

Sol-gel preparation of rare-earth-metal doped TiO₂ films for

the photocatalytic oxidation of ethanol in air

Iolanda Cimieri¹, Hilde Poelman², Dirk Poelman¹

¹LumiLab, Department of Solid State Sciences, Ghent University, Belgium

²Department of Chemical Engineering, Ghent University, Belgium



TiO₂ has emerged for its excellent photocatalytic properties applicable to environmental purification. However, most applications are limited to UV light irradiation because TiO₂ only absorbs light with $\lambda < 380\text{nm}$. The aim of this study was to extend the spectral sensitivity of TiO₂ to visible light by doping with rare-earth ions, which offer the advantage of transitions in the visible region.

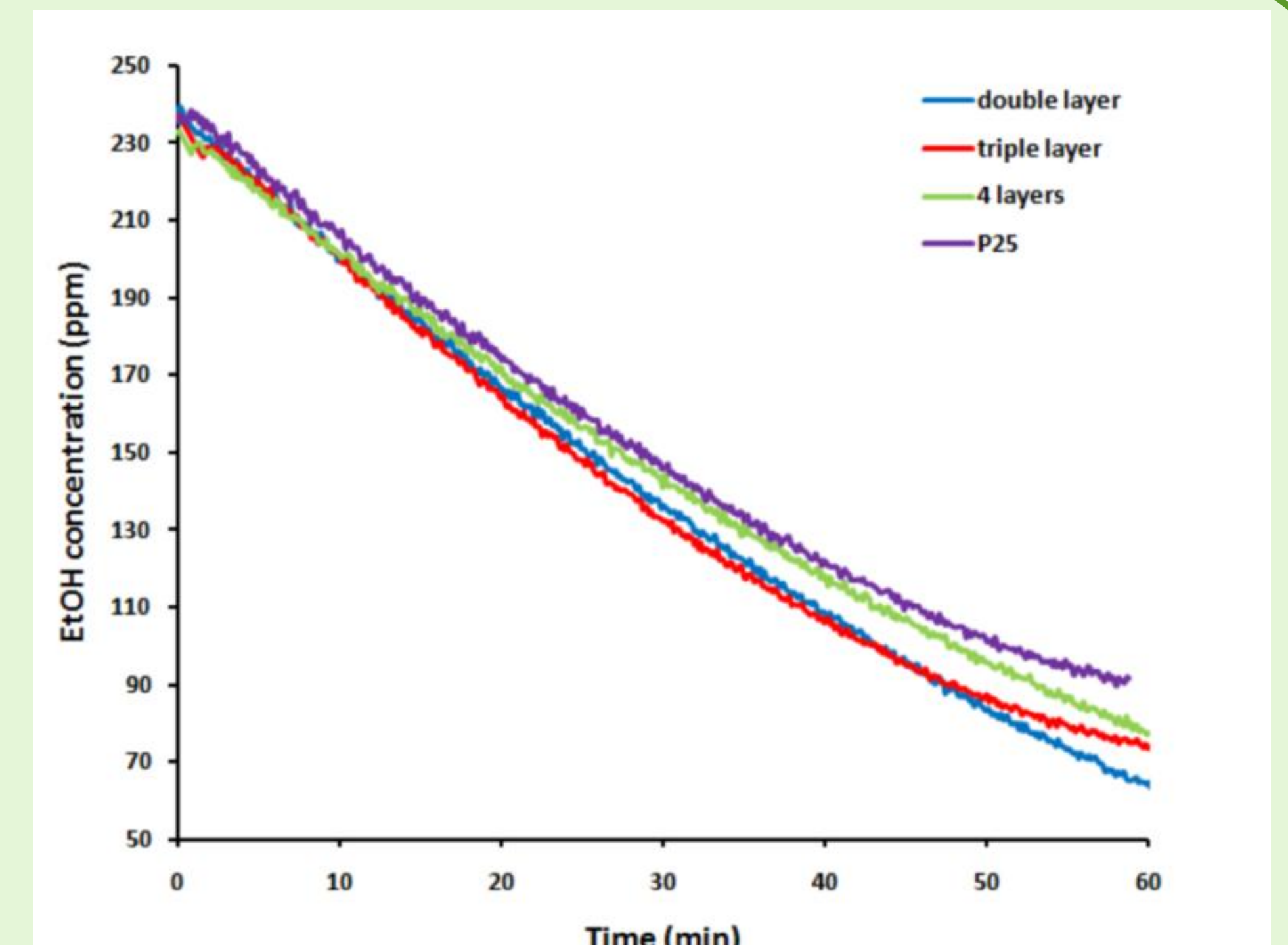
Thin layer preparation

A series of 1, 2 and 3wt.% lanthanum, cerium, neodymium, gadolinium, europium, holmium, samarium and dysprosium doped TiO₂ 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 TiO₂ films.

