†Electronic Supplementary Information (ESI) available:

Details of lattice parameter and crystallite size calculation:

The lattice parameter *a* for these cubic crystal system was calculated using the equation

$$a = d\sqrt{h^2 + k^2 + l^2}$$

where *hkl* are the Miller indices of the diffraction peak and *d* is the inter planar spacing. The crystallite size of all the samples were calculated by using the Debye-Scherrer equation - $D = 0.9\lambda/(\beta\cos\theta)$ where λ is the wave length of the incident X-ray, *β* is the full width at half maximum (FWHM) and *θ* is the corresponding angle of diffraction.

Crystallite size of the prepared samples were also calculated by using the well-known Williamson-Hall equation given by-

$$\frac{\beta\cos\theta}{\lambda} = \frac{1}{\delta} + \frac{\varepsilon\sin\theta}{\lambda}$$

Where *δ* is the crystallite size and *ε* is the effective lattice strain. When $\beta\cos\theta/\lambda$ was plotted against $\sin\theta/\lambda$ for the different samples and fitted linearly, the lattice strain and effective crystallite size were obtained from the slope of the straight line and inverse of the intersection of the straight line to the x axis respectively. The crystallite size calculated from both Debye-Scherrer equation and Williamson-Hall equation were closed to each other.

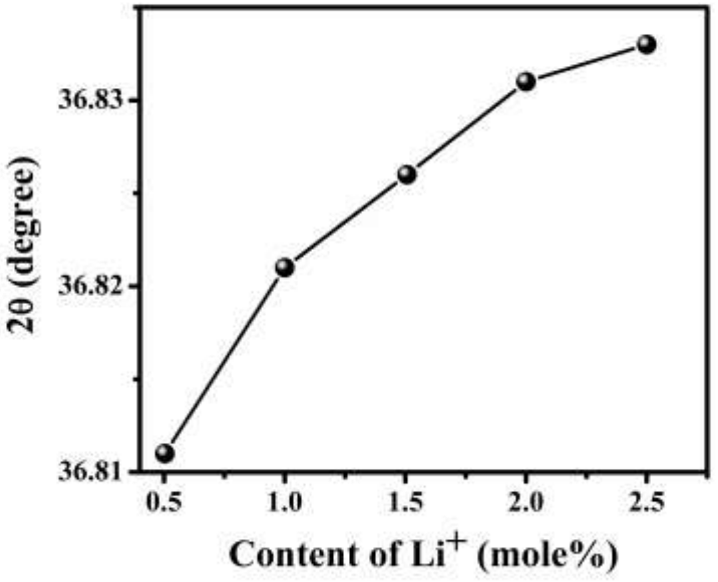

Figure S1: Variation of (311) XRD peak with respect to Li^+ concentration is shown in $MgAl_2O_4$:2%Eu^{3+}, Li^+ nanophosphors is shown in the figure. The higher angle shift of the peak indicates the gradual shrinkage of the unit cell with increasing concentration of Li^+.

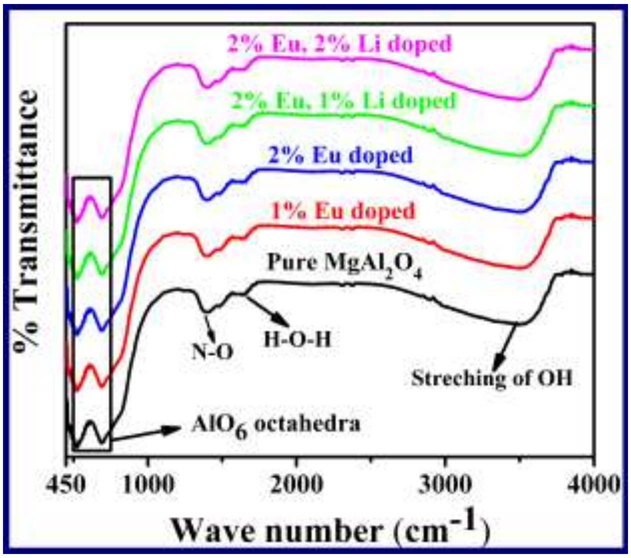

Figure S2: FT-IR spectra of pure, Eu^{3+} doped and Eu^{3+}, Li^+ co-doped $MgAl_2O_4$ nanophosphors are shown in Figure S2. The peaks in the spectra represent the vibration modes for the functional groups available in the samples. From figure S1 it is evident that the vibrational spectra of the doped samples are very similar to that of pure $MgAl_2O_4$. This indicates that the functional groups and structures are similar in the materials. All the obtained peaks are identical with the peaks of $MgAl_2O_4$ nanoparticles obtained by Chandradass et al [1]. The broad peak in the range of 3200-3700 cm-1 appears due to stretching vibration of OH groups indicating the presence of molecular water [2]. The peaks near 1370 cm^{-1} and 1645 cm^{-1} arises due to the bending vibration of N-O and H-O-H bonds respectively [3]. Two small and broad peaks at 539 cm^{-1} and 695 cm^{-1} correspond to the inorganic network of AlO_6 group confirmed the formation of $MgAl_2O_4$ spinel phase.

