# Sol-gel synthesis of $CaTiO_3:Pr^{3+}$ red phosphors: tailoring the synthetic parameters for luminescent and afterglow applications

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Pr-doped $CaTiO_3$ ($CaTiO_3:Pr^{3+}$) is a promising candidate to substitute currently available red luminescent materials in applications such as LED displays [1]. Further, $CaTiO_3:Pr^{3+}$ is a red persistent phosphor, *i.e.* it exhibits a sustained red light emission for an extended duration after removal of the light source. While materials with blue or green afterglow emission are relatively common, red persistent phosphors are quite rare. As a result, $CaTiO_3:Pr^{3+}$ is a promising material for applications such as safety signage, sunlight storage and bio-imaging [2]. The control of the phosphor morphology is crucial for a wide range of applications, *e.g.* in bio-imaging and in LED and FED displays [3]. In this study, we propose new synthetic routes to tailor the morphology as well as the luminescence and afterglow properties of $CaTiO_3:Pr^{3+}$ for the desired application. Sol-gel syntheses were selected owing to their notable advantages with respect to the more commonly employed solid state reactions, *e.g.* lower reaction temperatures, higher homogeneity of the final product, and smaller particles. Two different sol-gel syntheses, followed by calcination, were investigated: one catalyzed by acetic acid and the other catalyzed by HCl in the presence of hydroxypropilcellulose (HPC) as morphology modulator. The role of the calcination temperature on the material properties was investigated in a wide temperature range (600-1200°C). The obtained samples were thoroughly characterized for their structural, morphological, optical and luminescence properties. The desired perovskite phase was obtained at a calcination temperature of 800°C or higher. The presence of HPC hindered crystallization at 600°C, while it influenced the morphological features at higher calcination temperatures. Photoluminescence measurements showed that the most crystalline samples presented the highest luminescence, irrespectively of the adopted synthetic approach. On the other hand, crystallinity had a more complex effect on persistent luminescence properties. While the samples calcined at the lowest temperature showed a negligible afterglow emission, the highest energy storage capability was exhibited by samples calcined at 800°C. The synthetic procedure played also a significant role in the afterglow emission: samples from the acetic acid synthesis are better candidates as red persistent phosphors. On the other hand, considering their high luminescent emission, low afterglow, and more porous structure, samples from HPC synthesis may be considered the most promising red phosphors for display applications.

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