Electronic Supplementary Information (ESI†)

Roles of solvent, annealing and Bi^{3+} co-doping on crystal structure and luminescence properties of YPO_4: Eu^{3+} Nanoparticles

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Materials

All reagents used were of analytical grade (AR) grade. The starting materials for Y^{3+}, PO_4^{3-}, Eu^{3+}, Bi^{3+} are yttrium oxide (Y_2O_3, 99.99%, Sigma Aldrich), ammonium dihydrogen phosphate ($NH_4H_2PO_4$, 99.999%, Sigma Aldrich) and europium nitrate hexahydrate ($Eu(NO_3)_3.6H_2O$, 99.9%, Sigma Aldrich), bismuth nitrate pentahydrate ($Bi(NO_3)_3.5H_2O$, 99.99%, Sigma Aldrich), respectively. Concentrated nitric acid (HNO_3), ethylene glycol (EG), polyethylene glycol (PEG-6000), polyethylene glycol diacid (PEG-Diacid-600) were used without further purification. Milli Q water was used in the experiment.

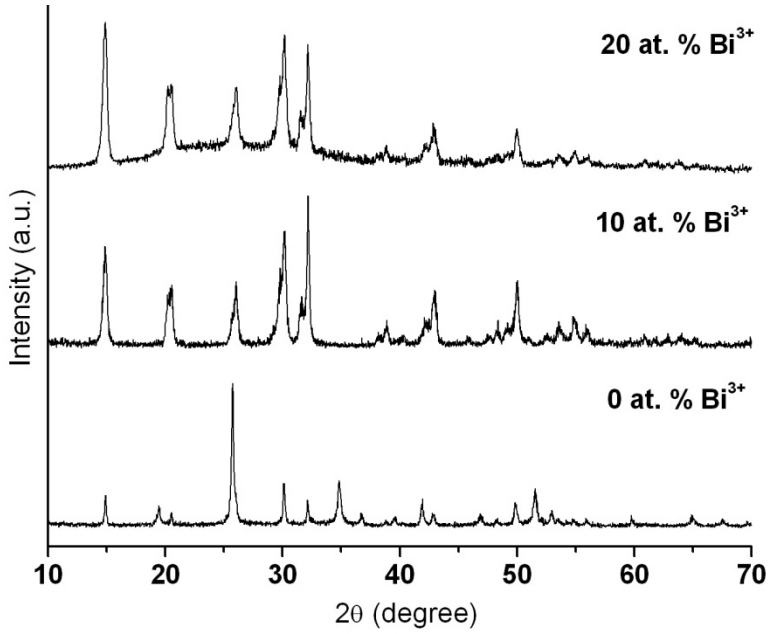


Fig. S1. XRD patterns of YPO_4: Eu co-doped with different concentrations of Bi^{3+} (0, 10 and 20 at. %) samples prepared in PEG-diacid medium.

