Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supplementary data

Effect of Ca^{2+}-ion co-doping on radiative properties via tuning the local symmetry around the Eu^{3+} ions in orange red light emitting $GdPO_4:Eu^{3+}$phosphors

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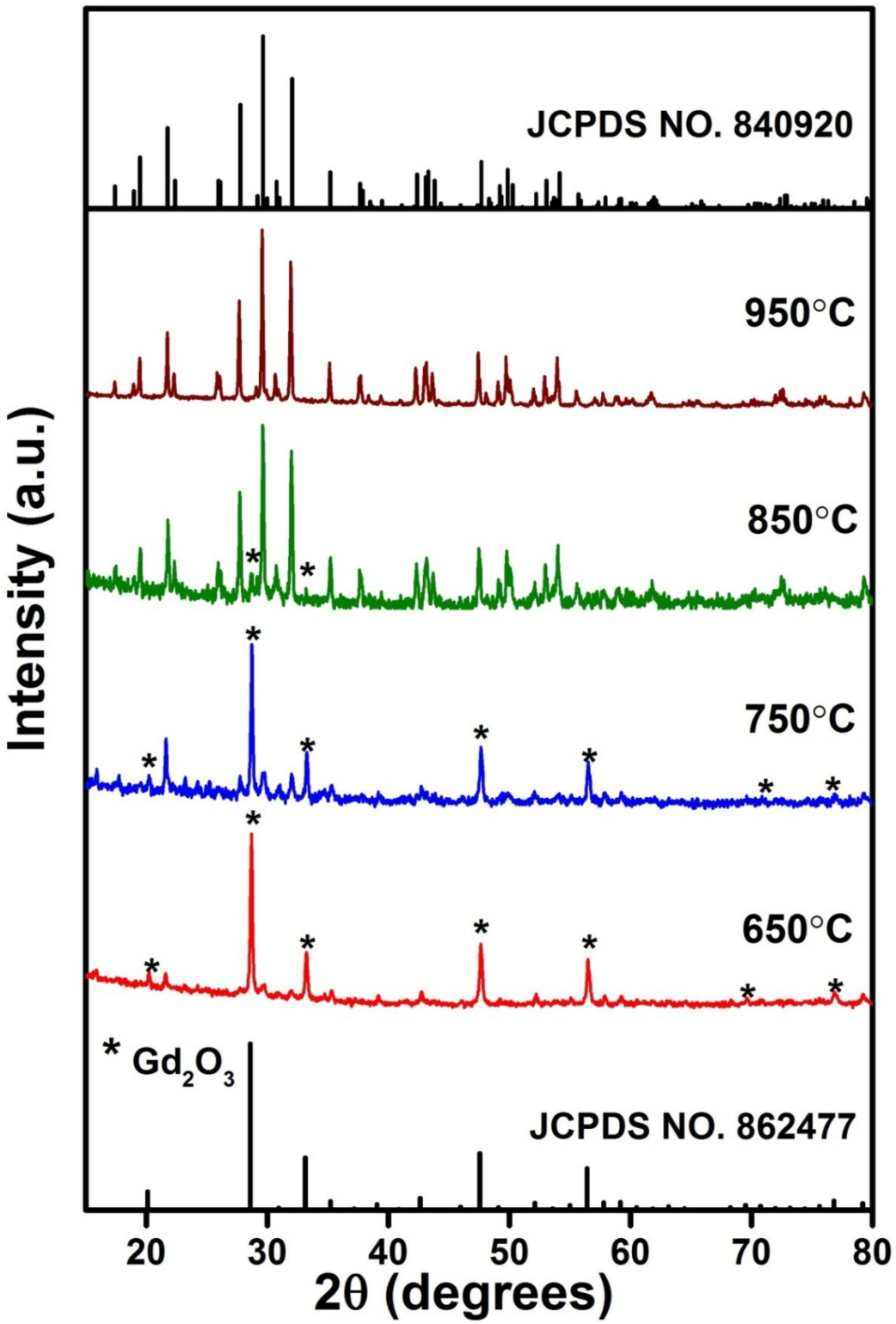

Fig. S1. Powder X-ray diffraction patterns of $Gd_{0.93}Eu_{0.07}PO_4$ phosphor calcined at different temperatures for 12 h.

