Development of a CNT/ZnO/TiO2 Membrane for Visible-Light Induced Photocatalytic Filtration of Water-Borne Organic and Bacterial Pollutants

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With 780 million people without access to a potable water source, the development of a simple, self-powered, and point-of-use water system is desirable to remove waterborne bacteria, and chemical pollutants. This research designed an inexpensive solar powered filtration device, that removed bacterial contamination, as well as organic chemical pollutants, such as 2,4-Dichlorophenoxyacetic acid (2,4D), a herbicide that is often found in agricultural water runoff. Recently, semiconductors have shown promise as nanomaterials that can help clean water through photocatalysis. TiO2 nanowires and ZnO/CNT nanorods were incorporated into a unique membrane for concurrent photocatalytic oxidation and separation. The structure of CNT/TiO2 composite is advantageous, as CNTs add strength and chemical stability to the filter membrane, while providing necessary heterojunctions at the CNT/TiO2 interface for efficient translation of sunlight for photocatalytic decomposition under visible light. Because contaminants are degraded at the surface, the membrane exhibits low fouling potential. TiO2 nanowires were synthesized via hydrothermal process and CNTs were doped with ZNO with an acid treatment. The materials were layered on 3 in. filter paper to form the CNT/ZnO/TiO2 composite membrane, that was then installed in a hand-held, solar-powered filtration system. At 3lumens illumination, the system removed as much as 85.3% 2,4D; removal was dramatically increased to 99.7% at 990 lumens. The system's disinfectant abilities were studied with E-coli k12. The membrane removed 90% of bacteria at 3lumens and 97% of bacteria at 990lumens. With typical sunlight at 377lumens, the filter will have 97% and 91% remediation for organic pollutants and bacteria respectively.

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