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Interest of Gas Phase Processes for the Synthesis of Materials Activated under Light: Example in Photocatalysis and Photovoltaic

N. Herlin Boime¹, S. Ngo², S. Bouhadoun¹², R. Belchi¹³, A. Habert¹, F. Dapozze², J. Bouclé³, C. Guillard²

¹, NIMBE, CEA, CNRS, Université Paris-Saclay, CEA Saclay 91191 Gif-sur-Yvette France
², IRCCELYON, CNRS-Université Claude Bernard Lyon 1, 2 av. Albert Einstein, 69626 Villeurbanne Cedex, France
³, Univ. Limoges, CNRS, XLIM, UMR 7252, F-87000 Limoges, France

Due to its high activity under near UV illumination, one of the most studied materials in photocatalytic as well as in photovoltaic studies is titanium dioxide TiO₂ especially in its anatase crystalline form. In both cases, one of the phenomena limiting the efficiency is the recombination of electron-holes pair. In this context, the use of composites based on TiO₂ nanoparticles and carbon or metallic nano-objects is a relevant strategy towards more efficient electron transfer processes.

This paper will present the one-step synthesis of such nanocomposites and some studies on their photocatalytic or photovoltaic applications. To achieve the synthesis of high quality nanocomposites presenting well-controlled physical properties, we use the laser pyrolysis method. This method is based on the interaction between a high power CO₂ laser and a gaseous or liquid precursor. In all cases Titanium tetraisopropoxide (TTIP) was used as the TiO₂ precursor. Hydrogen tetrachloroaurate was dissolved in the TTIP solution to produce Au loaded TiO₂ nanoparticles (Figure 1, left). The efficiency of these nanoparticles was studied under air and N₂ for the photocatalytic decomposition of acetic acid. Graphene nanoparticles were dispersed in liquid TTIP to produce composite nanoparticles where TiO₂ is grown at the surface of the graphene layers (Figure 1, right). These composite nanoparticles were used to form the porous layer of a perovskite solar cell. In both cases, a significant effect is observed by comparison to the performances obtained from pure TiO₂.

Figure 1: TEM images of (left) Au loaded TiO₂ nanoparticles (right) TiO₂ nanoparticles at the surface of a graphene layer.