Synthesis of hierarchically structured (Y_2O_3:Eu)@ Ag nanocomposites by ultrasonic spray pyrolysis with plasmon enhanced luminescence

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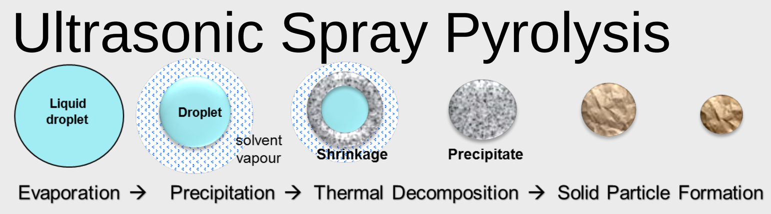
OBJECTIVE OF THE STUDY

- Understand the formation mechanisms of the hierarchical europium doped yttrium oxide core / silver shell nanostructures and contribute to the luminescence mechanism and metal/inorganic interface properties.
- Surface plasmon resonance enhancement of luminescence efficiency intensity by optimized Ag incorporation

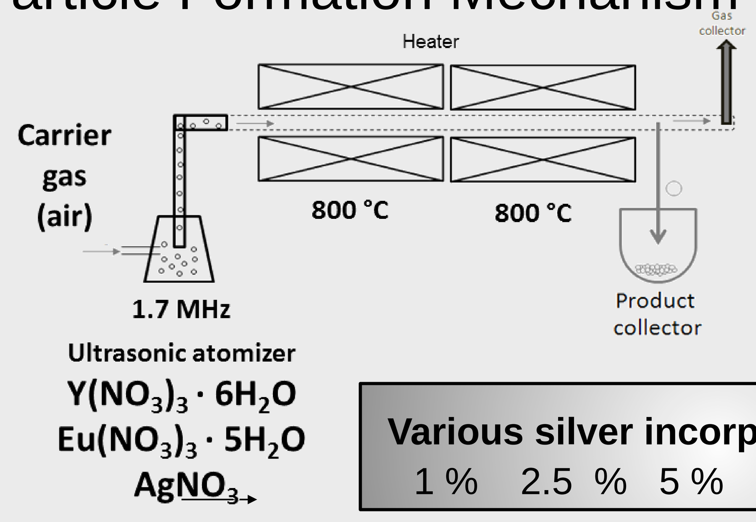
EXPERIMENTAL METHODS

Synthesis

Ultrasonic Spray Pyrolysis

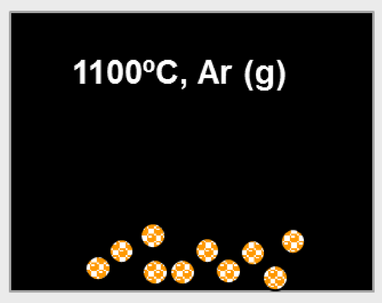


Particle Formation Mechanism



Various silver incorporation (wt. %)
1 % 2.5 % 5 % 7.5 % 10%

Heat Treatment

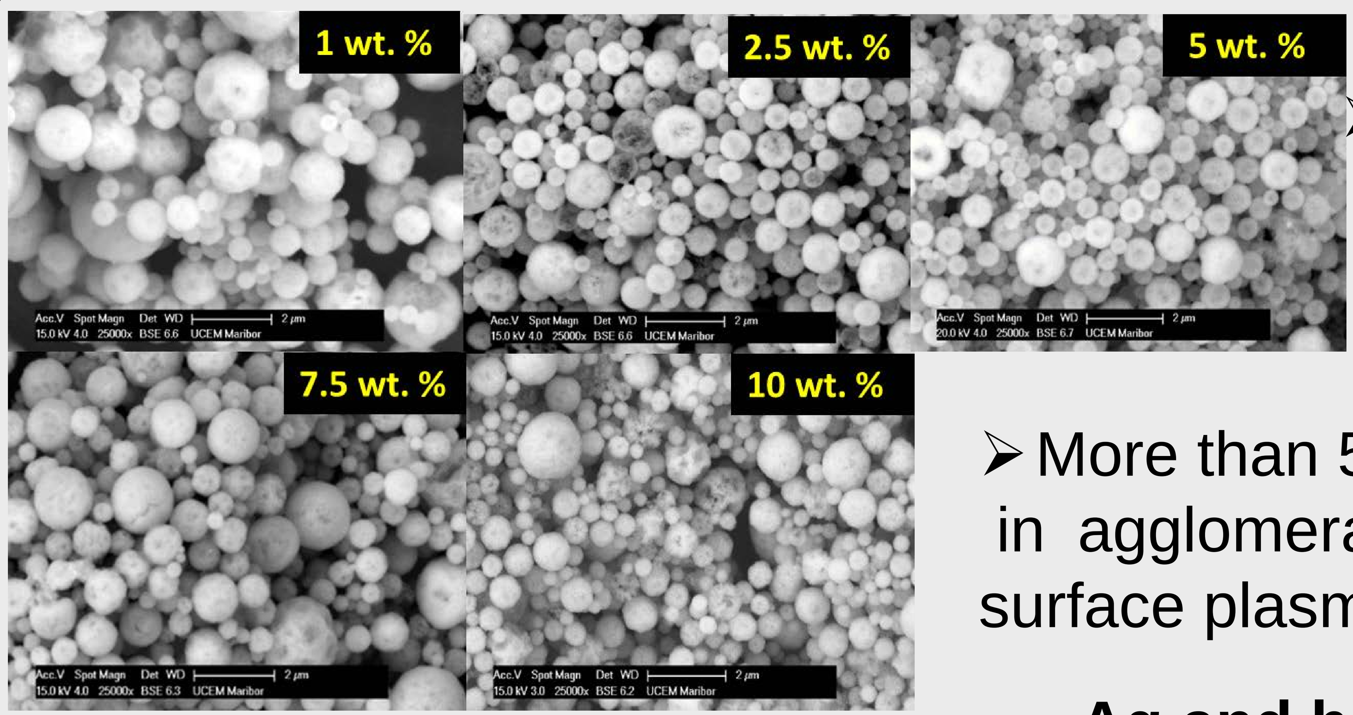


Various heat treatment conditions
- No heat treatment (a.p.)
- 2 hours
- 12 hours

Characterization

- **XRD** (crystal structure, lattice parameters)
- **SEM/TEM:** morphology, microstructure
- **PL:** PL efficiency