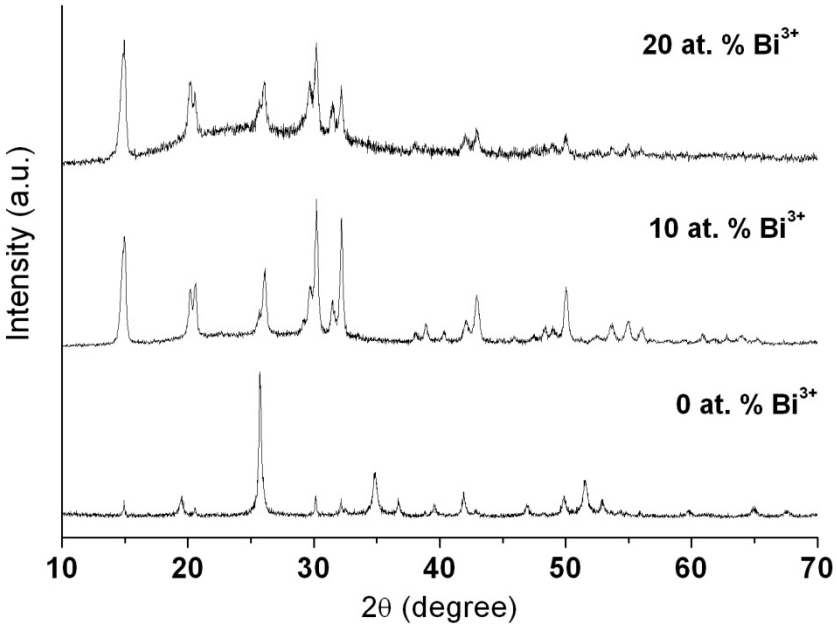


Fig. S2. XRD patterns of YPO_4:Eu co-doped with different concentrations of Bi^{3+} (0, 10 and 20 at. %) prepared in water medium.

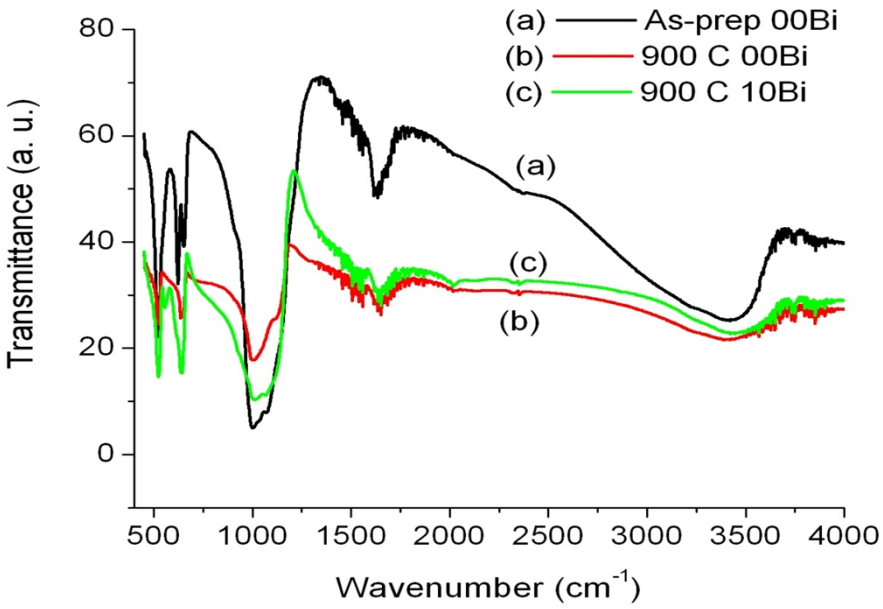


Fig. S3. FTIR spectra of YPO_4: Eu co-doped with different concentrations of Bi^{3+} samples prepared in PEG-diacid: (a) as-prepared (0 at.% Bi) and 900 ^oC heated samples (0 at.% Bi^{3+} (b) and 10 at.% Bi^{3+} (c)).