In order to choose the best film preparation conditions, it was evaluated the influence of different number of layers:

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

Double and triple coated undoped TiO₂ films, calcined at 450°C for 2h, are highly active, under UV+visible illumination, if compared with TiO₂ films, prepared by spin coating, from Degussa P25.

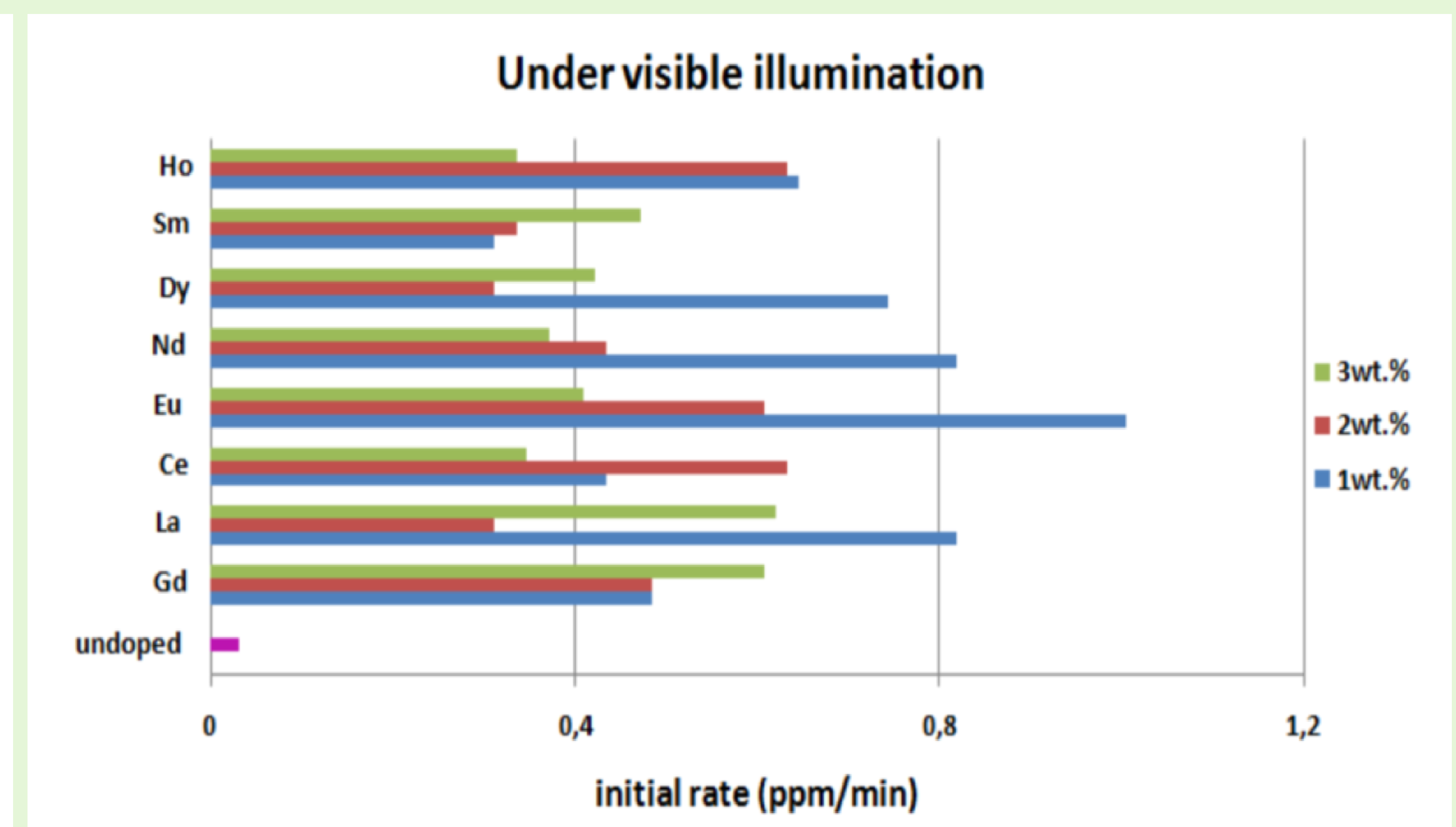
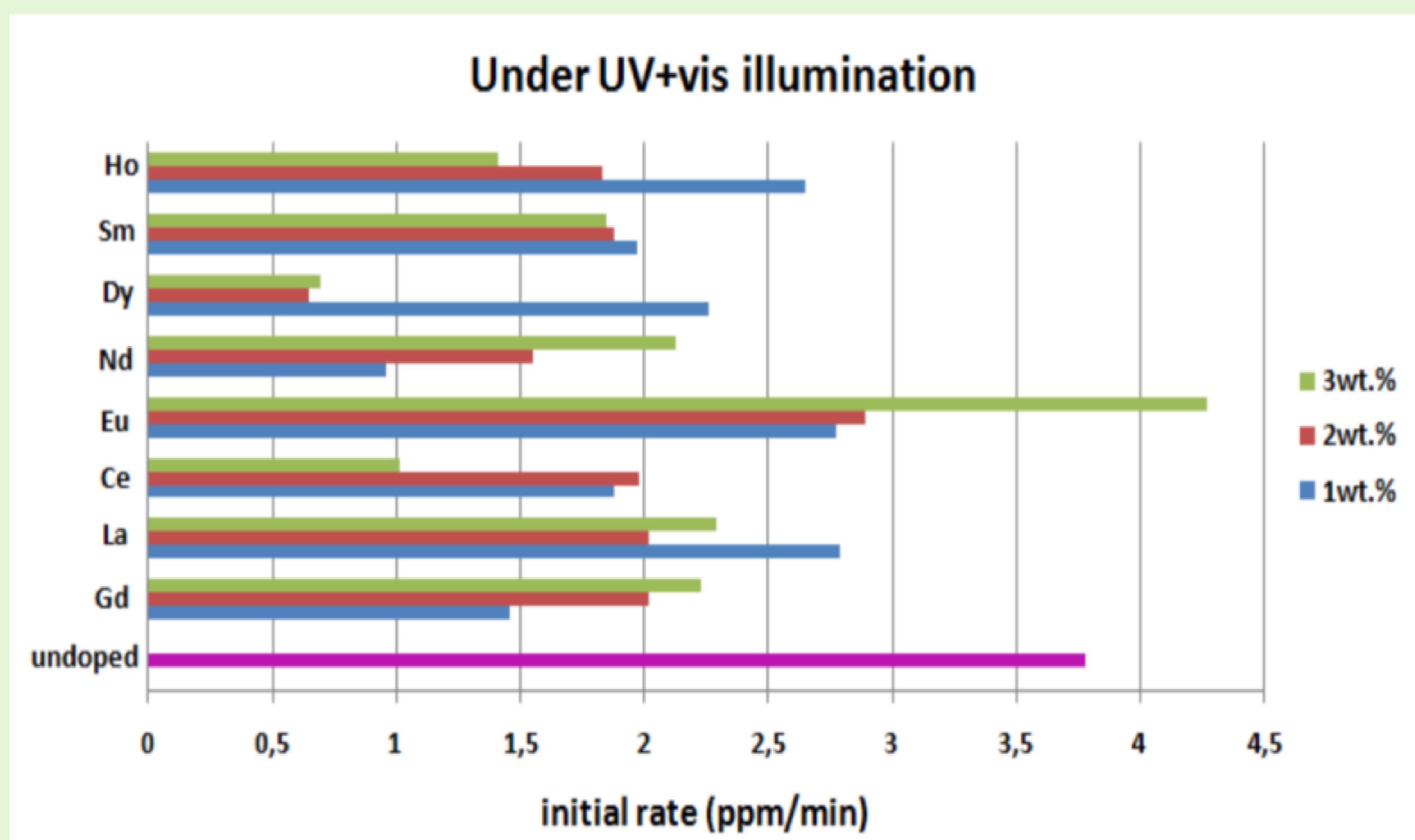


Thin layer analysis

The microstructure, optical and morphological properties of the films were investigated using XRD, SEM, ellipsometry, XPS, UV/Vis DRS and PL.

The triple 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/O₂ atmosphere, by means of an atmospheric gas analyser containing a mass spectrometer.

Doping effect



Conclusions

- Undoped sol-gel TiO₂ films of 2 and 3 layers show a higher photocatalytic activity than TiO₂ films prepared from Degussa P25.
- The doping has a great effect on the photocatalytic activity of TiO₂ under visible light.
- The visible response for La, Eu, Nd, Dy and Ho doped is larger for the 1wt.% doped films than for the 2wt.% and 3wt.% ones.
- Among the developed catalyst, the Eu doped titania shows the highest photocatalytic activity under UV+vis (3wt.%) and visible (1wt.%) irradiation.

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Contact: iolanda.cimieri@ugent.be