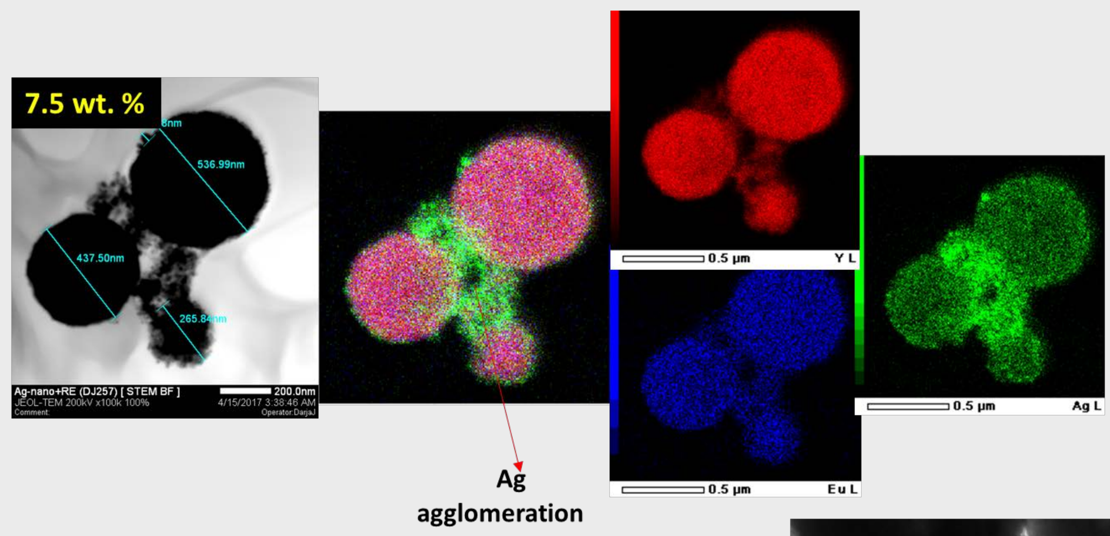
Ag effect on microstructure

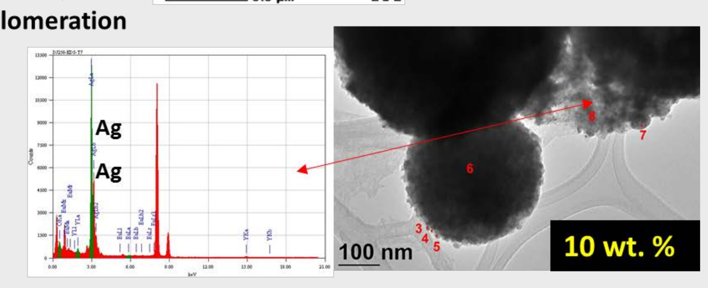


- 1, 2.5 and 5 wt. & Ag concentrations ehibited target morphology; dense spherical shape and homogenous size distribution
- More than 5 % Ag results in agglomeration which is detrimental to surface plasmon enhancement

Ag agglomerates at high concentrations

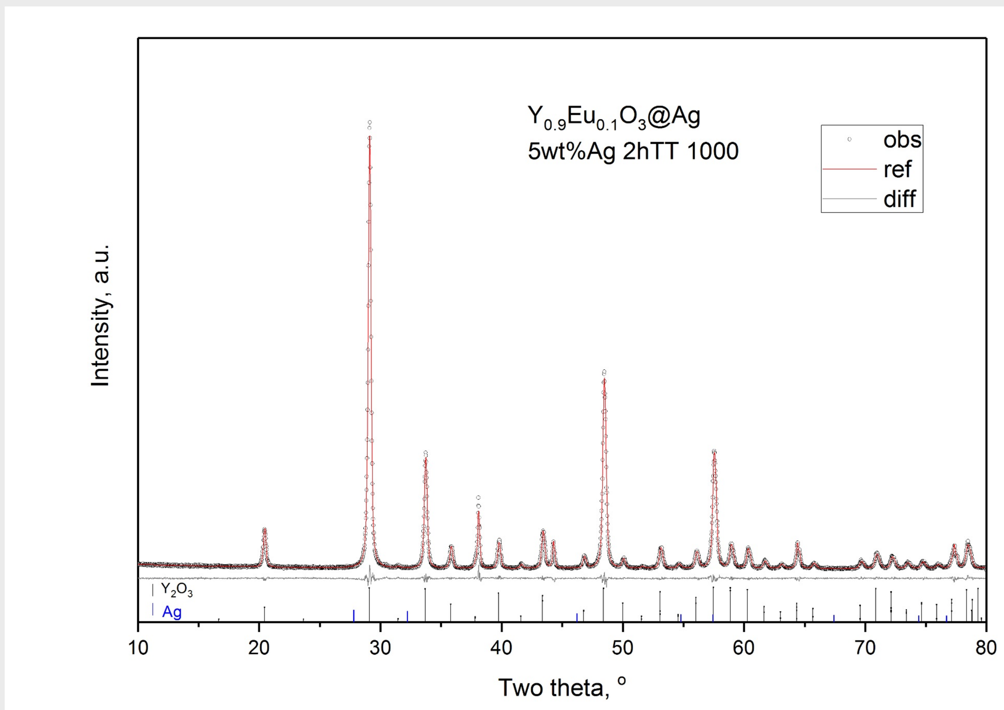
(STEM; homogenous Y, Eu distribution)