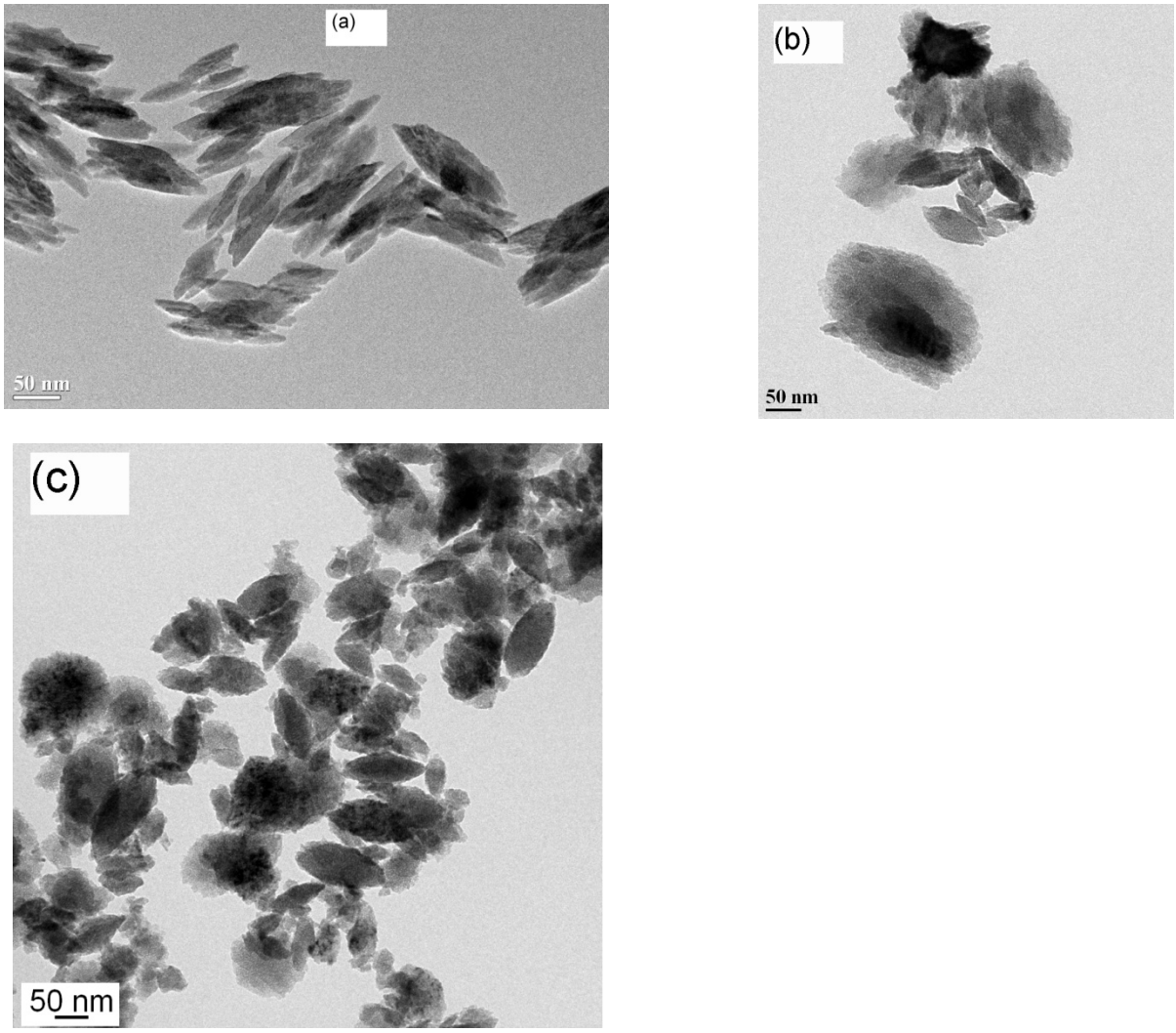


Fig. S4. TEM images of as-preparedYPO_4:Eu in different solvents: (a) PEG, (b) PEG-diacid and (c) water. It looks that there are more uniform sizes of particles in (a) as compared to (b) or (c). These will be characteristic of particles in different solvents.