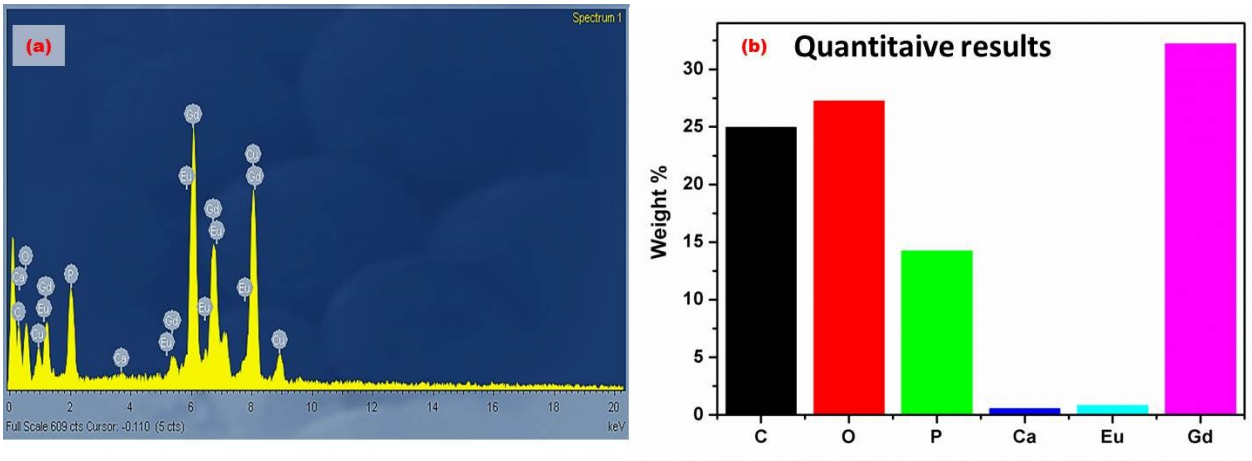

Fig. S2. EDX Spectra of $Gd_{0.86}Eu_{0.07}Ca_{0.07}PO_4$ phosphors.

