

Supporting information for

**Low temperature synthesis and characterization of single phase multi-
component fluorite oxide nanoparticle sols**

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Table S1. d spacing values of GLCHZ and GLYHZ calculated from SAED pattern as well as through XRD Rietveld refinement of xrd pattern.

Sample	Plane	d spacing (nm)	
		SAED pattern	Refinement
GLCHZ-RT	111	0.31	0.30
	200	0.28	0.26
	220	0.19	0.18
	311	0.16	0.16
GLCHZ-500	111	0.31	0.30
	200	0.27	0.26
	220	0.19	0.18
	311	0.16	0.16
GLYHZ-RT	111	0.31	0.30
	200	0.28	0.26

	220	0.19	0.18
	311	0.16	0.16
	111	0.30	0.30
	200	0.26	0.26
GLYHZ-500	220	0.18	0.18
	311	0.15	0.16

Table S2. Chemical composition of GLCHZ-RT and GLYHZ-RT using SEM-EDS and ICP-OES spectroscopy

Sample	Element (at %)						
	Ce	Gd	Hf	La	Zr	Y	
GLCHZ-RT	SEM-EDS	23.2	16.3	18.2	23.7	18.5	-
	ICP-OES	24.3	16.98	19.24	22.04	17.44	-
GLYHZ-RT	SEM-EDS	-	16.3	16.3	21.3	17.4	28.7
	ICP-OES	-	17.97	18.21	22.01	17.46	24.35

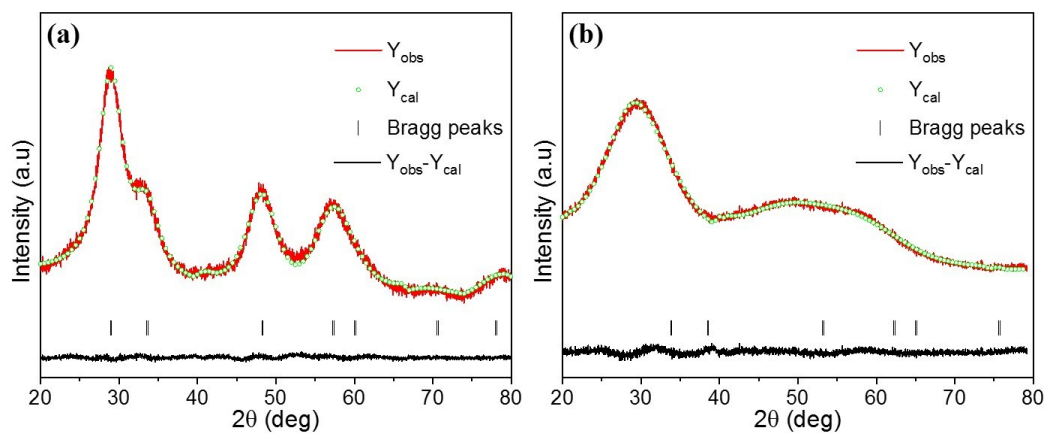


Fig. S1 Rietveld refinement plots of (a) GLCHZ-RT and (b) GLYHZ-RT nanoparticles.

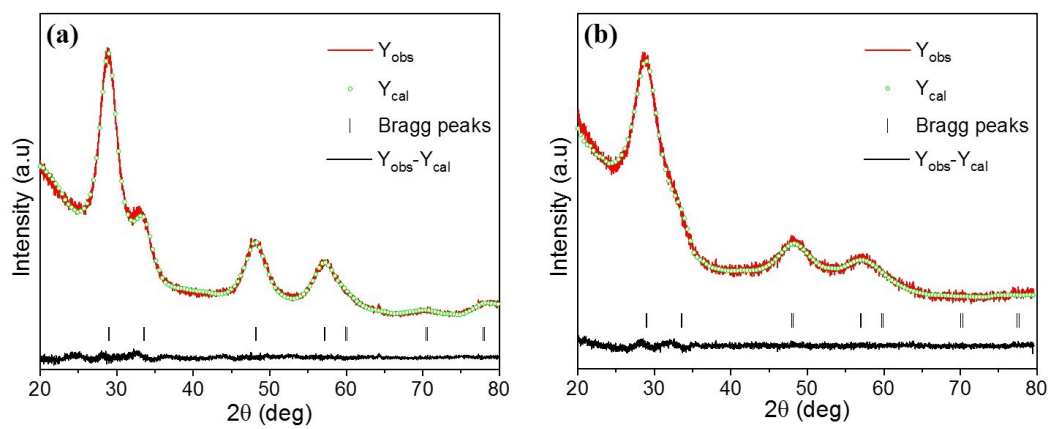


Fig. S2 Rietveld refinement plots of (a) GLCHZ-500 and (b) GLYHZ-500 nanoparticles.

