Rare-earth doped TiO_2 films for the visible light photocatalytic oxidation of ethanol in air.

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The photocatalytic activity of TiO_2 as well as its physico-chemical stability, self-cleaning property and high selectivity make it a suitable candidate for the removal of hazardous pollutants such as VOCs from contaminated indoor atmosphere. Since TiO_2 only absorbs light with $\lambda < 380$nm, most applications are limited to UV light irradiation.

The aim of this study was to extend the spectral sensitivity of TiO_2 to visible light by doping TiO_2 with rare-earth ions, which offer the advantage of transitions in the visible region.

Thin film preparation

The influence of a different number of undoped TiO_2 layers was evaluated upon activity:

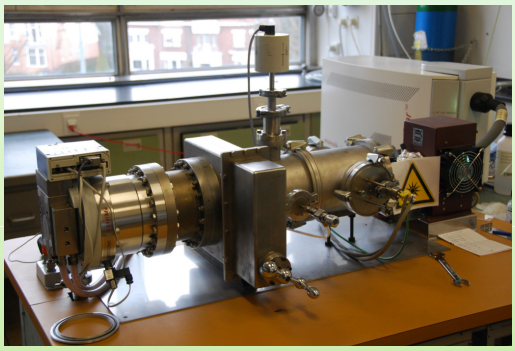
Sample	n° layers	Photocatalytic activity $\pm 3\sigma$ (ppm/min)
A	2	3.70 ± 0.10
B	3	3.78 ± 0.06
C	4	3.23 ± 0.13
P25	4	3.44 ± 0.16

Doubly and triply coated undoped TiO_2 films, calcined at 450°C for 2h, are highly active, under UV+visible illumination, if compared with TiO_2 films, prepared by spin coating, from Degussa P25.

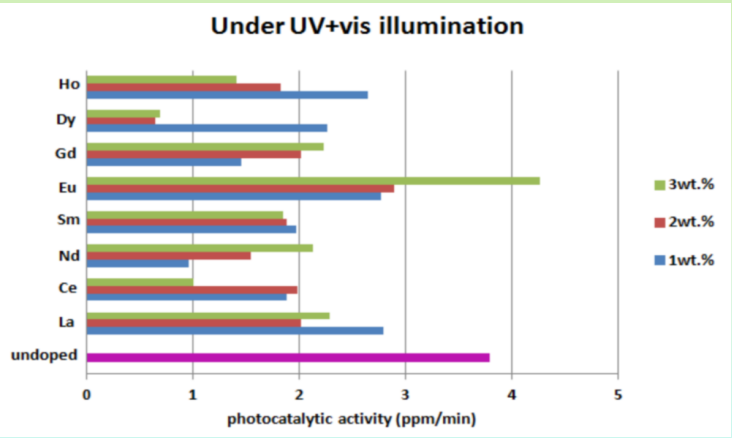
A series of 1, 2 and 3wt.% lanthanum, cerium, neodymium, gadolinium, europium, holmium, samarium and dysprosium doped TiO_2 sols were synthesized through a sol-gel method. The films were deposited by spin coating and calcined at 450 °C for 2 hours and compared with undoped TiO_2 films.

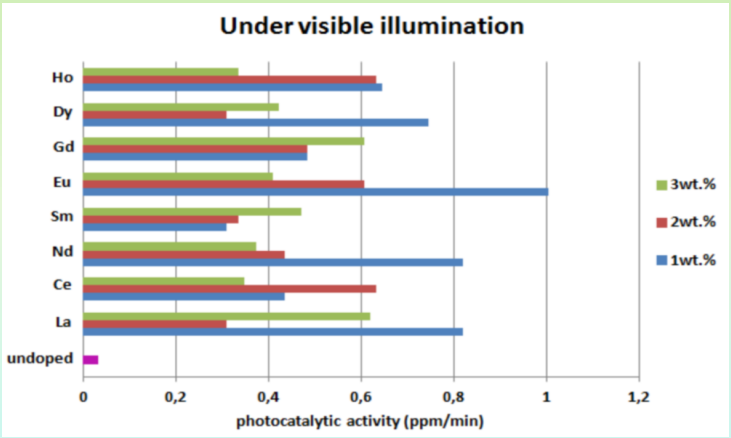
Thin film analysis

The microstructure, optical and morphological properties of the films were investigated using XRD, SEM, ellipsometry, XPS, UV/Vis DRS and PL. The triply coated thin films were tested in the breakdown reaction of EtOH as VOC molecule in air under UV and visible light. Photocatalytic measurements were performed in a custom made stainless steel batch reactor, in a controlled Ar/O_2 atmosphere, by means of an atmospheric gas analyser containing a mass spectrometer.



Doping effect





Conclusions

- Undoped sol-gel TiO_2 films of 2 and 3 layers show a higher photocatalytic activity than TiO_2 films prepared from Degussa P25.
- The doping has a great effect on the photocatalytic activity of TiO_2 under visible light.
- The visible response for La, Eu, Nd, Dy and Ho doped TiO_2 is larger for the 1wt.% doped films than for the 2wt.% and 3wt.% ones.
- Among the developed catalysts, the Eu doped titania shows the highest photocatalytic activity under UV+vis (3wt.%) and visible (1wt.%) irradiation.

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