Ph.D. defense

Institut de Chimie Séparative de Marcoule / CEA Marcoule
(UMR 5257, CEA, CNRS, Université Montpellier, ENSCM)

SARA EL HAKIM

will present her Ph.D. dissertation

Photocatalytic and sonocatalytic reactions with Ti@TiO_2 nanocatalyst for energy and environment

The defense will take place on **Friday, May 13, 2022** at **2.00 pm**

in the ICSM Auditorium

Catalytic processes have been widely investigated as a promising approach for providing sustainable energy and clean water resources. Among such, photocatalytic and sonocatalytic processes have been adapted as successful methods for fulfilling those two objectives. The key factor to these processes is the use of active materials capable of eliminating harmful molecules from wastewater and transforming others into products of high-added value. Those integrated in photocatalytic processes must be active under solar light. Today's major focus is the preparation of effective environmentally friendly photocatalysts using earth-abundant raw materials. One of the objectives of this thesis is to prepare noble-metal free Ti@TiO_2 core-shell nanoparticles throughout the sonohydrothermal treatment of commercially available titanium nanoparticles in pure water. Structural, chemical and optical properties of the prepared core-shell nanoparticles have been carefully studied and further compared to those of the initial titanium nanoparticles. The activity of these particles has been tested for the thermal-assisted photocatalytic hydrogen production and the degradation of pollutants with either light or ultrasound. Hydrogen production with those particles was tested from aqueous solutions composed of different sacrificial reagents (alcohols, carboxylic acid/amine mixture, and glucose) under controlled temperatures and inert atmosphere. Improved photocatalytic activity of Ti@TiO_2 nanoparticles with the increase of temperature (25°C – 95°C) was observed in all studied systems. The mechanism of the photocatalytic process has been discussed in terms of apparent activation energies and H/D kinetic isotope effects. In addition, comparative study of the activity of Ti@TiO_2 and initial Ti^0 nanoparticles towards the degradation of certain pollutants by light and by ultrasound was investigated herein. The presence of TiO_2 shell on the surface of Ti nanoparticles showed enhanced degradation of complexing molecules (EDTA) and organic dyes (RhB) under light in the presence of Ar/20% O_2 while higher activity towards sonocatalytic EDTA degradation was observed with air-passivated Ti^0 nanoparticles. At high-frequency ultrasound and in the presence of Ar/O_2 atmosphere, efficient sonochemical degradation of Rhodamine B has been observed even without catalyst.

Keywords: Core-shell nanoparticles; Photothermal effect; Hydrogen production; Sonocatalysis