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Structural and Optical Investigation on Undoped And Sm3+ Doped Na4Mg(WO4)3 Nanophosphors as an Efficient Photoluminescent Material

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Newly developed white LEDs are replacing fluorescent lamps and other widely used lighting sources to minimize carbon dioxide emissions and energy loss due to their promising and useful properties such as longer lifespan, reliability, improvement in energy efficiency and luminous efficiency. Tungstates are effective host materials for rare-earth ions dopant for the production of luminescent materials or phosphors. The Intra-4f shell transitions shielded by rare earth ions provide effective and recognizable emissions across a variety of wavelengths. These materials are eco-friendly, cost-effective and safe. The pure Na4Mg(WO4)3 and NMW:xSm3+ (x= 0.25-3 mol%) samples were synthesized in this study by combustion synthesis and various analytical techniques were employed to investigate its structural, morphological and spectroscopic properties. The XRD peaks confirmed the monoclinic phase with the space group C12/c1. The Debye-Scherrer formula was used to determine the crystallite size which was in good agreement with the computed particle size by high-resolution transmission electron microscopy analysis. The field emission scanning electron microscopy confirmed the phosphor's porous nature. The Kubelka-Munk function was used to compute the band gap of the phosphors which is in the range 4.23 to 4.53 eV based on data from diffuse reflectance spectra. When stimulated at 405 nm, photoluminescence spectra showed four separate emission peaks, which corresponded to the energy level transitions from 4G5/2 to 6HJ (J = 5/2, 7/2, 9/2 and 11/2). It is also confirmed that the quenching effect observed between Sm3+ ions is prominently attributed to quadrupole-quadrupole interactions. The distinct reddish emission for 1.5 mol% concentration of NMW:xSm3+ with color purity of 98.1% suggests promising potential for applications in optoelectronics and other photoluminescent materials.

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