

## Supplementary

# Highly efficient deep red-emitting Mn<sup>4+</sup>-powered oxyfluoride nanophosphor classified for plant growth and optical thermometric applications

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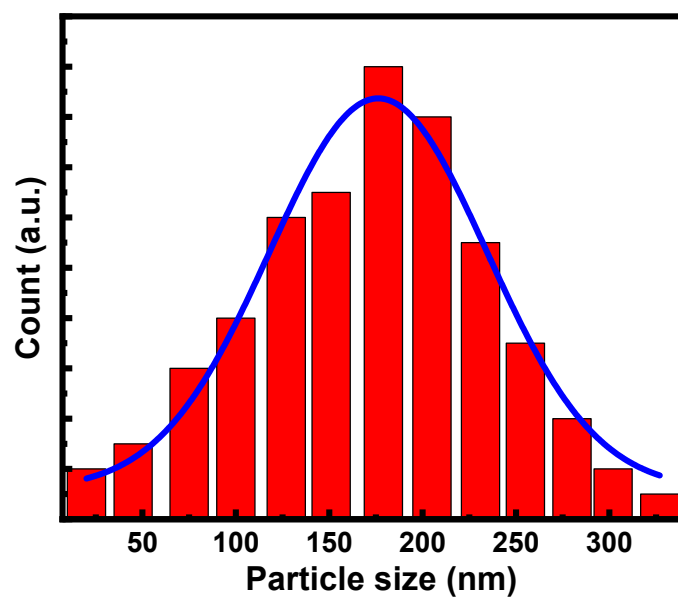
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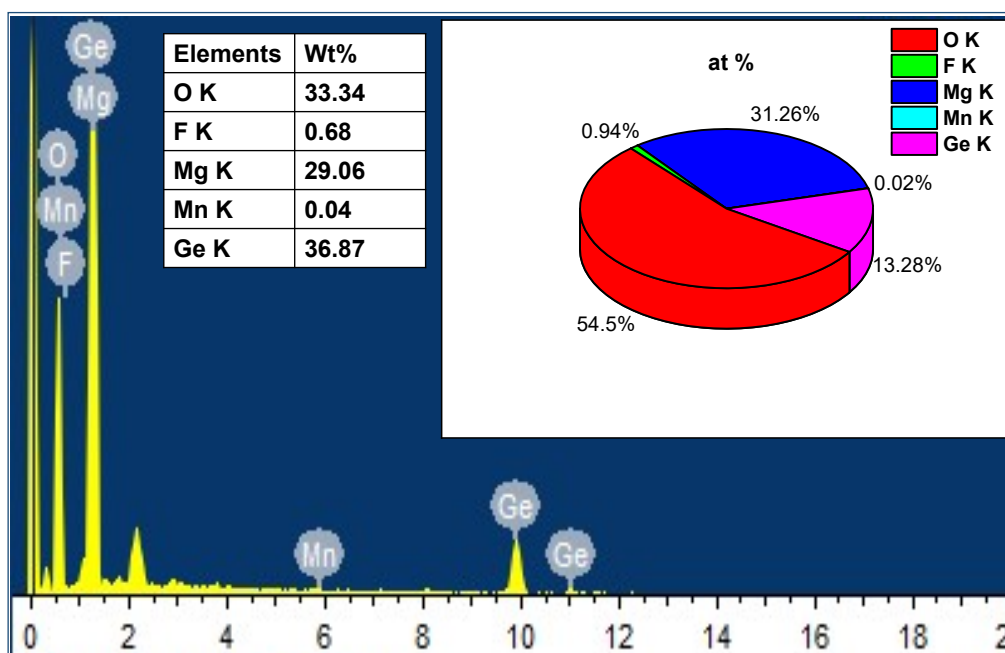
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India

