

## Influence of Microstructure on Luminescence of $Y_2O_3$ Powders

A. GAJOVIĆ<sup>(1)\*</sup>, K. FURIĆ<sup>(1)</sup>, N. TOMAŠIĆ<sup>(2)</sup>, D. S. SU<sup>(3)</sup> AND R. SCHLÖGL<sup>(3)</sup>

<sup>(1)</sup> Ruđer Bošković Institute, POB 180, HR-10002 Zagreb, Croatia,

<sup>(2)</sup> Institute of Mineralogy and Petrography, Faculty of Science, University of Zagreb, Horvatovac bb, HR-10000 Zagreb, Croatia,

<sup>(3)</sup> Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, D-14195 Berlin, Germany

For decades yttrium oxide has been an important material in ceramic industry. It was used in the first synthesized ceramic superconductor, but it plays nowadays an important role in preparation of novel light-emitting materials. Changes of  $Y_2O_3$  luminescence band as a consequence of different processes, such as moisturizing, heating and ball-milling, were observed in Raman spectra. In this work TEM and SAED were used to investigate changes in microstructure of  $Y_2O_3$  at nanometric scale that influenced the luminescence properties.

Commercial powders of  $Y_2O_3$  (purity 99.99 %) were studied. A high energy ball-milling was used for modifying the microstructure. The Raman spectra were recorded with a DILOR Z24 triple monochromator using the 514.5 and 488 nm laser lines for the excitation. TEM and SAED were performed in a Philips CM200 FEG TEM operated at 200 kV. For X-ray diffraction patterns (XRD) a Philips PW 3040/60 X'pert Pro powder diffractometer was used with  $Cu K\alpha_1$  radiation.

The luminescent bands of  $Y_2O_3$  depend strongly on the ad(b)sorbed water. The intensities increased notably after additional moisturizing with water vapor, but decreased and disappeared when heated at high temperature in vacuum. The changes of crystal structure due to moisturizing or heating were not observed by XRD. Since water does not exhibit such luminescence spectrum, it could be due to the incorporation of water (or  $OH^-$ ) in the crystal lattice of  $Y_2O_3$ .

With increasing ball-milling time the luminescent band in  $Y_2O_3$  Raman spectra decreased and finally vanished after 1 h milling (Fig. 1a). This change in Raman spectra was accompanied by the changes of crystal structure from cubic to monoclinic (Fig. 1b). High energy transfer from balls to powder could explain the expulsion of water (or  $OH^-$ ) causing the disappearance of the luminescent effect, but the luminescence was also absent in milled samples after long time deposit in atmosphere. The particle sizes decreased through milling (Fig. 2a and 2c) as it was more significantly shown in Fig. 2b and 2d. The absent of luminescence in nanometric-sized crystallites could not be explained in terms of surface adsorbed  $OH^-$  and  $CO_3^-$  as it was confirmed by humidity experiments<sup>1</sup>.

The absent of the luminescence in  $Y_2O_3$  nano-powders could be attributed to an increase of grain boundaries that influenced the mechanism of relaxation processes after excitation by 514.5 nm laser line.

## REFERENCES:

- (1) F. Vetrone, J.-C. Boyer, J. A. Capobianco, A. Speghini, M. Bettinelli, *Chem. Mater.* **15** (2003) 2737.

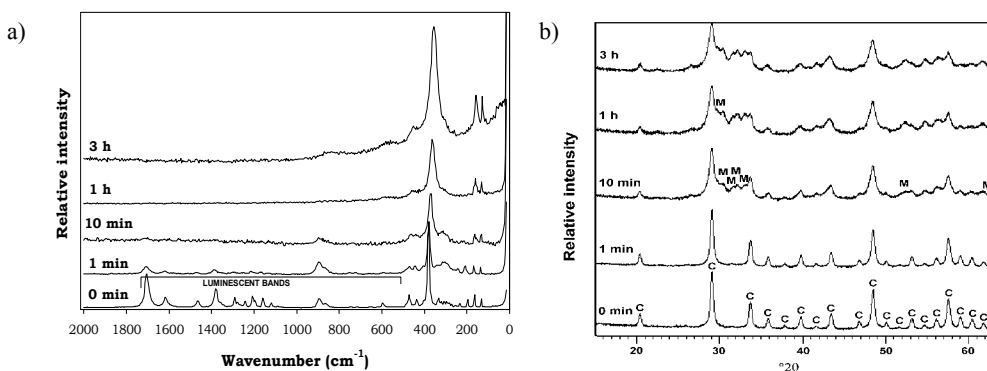


Figure 1:  $Y_2O_3$  ball-milled for denoted milling time: a) Raman spectra, b) XRD patterns (C – cubic, M – monoclinic)

