Utilization of new TiO_2 photocatalyst in purifier for removal of hazardous wastes

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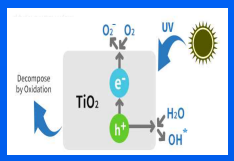
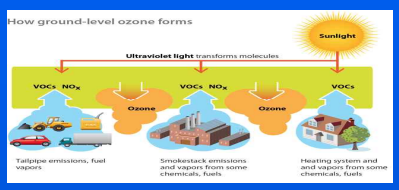
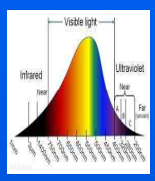
Introduction & Experimental



TiO_2 is widely used in the field of photocatalyst because of its strong oxidizing power and excellent durability. But, it **has a band-gap energy about 3.0 ~ 3.2 eV.** This means that to generate photocatalytic activity, it is necessary **to absorb the UV-light.**





In order to effectively utilize the light source, it is important to develop a photocatalyst having an activity in visible light.

How to remove hazardous wastes (VOCs) with new TiO_2 photocatalyst?

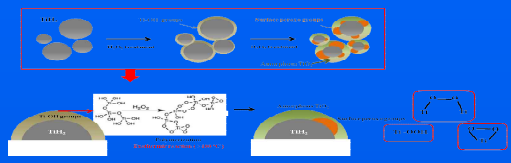


Fig. 1: Schematic of **amorp. Ti-based peroxo complex (ATPC)** synthesis

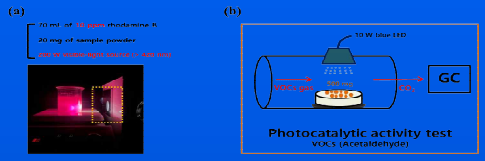


Fig. 2. Illustration of photocatalytic activity tests for removals of (a) RhB and (b) ACT.

Results & Discussion

1. Photocatalytic activity test with Ti-based peroxo complex

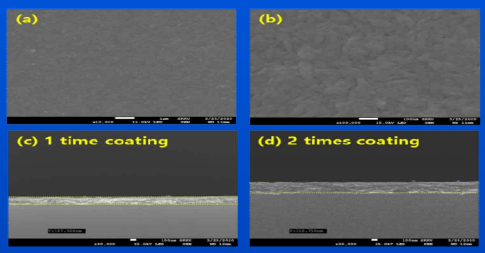


Fig. 3. SEM surface morphologies & cross-sectional images of spin-coated ATPC with different thickness.

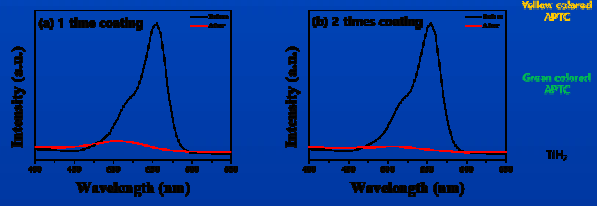


Fig. 4. UV-Vis absorption spectra measured before/after photocatalytic reaction of RhB dye on ATPC surfaces.

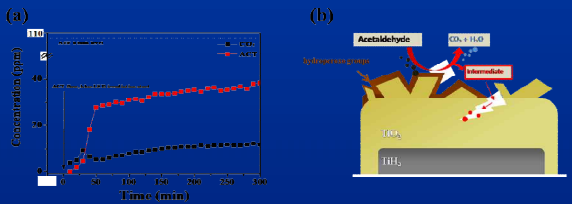
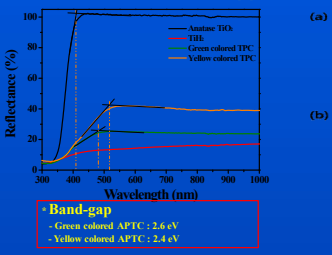
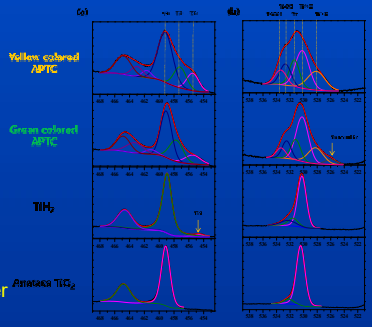


Fig. 5. Photocatalytic removal of ACT and reaction mech.





