Abstract #21, 224th ECS Meeting, © 2013 The Electrochemical Society

Bactericidal mechanisms of stratified ZnS photocatalysts and ZnO nanoparticles

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1. Introduction

There are various reports on the antibacterial effect of nanoparticles (NPs). For example, L. Zhang et., al reported that ZnO NPs shows the high bactericidal performance [1]. In order to use the NPs to antibacterial materials effectively, it is necessary to clarify the characteristics and mechanism of these materials. Therefore, antibacterial mechanism of various oxide and/or sulfide was evaluated.

On the other hand, we reported the new photocatalysts with specific morphology, called as stratified photocatalysts, and it is also reported that this material shows extremely high photocatalytic activity (hydrogen evolution rate from H_2S solution) [2]. Therefore, we tried to utilize the stratified ZnS photocatalysts (s-ZnS) as the bactericidal materials of water. As the results, it was apparently observed that bactericidal properties of s-ZnS were higher than that of the other materials, and it demonstrated that these properties were originated to their specific morphology. However, bactericidal mechanisms of s-ZnS were still unknown.

Therefore, in this study, in order to reveal the characteristics of s-ZnS and ZnO as the antibacterial material, antibacterial mechanism of these was evaluated.

2. Experimental

E.coli(NBRC3972) was used as the target bacterium in every experiments.

One of the most important key factors of bactericidal is considered to the dissolution of metal ions from NPs. Thus, solubility of materials was evaluated by measuring of filtered solution of dispersion. Bactericidal properties of the filtered solution and zinc standard solutions were evaluated. Bactericidal effect of materials was evaluated as follows. Cell suspensions adjusted to constant concentration was mixed with the materials, then the mixtures were spread and cultivated on solid agar media, consequently bactericidal effect was evaluated. Treated materials and also bacterial thin sections were evaluated by TEM.

3. Result and discussion

Fig.1 shows the relationship between ratio of remaining bacterium and concentration of Zinc ion. The ratio of s-ZnS was also inset in figure by using dotted line. From this graph, it apparently observed that bactericidal effect was not mainly originated to metal ion in the treatment solution.

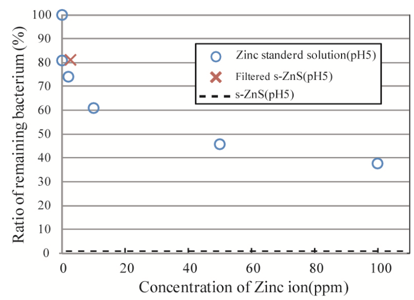

Fig.1 Ratio of remaining bacterium of s-ZnS (dotted line), Zinc standard solution (○) and filtered s-ZnS solution (×) at pH5.0 as the function of the Zn concentration

Fig.2 shows TEM micrograph of *E.coli* after bactericidal by using s-ZnS. As shown in this figure, *E.coli* was covered by s-ZnS particles, and spherical-shaped cells were apparently observed. This result indicates that the s-ZnS particle gives fatal effect on *E. coli* cell by destructing of its cell wall.

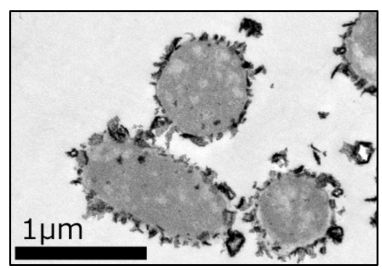

Fig.2 TEM micrograph of *E.coli* after bactericidal by using s-ZnS dispersion

4. Conclusion

ZnO and s-ZnS show the antibacterial characteristics. The cell was killed by respiration lost due to destruction of the cell wall. Other results will present in our presentation.

Acknowledgement
This work was supported by the Grant-in-Aid for Scientific Research (A) (No. 23241026).

References

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2)T. Arai, et.,al Proc. Int. Symp. on Cluster Assembled Mater, IPAP Conf. Series,3, (2001)75-78.