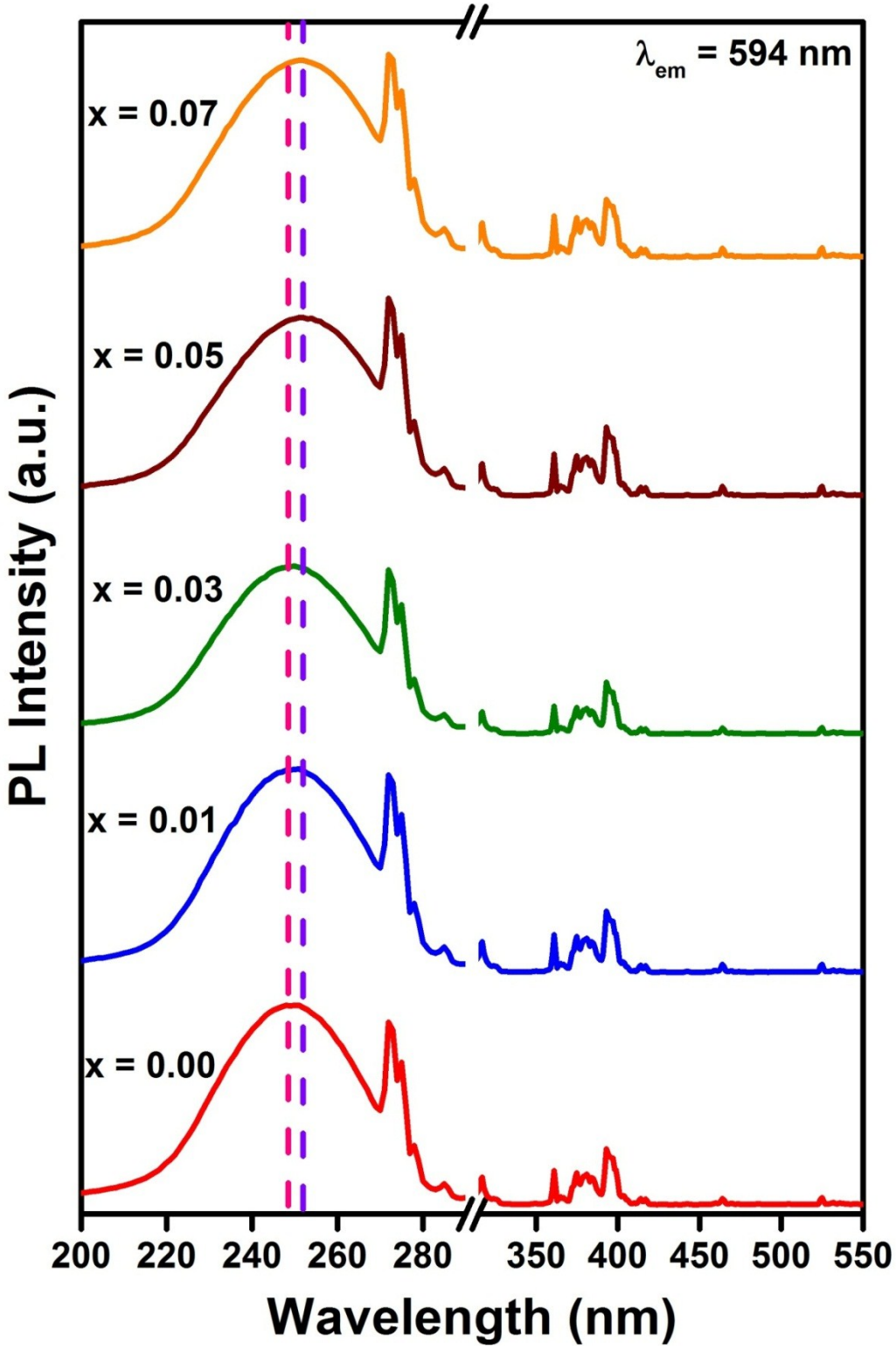

Fig.S3. Photoluminescence excitation spectra of $Gd_{0.93-x}Eu_{0.07}Ca_xPO_4$ phosphors prepared at 950 °C 12 h.

