Up-conversion luminescence in Ho^{3+} and Tm^{3+} co-doped Y_2O_3 :Yb^{3+} fine powders

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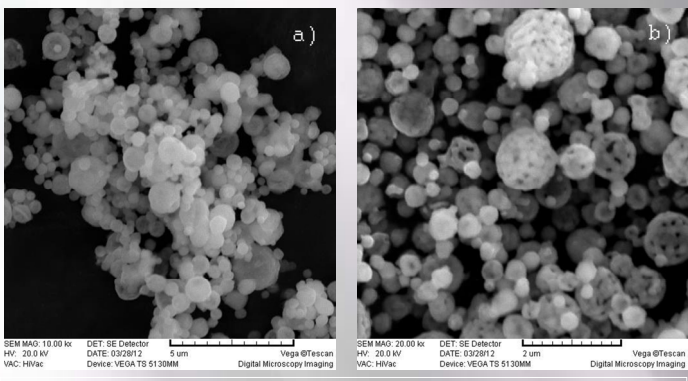
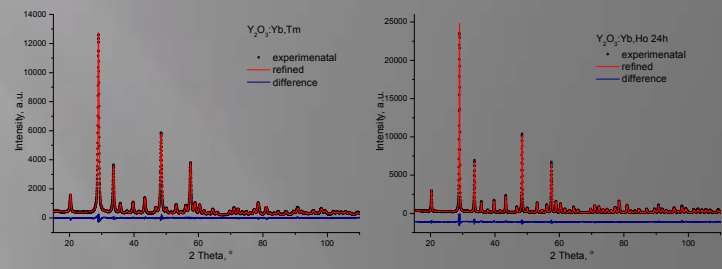
Abstract Fine yttrium oxide powders doped with Yb^{3+} and co-doped either with Tm^{3+} or Ho^{3+} were synthesized *via* spray pyrolysis at 900 °C using 0.1 M nitrate precursor. Synthesized powders were additionally thermally treated at 1100 °C for 24 h. The characterization was done through X-ray powder diffraction (XRPD), scanning electron microscopy (SEM) and measurements (PL). Optical characterization includes infrared, visible and ultraviolet spectra measurements as well as determination of the lifetime.



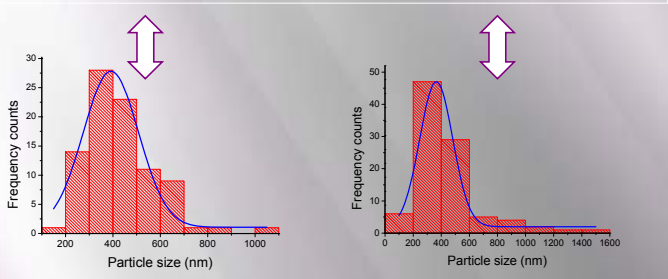
SEM of Y_2O_3:Yb^{3+}, Ho^{3+} powders obtained by spray pyrolysis at 1.7MHz (Profisonic, Prizma) asp (a) and calcined 24 h (b)



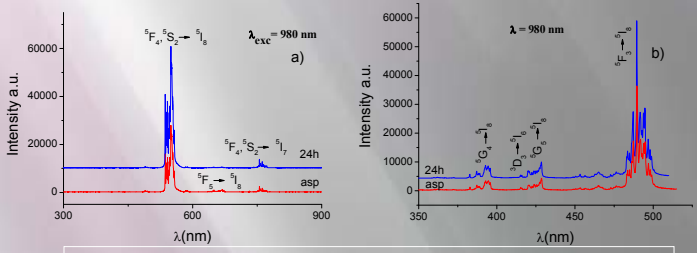
The XRPD patterns and structural refinement data for Y_2O_3:Yb^{3+} powders co-doped with Tm^{3+} (asp) or Ho^{3+} (calcined 24 h)

