

PHENOL PHOTODEGRADATION OVER Au/TiO₂ PHOTOCATALYSTS

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Introduction

Phenol is a common contaminant in different industrial discharges. TiO₂ heterogeneous photocatalysis has shown to be a promising method for the complete destruction of undesirable contaminants in water sources by using solar or artificial light illumination (Poulios et al, 2003). For increasing the TiO₂ photocatalytic efficiency different strategies have been studied, such as the doping with transition or noble metals, where gold is an interesting option (Hidalgo et al, 2009; Moreau et al, 2005). The aim of this work was the study of the influence of pH and deposition time over the photocatalytic activity of Au/TiO₂ catalysts for phenol photodegradation.

Synthesis of Au/TiO₂ catalysts

TiO₂ Sol-gel + 1 M H₂SO₄ + calcination at 650°C.

Photodeposition process:

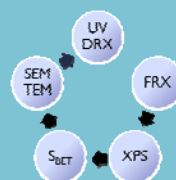
TiO₂ suspension on HAuCl₄ solutions (Au 0.5 - 2%)
pH 3 or 9

Illumination of the suspensions (15 to 240 min).
UVA intensity = 0.15 W/m².

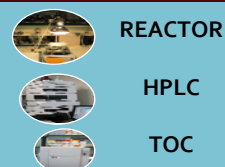
Filtration and drying at 110°C overnight.

Methods

Characterization



Phenol photodegradation



Results and Discussion

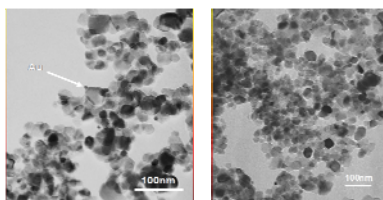


Figure 1. TEM Images for Au/TiO₂ catalysts Au 2% prepared at pH 3 (left) and pH 9 (right).

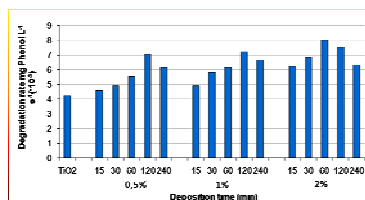


Figure 2. Photocatalytic Activity of Au/TiO₂ catalysts synthesized at pH 3.

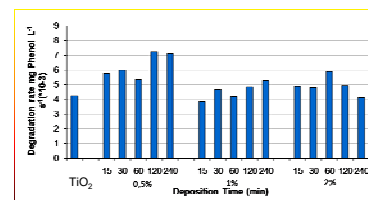


Figure 3. Photocatalytic Activity of Au/TiO₂ catalysts synthesized at pH 9.

Gold particle size is directly influenced by the pH used during photodeposition. The size increased with deposition time and gold content. At pH 3, large gold deposits were found (ca. 10 nm). A pH 9, an average gold particle size of 5 nm was observed, with a highly homogeneous distribution over the TiO₂ support.

XRD analysis showed anatase as only TiO₂ phase for all samples. UV-Vis absorption spectra identified a broad peak centred at 550 nm, indicative of the plasmonic absorption of nanocrystalline gold particles. FRX results showed that gold content increased with photodeposition time for both pH values.

XPS spectra for all catalysts suggest that Au species exist in three different states (metallic gold (Au⁰), nonmetallic gold (Au^{δ+}), and Au₂O₃ species). Nevertheless, Au⁰ is the major species in all catalysts. The fraction of Au⁰ also increased with the photodeposition time and gold content.

Figures 2 and 3 show the photocatalytic activity results for phenol degradation over the different catalysts. It can be seen that the deposition of gold significantly increased the activity of all materials.

Conclusions

The pH value during photodeposition showed to have a determinant influence on the final properties of Au/TiO₂ catalysts. At pH 9, better distribution and lower particle size of deposited gold was obtained compared to materials prepared at lower pH. A low gold particle size contributes to a higher improvement of the photocatalytic efficiency of Au-TiO₂. Best results for phenol photodegradation were obtained for Au/TiO₂ with a 0.5% gold content prepared at pH 9.

References

- Poulios I., Micropoulou E., Panou R., Kostopoulou E., Appl. Catal. B: Environ. 41 (2003) 345.
Hidalgo M.C., Maicu M., Navío J.A., Colón G., J. Phys. Chem. C. 113 (2009) 12840.
Moreau F, Bond GC, Taylor A.O., J. Catal. 231 (2005) 105–114.