Optimizing Luminescence of Terbium doped Y_2O_3 Thin-Films Grown by CVD and Spin-Coating Methods

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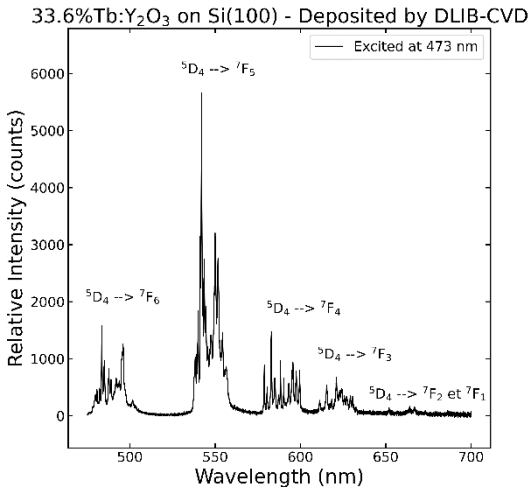
Rare-earth doped oxides are promising materials for a broad range of applications from light sources to quantum technologies. They can be obtained in different forms, among which thin films can offer a well-controlled growth process at wafer scales. In this work, we investigated Spin-Coating (SC) deposition and Liquid Injection Chemical Vapor Deposition (DLI-CVD) techniques for obtaining terbium (Tb) doped Y_2O_3 films [1].



Among rare earth ions, Tb^{3+} can show ms excited state lifetime even at high doping concentrations thanks to a favorable energy level scheme, leading to phenomena such as efficient Interparticle Förster Resonance Energy Transfer (IFRET) [2]. However, Tb can also be found as a tetravalent ion, Tb^{4+} [3]. This is not desirable since Tb^{4+} is not emitting and moreover can quench Tb^{3+} luminescence. As the formation of an oxide is classically performed under oxidizing atmosphere, the management of the valence of Tb may be challenging.

Here, we present the optimization of Tb:Y_2O_3 optical properties at a high doping concentration. We especially studied the influence of growth and post-annealing atmospheres and succeeded to prevent the oxidation of Tb^{3+} to Tb^{4+}. As a result, good optical properties, as well well-crystallized films, were obtained at high Tb concentration.

These results open the way to the development of high-quality rare earth doped thin films in which compositions and structures like buffer and caping layers can be efficiently tuned.

[1] Harada et al. (2022), Mater. Adv., 3, 1, 300-311.
[2] Henderson et al. (2006), Oxford University Press, Chapter 10, 455-504.
[3] Belaya et al. (2013), Inorg Mater, 50, 4, 379-386.

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