# Electronic Supplementary Information

## Tunable Luminescence in $Ce^{3+}$, $Mn^{2+}$-Codoped Calcium Fluorapatite through Combining Emissions and Modulation of Excitation: A Novel Strategy to White Light Emitting

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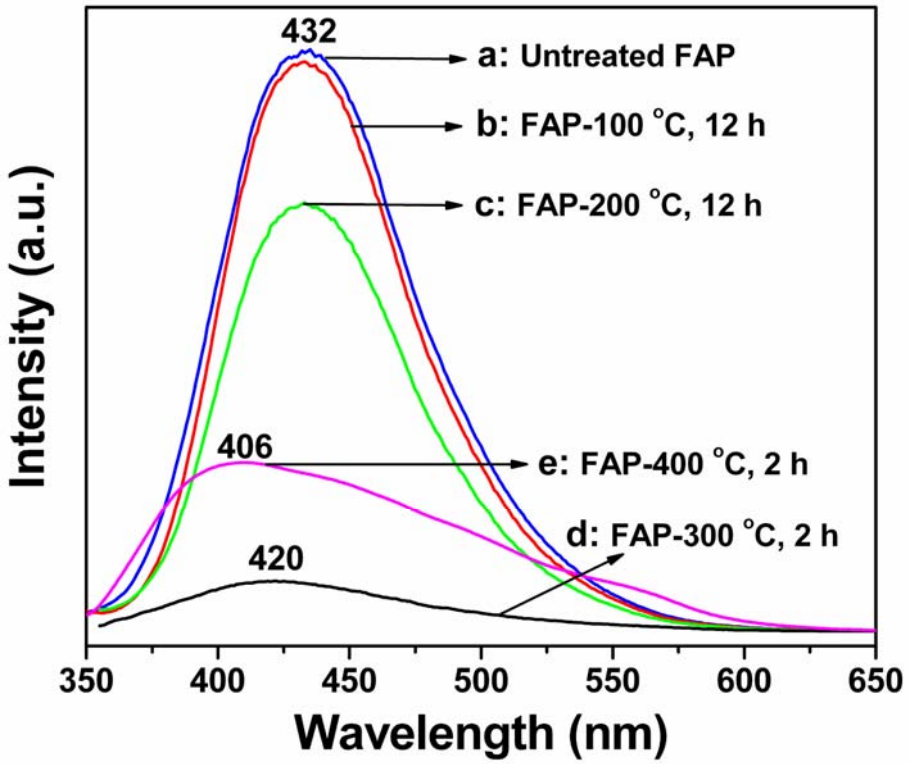


**Fig. S1** PL emission spectra of the untreated (a) and heat treated FAP (b-e) samples.

To investigate the stability of $CO_2^{\cdot -}$ radicals in the luminescent FAP sample, different heat treatments have been performed on the as-synthesized (untreated) FAP sample. In the synthesis process, the sample was synthesized by hydrothermal process at 180 $^oC$ and dried in air at 80 $^oC$ for 12 h to obtain the final FAP sample, which can indicate that the $CO_2^{\cdot -}$ species are stable at 80 $^oC$ **(Fig. S1a)**. In addition, we have performed other heat treatments (100, 200, 300, and 400 $^oC$) to further investigate the stability of the emission center of the blue luminescence for FAP nanorods. When the FAP sample was treated at 100 $^oC$ for 12 h, there is nearly no influence on the blue luminescence of FAP (**Fig. S1b**). Increasing the treat temperature to 200 $^oC$ (12 h), it can be found that the shape, profile, and maximum position for the emission spectrum

vary little, but the emission intensity decreases (**Fig. S1c**). This information can tell us that the blue emission center can not change treated under the condition less than 200 $^{o}$C. When FAP sample was calcined at 300 $^{o}$C for 2 h, the resulted sample showed a very weak emission (**Fig. S1d**), which can be hardly observed by our naked eyes. The PL emission intensity of the 400 °C annealed sample increased again, however, the profile and maximum of the corresponding emission spectrum is greatly different, which indicates that the emission centers in the host lattice have absolutely changed (the detail investigation of the new emission center has been reported in the previous work, see **Reference 35** in the manuscript). In conclusion, the blue emission center ($CO_2{\cdot}^-$) can be stable below 200 $^{o}$C. When the temperature is further increased to 300 $^{o}$C or higher, the $CO_2{\cdot}^-$ species can be destroyed.

**Table S1** Variation of CIE chromaticity coordinates of FAP: $Ce^{3+}$, $Mn^{2+}$ sample under the different excitation wavelength.

| $\lambda_{ex}$ (nm) | *x* | *y* |
|---|---|---|
| 295 | 0.335 | 0.379 |
| 305 | 0.322 | 0.352 |
| 308 | 0.316 | 0.328 |
| 310 | 0.299 | 0.321 |
| 312 | 0.278 | 0.282 |
| 314 | 0.261 | 0.253 |
| 320 | 0.211 | 0.168 |
| 342 | 0.167 | 0.098 |