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Non-rare-earth-doped sub-micron-grade narrow-band red phosphors for W-LED as well as FED and enhanced Bi^{3+}-doped blue light absorption

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Table. S1 Radius of the cations of host

Cation	Coordination number	Radius(Å)
Sr^{2+}	6	1.18
Ge^{4+}	4	0.39
	6	0.53
Bi^{3+}	6	1.03
Mn^{4+}	4	0.39
	6	0.53

Table. S2 Radius difference between cations and doped ions

Cation	Doped ion	Dr
Sr^{2+}(6)	Bi^{3+}(6)	12.7
	Mn^{4+}(6)	55.1
Ge^{4+}(4)	Mn^{4+}(4)	0
Ge^{4+}(6)	Bi^{3+}(6)	-94.3
	Mn^{4+}(6)	0

Table. S3 The residual factors (R_p, R_{wp}, and χ^2) of SGO: Bi^{3+}, Mn^{4+} phosphors.

Formula	**$SrGe_4O_9$**	**$SrGe_{3.995}O_9$: 0.005Mn^{4+}**	**$Sr_{0.98}Ge_4O_9$: 0.02Bi^{3+}**	**$Sr_{0.98}Ge_{3.995}O_9$: 0.005Mn^{4+}, 0.02Bi^{3+}**
Crystal system	trigonal			
Z	3			
Space-group	*P 3 2 1(150)*			
V	524.04(1)Å^3	525.42(1) Å^3	527.02(1) Å^3	527.79(1) Å^3
a	11.3021(1) Å	11.3121(1) Å	11.3240(1) Å	11.3155(1) Å
c	4.7372(0) Å	4.7412(0) Å	4.7456(0) Å	4.7417(1) Å
χ^2	2.398	1.950	2.144	2.521
R_{wp}	13.74%	13.30%	13.30%	13.36%
R_p	8.95%	9.03%	9.63%	9.67%

Table S4. Atomic coordinates for $SrGe_4O_9$

Atom	Wyckoff	x/a	y/b	z/c
Sr1	***3e***	**0.3325(5)**	**0**	**0**
Ge1	***1a***	**0**	**0**	**0**
Ge2	***2d***	**1/3**	**2/3**	**0.1138(9)**
Ge3	***3f***	**0.8267(4)**	**0**	**1/2**
Ge4	***6g***	**0.48733(20)**	**0.33076(31)**	**0.3988(4)**
O1	***3f***	**0.5385(12)**	**0**	**1/2**
O2	***6g***	**0.5892(8)**	**0.4217(8)**	**0.1215(18)**
O3	***6g***	**0.1458(8)**	**0.0465(10)**	**0.7753(21)**
O4	***6g***	**0.3388(9)**	**0.2265(7)**	**0.3038(16)**
O5	***6g***	**0.5035(6)**	**0.2557(7)**	**0.6568(16)**

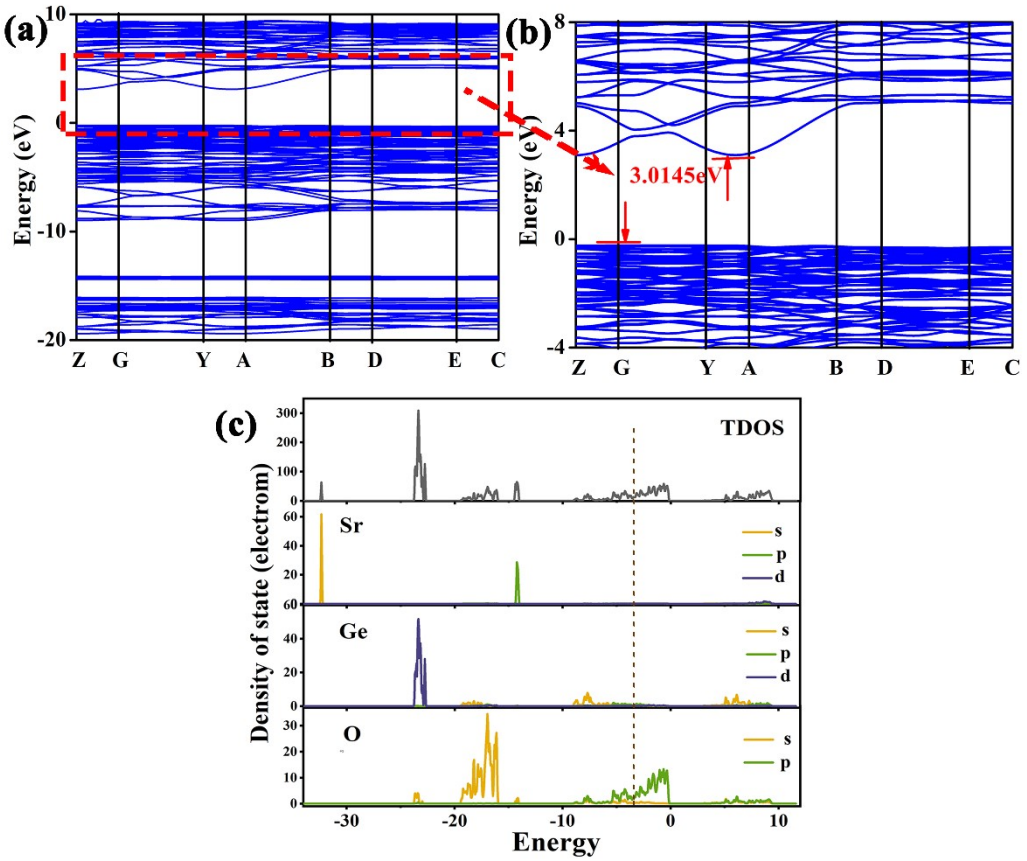

Figure. S2(a and b) Band structures of SGO; (c) Total and partial density of the states (DOS) for SGO

Figure. S2(a)(b) shows the band structure of SGO host obtained by refining the structure. The lowest point of the conduction band and the highest point of the valence band are not on the same position, indicating that SGO owns an indirect band gap and its energy is 3.0145 eV. Figure. S2(c) shows the total and separation density of SGO, which consists of s/p orbital of Sr, s/p/d orbital of Ge, and s/p orbital of O, forming the valence band from -35 eV to Fermi level. The conduction band of SGO consists of the d orbital of Sr, the s/p orbital of Ge, and the p orbital of O.