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Evolution of shapes and identification of level II and III features of fingerprints using $CaZrO_3:Sm^{3+}$ fluorescent markers prepared via solution combustion route

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ABSTRACT

Simple solution combustion route is used for the fabrication of $CaZrO_3$: Sm^{3+} (1–11 mol %) nanophosphors using *Aloe Vera* gel as a fuel. The powder X-ray diffraction profiles confirm the pure orthorhombic phase. The granular type particles with non-uniformity in the size is observed. Photoluminescence emission spectra exhibit intense peaks at ~571, 603, 651 and 708 nm, which are attributed to $^4G_{5/2} \rightarrow {}^6H_{5/2}$, $^4G_{5/2} \rightarrow {}^6H_{7/2}$, $^4G_{5/2} \rightarrow {}^6H_{9/2}$ and $^4G_{5/2} \rightarrow {}^6H_{11/2}$ transitions of Sm^{3+} ions, respectively. The photometric properties evident that the prepared samples emit bright orange - red light with 79% color purity. The average correlated color temperature value is found to be ~3100 K. Thermoluminescence glow curves exhibit a broad, intense peak at ~148 °C. The highest thermoluminescence intensity is recorded for 5 mol % of Sm^{3+} doped sample. The thermoluminescence intensity at ~148 °C is found to increase with increase of γ-dose. The optimized $CaZrO_3$:Sm^{3+} (5 mol %) nanophosphors used as a luminescent labeling agent for visualization latent fingerprints on various porous and non-porous surfaces under ultraviolet 254 nm and normal light. The obtained results exhibits well defined ridge details with high sensitivity, selectivity, and low background hindrance which showed greater advantages. Extensive fingerprint details, namely level II and III features are clearly revealed. Hence, aforementioned results evident that the optimized sample endorse wide spread of applications, namely solid state lighting, high temperature dosimetry and advanced forensic science fields.

1. Introduction

In the 19th century, latent fingerprints (LFPs) are the most useful physical evidence of individual identification. The study of such LFPs is the main course in forensic sciences. Generally, the hands and feet are constituted with the natural secretions due to eccrine glands, which produce sweat, a mixture of water, salt and other small traces [1–3]. Hence, numerous approaches have been explored in order to visualizing such sweat pores, namely powder staining, spraying with chemical reagents, iodine fuming, etc [4–7]. Nevertheless, the visualization efficiency of these techniques are limited to level II type of identification due to insufficient spatial resolution [8–10]. Level III features include all dimensional attributes of the ridge such as pores, ridge path deviation, edge contour, breaks, creases, scars, and other permanent details, providing quantitative data supporting more accurate and robust fingerprint (FP) recognition, especially in fragmentary FP comparison [11].

However, many researchers have made several attempts to visualize LFPs which will assist in advanced forensic investigations and to boost the success rate [12–15]. Hence, rare earth (RE) doped inorganic luminescent nanophosphors (NPs) are considered to be most efficient and significant agents for visualizing LFPs on both porous and non-porous surfaces owing to their distinctive optical and chemical properties [16–18]. Further, these labeling powders exhibit several benefits, namely smaller crystallite size, exceptional photo-chemical stability, enhanced luminescence property, morphological variations and low toxic nature [19].

Recently, nitride, sulfide and oxide based NPs are subsequently used

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