Facile Synthesis, Structural Properties and Upconversion Emission of Er$^{3+}$/Yb$^{3+}$ Co-doped Fluoride Nanocrystals

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Rare earth ions doped fluoride nanocrystals (NCs) have several favorable characteristics for photonic and biological applications such as low phonon energy ($<400\text{cm}^{-1}$), low photobleaching, multicolor labeling, low toxicity, and improved signal-to-noise ratio. Because the optical, electrical and magnetic properties of fluoride NCs vary widely with factors such as size, shape and crystallinity, the use of different fluoride matrices and the modification of their morphologies and phases can be used to manipulate these factors. Host matrices SrYF$_5$, NaYF$_4$, LaF$_3$, CaF$_2$, and SrF$_2$ were synthesized using a facile co-precipitation route and investigated the effect of the thermal treatment in different temperatures, specifically as-prepared samples and at 300, 500, 700, and 900 $^\circ$C. The trivalent lanthanide (Ln$^{3+}$) ions system Er$^{3+}$/Yb$^{3+}$ was chose as dopant for the study of the luminescent properties in each matrix. In addition to modification in morphology and phase, the heat treatment in each matrices allowed elimination of surface defects, as unsaturated bonds, surface-adsorbed ions/molecules (H$_2$O, CO$_2$), impurities, ligands, and an inhomogeneous distribution of lanthanide ions. The success of the synthesis of each matrix was verified investigating the phase, morphology, size, and photoluminescence of the NCs at each heat treatment temperature, by means of X-ray diffraction (XRD), transmission electron microscopy (TEM), and photoluminescence (PL) spectroscopy.