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Light Driven Degradation of Methyl Orange Dye Using Soluble and Immobilized Tin(IV) Porphyrin

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Water pollution is a major global concern, with organic dyes such as methyl orange (MO) being significant contributors. These dyes are often toxic and persistent in the environment and developing efficient and sustainable methods for dye degradation is crucial for environmental remediation [1]. Metalloporphyrins, particularly those containing metal ions like tin, iron and manganese, have emerged as promising photocatalysts for dye degradation due to their light-harvesting properties that can indirectly generate reactive species [2,3] However, their application can be limited by factors such as their stability, recovering and reusability. This work addresses these challenges by investigating the use of the dihydroxy-tin tetrakis-4-methylpyridilporphyrin chloride (SnP), the respective free base porphyrin (H2P) and SnP immobilized in sodium, cooper and cerium titanate nanotubes (Na-TNT, Cu-TNT and Ce-TNT respectively) for methyl orange dye bleaching. The reaction system was homemade built using 4 sources of light (25 W LED lamps assembled yielding a combined potence of about 100 W) in a square shaped box. A 5 mL glass vial containing the dye solution (3 mL, $5 \cdot 10^{-5}$ $molL^{-1}$) was placed in the center of the box and the system was magnetically stirred through the bottom of the box for 3 h. The percentage of the dye bleaching was determined by UVVIS spectroscopy using the previously detemined molar absorptivity of the MO. Preliminary results showed that without radiation all the investigated materials (for homogeneous catalysis: SnP and H2P and for heterogeneous catalysis: Na-TNT, Cu-TNT and Ce-TNT and the solids resulting from the SnP immobilization on them) cannot promote the dye bleaching. When the reactions were irradiated by the LED lamps, the reaction using Na-TNT, Ce-TNT and Cu-TNT presented no or low bleaching (0%, 31% our 20%, respectively). However, when the SnP or H2P were used as catalyst (homogenous reaction) the MO bleaching reached 100% but with high degradation percentage of the SnP (48%) and the H2P (70%). Upon irradiation however, 95% bleaching is reached using SnP-Na-TNT and 98% using SnP-Ce-TNT as catalyst. In short, we can observe that the SnP is an efficient catalyst for the photo assisted MO bleaching reaction, but in homogeneous media it is also partially destroyed, while after immobilization the destruction of the SnP is minimized keeping almost the same efficiency and making the recovery and reuse of the catalyst much easier.

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