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Optical Spectral and Lasing Potentials Analysis of Dysprosium and Samarium Ions Co-doped Strontium Magnesium Borate Glass Matrix

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Andrew Ichoja1, *Emmanuel .O.Odoh2 and Emmanuel .O. Adejo3*
*1,2,3 Federal University of Health Sciences, Department of Physics, Faculty of Science, P.M.B 145 Otukpo, Benue State, Nigeria*Corresponding author; andrew.ichoja@fuhso.edu.ng

1. Abstract
Improved Dy3+ + Sm3+ co-doped strontium magnesium borate glasses with the nominal compositions of 20SrO 10MgO (70 z) B2O3 0.7Dy2O3 zSm2O3 (0.2 z 1.0 mol%) were prepared via the melt-quenching system. The structural property of the quenched glass samples was investigated using X-ray diffraction (XRD). The ultraviolet-visible-near-IR spectroscopy (UV-Vis-NIR) spectra of the glasses exhibited characteristic absorption transitions of Dy3+ and Sm3+ respectively. The photoluminescence (PL) spectra for Dy3+ / Sm3+ co-doped glass system exhibited five emission bands due to the 4F9/2 6H15/2 (Dy3+), 4F9/2 6H13/2 (Dy3+), 4G5/2 6H7/2 (Sm3+), 4G5/2 6H9/2 (Sm3+) and 4G5/2 6H11/2 (Sm3+) transitions in Dy3+ and Sm3+, respectively. From the optical absorption measurements, the influence of Dy3+ and Sm3+ on the three Judd-OFelt (J O) intensity parameters (2, 4, 6) were evaluated. The achieved high values of the branching ratio (60% and 74%) and stimulated emission cross-section (10 10 22 cm2) recorded at 4F9/2 6H13/2 and 4G5/2 6H7/2 electronic transitions showed an excellent lasing and optical energy harnessing potentials of the proposed glass compositions.

2. Introduction
Borate glasses are known for remarkable structural and optical properties and are more promising materials than their crystalline equivalent due to their simple and inexpensive production skill, high thermal technology, and good coefficient of incorporation of rare earth [1]. High optical performance arising from the co-doping of rare earths opens new possibilities for various applications of the glass matrix including lasers, biomedicine, sensors, etc. However, the glass system is volatile and unstable hence, the inclusion of alkaline earth metal would enhance its mechanical stability [2]. The newly activated glass composition was prepared using the melt-quenching method. Structural and photoluminescence characteristics of the glass matrix were evaluated using XRD and UV-Vis analysis respectively. The lasing parameters such as stimulated emission cross-section, transition probability, and branching ratio were calculated by equation [3] given by Kindrat
.δ_e (φˆ’ Jˆ’,φJ)=(_pˆ4)/(8πcnˆ2 Δ _p) A_rad (φˆ’ Jˆ’,φJ)
where p is the wavelength at maximum peak, e is the emission cross-section, Arad is the radiative transition probability, and p is the effective bandwidth. The evaluated spectroscopic parameters indicate the possibility of the newly activated glass matrix for technological applications.

3. Results

Fig. 1: The XRD pattern of SrMgB2O3 glasses Fig. 2: The optical absorption spectra of SrMgB2O3 glasses

4. References

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Primary author: Dr ICHOJA, Andrew (Federal University of Health Sciences, Department of Physics, Faculty of Science, P.M.B 145 Otukpo Benue State, Nigeria)

Co-authors: Mr ADEJO, Emmanuel (Federal University of Health Sciences Otukpo, Department of Physics, Faculty of Science, P.M.B 145 Otukpo Benue State, Nigeria); Prof. ODOH, Emmanuel (Federal University of Health Sciences Otukpo, Department of Physics, Faculty of Science P.M.B 145 Otukpo Benue State, Nigeria)

Presenter: Dr ICHOJA, Andrew (Federal University of Health Sciences, Department of Physics, Faculty of Science, P.M.B 145 Otukpo Benue State, Nigeria)

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