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Characterisation of Y₂O₃ co-doped Bi³⁺ and Yb³⁺ thin films synthesised using pulsed laser deposition and spin coating.

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Phosphor materials doped with various rare-earth (RE) elements have been used by the lighting industry in light emitting diodes and mercury free fluorescent tubes due to the wide range of possible luminescence ranging from ultraviolet (UV) through to the near-infrared (NIR) regions. In recent years, phosphor materials have been used to alter the solar spectrum in order to reduce the spectral mismatch and improve the conversion efficiency of solar cells. RE³⁺ - Yb³⁺ co-doped phosphors have shown potential for down-converting/shifting UV photons to NIR photons, but due to the parity forbidden 4f transition of RE³⁺, they are generally inefficient at absorbing photons in the UV and blue regions resulting in a weak NIR Yb³⁺ emission. Metal donor ions such as Bi³⁺ have shown to be an alternative to rare-earth ions for enhancing the NIR emission of Yb³⁺ ions. Y₂O₃:Bi³⁺,Yb³⁺ thin films were prepared using the pulsed laser deposition (PLD) and spin coating techniques. For films prepared through spin coating we found that the molarity of the Y₂O₃:Bi³⁺,Yb³⁺ solution plays an important role in the smoothness of the prepared films. Scanning electron microscopy analysis showed that films prepared at concentrations greater than 0.4 M were rough and dispersed with large agglomerations in the order of 100 µm, while films prepared at 0.2 M were significantly smoother and no agglomerations. Films synthesised using PLD also showed a rough surface, however the size of the agglomerated particles were approximately 1 µm. These small agglomerations were expected due to the laser ablation process which has an explosive-like character. Finally, under UV (325 nm) excitation the photoluminescence analysis for both the PLD and spin coating synthesised thin films yielded good luminescence properties in both the visible and more importantly in the NIR region. The result demonstrated that UV to NIR down-conversion/shifting is possible and may be used to modify the solar spectrum with the aim of improving the efficiency of solar cells.

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Prof HC Swart
University of the Free State
SwartHC@ufs.ac.za

Primary authors: Mr LEE, Edward (University of the Free State); Prof. SWART, Hendrik (University of the Free State)

Co-authors: Prof. TERBLANS, JJ (Koos) (UFS); Prof. KROON, R. E. (University of the Free State); Dr CRACIUN, Valentin (National Institute for Lasers, Plasma and Radiation Physics, Magurele, Romania)

Presenter: Mr LEE, Edward (University of the Free State)

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