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New up-conversion Process

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In recent years, renewed interest has been directed toward up-conversion devices and materials. The interest is principally due to prospects for the realization of infrared up-conversion lasers pumped with laser diodes. The revival of interest for the up-conversion phenomenon is due to the advent of powerful and less costly that can be used as excitation sources and the appearance of new materials such as fluorine containing phosphors. The first report on an infrared up-conversion is BaY_2F_8 crystal doped with Ho^{3+} and Yb^{3+} . The present paper reports, Calcium Silicates containing Fluorine doped with Ce^{3+} and $BaSrCeO_4$:Eu are new up-conversion phosphors. These phosphor are synthesized by the standard Solid-state reaction method and heated up to 1200^{o}C in a muffle furnace for 2 hrs. The following figure-1 shows the excitation and emission spectra. In the excitation spectra two peaks are observed at 265 and 325nm and the corresponding curves 1, 2, 3 indicates the emission under 325, 630 and 650nm excitation respectively, broad peak with high intensity from 390-500 nm followed by bit yellow emission. Figutre-2 is the PL of $BaSrCeO_4$:Eu . When the phosphor is excited whit 254nm main emissions are around 595nm. The same phosphor is excited with 625nm the emission is around 595nm with higher intensity. The observed luminescence in the studied phosphors are cooperative up-conversion process.

The upper-state lifetime in a solid-state gain medium, or more generally the lifetime of a metastable electronic state of a dopant ion in such a medium, can be strongly reduced by decay processes which involve the simultaneous emission of several phonons. Such a process is called a multi-phonon transition. Multiple phonons are typically required for such transitions because the energy of a single phonon is not sufficient to match the difference in level energies. It is known fact the Green/Blue or red visible up conversion luminescence from Tb^{3+} $^5D_3$, $^5D_4 \rightarrow {}^7F_J$, or Eu^{3+} $^5D_0 \rightarrow {}^7F_J$ transitions, respectively, has been observed upon Yb^{3+} $^2F_{7/2} \rightarrow {}^2F_{5/2}$ excitation at 975 nm.

The rate of multi-phonon transitions decreases exponentially with increasing number of phonons required. As a consequence, a certain metastable state may exhibit a very strong reduction in its lifetime by multi-phonon emission if the host medium supports phonons with relatively high energy, whereas the same process may be negligible for a host medium with lower phonon energies. For that reason, many up-conversion phosphors work only with gain media which have small phonon energies, such as heavy metal ceramics, so that sufficient lifetimes of certain energy levels are achieved. In other cases, however, high enough phonon energies are important if these are required for facilitating certain non- radiative transitions, which are needed to depopulate the lower level.

A detailed investigation on the spectroscopy and excited state dynamics of these systems is extremely important in order to understand the up conversion processes observed in the present phosphor systems. The results are interested and the work is in progresses.

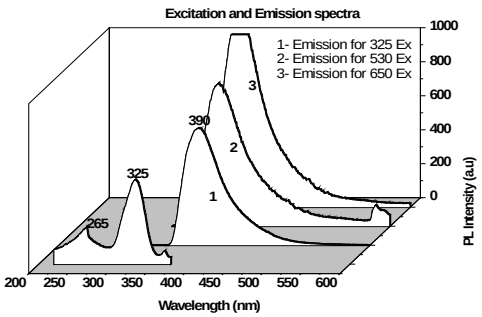

Figure: 1

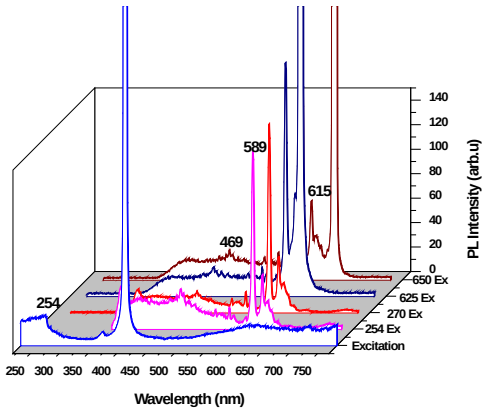

Figure: 2

Conclusions: The phosphor is excited whit 254nm main emissions are around 595nm. The same phosphor is excited with 625nm the emission is around 595nm with

higher intensity. The observed luminescence in the studied phosphors can be called as cooperative up-conversion process.

References

1. F. Auzel, “Upconversion and anti-Stokes processes with f and d ions in solids”, Chem. Rev. 104, 139 (2004)
2. J. W. Kim et al., “Influence of energy-transfer-upconversion on threshold pump power in quasi-three-level solid-state lasers”, Opt. Express 17 (14), 11935 (2009)
3. Dejneka J M 1998 MRS Bull. 23 57
4. Expedito J, Silva C, Sa G F de and Santa-Cruz P A 2001 J. of Alloys and Compounds 323-324 336
5. Shalav A, Richards B S and Green M A 2007 Sol. Energy Mater. Sol. Cells (reprintdoi :10.1016/j.solmat.2007.02.007)
6. Dong B, Yang T and Lei M K 2006 Optical high temperature sensor based on green up conversion emission in Er3+doped Al2O3 Sens. Actuators B Chem. (Preprint doi:10.1016/j. snb.2006.10.002)
7. Ferber S, Gaebler V and Eichler H-J 2002 Optical Materials 20 211
8. Dantele G, Mortier M, Patriarche G and Vivien D 2006 J. of Sol. St. Chem. 179 1995
9. Jin W, Xusheng Q, Xianping F and Minquan W 2006 J. of Rare Earths 24 67
10. [Silva J E C, Sa G F de and Santa-Cruz P A 2001 J. of Alloys and Compounds 323-324 260
11. [9] Mortier M and Patriarche G 2000 J. of Materials Science 35 4849
12. [10] Yu Y, Chen D, Wang Y Liu F and Ma E 2007 J. of Non-Crystalline Solids 353 405
13. Polnau M, Gamelin D R, Luthi S R, Gudel H U and Hehlen M P 2000 Phys. Rev. B 61 5 3337
14. Auzel F 2004 Chem. Rev. 2004 104 139
15. Humlicek J 1999 phys. stat. sol. (b) 215 155
16. Tsvetkov E G, Pylneva N A and Davydov A V 2006 J. of Crystal Growth 292 358
17. Haase, M. and Schäfer, H. (2011), Upconverting Nanoparticles. Angewandte Chemie International Edition, 50: 5808–5829.
18. Upconversion and Anti-Stokes Processes with f and d Ions in Solids François Auzel Chem. Rev., 2004, 104 (1), pp 139–174
19. Design of Luminescent Inorganic Materials: New Photophysical Processes Studied by Optical Spectroscopy Daniel R. Gamelin and Hans U. Güdel Acc. Chem. Res., 2000, 33 (4), pp 235–242 doi:10.1021/ar990102y
20. R. Sheps, “Upconversion laser processes”, Prog. Quantum Electron. 20 (4), 271 (1996)
21. M.-F. Joubert, “Photon avalanche upconversion in rare earth laser materials”, Opt. Mater. 11 (2), 181 (1999)