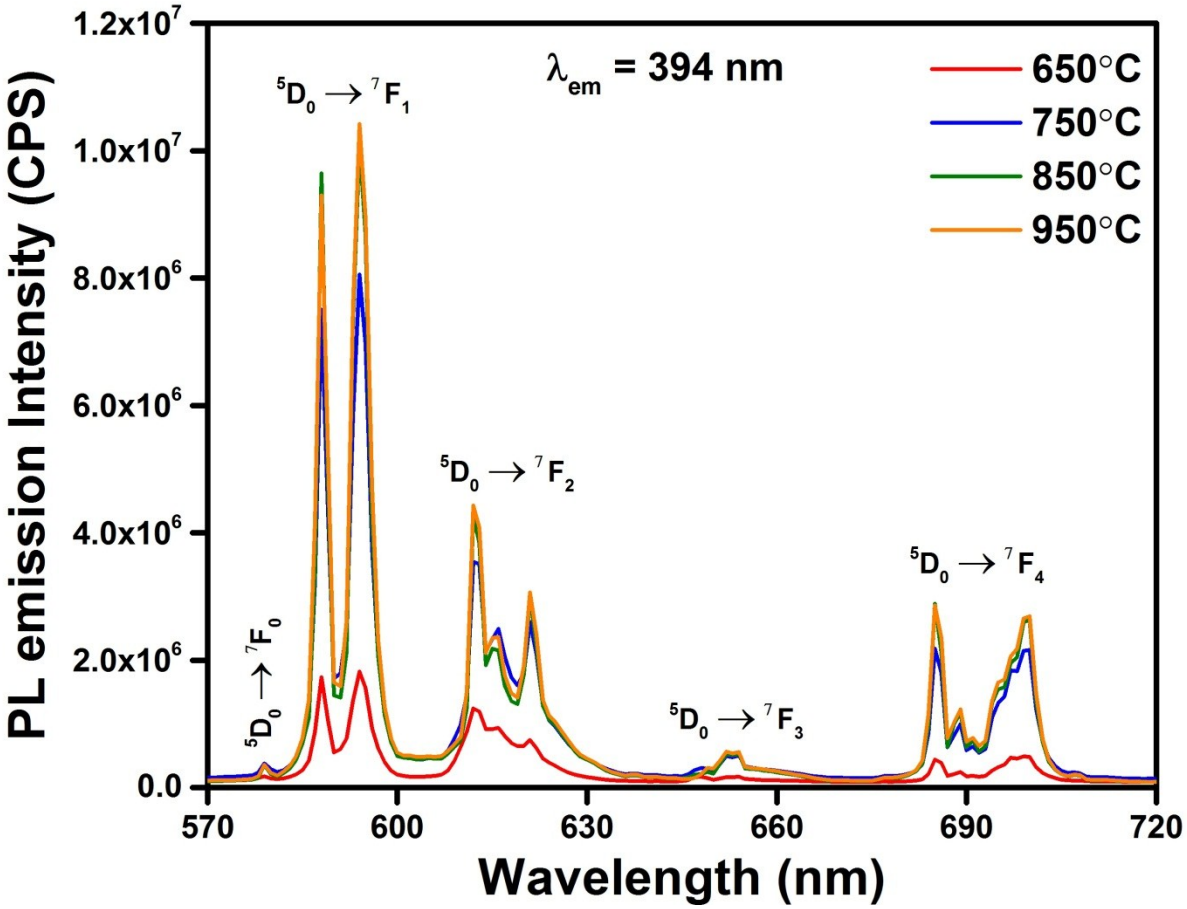

Fig. S4. Photoluminescence emission spectra for $Gd_{0.93}Eu_{0.07}PO_4$ (λ_{ex} = 394 nm) phosphors prepared at different temperature.

