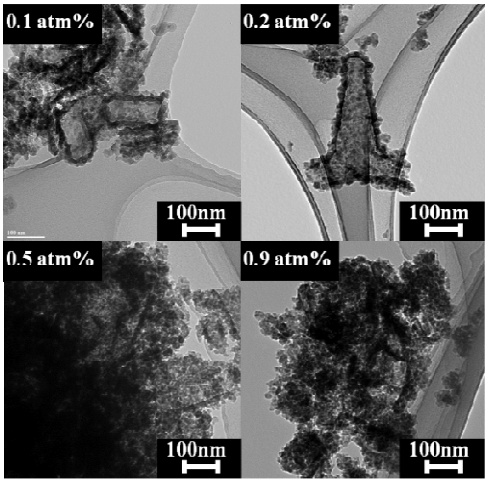

Fig. 1 TEM images of Pt/ZnO after sulfurization and acid treatment

4. Conclusion

To achieve the Pt deposition at inside of the wall, it will need that a method does not prevent the formation of stratified morphology when ZnO are sulfurated and acid treated. Other results will be presented in our presentation.

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