Photocatalytic reduction of N2 in water under simulated solar light using F-doped nano-Fe2O3: the role of interfacial segregation

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Resumo:

The photoreduction of N2 to produce ammonia presents a promising alternative in sustainable chemistry, driven by the need to transition away from the energy-intensive Haber-Bosch process. By utilizing solar light for N2 photoreduction, this method harnesses renewable energy, offering a more environmentally friendly and energy-efficient pathway. Iron oxides have been proposed as potential catalysts for photochemical N2 fixation due to their abundance and low toxicity. However, iron oxide also exhibits low charge transfer, a short diffusion length, and a high electron-hole recombination rate. One strategy to address this issue is doping iron oxide with ions that can prolong the recombination time of the electron-hole pair, thereby enhancing its photocatalytic performance. In this study, Fe2O3 and F-doped Fe2O3 nanoparticles were synthesized using a modified polymeric precursor method. The segregation of F ions at the interfaces of Fe2O3 was confirmed through selective lixiviation. Subsequent analysis using electrochemical impedance spectroscopy (EIS) demonstrated a significant reduction in electric resistivity in the doped samples, attributed to grain boundary segregation of F, which facilitates electron and hole transport. Finally, the ammonia production using Fe2O3 and F-doped Fe2O3 nanoparticles was evaluated in a reactor under UV light.