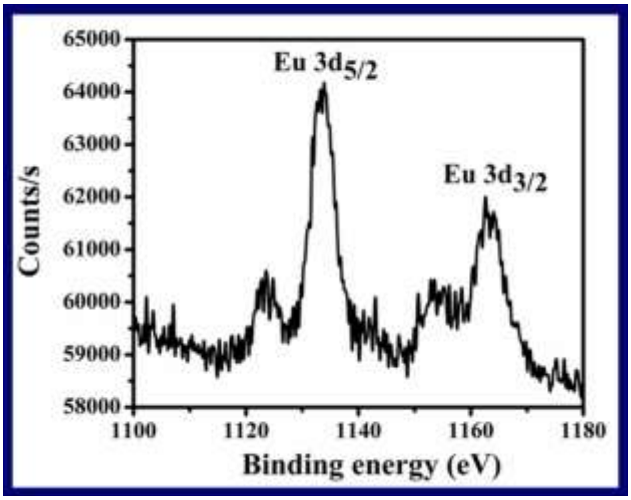

Figure S3: High resolution scan of Eu 3d peaks of $MgAl_2O_4$:2% Eu^{3+} nanophosphors, which shows apparently same intense 3d peaks as compared to that of 2% Li^+ codoped $MgAl_2O_4$:2% Eu^{3+} nanophosphors.

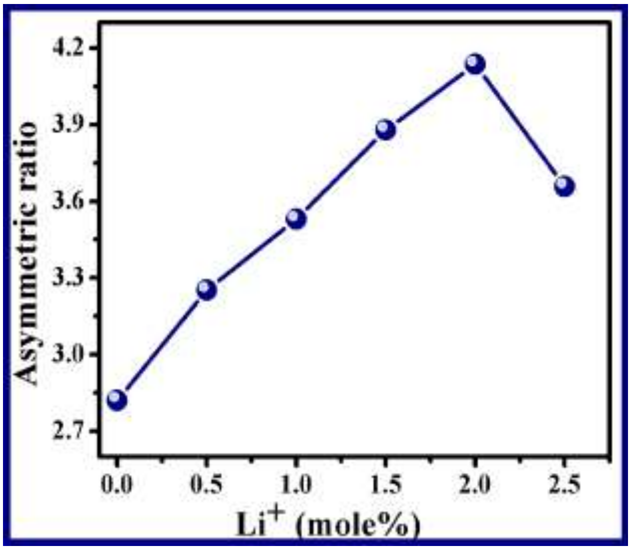

Figure S4: Variation of asymmetric ratio for different Li$^+$ concentration in $MgAl_2O_4$:2%Eu^{3+}, Li$^+$ nanophosphors is shown in figure above. At first the asymmetry ratio increases upto 2% of Li$^+$ concentration and then it decreases. This is due to the fact that Li$^+$ doping in the host lattice always creates some lattice defects, which lowers the symmetry around the Eu^{3+} ions. Due to this reduced symmetry, electric dipole transitions get an opportunity to play a dominant role, which increases the asymmetric ratio consequently.

