Luminescent properties of Er^{3+}/Yb^{3+}-codoped tantalum germanate glasses and glass-ceramics.

Camila Pereira[1](PG), Cristiano Ramos da Cunha[1](PG), Gael Poirier[1](PQ), Fábia C. Cassanjes[1*](PQ), Rogeria R. Gonçalves[2](PQ), Antônio E. De Souza[3](PG), Marcelo Nalin[3](PQ), Sidney J.L Ribeiro[3](PQ).

[1] *Institute of Science and Technology, Federal University of Alfenas, Poços de Caldas-MG, Brazil*

[2] *Department of Chemistry, University of São Paulo, Ribeirão Preto-SP, Brazil*

[3] *Institute of Chemistry, State University Júlio de Mesquita Filho, Araraquara-SP, Brazil*

Palavras Chave: *glasses, glass-ceramics, germanate, tantalum.*

Introduction

Several works reported in the literature that amorphous materials based on SiO_2-Ta_2O_5 obtained by sol-gel are promising glass hosts for luminescent rare earth ions since Ta_2O_5 incorporation decreases the phonon energy as well as increases the refractive index. Ta_2O_5 crystallization further enhances the luminescent properties when tantalum oxide nanocrystals are precipitated inside the silica network [1-2]. In this work, Er^{3+}/Yb^{3+} codoped glass samples were obtained by the melt-quenching method in the ternary system (90-x)GeO_2-10K_2O-xTa_2O_5 with x varying from 0 to 20%. Heat treatments above Tg allowed to precipitate the orthorhombic Ta_2O_5 phase. Luminescent properties of the starting glasses and glass-ceramics in the infrared range were compared.

Results and Discussion

Transparent glasses were obtained by melting around 1500°C in the ternary system (90-x)GeO_2-10K_2O-xTa_2O_5 codoped with 0,1% of Er_2O_3 and 0,5% of Yb_2O_3. The glass samples containing 15% and 20% of Ta_2O_5 exhibit intense crystallization events identified by DSC. Heat treatment around the crystallization temperature were performed in the sample Ta20 and the orthorhombic Ta_2O_5 phase could be detected as shown in Figure 1a.

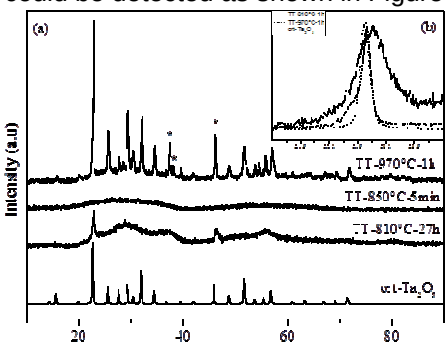

Figure 1. X-ray diffraction patterns of heat-treated glasses and orthorhombic Ta_2O_5.

As can be seen from Figure 1b, suitable heat-treatment of the starting glass at 810°C for 27h results in broad diffraction peaks, suggesting small crystallite sizes. Applying the Scherrer equation allowed to determine an average crystallite size of about 20nm for this glass-ceramic. Emission of Er^{3+} in the infrared was compared for the glass and glass-ceramics as shown in Figure 2.

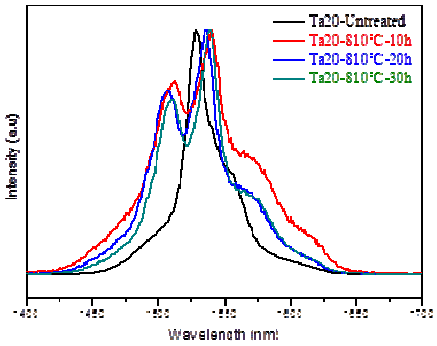

Figure 2. Emission spectra of glass and glass-ceramics in the infrared under excitation at 978nm.

The bandwidth of the emission band centered around 1535nm is strongly enhanced from 35nm to 65nm after heat-treatments, suggesting that Er^{3+} are preferentially located inside the tantalum oxide crystallites with low phonon energy and high refractive index. These results are promising for application in optical amplifiers since larger emission bands are required for amplification in a larger wavelength range.

Conclusion

New tantalum germanate glasses were obtained by melt-quenching and the resulting materials are promising hosts for rare earth luminescent ions. Crystallization of Ta_2O_5 nanocrystallites is efficient to broaden the emission band of Er^{3+} around 1535nm, suggesting potential applications as optical amplifiers.

Acknowledgments

The authors thank FAPEMIG, CNPq, CAPES, FINEP and UNIFAL-MG for financial support.

[1] Fitzgerald, V. *J.Sol-Gel Sci. Techn.* **2007**, *44, 153.*
[2] Ferrari, J. *J.Am.Cer.Soc.* **2010**, *1-8.*