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

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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 TiO_2 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 TiO_2 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 CO_2 laser and a gaseous or liquid precursor. In all cases Titanium tetraisopropoxide (TTIP) was used as the TiO_2 precursor. Hydrogen tetrachloroaurate was dissolved in the TTIP solution to produce Au loaded TiO_2 nanoparticles (Figure 1, left). The efficiency of these nanoparticles was studied under air and N_2 for the photocatalytic decomposition of acetic acid. Graphene nanoparticles were dispersed in liquid TTIP to produce composite nanoparticles where TiO_2 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 TiO_2.

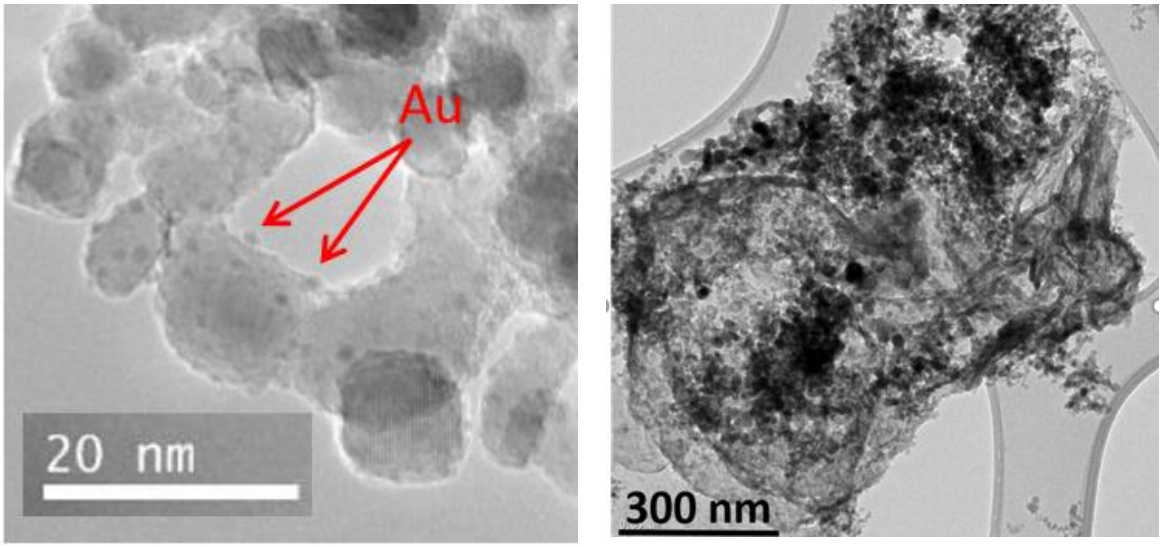

Figure 1 : TEM images of (left) Au loaded TiO_2 nanoparticles (right) TiO_2 nanoparticles at the surface of a graphene layer.