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Structural and luminescent properties of europium doped TiO_2 thick films synthesized by the ultrasonic spray pyrolysis technique

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Abstract
The structural and luminescent properties of trivalent europium-doped titanium dioxide films synthesized by the ultrasonic spray pyrolysis technique at several substrate temperatures are reported. These films are nanocrystalline and present a mixture of tetragonal (anatase and rutile) crystal structures of the titania as determined by x-ray diffraction. The rutile crystal structure became predominant as the substrate temperature during deposition was increased. Under UV and electron beam excitation, these coatings showed strong luminescence due to f–f transitions and the dominant transition was the hypersensitive $^5D_0 \rightarrow {}^7F_2$ red emission of Eu^{3+}. The photo- and cathodoluminescence characteristics of these films were studied as a function of growth parameters such as substrate temperature and europium concentration. Excitation with a wavelength of 396 nm resulted in photoluminescent emission peaks located at 557, 580, 592, 615, 652 and 703 nm, associated with the electronic transitions of the Eu^{3+} ion. The photoluminescence (PL) intensity as a whole is observed to decrease as the deposition temperature is increased. Also, with increasing doping concentration, a quenching of the PL is observed. The chemical composition and surface morphology characteristics of the films are also reported.

1. Introduction

Titanium dioxide (TiO_2) is one of the most extensively studied metal oxides because of its potential applications as photo-catalyzer, self-cleaning material, ultrawhite pigment, light scatterer, bio-compatible material and high refractive material for optoelectronic devices [1–5], and also in waste water purification [6], in solar cells [7], as a gas sensor material [8], host lattice for phosphors [9] and thermoluminescent applications [10], among others. TiO_2 films have been deposited by different methods, such as ablation laser deposition [11], RF-sputtering [12], sol–gel processes [13], chemical vapour deposition (CVD) [14] and ultrasonic spray pyrolysis (USP) [15]. The USP technique is considered as a low cost process, versatile, easily scalable to industrial applications and appropriate for the deposition of metallic oxide films doped with rare earth ions [16, 17].

TiO_2 has also attracted much attention for many years due to its physical properties, which show variations influenced by impurities, oxygen defects and crystalline modifications. In