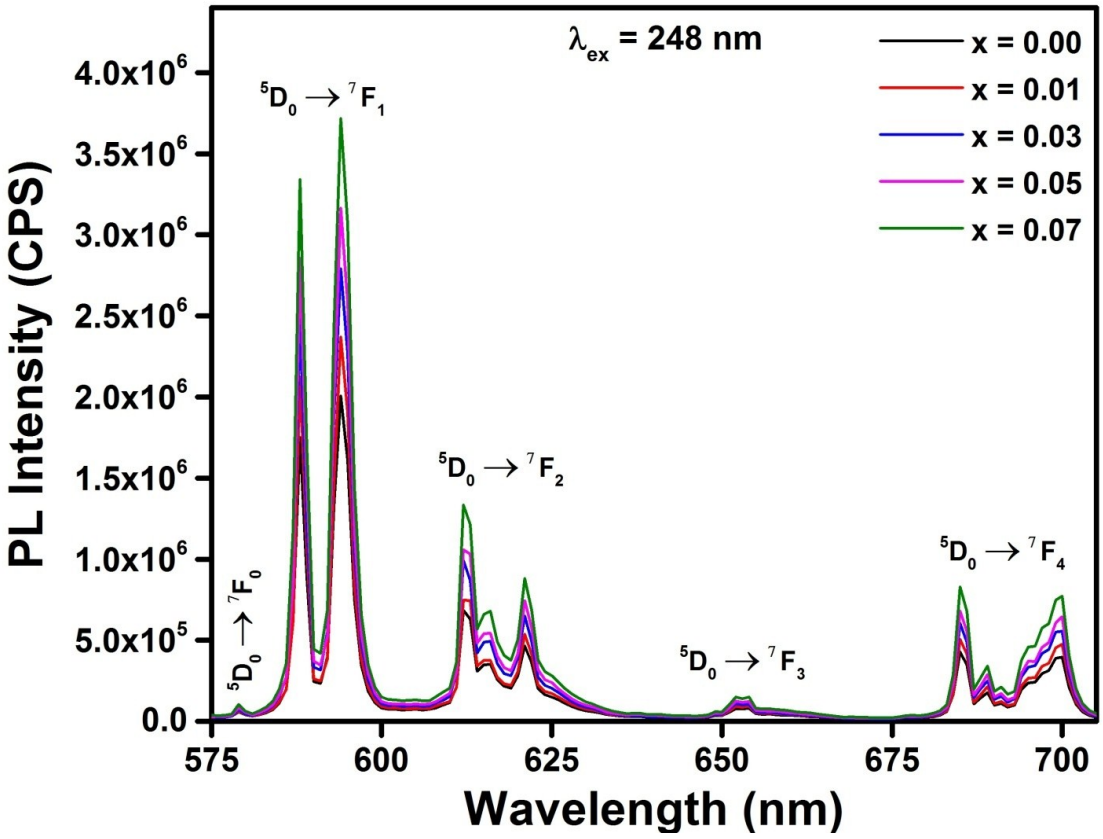

Fig. S5. Photoluminescence emission spectra of the $Gd_{0.93-x}Eu_{0.07}Ca_xPO_4$ phosphors recorded at λ_{ex} = 248 nm.

