Er^{3+} as optical probe to detect order/disorder in SiO_2-TiO_2-$PO_{2.5}$ sol-gel thin films

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Rare earth (RE) ions are nowadays regarded as one of the most versatile luminescent systems capable of producing light in a wide spectral range covering from the deep UV up to the medium infrared with a quantum efficiency almost reaching 100%. They, indeed, have been the basis of past solid state lasers that still play a relevant role in engineering and in general science.
This work explores the basic principles and state-of-art mechanisms of RE fluorescence, paying special attention to a correlation between the shape of the fluorescence emission spectra and specific morphologic aspects on the environment of the RE, generally intrinsic characteristics of sol-gel materials, such as porosity, nanocrystallites and phase transitions. Er^{3+}ions were used as optical probe to provide information about disorder, crystallization, densification and defect formation in Er^{3+} doped SiO_2-TiO_2-$PO_{2.5}$ sol-gel thin films.
Measurements of the fluorescence spectra and the lifetime of the erbium $^4I_{13/2}$ metastable level were performed. The amorphous films, as well those containing erbium crystal phases, were characterized by XRD, XPS, AFM and vacuum-ultraviolet (VUV).
It was observed that modifications in local order/disorder, lead to a broadening of Er^{3+} emission band and crystallization or defect creation causes a luminescence decrease and changes in fluorescence lifetime.