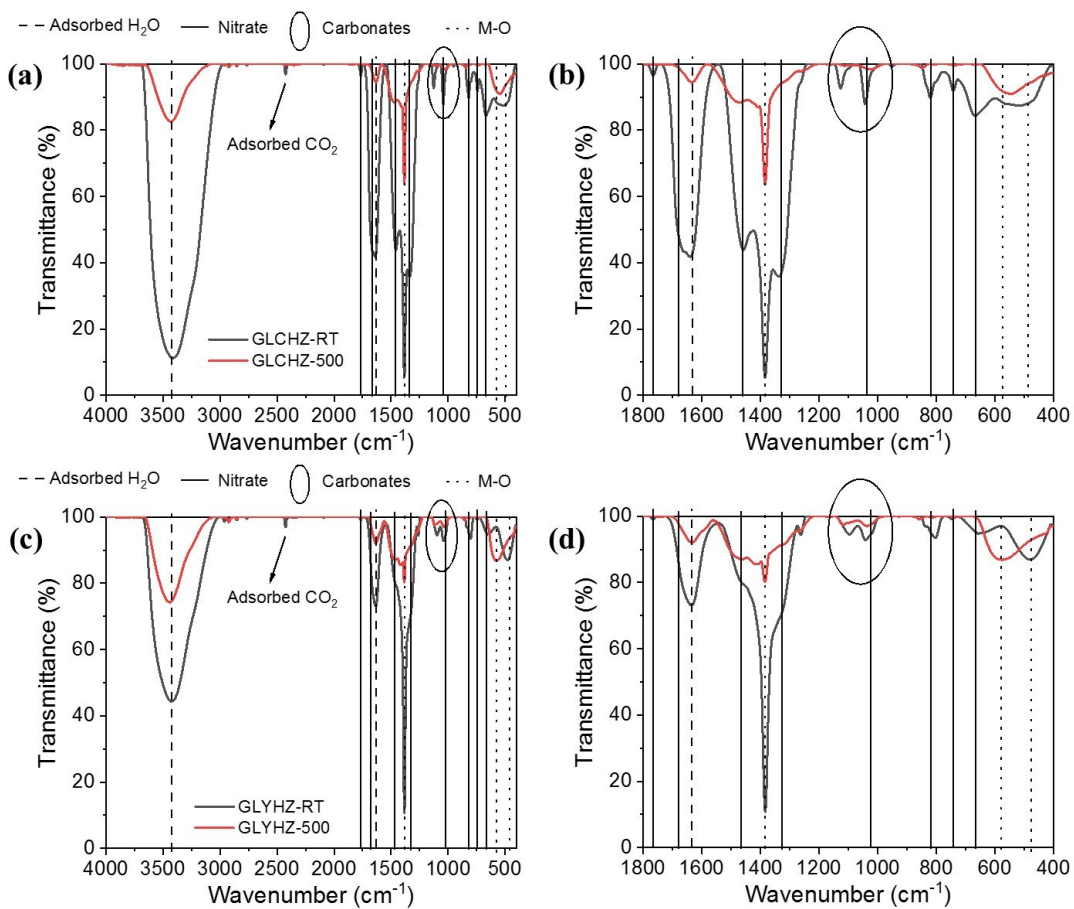


Fig. S3 FT-IR spectra of as-synthesized and calcined (a) GHCHZ (left) and (b) GLYHZ (right) nanoparticles (c) and (d) enlarged FT-IR spectrum of GLCHZ and GLYHZ respectively.

Table S3. Assignment of FTIR peaks with various vibrational modes of as-synthesized and calcined GLYHZ and GLCHZ powders.

Wavenumber (cm⁻¹)	Mode	Reference
2900-3750	Adsorbed water	1-3
1640	H ₂ O bending	1
1765, 1665, 1461, 1337, 1042, 819, 742, 668	Nitrates	1, 4
2250 – 2400,	Adsorbed CO ₂	5
1025 – 1063	Adsorbed carbonates	6, 7
400 - 750	M-O stretching	1, 2

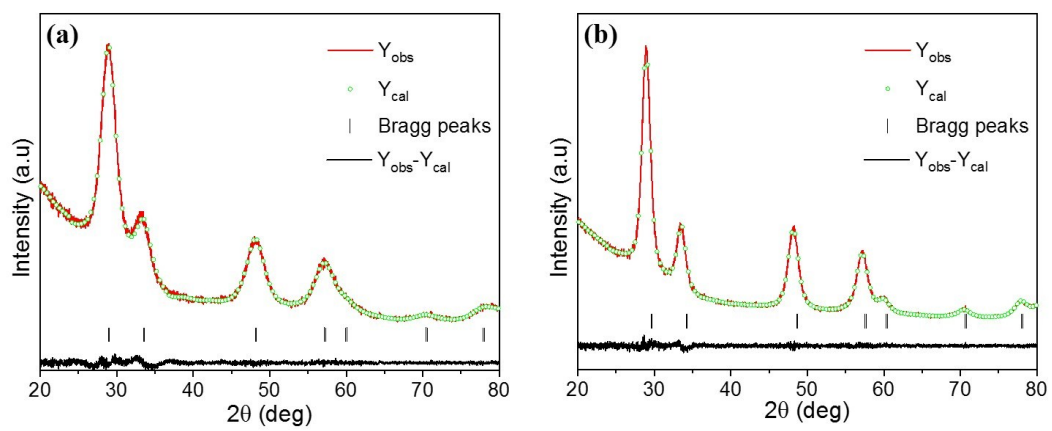


Fig. S4 Rietveld refinement plots of (a) GLCHZ-750 and (b) GLCHZ-1000 nanoparticles.