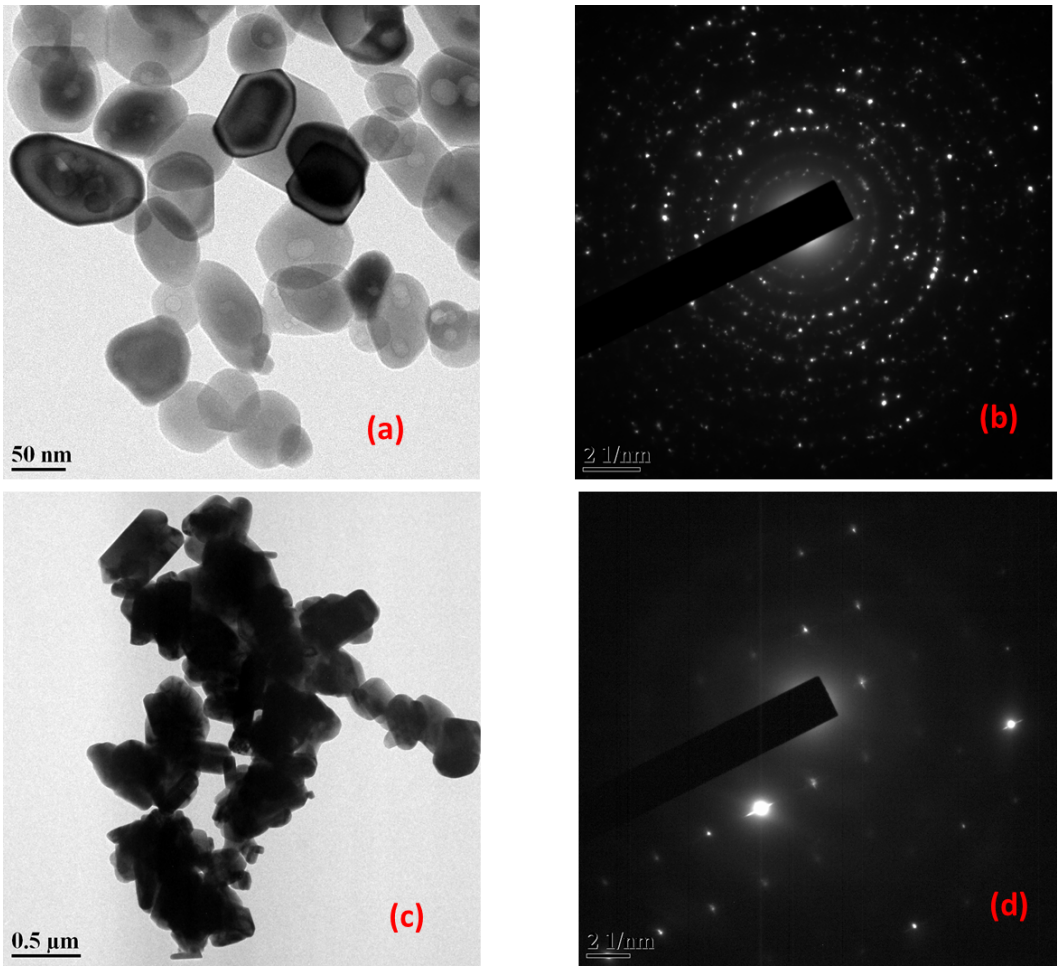

50 nm
(a)
2 1/nm
(b)
0.5 µm
(c)
2 1/nm
(d)

Fig. S5. TEM images of 900 ^{o}C heated samples of YPO_4:Euprepared in PEG-diacid: (a) 0 at.% Bi and (c) 10 at.% Bi and their corresponding SAED patterns (b) and (d).