	(Y2O3:Yb, Tm) asp	(Y_2O_3:Yb, Ho) 1100 °C , 24h
Unit cell (Å)	10.5909 (1)	10.5954(8)
Crystallite Size (nm)	21.6 (2)	59.5(8)
Microstrain (%)	0.082 (4)	/
Y_1:O bond length (Å)	2.2074 (34) 2.2777 (33) 2.3687 (35)	2.2528(39) 2.2636(38) 2.3449(39)
Y_2:O bond length (Å)	2.2911 (36)	2..2681(40)
Y_1 (Y^{3+}, Yb^{3+},Tm^{3+}/Ho^{3+}) x	-0.03166(5)	-0.03289(5)
O^{2-} x y z	 0.3937 (3) 0.1541 (3) 0.3801 (3)	 0.3090(4) 0.1527(3) 0.3785(4)
Occ Y_1 (Y^{3+})	C_2:0.936 , S_6: 0.952	C_2:0.937, S_6:0.948
R_{Bragg}	1.03	2.21
Goodness of fit	1.002	1.633

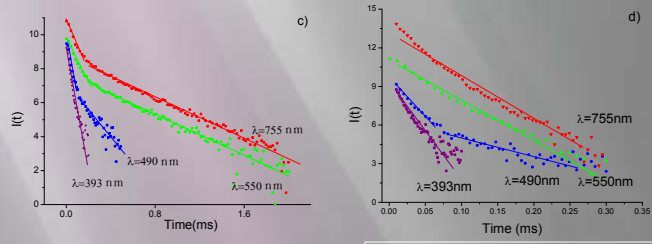
Generation of cubic bixbyte-structure (S.G. *Ia*-3) is confirmed in all samples. The microstructural data implies nanocrystalline nature of samples even in the calcined powder (~ 60 nm). Low values of strain along with the slight decrease of unit cell indicate good dopants accommodation in the host lattice. Preferential accommodation is determined for Y1 (C2) site in both systems.



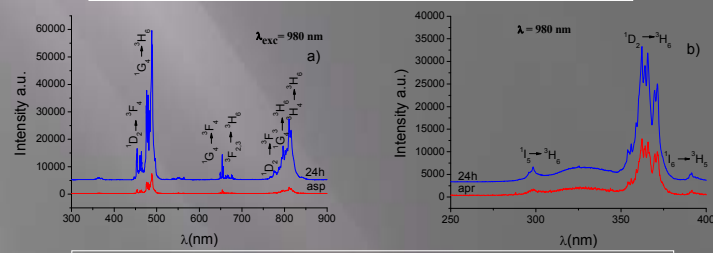
Optical properties Y_2O_3 : Yb^{3+} Ho^{3+}



Photoluminescent emission in VIS (a) and UV (b) spectra
Emission decay for as-prepared (c) and 24 h calcined powder (d)



Optical properties Y_2O_3 : Yb^{3+} Tm^{3+}



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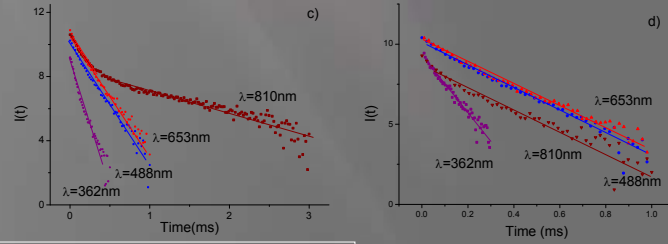

Decay time (ms)		
λ (nm)	asp, Ho^{3+}	1100 °C/24h, Ho^{3+}
393	0,017	0,029
490	0,016±0,090	0,035±0,130
550	0,042	0,072±0,350
755	0,044	0,082±0,357

Conclusion

Spherical, submicronic, nanoporous and agglomerated-free Y_2O_3-based particles obtained *via* spray pyrolysis crystallize in a cubic bixbyte-structure, S.G. *Ia*-3, with a preferential dopants accommodation in C2 site position. Their nanocrystalline nature provides sharp and well defined emission peaks after excitation. Advanced powders upconverting characteristics are confirmed with the high values of the decay times related to Ho^{3+} and Tm^{3+} transitions in whole spectra region.

Decay time (ms)		
λ (nm)	asp, Tm^{3+}	1100 °C/24h, Tm^{3+}
362	0,057	0,071
488	0,144	0,142
653	0,155	0,136
810	0,155	0,143±0,733

Acknowledgements

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