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Photoluminescent behavior of $PbTi_{0.8}O_{2.6}$ system obtained by microwave assisted hydrothermal method

E. C. Paris(1)*, R. S. André(2), M. R. Joya(3), M. S. Li(3), J. A. Varela(1) and E. Longo(1)

(1) LIEC-CMDMC, IQ, Universidade Estadual Paulista, Araraquara, SP, Brasil, e-mail:elaine@liec.ufscar.br
(2) LIEC-CMDMC, DQ, Universidade Federal de São Carlos, São Carlos, SP, Brasil
(3) IFSC, da Universidade de São Paulo, São Carlos, SP, Brasil
* Corresponding author.

Abstract – $PbTi_{0.8}O_{2.6}$ polycrystalline particles were obtained by microwave assisted hydrothermal method (HTMW) at 140°C for 40 min. Photoluminescent property at room temperature was verified at first time for this system. This broad band photoluminescent behavior was observed in the visible spectrum range, which was attributed to defects generated by titanium and oxygen deficiencies in the $PbTi_{0.8}O_{2.6}$ lattice. It was also demonstrated that the most efficient excitation wavelength is 350 nm.

According to Web of Science database, there is only one article (Reference 1) related to synthesis and/or characterization of $PbTi_{0.8}O_{2.6}$ phase. Sun et al. [1] by means of sol-hydrothermal method obtained $PbTi_{0.8}O_{2.6}$ particles at 80°C, which can be converted to $PbTiO_3$ after controlled hydrothermal treatment. However, any property was observed for $PbTi_{0.8}O_{2.6}$ phase in this work.

In the present work was obtained $PbTi_{0.8}O_{2.6}$ phase by microwave-hydrothermal method (HTMW) at 140°C for 40 min with heating rate of 140°C min^{-1}. The aim of this work was to evaluate the photoluminescence property of this $PbTi_{0.8}O_{2.6}$ system in different excitation wavelengths. Figure 1 illustrates the photoluminescence spectrum at room temperature for this material in function of three different excitation wavelengths: 350, 530 and 568 nm. As can be seen in this figure, the maximum emission for this sample occurs in the excitation wavelength of 350 nm followed by 568 nm. The lowest photoluminescence intensity occurs for excitation of 530 nm. By analysis of the Figure 1, it is verified that for all excitation wavelengths were obtained a broad band photoluminescence. This behavior is a typical multiphoton process, in which the relaxation occurs by several ways, involving the participation of numerous states inside the material band gap. In order to compare the electronic band characteristics of $PbTi_{0.8}O_{2.6}$, $Pb_2Ti_2O_6$ and $PbTiO_3$ systems obtained by HTMW method, and related them with PL response for $PbTi_{0.8}O_{2.6}$ phase were realized ultraviolet-visible measurements. By means of optic absorbance spectra were obtained the gap values of 3.56, 3.05 and 3.42 eV for $PbTi_{0.8}O_{2.6}$, $Pb_2Ti_2O_6$ and $PbTiO_3$ systems, respectively. Thus, it is clear that the photoluminescent property do not occurs due to differences in the gap values for these metastable phases. In this way, a fact that can be responsible by this property is the structural disorder of the $PbTi_{0.8}O_{2.6}$ phase generated by atomic deficiency of titanium and oxygen in relation to the thermodynamically stable phase of $PbTiO_3$. This structural disorder of the $PbTi_{0.8}O_{2.6}$ system can be responsible by intermediate transition levels into the band gap, promoting the photoluminescent behavior.

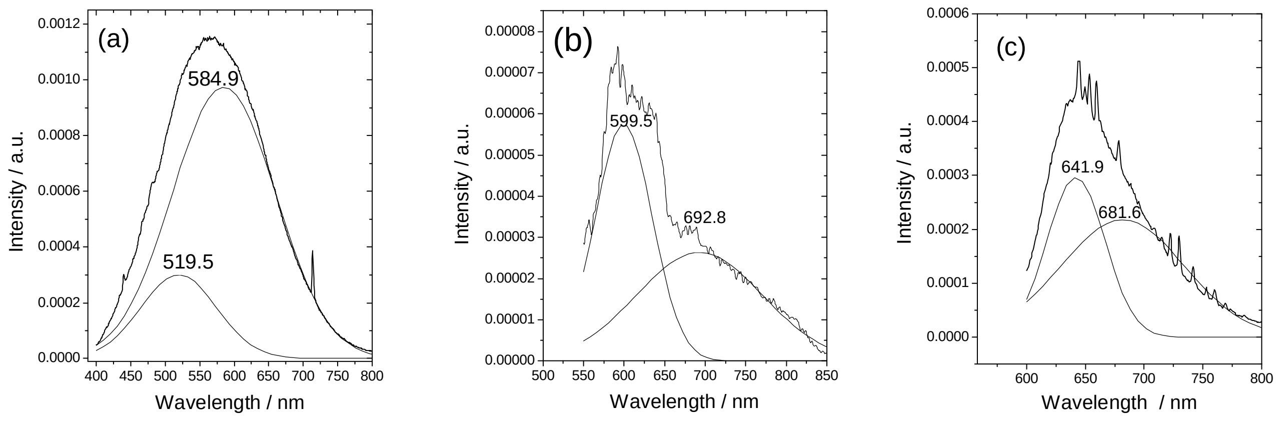

Figure 1: Photoluminescence spectra for $PbTi_{0.8}O_{2.6}$ system in function of the excitation wavelength: 350 (a), 530 (b) and 568 nm (c).

[1] Y.J. Sun, S. Tian, X.B. Li, Pricm 5: the Fifth Pacific Rim International Conference on Advanced Materials and Processing 1-5 (2005) 3517.