Synthesis and Evaluation of TiO_2 Material in Environmental Application by Direct Utilization of Solar Light

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Objectives: The major goal of this project is to explore innovative methods (sol-gel, microwave plasma CVD, sputtering) techniques to prepare visible light-activated, nitrogen-doped TiO_2 ($TiO_{2-x}N_x$) films, nanoporous membranes, and nanotubes for environmental applications in the photocatalytic treatment of water using visible light. $TiO_{2-x}N_x$ catalyst is an environmentally friendly material and it will be used in "green" processes where the energy source will be that of solar light.

Approach:

- Years 1-2: Use of environmentally friendly nanotechnology methods for the synthesis of $TiO_{2-x}N_x$ materials with tailor-designed porosity (see Fig. 10 for properties of TiO_2 nanomaterials synthesized using self-assembling methods), which can be activated by visible light. These can include templating materials and appropriate methods to provide the nitrogen content. Examine the role of various precursors and conditions in catalyst synthesis and optimization. Study fundamental relevant phenomena on the synthesis of such nanometarials.
- Years 1-2. Characterization of these materials using available instrumentation at UC.
- Years 2-3. Evaluation of catalyst efficiency to destroy organic contaminants (i.e., biological toxins) using solar light as the energy input (the only energy input required in the process besides pumping of the water). Examine the effect of process conditions in optimizing process performance. Evaluate the potential for the complete destruction of organic contaminants and determine catalyst quantum yields (i.e., photon efficiency) and process costs.

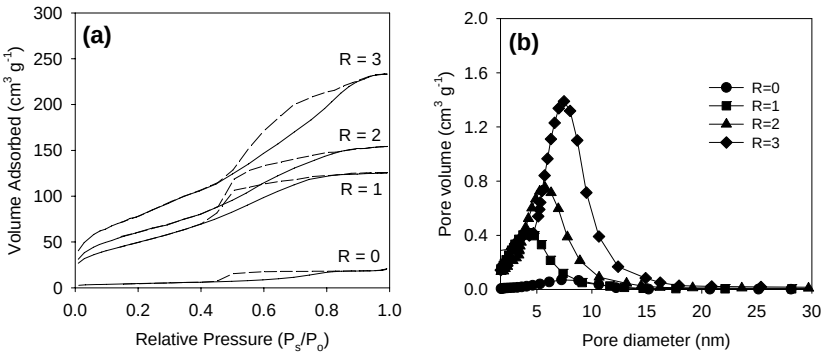

Fig. 10. (a) N_2 adsorption-desorption isotherms, and (b) pore size distribution of TiO_2 membranes synthesized with self-assembling based sol gel methods made of Tween 80, isopropanol, acetic acid and titanium tetraisopropoxide at molar ratios R:45:6:1, respectively. Effect of surfactant molar ratio. Note that the material is almost non porous in the absence of surfactant.

Note: Dr Dionysiou is currently collaborating on the synthesis of TiO_2 materials and their evaluation in environmental and photovoltaic applications with Dr. Elias Stathatos of the University of Patras (Greece). Dr. Stathatos has all facilities for measuring photon to electron conversion efficiencies in dye-sensitized solar cells and can assist in the fabrication of such systems at UC if funds become available.