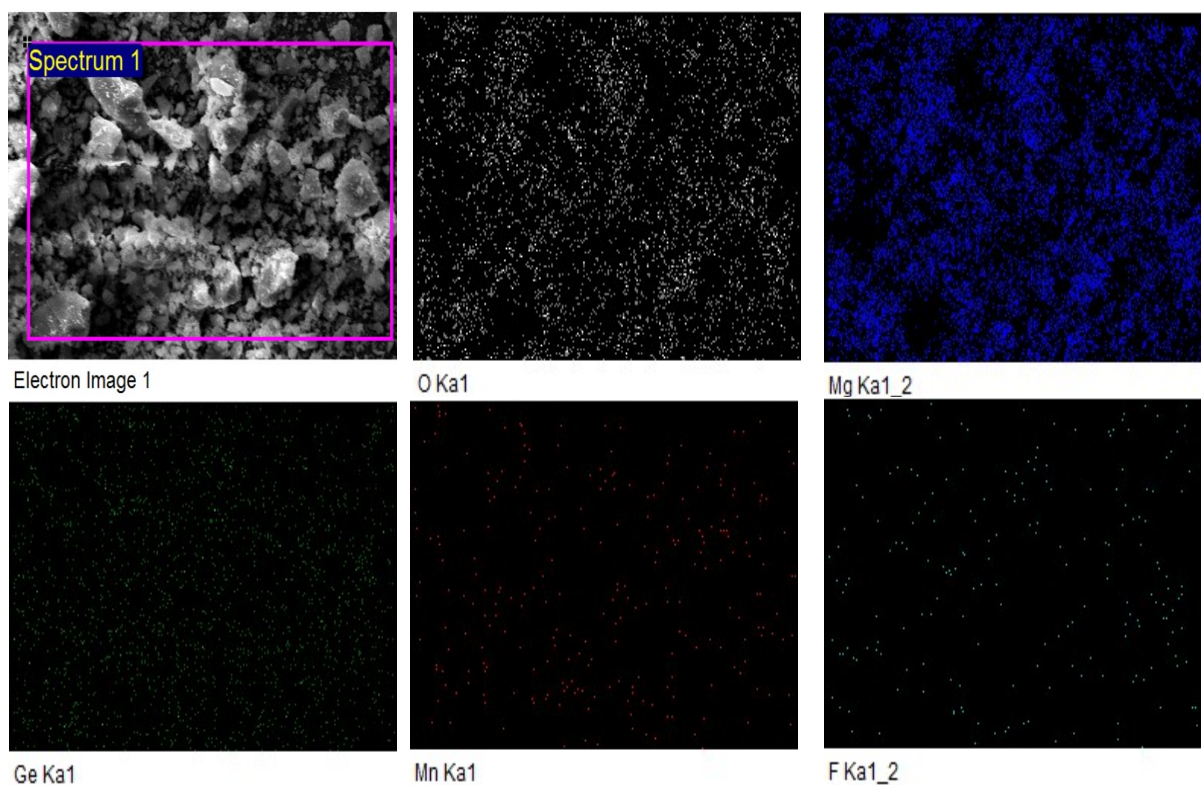
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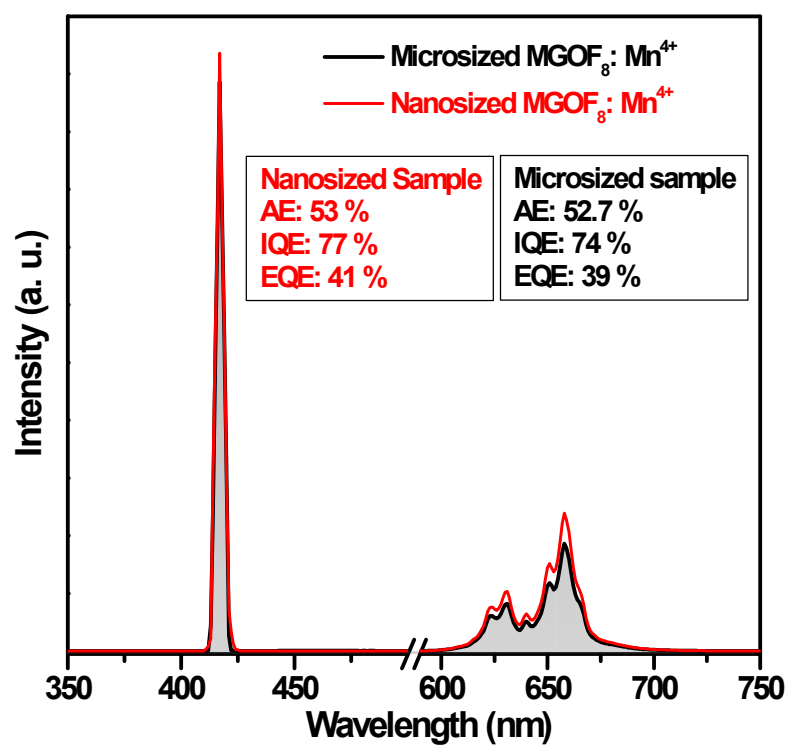
*Fig. S1* Partcile size distribution diagram of MGOF: Mn<sup>4+</sup> phosphor



