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Novel NIR Emitting Phosphors

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Introduction

In recent years near-infrared luminescence has attracted considerable attention because of the following important applications areas. Firstly, NIR-Lasers are used for medical purposes, as human tissue show high absorbance in the range between 650 and 1000 nm, 1200 and 1350 nm, 1500 and 1700 nm. Secondly, in telecommunication optical networks based on silica fibers, NIR radiation is used as silica hardly absorbs in the spectral range between 1000 and 1800 nm.

This work deals with luminescence of $LiGdMo_2O_8$ doped with Yb^{3+} and Tm^{3+} ions and $LiTbMo_2O_8$ doped with Yb^{3+}. Molybdates activated with Yb^{3+} are already described as potential laser crystals in literature [1] and the ion couples Tm^{3+}/Yb^{3+} and Tb^{3+}/Yb^{3+} are known to show cooperative down-conversion i.e. NIR luminescence upon near UV or blue excitation with a quantum efficiency larger than 100% [2]. All samples were synthesized by conventional solid-state methods under ambient atmosphere. The luminescence properties were investigated with regard to energy transfer between above mentioned ion couples.

Results and Conclusions

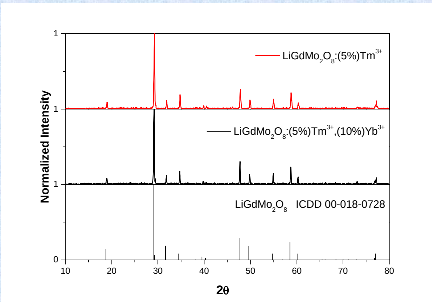

Fig. 1. XRD pattern of $LiGdMo_2O_8$ doped with Yb^{3+} and Tm^{3+}

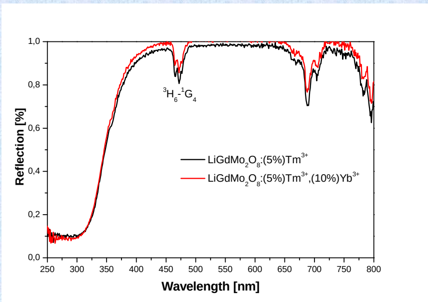

Fig. 2. Reflection spectra of $LiGdMo_2O_8$ doped with Yb^{3+} and with Yb^{3+}/Tm^{3+}

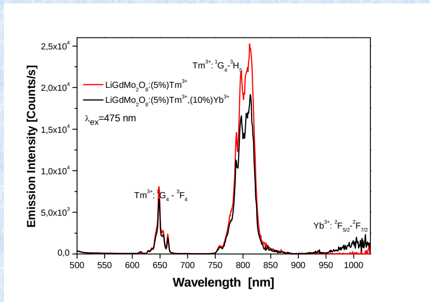

Fig. 3. Emission spectra of $LiGdMo_2O_8$ doped with Yb^{3+} and Tm^{3+}

$LiGdMo_2O_8$:Tm^{3+} shows emission from Tm^{3+} : $^1G_4$ – $^3F_4$ (650 nm) and $^1G_4$ – $^3H_5$ (800 nm) upon excitation at 475 nm ($^3H_6$ – $^1G_4$ transition of Tm^{3+}). This material co-doped with Yb^{3+} exhibits additionally emission from Yb^{3+}, viz. the $^2F_{5/2}$ – $^2F_{7/2}$ transition and a decrease in intensity of the peak at 800 nm. This result thus indicates $^1G_4$ – $^2F_{5/2}$ energy transfer from Tm^{3+} to Yb^{3+}, as it was already observed for $GdAl_3(BO_3)_4$:Tm,Yb [2] and therefore NIR luminescence at 1000 nm occurs.

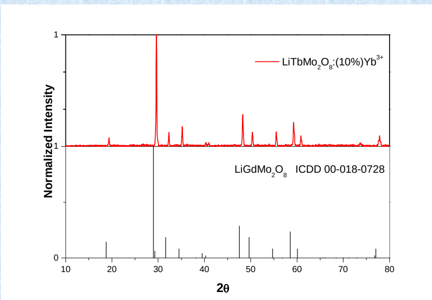

Fig. 4. XRD pattern of $LiTbMo_2O_8$ doped with Yb^{3+}

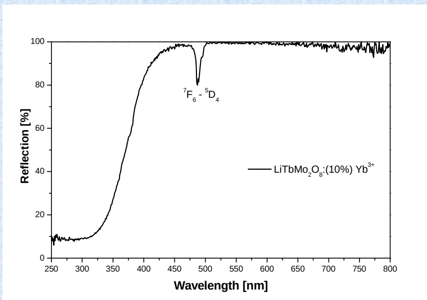

Fig. 5. Reflection spectrum of $LiTbMo_2O_8$ doped with Yb^{3+}

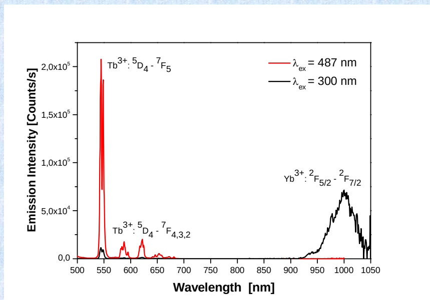

Fig. 6. Emission spectrum of $LiTbMo_2O_8$ doped with Yb^{3+}

$LiTbMo_2O_8$:Yb^{3+} shows NIR emission upon band gap excitation with a peak maximum at 1000 nm. Upon excitation into the $^7F_0$ - $^5D_4$ transition of Tb^{3+} at 487 nm only $^5D_4$- ^7F_J transitions of Tb^{3+} occur. There is no luminescence from the $^2F_{5/2}$ level of Yb^{3+}, as it was claimed in literature [2]. Energy transfer from Tb^{3+} to Yb^{3+} ion in all prepared molybdate samples with Yb^{3+} concentration between 0,1% and 10% does not take place and therefore no NIR emission is observed.

References

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[2] Q. Y .Zhang, G. F. Yang, Z.H. Jiang, Applied Physics Letters 91 (2007), 051903 – 051903-3