§11. Study of Microwave Effect on Photocatalytic Surface by Using In-situ Observation Techniques

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In earlier studies, we noted that photodegradation can be enhanced with the assistance of microwave radiation to degrade wastewater and soil pollutants even under inferior photodecomposition conditions such as small quantities of TiO_2 used, low concentration of dissolved oxygen and low light irradiance. A characteristic feature of the reaction on the TiO_2 surface involves thermal effect and non-thermal effect (no conventional heating) originating from absorption of microwave radiation. The number of $^{\bullet}OH$ radicals produced during the TiO_2 photooxidation of water under simultaneous UV and microwave radiation was assessed by the electron spin resonance (ESR) technique [**1**]. The number of such $^{\bullet}OH$ radicals has also proven to be an important factor in the photodegradation of wastewaters by the TiO_2 photoassisted methodology in TiO_2 dispersions.

In this study we examined the microwave effects aimed at promoting TiO_2-assisted surface photoreactions. In short, the specific influence of microwaves on the metal oxide impacts on the affinity of the hydrophilic/hydrophobic TiO_2 surface.

Generally, UV light radiation can alter the hydrophilic/hydrophobic nature of the TiO_2 particle surface. The hydrophilic/hydrophobic nature of the TiO_2 particle surface is an important factor in wastewater treatment because the photoassisted degradation of organic substrates is heavily dependent on surface events. Such hydrophilic/hydrophobic changes that might occur on the TiO_2 surface were therefore examined by contact angle measurements with water under MW/UV irradiation. The average contact angles were less than ~4 degrees under UV illumination alone but were ca. 18 degrees when microwave radiation was coupled to UV light (see Figure 1). This increase in contact angles on the TiO_2 particles indicates that microwave radiation increased the hydrophobic character of the TiO_2 particle surface, which has consequences on the adsorption mode of the organic substrate and thus on the overall mechanism of degradation. Changes in the morphology of the TiO_2 surface involve changes in the population of surface hydroxyl groups as a result of the microwave irradiation. It is tempting to speculate that the cause for the increase of hydrophobicity is partially due to formation of micro-/nano-scale hot spots on the TiO_2 surface, although we were unable to measure such spots by thermographic and by infrared radiation thermometric methods. Note that the contact angles measured when the TiO_2 particles were exposed to the MW/UV method were never smaller than the angles measured when the UV method was used.

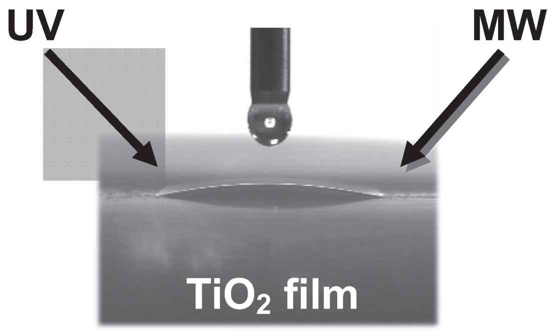

Fig. 1 Contact angles for a drop of water on the TiO_2 film to examine the hydrophobicity/hydrophilicity under the irradiation of MW and UV.

The initially formed intermediates also play a role in the extent of adsorption of organic substances on the TiO_2 surface and therefore can impact on the overall dynamics of the photomineralization with significant differences observed whether the dispersion is exposed to UV radiation alone or to both MW and UV radiations. The TiO_2 photoassisted degradations of dye RhB, UV irradiation alone produced intermediates different from those seen under MW/UV irradiation. The main factor depends on the hydrophobicity/hydrophilicity on the TiO_2 surface.

1) Horikoshi, S.; Hidaka, H.; Serpone, N. Chem. Phys. Lett. 376, (2003) 475.