Ag and heat treatment effect on crystal structure

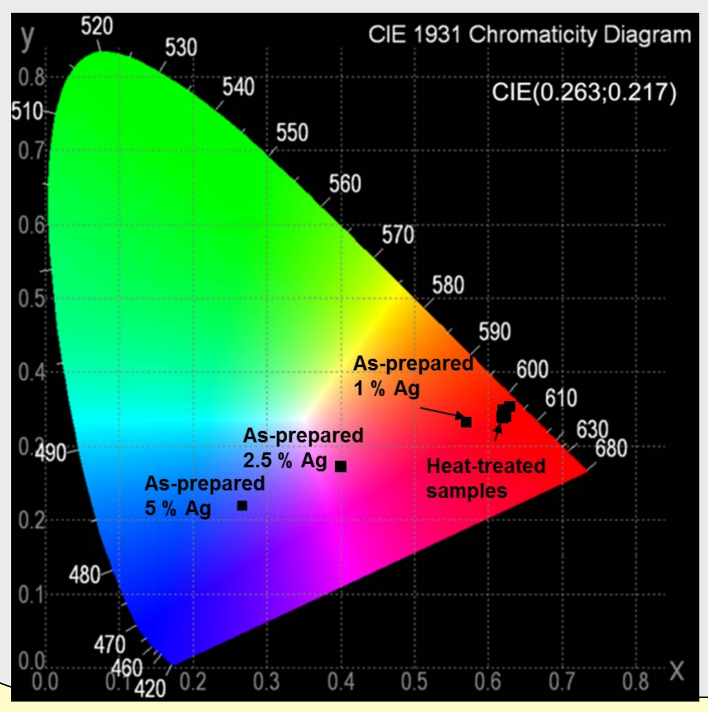
	1 % Ag (a.p.)	1 % Ag (2h)	1 % Ag (12 h)	2.5 % Ag (a.p.)	2.5 % Ag (2 h)	2.5 % Ag (12 h.)	5 % Ag (a.p.)	5 % Ag (2 h)**	5 % Ag (12 h)
Crystal structure	Cubic, Ia-3	Cubic, Ia-3	Cubic, Ia-3	Cubic, Ia-3	Cubic, Ia-3	Cubic, Ia-3	Cubic, Ia-3	Cubic, Ia-3	Cubic, Ia-3
Unit cell parameter a (Å)	10.6292 (5)	10.6199 (2)	10.6193 (2)	10.6257 (6)	10.6199 (2)	10.6209 (2)	10.6248 (5)	10.6195 (2)	10.6193 (1)
Crystallite size (nm)	15.9 (2)	42.2(7)	45.6(7)	15.6(2)	42.1(9)	39.0(5)	16.5(3)	42.1(6)	44.5(6)
OccY1 (C2)*	0.933	0.936	0.942	0.947	0.933	0.939	0.969	0.945	0.945
OccY2 (S6)*	0.981	0.972	0.954	0.939	0.981	0.963	0.873	0.945	0.945
Phase content	100%	100%	100%	100%	100%	Minor phase Ag	Minor phase AgCl	Minor phase Ag	Minor phase Ag



