SILICA FROM WASTE OF FLUORINE-DERIVATIVES INDUSTRY APPLIED FOR MICROSCAFS® SYNTHESIS

SILICE DERIVANTE DA UN SOTTOPRODOTTO DELL'INDUSTRIA DEI FLUORO-DERIVATI APPLICATA NELLA SINTESI DI MICROSCAFS®

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Introduction

In the ambit of recovery of end-of-life products, silica has proven to be an example of effective waste valorization with a view to the circular economy. The aim of the present work is to investigate industry-relevant applications of silicon dioxide derived as secondary product from the conversion process of hexafluorosilicic acid (H_2SiF_6 or FSA), a dangerous by-product of fluorine and phosphate industry, into synthetic calcium fluoride. In particular, the silica obtained FSA, with controlled features and morphology, is used in the synthesis of microspheres (40-80 μm), with interconnected macroporosity (MICROSCAFS®), replacing the conventional silica precursor tetraethyl orthosilicate (TEOS). The materials obtained were thus characterized and studied as photocatalysts for solar light-driven photocatalytic degradation of organic pollutants in aqueous solution.

Material and Methods

Silica is first recovered in gel form from FSA through a reaction with ammonia solution (pH of 8.5) at room temperature. The silica is then filtered, washed, and redispersed in deionized water, forming a FSA-silica dispersion, before the MICROSCAFS® preparation. Their synthesis technique combines polymerization-induced phase separation and sol-gel chemistry to form micro-sized spheres with tailored size and porosity. The FSA-silica dispersion is added to a hydrolyzed solution of (3-glycidyloxypropyl)trimethoxysilane (GPTMS), while a solution of glacial acetic acid and titanium(IV) isopropoxide (TiPOT) is prepared separately. These solutions are then combined and added to a water-in-oil emulsion, with decalin and Span 80 as oil phase, and vigorously stirred at 50°C. Ammonia is added at the final step, and the polycondensation reaction is allowed to proceed at 50°C for 30 minutes. The resulting MICROSCAFS® are separated by filtration, washed, dried, and appropriately heat-treated (550-900°C). Morphology and porous structure are assessed using Hg porosimetry, N_2 physisorption, and SEM analysis.

Results

The photocatalytic performance of the prepared materials was evaluated in a batch reactor for degrading two pollutants in water: an organic dye, methyl orange, and a widely studied broad-spectrum antibiotic, minocycline. Recovery experiments were conducted, showing material reusability and recyclability. The results were compared with samples obtained from conventional precursors, showing a correlation between material composition, surface properties, and photocatalytic activity.

Discussion

The results indicate that the materials prepared with FSA-derived silica show promising results for this application, allowing to consider FSA as a valuable alternative to traditional precursors, especially for applications of high technological interest. Furthermore, the possibility of introducing titanium centers into media should be considered as a practical approach to prepare photoactive composite materials.