Nanostructured Fe-based Materials for Photocatalysis and Photoelectrochemical Water Splitting

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Efficient conversion and storage of solar energy are crucial steps in the establishment of a renewable and carbon neutral energy supply. Photocatalysis is considered promising to make use of the large amounts of sunlight that reach the surface of earth. It renders the direct conversion of light into chemical energy possible, circumventing the problem of expensive energy storage using batteries, that comes with the use of photovoltaics. In recent years, earth-abundant spinel ferrites have emerged as auspicious materials for applications in photoelectrochemistry and photocatalysis. They have the inherent ability to absorb a large part of the visible light spectrum with band gaps around 2 eV, while being at the same time stable against photocorrosion.

We developed a fast microwave-assisted synthesis yielding phase-pure $MgFe_2O_4$, $NiFe_2O_4$ and $ZnFe_2O_4$ nanoparticles. The crystallite size can be tailored by post-synthetic heat treatment, however the materials are already partly crystalline as-prepared, with specific surface areas of around 200 m^2/g and good colloidal stability. First results of photocatalytic experiments will be presented, as well as the conversion of some spinel oxides into sulfides.

In addition, well-ordered mesoporous $ZnFe_2O_4$ and α-$LiFe_5O_8$ thin film photoanodes were fabricated by sol-gel synthesis, and utilised in photoelectrochemical water oxidation. Recently, we presented a low temperature synthesis of a p-type earth-abundant iron oxide photocathode, hierarchical porous thin films of fully crystallline and phase-pure $CaFe_2O_4$ were prepared. For the first time, this material can be prepared at temperatures as low as 700 °C. A novel synthesis for macroporous $CaFe_2O_4$ foams will also be presented.