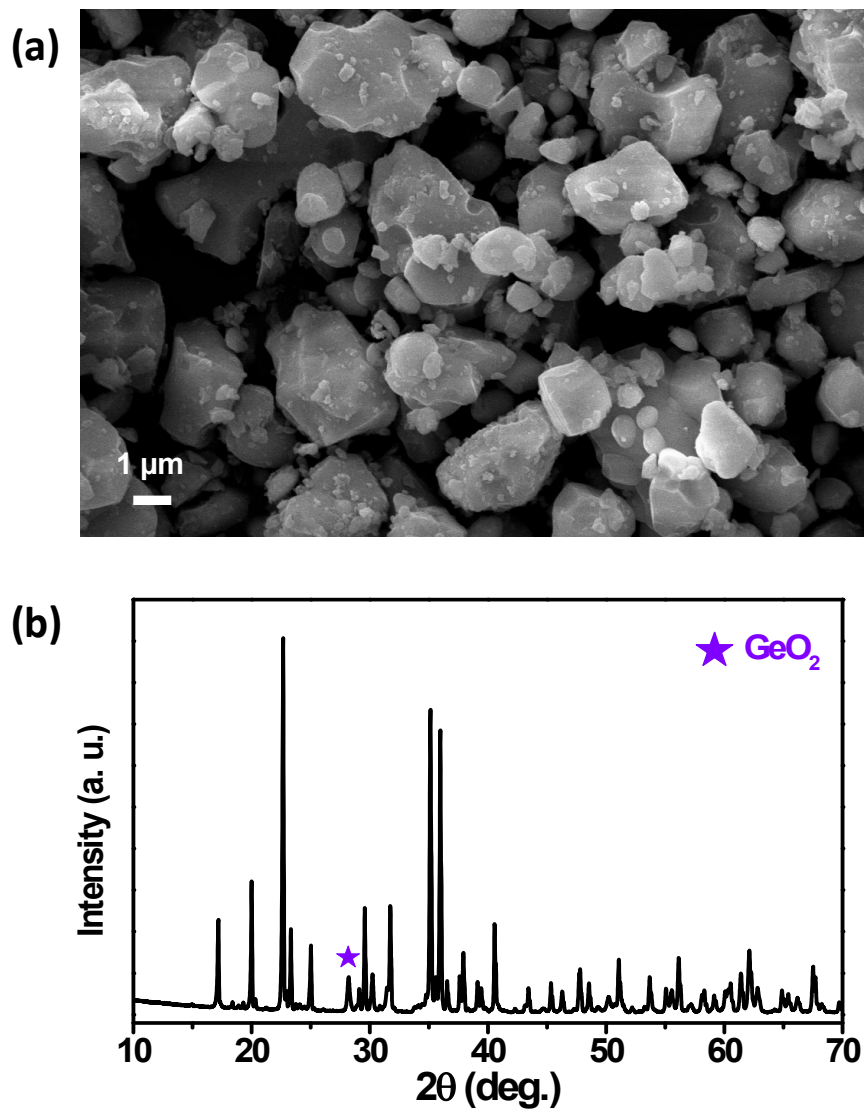
*Fig. S2* Energy dispersive X-ray spectrum of MGOF: Mn<sup>4+</sup> phosphor