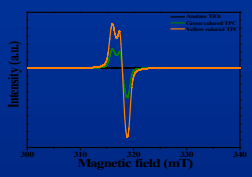


Fig. 6. XPS (upper) and EPR (lower)

2. Application test for air-purifier system

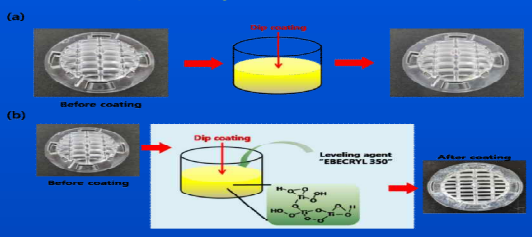


Fig. 7. Coating process of ATPC on ABS plastic filter in purifier with/without E-360 agent.

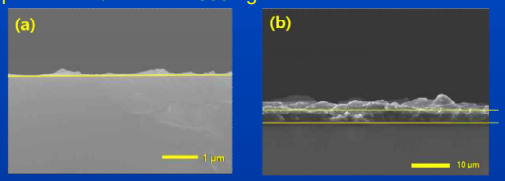


Fig. 8. Cross-sectional SEM images of dipping-coated ATPC coated layer on ABS plastic filter.

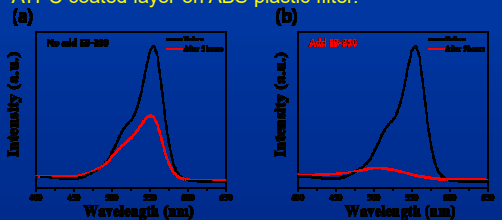


Fig. 9. UV-Vis absorption spectra measured before/after photocatalytic reaction of RhB with ATPC coated filter.

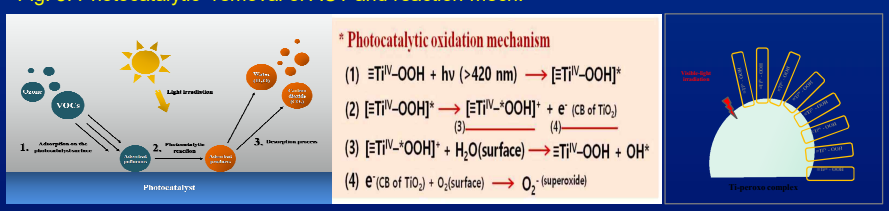


Fig. 10. Photo images of air purifier adapted APTC coated filter in a car.

Conclusions

In this study, amorphous Ti-based hydroperoxo complex (ATPC) was successfully synthesized by a facile method only using titanium hydride (metallic Ti) and H_2O_2 under mild conditions. TiH_2 is known to have many more reactive sites than metal oxides such as TiO_2. Therefore, TiH_2 was selected as a precursor and Ti based peroxo complexes were successfully synthesized for the first time. Qualitative and quantitative analyses through optical measurements revealed that the synthesized ATPC had many peroxo groups and various oxidation states of Ti (Ti^{2+}, Ti^{3+} and Ti^{4+}). The photocatalytic properties of successfully synthesized ATPC show very fast organic RhB decolorization rates, unlike other conventional visible-light catalysts. This is possible because many peroxo complexes can form more active radicals. Therefore, degradation experiment of VOCs such as acetaldehyde (ACT) in a gas phase was also carried out. Since an application test is one of the important items in the photocatalytic experiment as well as commercialization, we did fabricate a filter system in air-purifier by adapting synthesized ATPC, and then successfully removed air pollutans. Based on this study, we suggested a possible photocatalytic oxidation mechanism with ATPC.