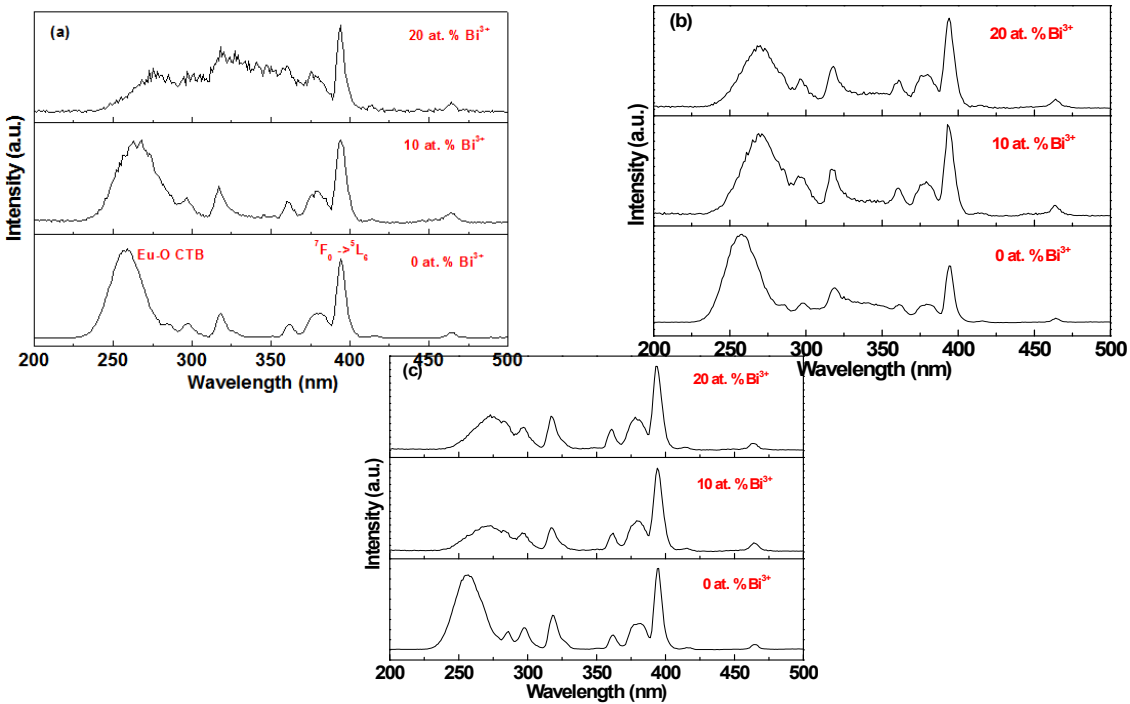


Fig. S6. Excitation spectra (monitoring emission wavelength at 612 nm) of Bi^{3+} (0, 10 and 20 at.%) co-doped YPO_4:Eu prepared in different solvents (a) PEG, (b) PEG-diacid and (c) water.

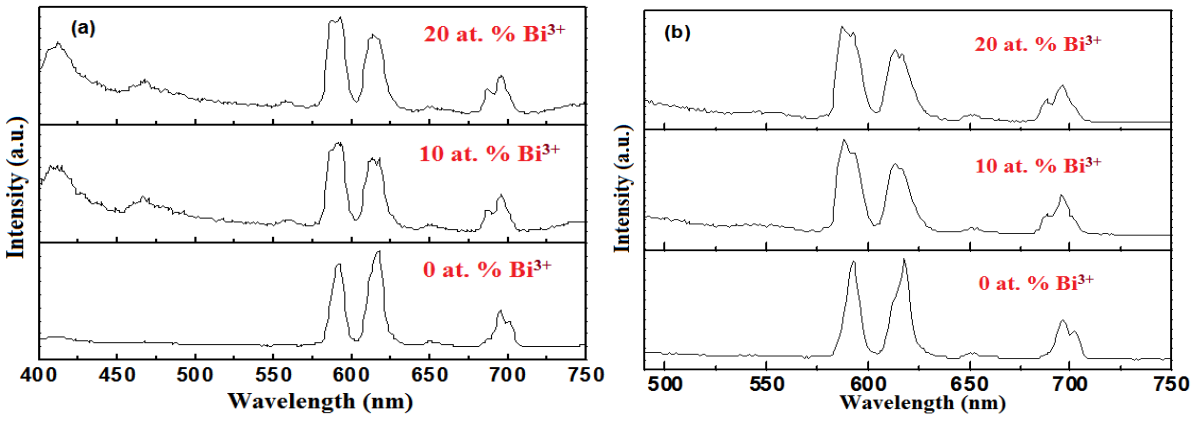


Fig. S7. Emission spectra of Bi^{3+} co-doped YPO4:Eu prepared in PEG-diacid solvent after excitation at (a) 260 and (b) 395 nm.