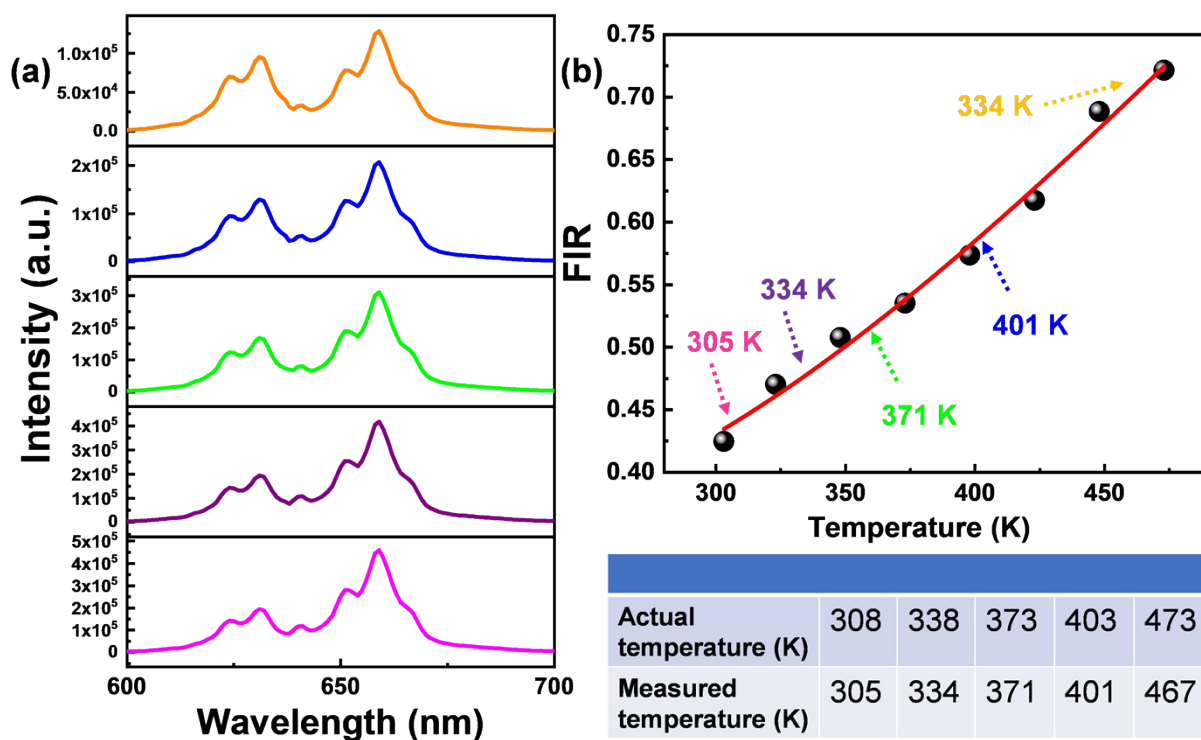
**Fig. S3** EDX elemental mapping of MGOF:  $Mn^{4+}$  phosphor



**Fig. S4** Comparative emission spectra of MGOF:  $Mn^{4+}$  nanophosphor and solid-state synthesized MGOF:  $Mn^{4+}$  microsized phosphor for calculating the blue absorption efficiency and PL quantum efficiencies.



**Fig. S5** (a) SEM and (b) XRD of solid state synthesized MGOF:Mn<sup>4+</sup> microsized phosphor.



*Fig. S6 (a) The luminescence spectra recorded at different random temperatures, (b) the FIR plot for comparing the calculated temperature with the actual temperature.*

**Table S1** The atomic coordinate positions and the fraction of occupancy for the MGOF:

*Mn<sup>4+</sup> nanophosphor.*

Atoms	Name	x	y	z	Occupancy	U <sub>iso</sub>
Mg	Mg1	0.00000	0.50000	0.50000	1.0000	0.00907
Mg	Mg2	0.00000	0.00000	0.50000	1.0000	0.09849
Mg	Mg3	0.17570	0.17810	0.00000	1.0000	0.00600
Mg	Mg4	0.32600	0.14630	0.50000	1.0000	0.03931
Mg	Mg5	-0.00440	0.25170	0.24230	1.0000	0.02029
Mg	Mg6	0.33160	0.41900	0.24610	1.0000	0.04218
Ge	Ge1	0.00000	0.00000	0.00000	0.9900	0.00482
Mn	Mn	0.00000	0.00000	0.00000	0.0100	0.01000
Ge	Ge2	0.12560	0.50160	0.00000	1.0000	0.00433
Ge	Ge3	0.18369	0.32025	0.50000	0.5540	0.00600
O	O1	0.08482	0.33462	0.00000	1.0000	0.08267
O	O2	0.42180	0.34810	0.00000	1.0000	0.12093
O	O3	0.25180	0.00310	0.00000	1.0000	0.02806
O	O4	0.07096	0.32890	0.50000	0.8536	0.00500
F	F4	0.07096	0.32890	0.50000	0.1464	0.50732
O	O5	0.41310	0.33140	0.50000	1.0000	0.00733
O	O6	0.26664	-0.02396	0.50000	0.2631	0.00633
F	F6	0.26664	-0.02396	0.50000	0.7369	0.00633
O	O7	0.07560	0.07740	0.22350	1.0000	0.14939
O	O8	0.41450	0.08120	0.24850	1.0000	0.10490
O	O9	0.24062	0.25609	0.29283	0.5504	0.17196
F	F9	0.24062	0.25609	0.29283	0.4496	0.17196