

Photocatalytic Degradation of Aqueous Pollutants using Titania-coated Plastic Optical Fiber Fabrics

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Plastic optical fiber fabrics are widely utilized as efficient support materials owing to their high flexibility.^[1] In this study, we have investigated a remote photocatalysis system using modified plastic optical fiber fabrics. Plastic optical fiber that have surface defects such as scratches can transmit and scatter light to effectively illuminate photocatalysts.^[2] We successfully deposited TiO₂ onto a modified plastic optical fiber fabric using the dip-coating method. The drying temperature was fixed at 50 °C in order to inhibit the decomposition of the fabric. TiO₂-coated woven plastic optical fiber fabric (POF/TiO₂) was applied to the simultaneous oxidation of 4-chlorophenol (4-CP) and reduction of Cr(VI) and the photocatalytic degradation of MB. Figure 1 showed that the dark adsorption of Cr(VI) was negligible and the 4-CP was slightly adsorbed on the surface of POF/TiO₂. Under UV illumination using a remote light source, simultaneous 4-CP oxidation and Cr(VI) reduction are clearly observed. This result obviously suggests that POF/TiO₂ could photocatalytically and simultaneously oxidize 4-CP and reduce Cr(VI) by remote UV irradiation.

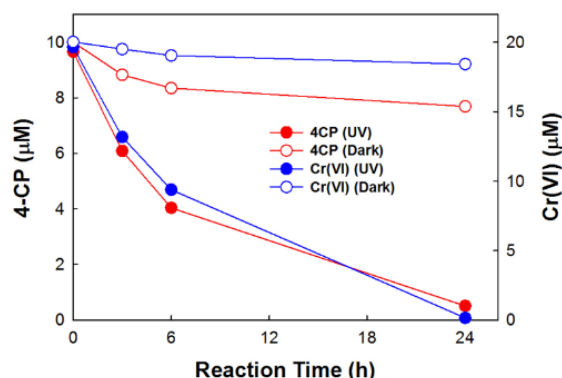


Figure 1. Simultaneous conversions of 4-CP and Cr(VI) on POF/TiO₂.

Recent studies have attempted to enhance the photocatalytic activity of GO-modified TiO₂ by interfacial electron transfer as well as adsorption.^[3] In this study, we modified POF/TiO₂ with GO and studied the simultaneous reactions of 4-CP and Cr(VI). For comparison, simultaneous 4-CP oxidation and Cr(VI) reduction were also carried out with POF/GO as shown in Figure 2. It is observed that the decrease of 4-CP and Cr(VI) were faster occurred on POF/TiO₂/GO than that on POF/TiO₂. However, in the presence of POF/GO, the concentration of both 4-CP and Cr(VI) are drastically decreased and completely removed from the solution within 24 h even under dark condition. Here, the effect of UV irradiation was almost negligible. This implies that rapid and complete decrease of 4-CP and Cr(VI) could be attributed to the strong adsorption effect of GO.

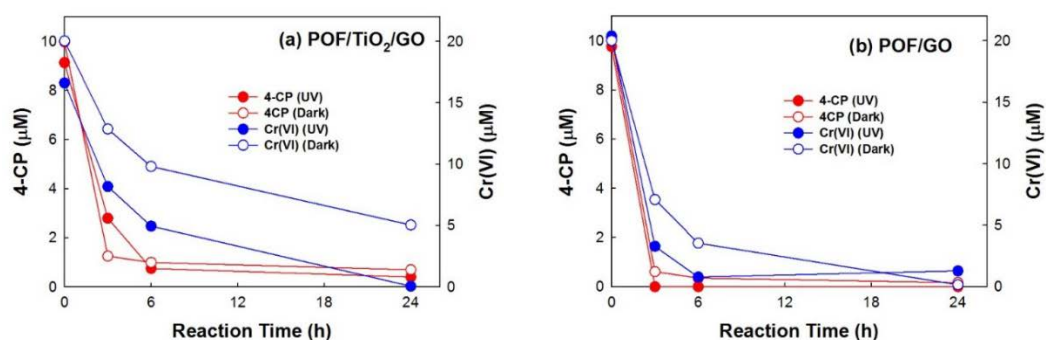


Figure 2. Simultaneous conversions of 4-CP and Cr(VI) on (a) POF/TiO₂(5)/GO and (b) POF/GO.

For the photocatalytic degradation of MB, the degradation of MB by direct photolysis, or through dark reactions of the adsorbed MB on the surface of the fabric, was not observed. MB degradation increased with increasing TiO₂ loading, Pt deposition, increasing solution pH, and decreasing initial MB concentration. The repeatability of the POF/TiO₂ system for photocatalytic degradation of MB was also tested. POF/TiO₂ and POF/Pt-TiO₂ were used in consecutive cycles during the photocatalytic degradation of MB, and efficiencies per cycle were evaluated and compared as shown in Figure 3. The process was repeated up to 13 times. These results demonstrate that POF/TiO₂ shows good stability after recovery and that POF/TiO₂ reuse is effective.

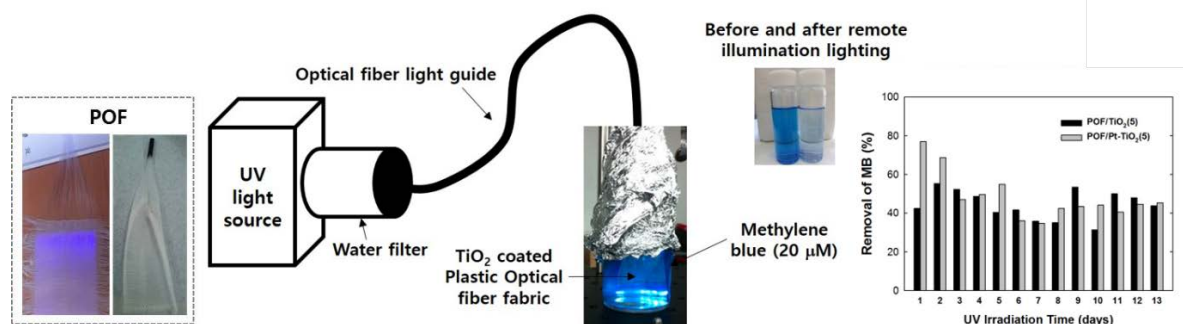


Figure 3. Remote photocatalytic degradation of MB on POF/TiO₂

Repeated testing in the above-mentioned degradation and simultaneous redox reactions revealed that the TiO₂-coated woven plastic optical fiber fabrics retain good activity after multiple cycles. On the basis of these results, we propose that plastic optical fiber fabrics together with photocatalysts are suitable for remote (in situ) advanced oxidation process useful for the remediation of contaminated soil or groundwater.

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