SILICA-CERIA (SIO_2@CEO_2) CERAMIC PHOTOCATALYSTS IN GLAZED TILES

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1. INTRODUCTION

Photocatalysis uses medium band gap ceramic semiconductors (anatase, zirconia, ceria, haematite, chromite, scheelite...) that are able to promote electron-hole pairs by light irradiation with a sufficient lifespan before recombining to interact with environmental agents (water or air), generating both reducing (interaction with electrons) and oxidising (interaction with holes) ions and radicals. In general, oxidising species are more efficient and photocatalysis is used as an advanced oxidation process (AOP) for the biodegradation of refractory organic substances such as azo dyes (1) or atmospheric pollutants.

2. EXPERIMENTAL AND DISCUSSION OF RESULTS

This report assesses the photocatalytic activity of silica-ceria composites ($xSiO_2@(1-x)CeO_2$, x=0, 0.1, 0.1, 0.3 and 0.5) on the azo Orange II dye in solution as well as on NOx in air. The composites were obtained by Sol-Gel methods based on the hydrolysis-condensation of alcoholic solutions of tetraethyl orthosilicate (TEOS) and cerium (III) nitrate (1,2). The resulting xerogels, dried under IR lamp (Fig. 1.a) with low silica concentration (x=0-0.3), display high hygroscopicity and form very stable gels. Those with a high silica concentration (x=0.5) (XRD results, UV-Vis-NIR spectroscopy with Tauc insert where appropriate, Orange II photodegradation and SEM microscopy in row 2 of Fig. 1) are white semi-conducting powders that have a significant photodegradation capability against Orange II (half-life $t_{1/2}$ of around 127 min) and NOx (E=34.4% nitrate abatement efficiency), although the recovery of the powders for cycling was hindered due to wetting. In order to improve cyclability, the samples were stabilised at 300°C/1h and 500°C/1h successively. At 300°C (Fig. 1.b), white powders were obtained (results in row 4 of Fig. 1), in which only nanostructured CeO_2 cerianite is detected by XRD (Scherrer crystallite size of about 32.5 nm contrasted by SEM), whose half-life times on Orange II are only significant for x=0.5 at 300°C ($t_{1/2}$ around 209 min). At 500ºC (Fig. 1.c and results in row 6), white CeO_2 nanoparticulate (Scherrer crystallite size of about 41 nm contrasted by SEM) powders are obtained, which are not photocatalytic against Orange II, but do maintain their efficiency versus NOx in air (E=59.1% in x=0.5 at 500°C). The alcoholic emulsions obtained prior to drying were applied by 120-thread screen printing on glazed monoporosa tiles and dried under IR lamp. The photodegradation on Orange II of the study tiles displays a moderate $t_{1/2}$ of about 228 min for x=0.5 (lower than x=0, $t_{1/2}$=392).

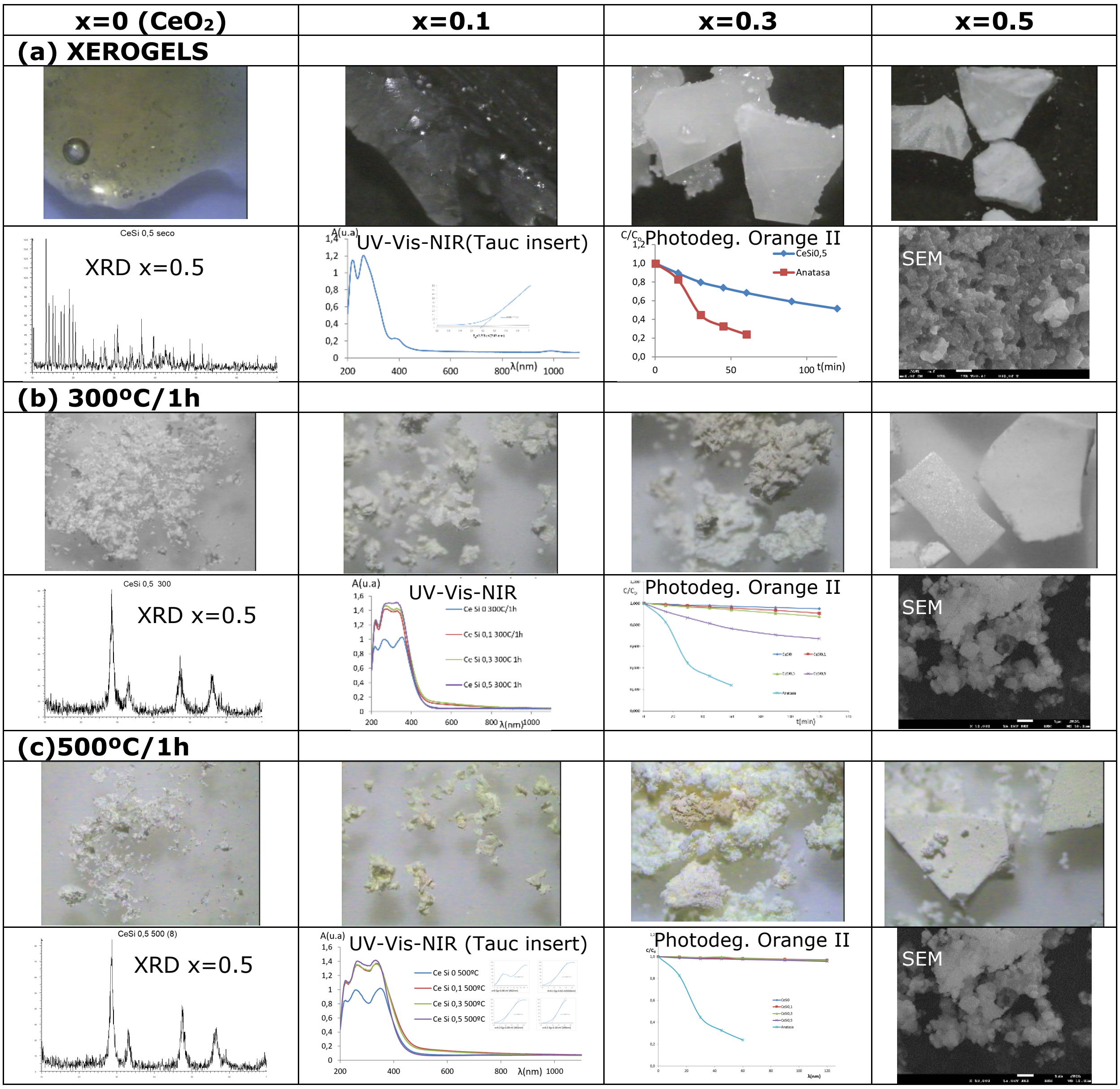

***Figure 1**. Composites ($xSiO_2@(1-x)CeO_2$, x=0, 0.1, 0.3 & 0.5) and characterisations indicated*

3. CONCLUSIONS

Our study of these composites (xSiO2@(1-x)CeO2, x=0-0.5) indicates improved photocatalytic activity when silica is incorporated in Sol-Gel emulsions applied both as powder and by screen-printing on glazed tiles.

4. ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support of Universitat Jaume I (Plan 2021).

5. REFERENCES

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