GREEN EMITTING UP-CONVERSION FROM $CdSiO_3:Yb^{3+},Tb^{3+}$ MATERIALS

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Highlights

This work presents the synthesis and characterization of $CdSiO_3:Yb^{3+},Tb^{3+}$ with persistent and up-conversion luminescence.

Abstract

Up-conversion materials can produce light or UV radiation under infrared excitation. These materials receive special attention due to their potential applications to increase solar cell efficiency [1] and as biomarkers. Lately, persistent up-conversion luminescence was observed in $ZrO_2:Yb^{3+},Er^{3+}$ materials for the first time [2] but, hitherto, it is the only report on this the new phenomenon. As a new approach to obtain persistent up-conversion luminescence materials, this work presents the preparation and up-conversion properties of $CdSiO_3:Yb^{3+},Tb^{3+}$.

The $CdSiO_3:Yb^{3+},Tb^{3+}$ materials were synthesized with a conventional solid state reaction with Tb^{3+} and Yb^{3+} concentrations of 1 and 0.1 to 20 mol-% of the Cd amount, respectively. The materials were characterized with X-ray powder diffraction (XPD), thermoluminescence, UV and IR excited and persistent luminescence spectroscopies as well as up-conversion and persistent luminescence rise and decay times.

The XPD patterns (Fig.; left) confirm the presence of the monoclinic metasilicate ($CdSiO_3$) phase with the usual orthosilicate (Cd_2SiO_4) impurity. The materials with high (10 and 20 mol-%) Yb^{3+} concentrations also showed the presence of the $Yb_2Si_2O_7$ phase. The materials exhibit green persistent luminescence after UV (254 nm) irradiation, similar to that observed from $CdSiO_3:Tb^{3+}$ [3]. However, persistent luminescence was not observed after IR irradiation, even if green up-conversion luminescence was clearly obtained (Fig.; right). The up-conversion spectra are similar to the UV irradiated, except for the absence of the $^5D_3$ emission, indicating that the IR excitation populates mainly the $^5D_4$ emitting level. Since the $^5D_4$ level is below the conduction band of $CdSiO_3$ [3], trapping of electrons is not efficient, thus reducing the probability of persistent up-conversion luminescence in this material. An increase in the Yb^{3+} concentration leads to quenching of Tb^{3+} luminescence (Fig.; right, inset) probably due to segregation of the $Yb_2Si_2O_7$ phase which deprives Yb^{3+} concentration in $CdSiO_3$. These results indicate that $CdSiO_3:Yb^{3+},Tb^{3+}$ can be used as an optical marker yielding both persistent and up-conversion luminescence but not a combination of them. More studies are necessary to obtain new persistent up-conversion materials.

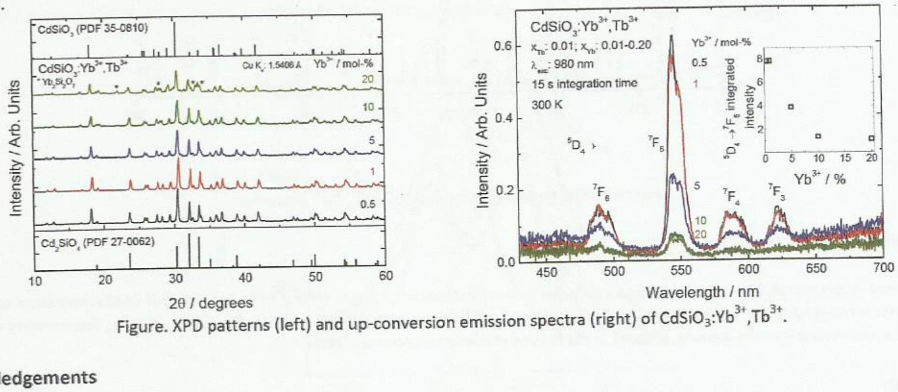

Figure. XPD patterns (left) and up-conversion emission spectra (right) of $CdSiO_3:Yb^{3+},Tb^{3+}$.

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References

[1] J. De Wild, A. Meijerink, J. K. Rath, W. G. J. H. M. van Sark, R. E. I. Schropp, *Energy Environ. Sci.* 4 (2011) 4835-4848.

[2] L. Pihlgren, T. Laihinen, L. C. V. Rodrigues, S. Carlson, K. O. Eskola, A. Kotlov, M. Lastusaari, T. Soukka, H. F. Brito, J. Hölsä, *Opt. Mater.* (2014) *in press.*

[3] L. C. V. Rodrigues, H. F. Brito, J. Hölsä, R. Stefani, M. C. F. C. Felinto, M. Lastusaari, T. Laamanen, L. A. O. Nunes, *J. Phys. Chem. C 116* (2012) 11232-11240.