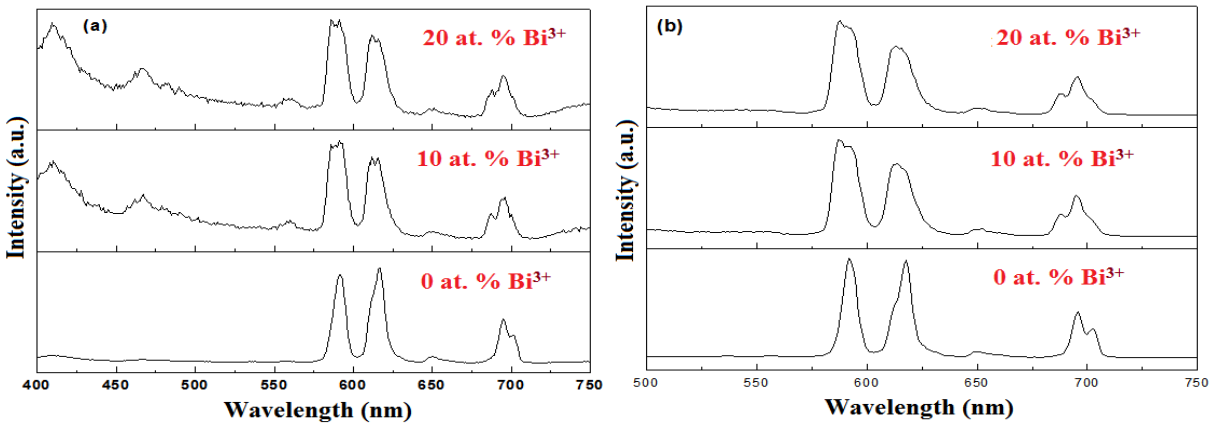
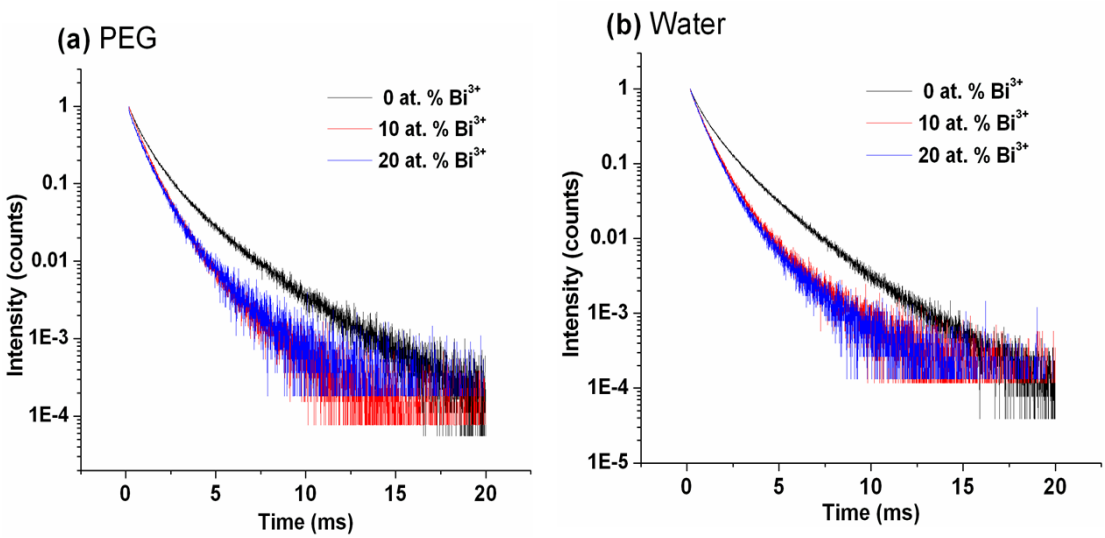


Fig. S8. Emission spectra of Bi^{3+} co-doped YPO4:Eu prepared in water after excitation at (a) 260 and (b) 395 nm.

Note: There are a typical emission peak of Eu^{3+} at ~592 nm corresponding to the magnetic dipole transition ($^5D_0 \rightarrow {}^7F_1$) along with peak at ~617 nm corresponding to the electric dipole transitions ($^5D_0 \rightarrow {}^7F_2$). Here, $^5D_0 \rightarrow {}^7F_1$ transition has $\Delta j = \pm 1$ and it should have 2 splitting. Whereas, $^5D_0 \rightarrow {}^7F_2$ transition has $\Delta j = \pm 2$ and it should have 3 splitting.