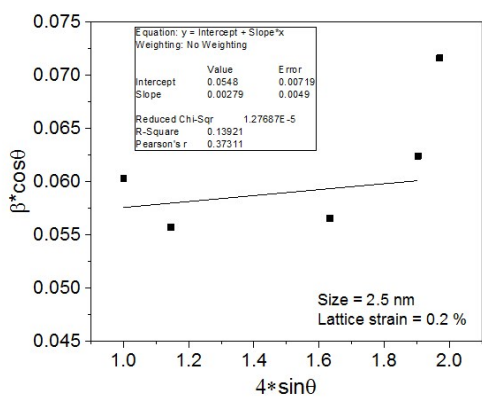


Fig. S5 Williamson-Hall plot of GLCHZ-RT nanoparticles

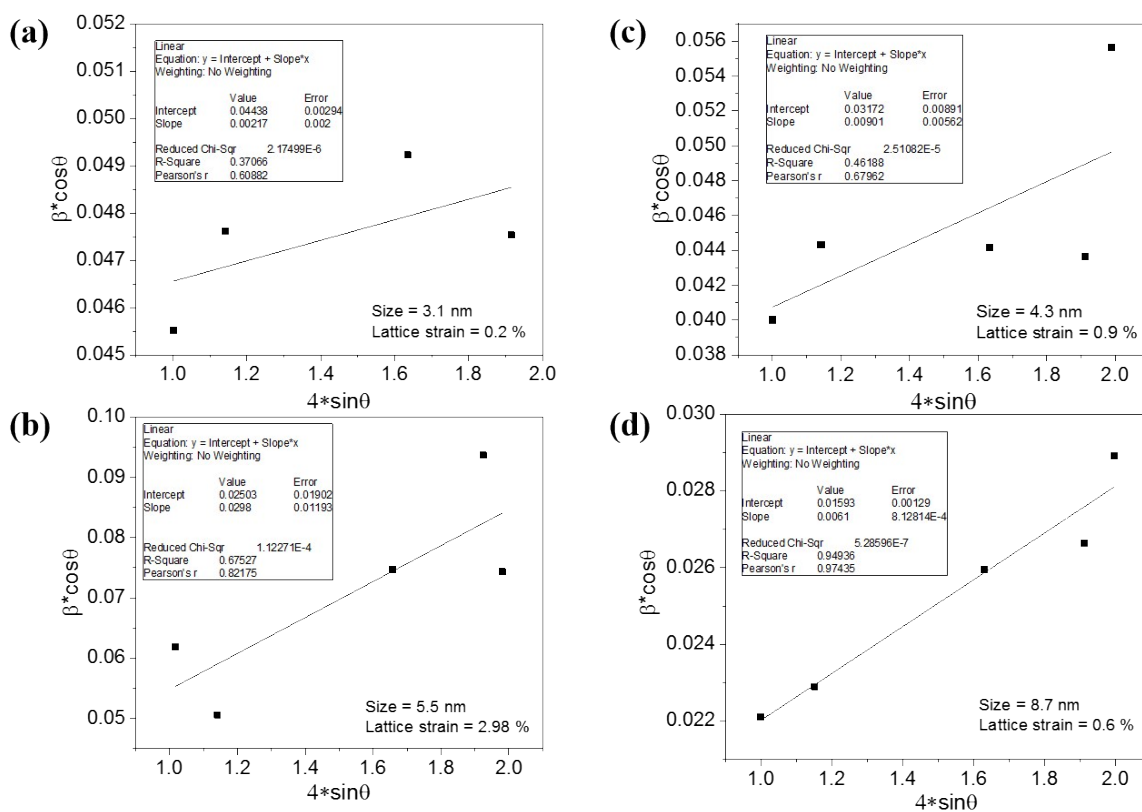


Fig. S6 Williamson-Hall plots of (a) GLCHZ-500, (b) GLYHZ-500, (c) GLCHZ-750 and (d) GLCHZ-1000 nanoparticles.

Table S4. Summary of refined values for different compositions

Sample	Size^a (nm)	microstrain^a (%)	Lattice parameter (Å)	R_p (%)	R_{wp} (%)	χ^2	Goodness of Fit
GLYHZ-RT	-	-	5.343 ± 0.001	4.44	5.02	1.36	1.17
GLYHZ-500	5.5	2.98 ± 1.1	5.338 ± 0.002	3.48	4.15	1.62	1.27
GLCHZ-RT	2.5	0.2 ± 0.4	5.340 ± 0.002	9.39	9.66	1.59	1.26
GLCHZ-500	3.1	0.2 ± 0.2	5.346 ± 0.001	7.05	8.07	1.63	1.27
GLCHZ-750	4.3	0.9 ± 0.5	5.347 ± 0.001	7.45	8.34	1.51	1.23
GLCHZ-1000	8.7	0.6 ± 0.08	5.343 ± 0.004	7.22	7.37	1.19	1.09

^a values obtained from Williamson-Hall Plot.

References

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