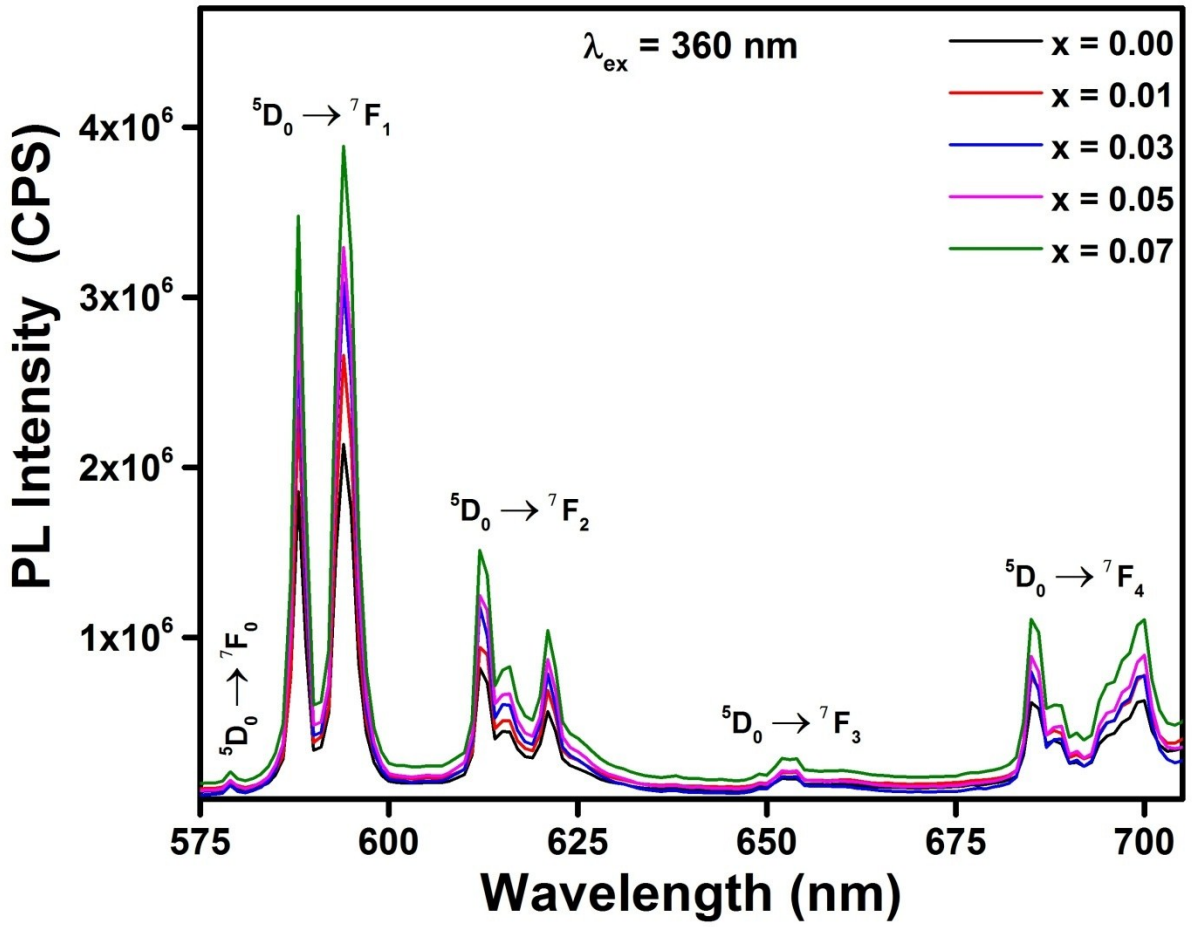

Fig. S6. Photoluminescence emission spectra of the $Gd_{0.93-x}Eu_{0.07}Ca_xPO_4$ phosphors recorded at λ_{ex} = 360 nm.

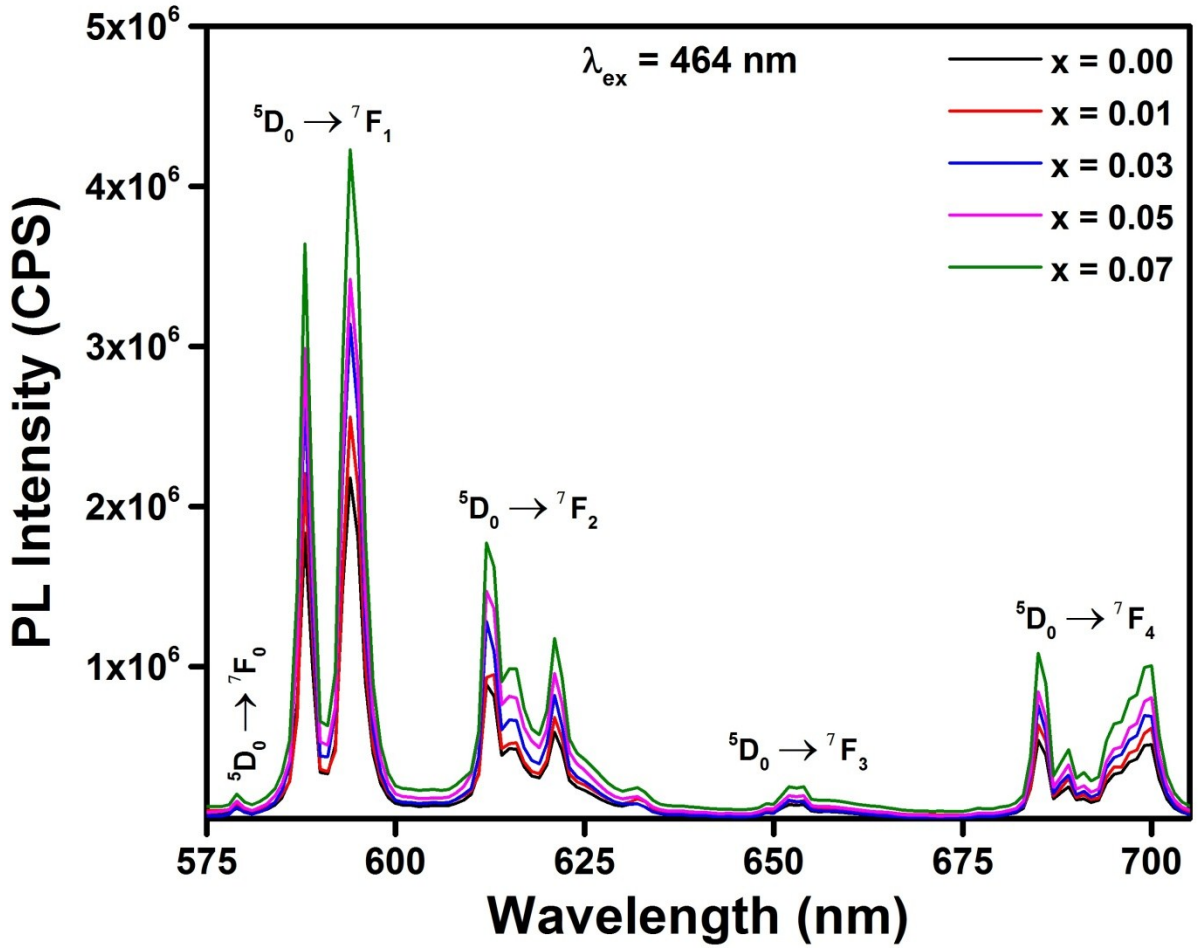

Fig. S7. Photoluminescence emission spectra of $Gd_{0.93-x}Eu_{0.07}Ca_xPO_4$ phosphors recorded at λ_{ex} = 464 nm.

