Nickel Oxy-hydroxide Thin Films as Efficient Electrocatalysts for Dye Wastewater Treatment

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Carcinogenic and mutagenic dyes in industrial wastewater have significant adverse effects on aquatic flora and fauna. Current methods of physicochemical and biological treatments to eliminate dyes are limited in their treatment capacity, secondary sludge production and microbial resistance. This project presents a novel application of nickel oxy-hydroxide thin film as a low-cost and effective medium to directly degrade azo dyes. Nickel oxy-hydroxide thin film was initially tested for the adsorption of dyes in this work. Serendipitously, the material was found to actually catalyze the oxidation of azo dyes. The oxidative cleavage of azo bonds by nickel oxy-hydroxide was then characterized by NMR. The degraded product could be fully mineralized upon treatment with biological agents such as algae Chlorella. In terms of decolorization efficiency, nickel oxy-hydroxide thin film (92.2%) outperformed nickel hydroxide thin film (63%) which removes dyes by adsorption. The efficiency afforded by nickel oxy-hydroxide thin film is comparable to that of Ti-supported Pt (91%), one of the most efficient anodes currently used in electro-oxidation processes. More remarkably, the oxidative performance improved by two times when a constant electrode potential was supplied to regenerate the gradually depleting nickel oxy-hydroxide. This triggering potential was optimized to minimize unwanted side reactions. Further, the energy consumed (4.97 kWh/m3) was nine times lower than that of Ti-supported Pt (44.1 kWh/m3). This serendipitous and novel application of nickel oxy-hydroxide thin-films proves critical as an energy-efficient, maintenance-free and cost-effective treatment and management of industrial wastewater.

Awards Won:

Third Award of $1,000

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