TUNING TITANIUM DIOXIDE WITH Cu_5-ATOMIC QUANTUM CLUSTERS FOR HYDROGEN PHOTOPRODUCTION

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Atomic quantum clusters (AQCs) are particles formed by small number of atoms of a metal (less than ≈100). They present novel properties such as fluorescence, catalysis, photocatalysis, and biomedical properties that differ from both nanoparticles and bulk of the same material. These properties depend strictly on the cluster size.[1] AQCs are not metallic, they are semiconductors whose band gap energy is tunable by the size. The smallest AQCs the biggest bandgap, becoming really promising in photocatalytic applications.

TiO_2 is a popular semiconductor used in photocatalytic applications, but its main limitation is the lack of light absorption on the visible. The optical response of TiO_2 changes in presence of Cu_5-AQCs increasing and moving the absorption from ultraviolet region to visible. The optical response is measured by diffuse reflectance spectrometry (DRS) (Figure 1A). The Cu_5 interact with TiO_2 transferring and electron and creating a polaron ($Ti:3d^1$) that is characterized by electron-paramagnetic resonance (Figure 1B).

The hydrogen photoproduction reaction is carried out in the presence of a hole scavenger, triethylamine. TiO_2 doped with Cu_5 increases its hydrogen production due to increased absorption in the visible region and the appearance of the surface polaron with a theoretical bandgap of 0.9 eV [2, 3]. One of the principal problems in photocatalysis is the pair electron-hole recombination that is avoided too by polaron appearance that induces the charges separation.

REFERENCES

[1] J. Calvo Fuentes, J. Rivas, M.A. López-Quintela, Encyclopedia of Nanotechnology, (2012) 2639–2648
[2] S. Huseyinova, J. Blanco, F. G. Requejo, J. M. Ramallo-López, M. C. Blanco, D. Buceta and M. A. López-Quintela, J. Phys. Chem. C, 120 (2016) 15902-15908
[3] M.P. de Lara-Castells, A.W. Hauser, J.M. Ramallo-López, D. Buceta, L.J. Giovanetti, M.A. López-Quintela, F.G. Requejo, J. Mater. Chem. A, 13 (2019) 7489-7500

FIGURES

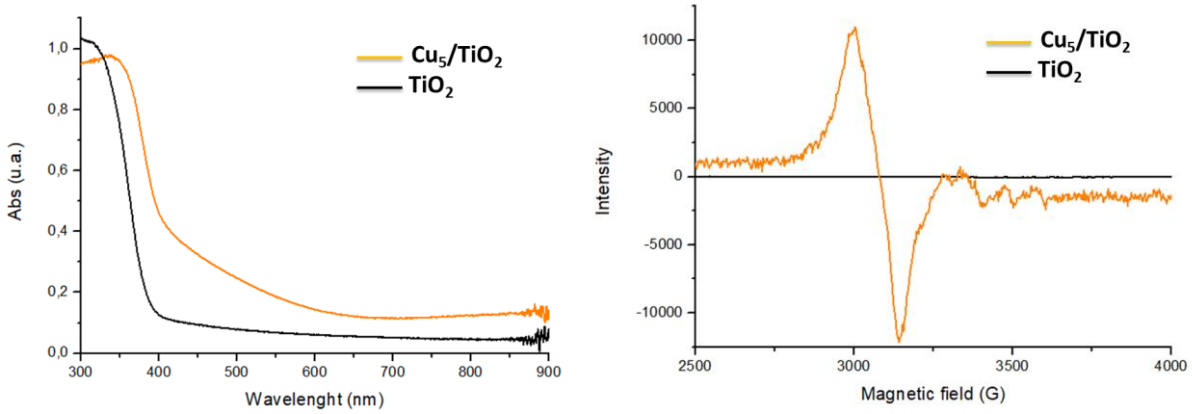

Figure 1: (A) UV-vis absorption spectra of TiO_2 undoped and TiO_2 doped with Cu_5-AQCs. (B) EPR spectra of TiO_2 undoped and TiO_2 doped with Cu_5-AQCs.