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Analysis of Nd3+ concentration on the structure, morphology and photoluminescence of sol-gel Sr3ZnAl2O7 nanophosphor

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Neodymium activated strontium zinc aluminate (Sr3ZnAl2O7:x%Nd3+) nanophosphor was synthesized using the sol-gel technique whereby the Nd3+ concentration was varied in the range $0 \leq x \leq 2$. The effect of Nd3+ concentration on the structure, particle morphology and photoluminescence properties of Sr3ZnAl2O7 were investigated. The X-ray diffraction (XRD) results revealed that all samples resembled the mixture of both ZnAl2O4 and Sr3Al2O6 cubic structures. Nd3+ doping influenced the crystallite sizes of the prepared phosphor materials. The energy dispersive X-ray spectroscopy (EDS) results confirmed the presence of all expected elements in the composition. Scanning electron microscopy (SEM) revealed that as the Nd3+ concentration increased the surface morphology changed to smooth mountain like structures. The ultraviolet-visible (UV-Vis) diffuse reflection spectroscopy showed that the band gap of Sr3ZnAl2O7 can be tuned from 2.74 to 2.95 eV by increasing the Nd3+ concentration. When the host is excited above the bandgap (374 nm), broad emission attributed to defects occurs with the maximum near 585 nm. Doped samples excited in this manner do not exhibit additional luminescence due to the Nd3+ ions, but in contrast there is a small dip in the defect emission band near 585 nm due to absorption attributed to Nd3+ ions. Characteristic infrared emissions of Nd3+ ions at 885, 1064 and 1340 nm were observed by directly exciting the Nd3+ ions at 585 nm ($4I9/2 \longrightarrow 5G5/2+2G7/2$) and were attributed to $4F3/2 \longrightarrow 4I9/2$, $4I11/2$ and $4I13/2$ transitions, respectively. The Commission Internationale de l'Eclairage (CIE) coordinates results showed that the emission colour cannot be tuned by varying the Nd3+ concentration.

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