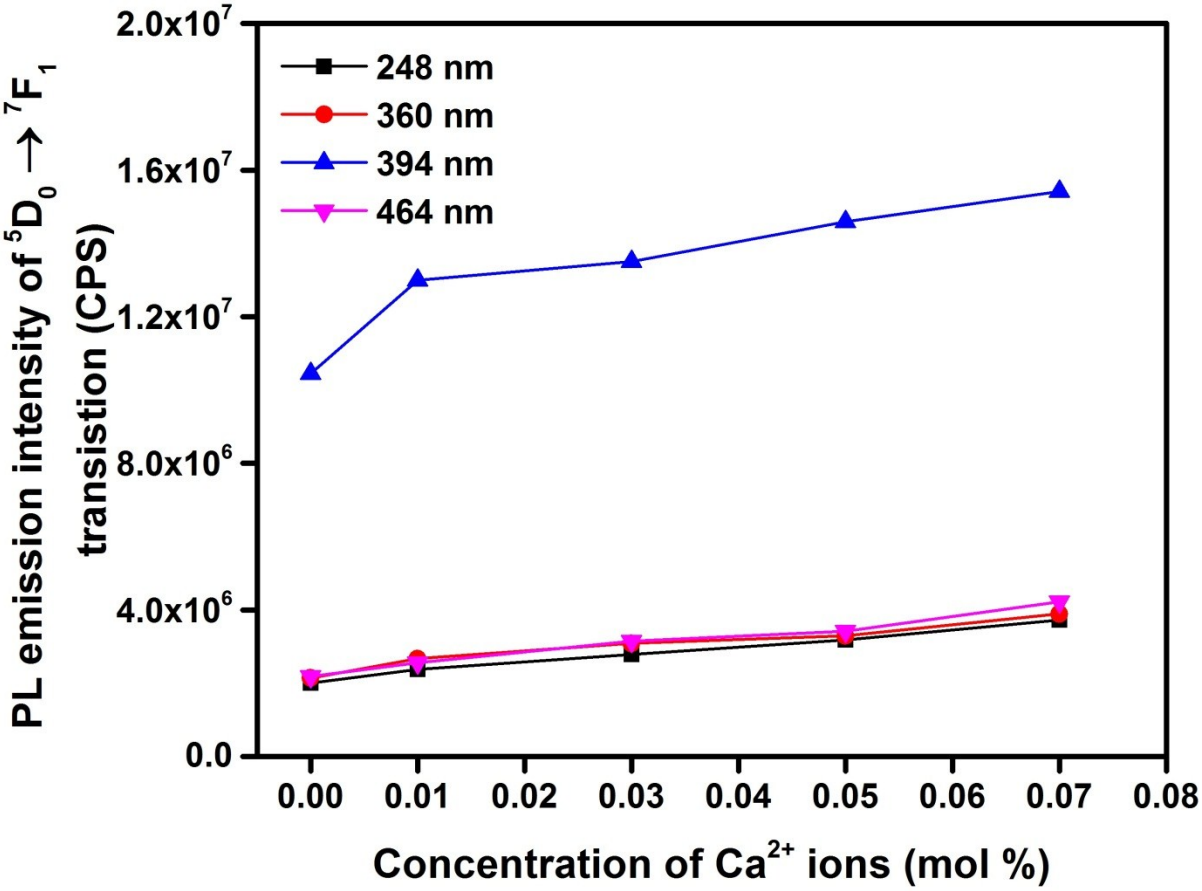

Fig. S8. Variation of emission intensity of $^5D_0 \rightarrow {}^7F_1$ peaks as a function of Ca^{2+} ions concentration at different excitation wavelengths.

