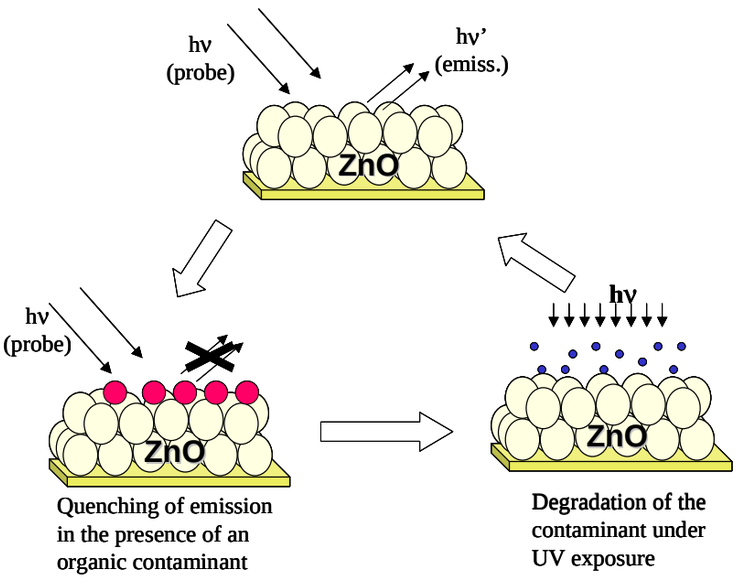
Simultaneous Detection and Degradation of Low Level Organic Contaminants Using ZnO Nanostructures

Prashant V. Kamat and Rebecca Huehn
Notre Dame Radiation Laboratory
University of Notre Dame,
Notre Dame, Indiana 46556-0579
(Tel. (219) 631-5411; Fax: (219) 631-8068)

A desirable feature for the detoxification of air and water is to develop a catalyst system that can simultaneously sense and destroy toxic chemicals. Such a catalyst system is especially useful to trigger the photocatalytic operation on demand, i.e., photocatalysis becomes operational only when the system senses the presence of a aromatic compound in the immediate surrounding. ZnO promises to be a promising candidate for such a specialized environmental application (Scheme 1). We present here a unique approach of sensing and destruction of organic compound using a metal oxide semiconductor. By using 4-chlorocatechol (4-CC) as a model compound we demonstrate here the dual role of ZnO semiconductor film as a sensor and as a photocatalyst.



Scheme 1

The ZnO emission is sensitive to the presence of aromatic compounds such as chlorinated phenols in water. The observed emission quenching is quantitative as the extent of quenching by the organics is determined by the adsorption equilibria. A detection sensitivity of the order of 1 ppm can be achieved in these systems. A major feature of the ZnO semiconductor system is its ability to degrade the organic contaminant under high intensity UV-illumination. The ZnO film-based sensors are also useful to monitor the course of a decontamination process as the emission intensity corresponds to the presence of aromatic species in water. The use of nanostructured ZnO films in these studies highlights the possibility of designing nanosensors for monitoring the quality of drinking and underground water.

Acknowledgments: The work described herein was supported by the Office of the Basic Energy Sciences of the US Department of Energy.