**** Rietweld refinement of 2.5 wt % 2 h sample**

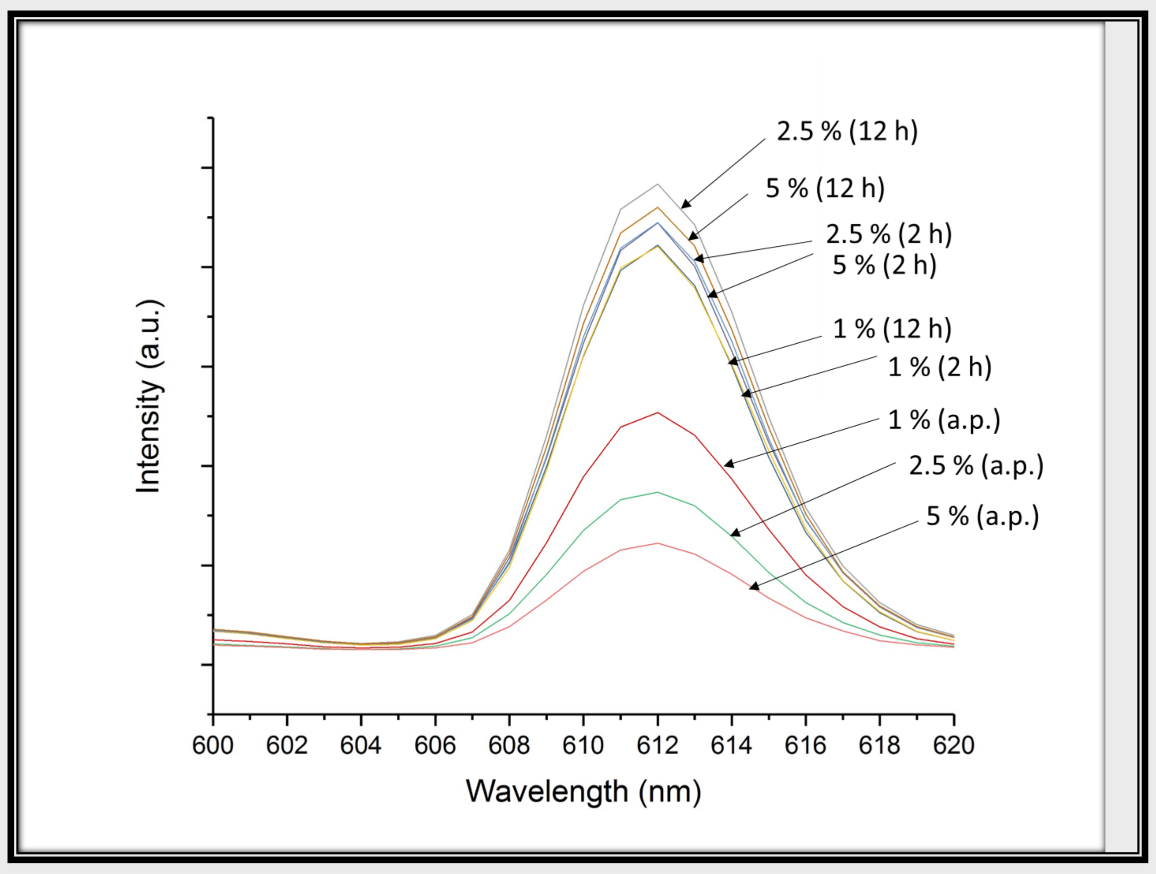
Ag and heat treatment effect on photoluminescence

- Among a.p. samples, PL emission intensity increase with decreasing content of Ag
- All heat treated samples exhibited better PL than as prepared samples
- Time of the treatment (2 or 12 hours) did not cause a dramatic change.
- For heat treated samples, higher Ag concentrations; better PL implying Ag diffuse to more favorable positions



- Colour point of all heat treated samples are same
- No red emission in as prepared samples except 1 wt. % Ag

CIA Diagram: Location of all samples revealing emitted color



Comparison of the main red-emitting peak (612 nm; $d^5{}_0 \rightarrow f^7{}_2$) according to normalized intensities with respect to peak located at 582 nm

CONCLUSION

- Heat treatment increases PL efficiency
- Ag addition followed by heat treatment results in high PL efficiency.
- As prepared samples with higher silver addition exhibits poor PL

FUTURE WORK

- HRTEM analyses will be used to provide a better explanation
- Eu concentration will be examined for higher luminescence efficiency

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