Table S1. Rietveld refined structural parameters for $Gd_{0.93-x}Eu_{0.07}Ca_xPO_4$ ($0.00 \leq x \leq 0.07$) phosphors.

Ca^{2+} content	Ca^{2+} (0 mol%)	Ca^{2+} (1 mol%)	Ca^{2+}(3 mol%)	Ca^{2+} (5 mol%)	Ca^{2+} (7 mol%)
Crystal System	Monoclinic	Monoclinic	Monoclinic	Monoclinic	Monoclinic
Space group	$P12_{1/n\,1}$ (14)	$P\,12_{1/n\,1}$ (14)	$P12_{1/n\,1}$ (14)	$P12_{1/n\,1}$ (14)	$P12_{1/n\,1}$ (14)
Lattice Parameters					
a (Å)	6.653(2)	6.654(3)	6.654(3)	6.655(3)	6.655(2)
b (Å)	6.850(1)	6.847(2)	6.848(4)	6.848(2)	6.849(3)
c (Å)	6.339(2)	6.339(1)	6.340(3)	6.341(2)	6.341(2)
Cell volume (Å^3)	280.02(7)	280.21(2)	280.33(1)	280.38(2)	280.43(7)
β (°)	103.99(7)	104.00(2)	104.01(5)	104.02(1)	104.02(2)
Atomic positions					
$Gd^{3+}/Eu^{3+}/Ca^{2+}$	(4b)	(4b)	(4b)	(4b)	(4b)
x	0.2812(24)	0.2801(34)	0.2809(44)	0.2818(34)	0.2813(35)
y	0.1554(29)	0.1547(42)	0.1549(53)	0.1552(42)	0.1552(42)
z	0.0963(31)	0.0961(44)	0.0948(58)	0.0952(45)	0.0957(45)
P	(4a)	(4a)	(4a)	(4a)	(4a)
x	0.3030 (10)	0.3004(9)	0.3005(18)	0.2987(14)	0.2997(23)
y	0.1602 (11)	0.1614(15)	0.1598(19)	0.1610(13)	0.1607(21)
z	0.6179 (9)	0.6181(14)	0.6213(17)	0.6169(11)	0.6153(22)
O1	(16f)	(16f)	(16f)	(16f)	(16f)
x	0.2425(19)	0.2429(27)	0.2350(24)	0.2477(25)	0.2465(40)
y	-0.0013(18)	-0.0010(18)	-0.0077(24)	-0.0015(22)	-0.0067(36)
z	0.4291(23)	0.4275(32)	0.4203(43)	0.4177(24)	0.4301(43)
O2	(16f)	(16f)	(16f)	(16f)	(16f)
x	0.3822(13)	0.3812(18)	0.3783(23)	0.3858(18)	0.3872(27)
y	0.3303(20)	0.3261(27)	0.3187(32)	0.3357(28)	0.3297(39)
z	0.5026(19)	0.5038(26)	0.5019(33)	0.5081(25)	0.5023(41)
O3	(16f)	(16f)	(16f)	(16f)	(16f)
x	0.4757(16)	0.4688(22)	0.4673(29)	0.4730(22)	0.4739(27)
y	0.1045(15)	0.1071(21)	0.1055(33)	0.1009(19)	0.1019(20)

z	0.8113(16)	0.8096(22)	0.8070(31)	0.8133(23)	0.8160(23)
O4	(16f)	(16f)	(16f)	(16f)	(16f)
x	0.1208(17)	0.1175(24)	0.1138(30)	0.1138(23)	0.1033(23)
y	0.1996(18)	0.2023(25)	0.1952(33)	0.1974(25)	0.1997(25)
z	0.7144(18)	0.7176(26)	0.7049(31)	0.7080(24)	0.7073(24)
***R* Factors**					
R_p	1.33	1.65	1.95	1.63	1.64
R_{wp}	1.75	2.09	2.45	2.07	2.08
R_{exp}	1.58	2.20	2.53	2.25	2.25
χ^2	1.23	0.90	0.94	0.84	0.85
R_{Bragg}	5.49	6.31	8.53	5.90	6.41
R_F	5.33	5.73	6.63	5.51	6.29