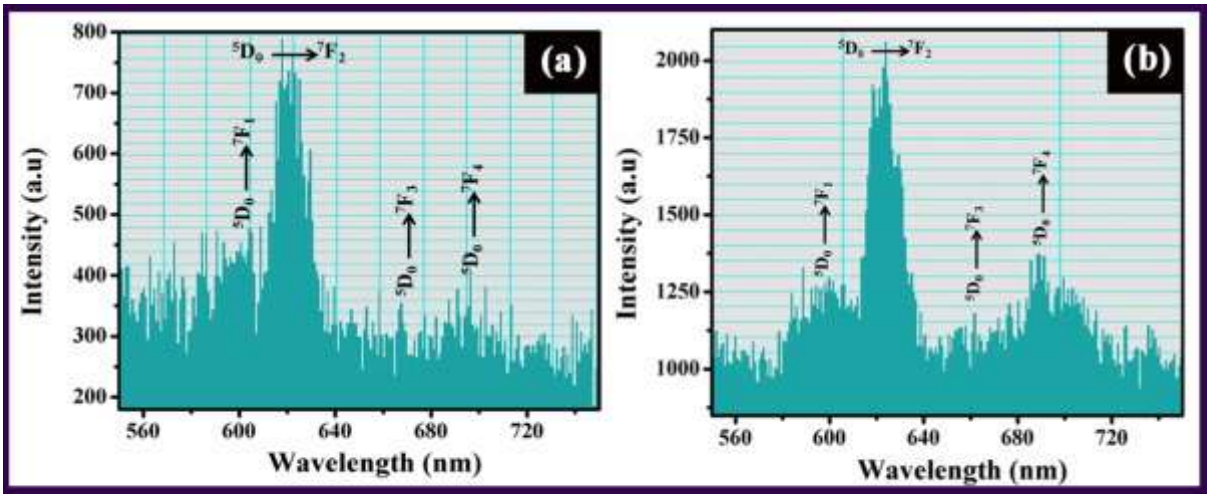

Figure S5: The Cathodoluminescence spectra of 2% Eu^{3+} and 2% Eu^{3+}, 2% Li^{+} doped nanophosphors is shown in figure S5(a) and S5(b) respectively. Upon low voltage electron beam excitation (900 V), Eu^{3+} doped and Eu^{3+}, Li^{+} co-doped both the phosphors show bright red emission having the strongest peak at 615 nm. Generally $MgAl_2O_4$:Eu^{3+} nanophosphor comprises of large surface area containing a large number of surface defects. Introduction of Li^{+} increases the crystallite size and reduces the surface defects, which increases the radiative recombination probability as well as the CL intensity.

Judd-Ofelt intensity parameter and quantum efficiency calculation:

The JO intensity parameters Ω_λ (λ=2, 4) give information on the intensities and nature of the hypersensitive transitions of the RE ion. The experimental intensity parameters (Ω_2) were determined from the emission spectra for Eu^{3+} ion based on the $^5D_0 \rightarrow {}^7F_2$ electric-dipole transition taking the $^5D_0 \rightarrow {}^7F_1$ magnetic dipole transitions as the reference and can estimated according to the equation

$$A_{0\to\lambda} = \frac{4e^2\omega^3}{3\hbar c^3}\chi \sum_{\lambda=2,4} \Omega_\lambda \left| \left\langle {}^5D_0 \left\| U^\lambda \right\| {}^7F_J \right\rangle \right|^2$$

where $A_{0\to\lambda}$ is the coefficient of spontaneous emission, $A_{0\to1}$ is given by the expression-

$A_{0\to1} = 0.31\times10^{-11}(n_0)^3(\nu_{0\to1})^3$, and its values are estimated to be around 50 s^{-1} [4], e is the electronic charge, ω is the angular frequency of the transition, $\hbar$ is Planck's constant, c is the velocity of light, χ is the Lorentz local field correction and is expressed as-

$$\chi = \frac{n\left(n^2+2\right)^2}{9}$$

Where n is the refractive index of the sample which is experimentally determined and we can get the values of Ω_2 and Ω_4 by determining $A_{0-\lambda}$ directly from the luminescence spectra taking

$\left\langle {}^5D_0 \left\| U^2 \right\| {}^7F_2 \right\rangle = 0.0035$ and $\left\langle {}^5D_0 \left\| U^4 \right\| {}^7F_4 \right\rangle = 0.0030$ [5],

Radiative (A_{rad}), non-radiative (A_{nrad}) transition, and average decay time are related through the following equation

$$A_{tot} = \frac{1}{\tau} = A_{rad} + A_{nrad}$$

where (A_{rad}) can be expressed as

$$A_{rad} = \sum_J A_{0\to J}$$

As quantum efficiency is expressed as the ratio of the number of photons emitted by the Eu^{3+} ion and the number of photons absorbed by the Eu^{3+} ion, it can be expressed as

$$\eta = \frac{A_{rad}}{A_{rad} + A_{nrad}}$$

Calculated Judd-Ofelt parameters reveal that Li^+ co-doped nanophosphors are superior than Eu^{3+} doped $MgAl_2O_4$ nanophosphors.

References:

1. J. Chandradassa, M. Balasubramanian, D. S. Bae, J. Kim and K.H. Kim, *J Alloy Compd* , 2010, **L25**,491.
2. S.U. Rege and R.T. Yang, *Chem Eng Sci*, 2001, **56,** 3781.
3. M. J. Iqbal and B. Ismail, *J Alloy Compd* , 2009, **472**, 434.

4. M. A. F. Monteiro, H. F. Brito, M. C. F. C. M. Felinto, G. E. S. Brito, E. E. S. Teotonio, F.M. Vichi and R. Stefani, *Microporous and Mesoporous Materials*, 2008, **108**, 237.
5. R. J. Wiglusz, T. Grzyb, S. Lis and W. Strek, *Journal of Nanoscience and Nanotechnology* , 2009, **9**, 5803.