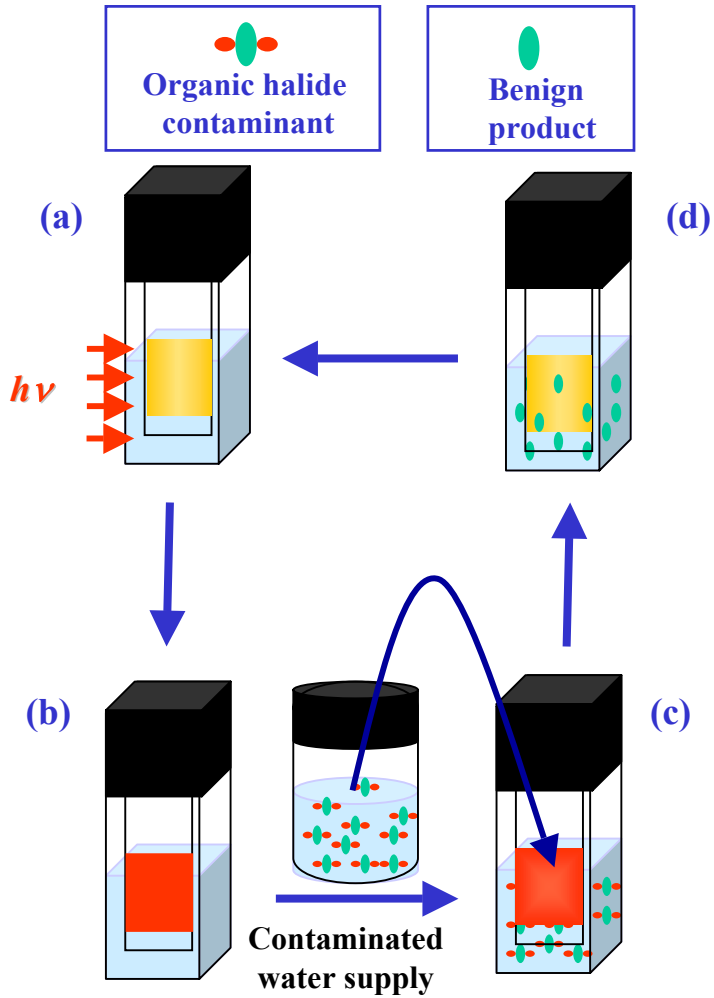
Enhanced Organic Halide Reactivity by Hemin Anchored to Nanocrystalline TiO_2

Johns Hopkins University

Che-0089168

Halogenated organic compounds are among the most widely used synthetic chemicals, however, most are resistant to natural degradation and are therefore prominent environmental contaminants. We have been actively involved in developing catalytic systems that can selectively dehalogenate organic halides to produce benign products. We have demonstrated the reduction of chlorinated solvents and chloroacetamide pesticides using a solid state catalyst consisting of an iron porphyrin, hemin, and nanocrystalline TiO_2 thin films. In this system, light irradiation into the TiO_2 band gap resulted in electron transfer from the conduction band of TiO_2 to the iron center of the porphyrin, thus reducing Fe(III) to Fe(II). The generated Fe(II) reduced the organic halides in the dark. The catalytic system is effective in both organic and aqueous media and can potentially be used to remove contaminants from ground water. An interesting feature of these molecular materials catalysts is that the hemin shows enhanced reactivity when bound to TiO_2 relative to fluid solution. For example, hemin anchored to TiO_2 will reduce the common herbicide, alachlor, where hemin in fluid solution will not. Studies are underway to better understand this interesting behavior.

This research was made possible by the National Science Foundation-funded Collaborative Research Activities in Environmental Molecular Sciences (CRAEMS) Center at Johns Hopkins, which is dedicated to understanding environmental redox-mediated dehalogenation chemistry.



(a) Solid state catalyst consisting of hemin anchored to nanocrystalline TiO_2 is exposed to light for activation. (b) Activated catalyst (c) Contaminated water is introduced to the activated catalyst (d) Catalyst converts the contaminants to benign products and can be reactivated