Ultrasonic effects on photocatalytic reactions
(Joint system of sonolysis and photocatalysis)

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The effects of ultrasonic irradiation on photocatalytic reactions have been demonstrated since 1992 [1~5]. In recent years, this sonophotocatalytic system has received much attention with the investigations focusing environmental sciences. In this category, highly decomposition rate is required in order to remove contaminants. Since there are great kinds of contaminants, it goes without saying; not only displaying synergistic effect for the particular substrate but also indicating the mechanism of the effect is important. We try to classify coupling effects into several groups and explain each group. On the sonophotocatalytic system, interestingly, a solvent usually takes part in a reaction.

Sonophotocatalysis is assumed to group into three categories as follows;

**Category I (Sonochemical process):** The source of chemical effects is a phenomenon known as acoustic cavitation. Temperatures estimated more than 5000 K and pressures of 30 hPa are produced in tiny cavitation babbles. This phenomenon means high temperature and pressure chemical reaction field appears in and around cavitation babbles. Not only substrate in the solution but also solvent is activated and highly active chemical species (‘OH, O, H₂O₂, and so on) are produced.

**Category II (Photocatalytic process):** We explain heterogeneous photocatalytic process. Titanium oxide (TiO₂) is usually adopted as photocatalyst. Electrons and positive holes are produced on the photocatalyst particle by photo-irradiation. They provoke the substrate to activation and destruction. The solvent, which means water in many cases can seldom activate.

**Category III (Coupling process):** The activated intermediates play an important role for synergistic effect. As seen above explanation, there are three classified activated chemical species; those are intermediates just after destruction of substrates by sonolysis or photocatalysis and highly active radicals from solvent by sonolysis. The 1st and 2nd species transfer to stable products except for back reactions. The presence of activated intermediates originated from substrates belonging to Category I may accelerate the rate of photocatalysis. Consequently, substrates disappear in shorter period. On the other hand, the 3rd species attack substrates. Namely, radicals originated from solvent also play the important role in Category III. They appear only in the case of Category I. Therefore, the sonoochemical process is essential part for synergistic effects.

In addition, as physical effects, activation of photocatalysts under ultrasonic irradiation is another effect. The activation means the increase in surface area and the remove of adsorbed obstructions from the surface of photocatalyst.

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