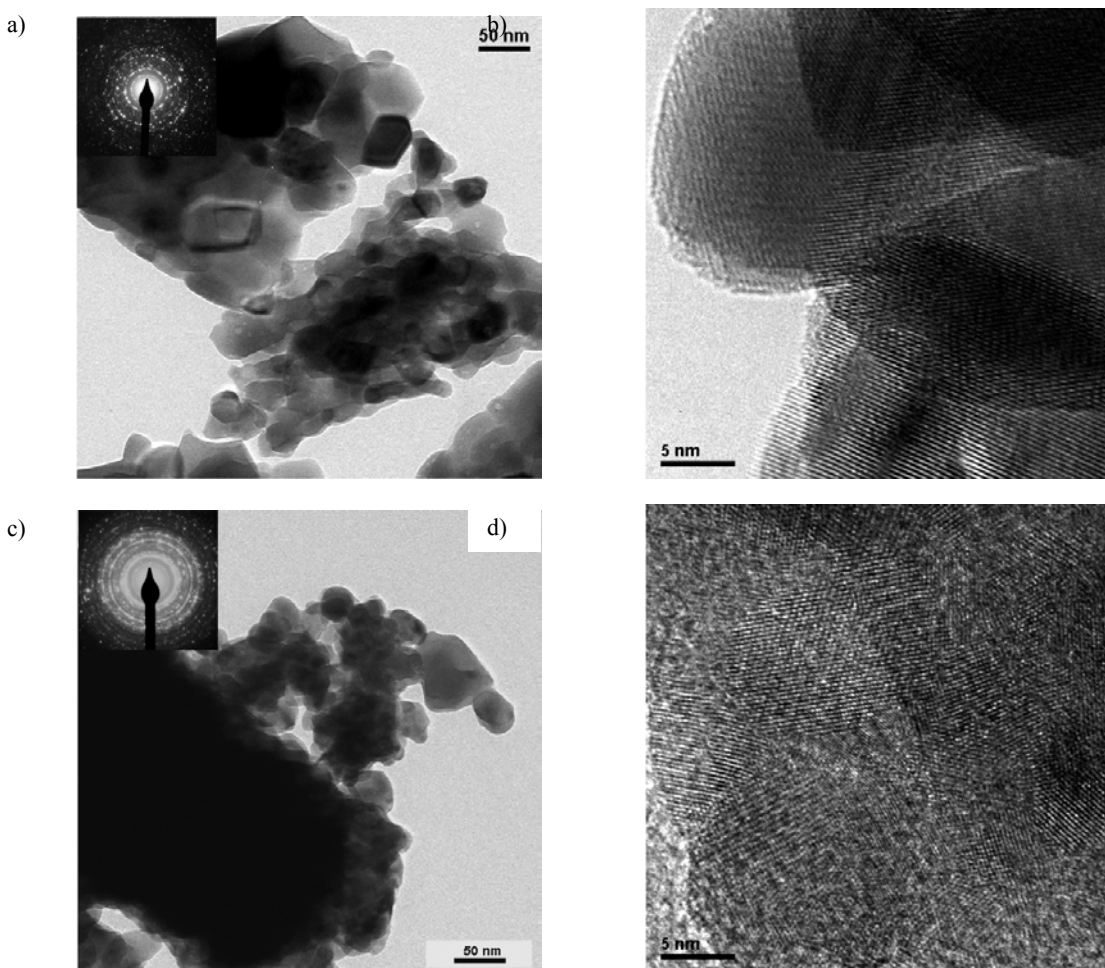


Figure 2: TEM, SAED and HRTEM of: a) and b) unmilled  $Y_2O_3$ ; c) and d) of sample milled for 1 h