CIAR CURRENTS

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The Newsletter of the Center for Indoor Air Researc

CIAR PUBLICATIONS

- *Request for Applications* includes CIAR's Research Agenda, application forms, and general information about CIAR.
- *Publications Resulting from CIAR Supported Research* - a reference list of published articles, updated monthly.
- *Postdoctoral Fellowships* describes the application process for CIAR's program.
- *Workshop on Environmental Tobacco Smoke Generation and Exposures* relates information, drawn from a workshop sponsored and organized by CIAR, on techniques for generating ETS; characterizing the environments in which ETS is generated; exposures to ETS; and defining guidelines for the conduct of meaningful experiments with ETS.
- *Selected Readings* provide the reader with several current articles on a variety of indoor air topics:
    - *System Control of Indoor Air Quality (revised)* - on engineering control strategies for indoor air problems.
    - *Biological Aerosols* - on the status of bioaerosols in relation to indoor air quality.
    - *Sick Building Syndrome (revised)* - on the assessment of SBS in relation to environmental and psychological factors.
    - *The Impact of Indoor Air Quality on Allergies and Asthma* - presents some relevant papers on this increasingly important indoor air topic.
- Copies of these publications are available at no charge from CIAR.

PHOTOCATALYTIC COMPLETE OXIDATION OF INDOOR AIR CONTAMINANTS

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Gaseous indoor air contaminants may be removed by scrubbing, filtering, or adsorbi the contaminants. These techniques transfer the contaminants to another phase ratl than eliminating them, however, and additional disposal or handling steps a subsequently required. In the presence of air or oxygen, UV-irradiated TiO_2 is capable complete destruction of indoor air contaminants via photocatalytic oxidation. Tl activation of crystalline TiO_2 by UV light can be written

$$TiO_2 \xrightarrow{UV} \text{exciton} \rightarrow h^+ + e^-$$

The electron holes (h^+) are powerful oxidizing agents — their oxidation potential sufficient for complete oxidation at room temperature of nearly any indoor a contaminant. Hydrocarbons, for example, are completely oxidized to CO_2 and water.

An important step of the photocatalytic oxidation is for the electron hole to diffu through the solid to the solid-gas interface to react with an adsorbed gas molecul Photocatalysis, like ordinary catalysis, occurs only at the solid-gas interface. For tl reason, practical catalysts are usually porous materials with high specific surface area most of which is internal (i.e., within pores). The pore walls are accessible to the reacta molecules via gaseous diffusion, but they are not easily irradiated by incident light, thu most of the internal surface area is not photo-activated. Therefore, nonporous forms a often chosed for photocatalysts. In nonporous TiO_2, electron holes are created to deptl of about 4.5 microns, as shown in Figure 1 ("+" signifies an electron hole, "-" a fre electron). The further from the gas-solid surface they are created, the more likely tl holes are to simply find a free electron and recombine (the reverse of the excitatic reaction) without finding a surface-adsorbed molecule. Researchers have tried to addres this problem using fluidized beds of very fine non-porous TiO_2 powders illuminated by U light, using honeycomb monoliths coated with TiO_2, and using thin films of TiO_2 of glas plates, but none of these approaches are entirely satisfactory.

We have synthesized highly porous, photocatalytically active TiO_2 aerogels. The hig porosity (we have achieved approximately 99% porous materials) means that UV lig penetrates much deeper into the aerogel so that larger particles can be effectively use We believe this will simplify the application of photocatalysts for indoor a decontamination, allowing the use of fixed beds with particles sufficiently large to allo

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Photocatalytic Complete Oxidation

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easy flow of air. The thin walls of the aerogel mean that electron holes formed in the titania have a much shorter path to solid-gas interface (as shown in Figure 2) where they can react with adsorbed gases.

We have measured and compared the photocatalytic activity of our TiO_2 aerogels and a commercially available nonporous powder using a fixed bed reactor. The experimental setup is shown in Figure 3. Our results show that, despite its low crystallinity, the aerogel bed oxidizes a variety of contaminants as well or better than a highly crystalline anatase powder. The high surface area of the aerogel gives it very good adsorption properties for polar contaminants; in Figure 4a, the gas phase acetone concentration decreases in a nearly step fashion as acetone initially adsorbs on the aerogel. Subsequently, the acetone is completely oxidized. On the anatase powder, the drop in gaseous concentration due to adsorption is much smaller, and the subsequent oxidation rate lower. Methane, a nonpolar contaminant, adsorbs only slightly on either the aerogel or the anatase powder, but is completely oxidized nevertheless, as shown in Figure 4b.

The high porosity of the aerogel means that larger particles may be used in a fixed bed configuration. The use of larger aerogel particles will allow for low pressure drop flow of air and the use of fixed beds makes much simpler the engineering of applications for indoor air decontamination. We are currently working on ways to further improve the activity of the aerogel and on configuring a photocatalytic reactor for a specific indoor application.

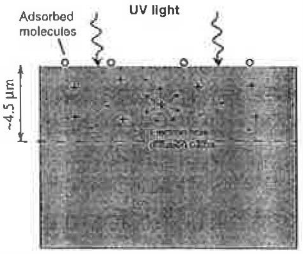

Figure 1

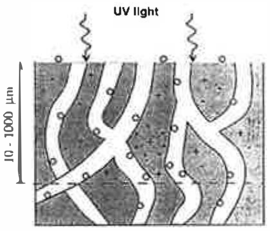

Figure 2

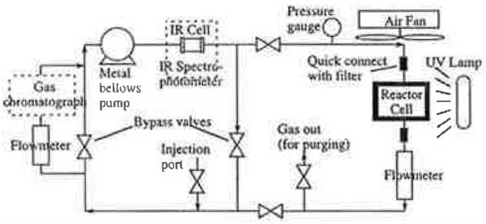

Figure 3

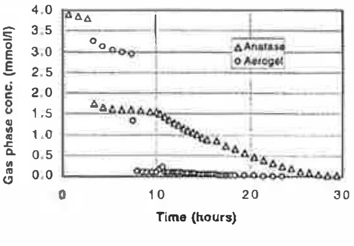

Figure 4a

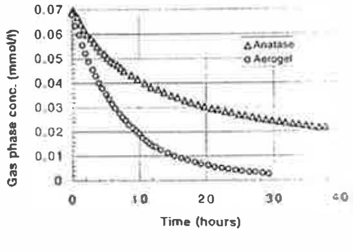

Figure 4b