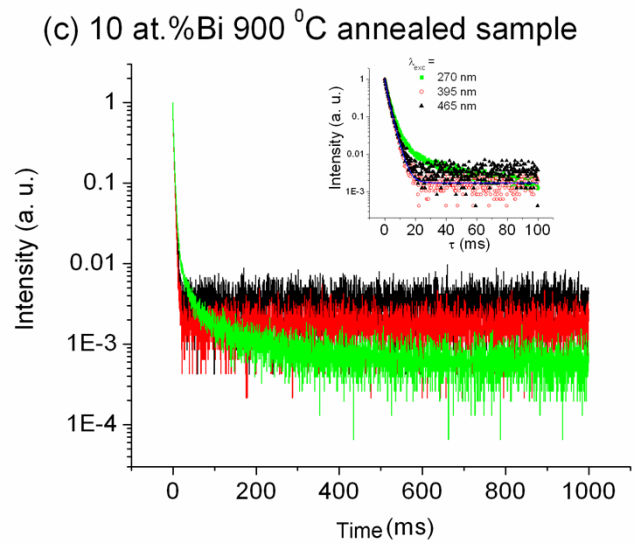


Fig. S9. Decay curves of $^5D_0$ (612 nm) level of Eu^{3+} in Bi-doped YPO_4: Eu^{3+}as prepared samples prepared in (a) PEG (λ_{exc} = 395 nm) and (b) water (λ_{exc} = 395 nm). (c) 900 °C heated YPO_4: Eu-10Bi samples prepared in PEG-diacid (λ_{exc} = 270, 395, 465 nm).

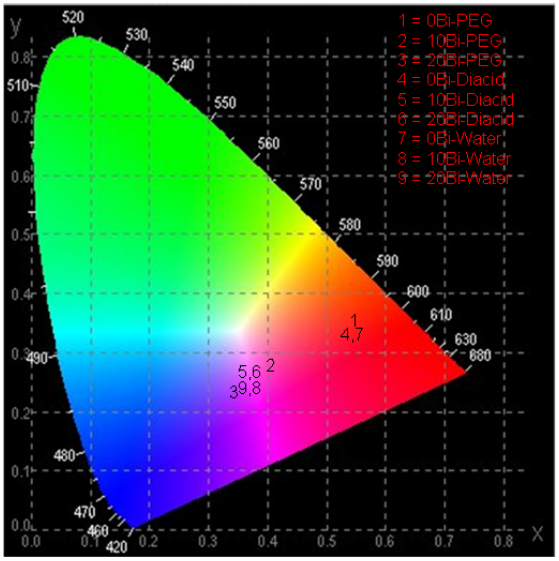


Fig. S10. CIE-coordinates obtained from YPO_4:Eu co-doped with different concentrations of Bi^{3+} (0, 10 and 20 at. %) samples prepared in PEG, PEG-diacid and water mediums.

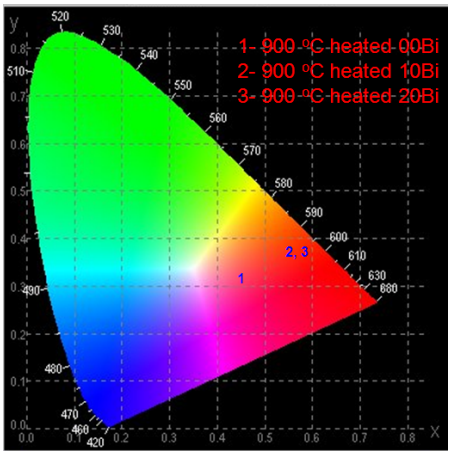


Fig. S11. CIE-coordinates obtained from 900 °C heated YPO_4:Eu co-doped with different concentrations of Bi^{3+} (0, 10 and 20 at. %) samples prepared in PEG-diacid.