

환경일반-P9 Photocatalytic degradation of 2-chlorophenol using TiO₂ thin films prepared by CVD and IBS method

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1. Introduction

The aim of this study is to investigate the catalytic behavior of supported TiO₂ catalyst prepared by the IBS and CVD method. The change in the photocatalytic activity of thin film, TiO₂, was exemplified by the oxidation of 2-chlorophenol(2-CP) under air saturation and cooling condition. The photocatalytic efficiency of the thin films coated on various supportive surface such as stainless steel cloth(SS), Copper cloth, quartz glass tube(QGT), and silica gel(SG) were also investigated.

2. Materials and Methods

2.1 Materials: TiO₂(P25), stainless steel or copper cloth(SS; 37 μ m, 75 μ m or Cu; 75 μ m, 40cm³), TIP, 2-CP and silica- gel(DavisilTM, 355-250 μ m).

2.2 Preparation of TiO₂ thin films by CVD and IBS method: Detail steps for the preparation of TiO₂ thin films by IBS method was reported elsewhere(Guerin, D., and Saha, S. I., 1997). The hot-wall low-pressure reactor setup for preparation of TiO₂ thin film by CVD(Chemical Vapor Deposition) method was discussed in the paper reported previously(Weidong, L., *et al.*, 2001).

2.3 Preparation of TiO₂ thin film by sol-gel method: TiO₂ thin film was prepared by photoreducing TiO₂ onto the supporter using P25 powder or titanium tetraisopropoxide solution following a method similar to the one described by Jung(Jung, O. J., 2001). Thin film characterization: X-ray diffractometer(XRD-Rigaku D-Max B), The element concentration on the surface of the TiO₂/Support; XPS Model . ESCA 750, observation of surfac morpholgy for the thin film; SEM(AMRAY1810)

2.4 Photoreactor and light source: The photoreactor consisted of a cylindrical pyrex-glass cell with the size of 20cm in diameter and 30cm in hight inside-coated with mirror. The UV light lamp(100 or 200 W Hg lamp purchased from the(Ace Glass Inc.) was immersed into the solution with the cold air-cooling jacket.

2.5 Procedure and analysis: ①HPLC(HP-1100 system) equipped with UV detector and column, ②TOC analyzer(Tekmar-Dohrmann, DC-190), ③IC(Dionex Bio LC Chromatography) equipped with electrochemical detector.

3. Results and discussion

The film shows a slight(101) preferred orientation. Besides the oxygen peak, there exist two Ti peaks $\text{Ti}(2\text{P}_{3/2})$ and $\text{Ti}(2\text{P}_{1/2})$ which is located at 458.4 eV and 464.1 eV respectively. Results also indicate that stainless steel support is slightly advantageous compared to copper support. Moreover, finer stainless steel($37\mu\text{m}$) size yields better 2-CP degradation than coarse mesh($75\mu\text{m}$). The photocatalytic activities in terms of 2-CP degradation follows the decreasing order: $\text{SS}(37\mu\text{m}) > \text{SS}(75\mu\text{m}) > \text{Cu}(75\mu\text{m})$.

The first results of 2-CP degradation by thin film TiO_2 prepared on the surface of QGT by different coating method, namely, sol-gel method by $\text{TiO}_2(\text{P25})$ and TIP, or CVD method by TIP. The second results indicate that IBS thin film brings a little faster rate in 2-CP degradation than CVD. The third results show that sol-gel thin film prepared by CVD method is less photoactive than TiO_2 thin film supported on SS by IBS and CVD. Results show that the 2-CP degradation follows the order: $\text{TiO}_2\text{-SS}(37\mu\text{m})\text{-IBS} > \text{TiO}_2\text{-QGT-CVD} > \text{TiO}_2\text{-SG-CVD} \gg \text{P25(suspension)}$. Specially, 99% of 2-CP were destructed within 90 min by $\text{TiO}_2\text{-SS-IBS}$ thin film. The photocatalytic efficiencies have been dramatically enhanced in the order of decrease of heating temperature when TiO_2 thin films were prepared by IBS(25°C), CVD($450\text{--}550^\circ\text{C}$) and sol-gel($600\text{--}650^\circ\text{C}$) method. The last results from regression analysis for the $\text{TiO}_2\text{-SS-IBS}$, yields a rate constant(k) of $2.90 \times 10^{-2} \text{ mM/min}$ and the adsorption coefficient(K) is 6.43 mM^{-1} .

4. Conclusion

Results indicate that $\text{SS}(37\mu\text{m})\text{-TiO}_2$ thin film prepared by IBS method improves the photodegradation 2-CP. Among all supporting materials studied, $\text{SS}(37\mu\text{m})$ appears to be the best support.

References

- Weidong, L., Saha, I. S., Jung, O. J., and N, C. 2001, Metallorganic Chemical Deposition and Characterization of TiO_2 Nanoparticles, *J. Applied Physics*, impress.
- Jung, O. J., 2001, Synergistic Effect on the Photocatalytic Degradation of 2-CP using TiO_2 Thin Films Doped with Some Transition Metals in water, *Bulletin Kor. Chem.*, **22**(10), impress.