S1.In the synthesis process of $NaYF_4$: Yb, Er nanocrystals, NaOH was coexist with oleic acid, Re $(NO_3)_3$ and NaF. NaOH can react with oleic acid to form sodium oleate, and also can react with rare earth ions to form precipitation of Re $(OH)_3$. In order to prove which reaction show priority, an experiment was done. 0.7 g NaOH, 7 mL OA, 14 mL deionized water, and 16.5 mL ethanol were mixed with stirring at room temperature. A settled solution was obtained and the pH value was 7.43. This indicated that OA reacted with NaOH and the sodium oleate was obtained. Then 2.5 mL 0.4 M 78% Y $(NO_3)_3$, 20% Yb $(NO_3)_3$ and 2% Er $(NO_3)_3$ aqueous solution were added into the above solution, and white precipitations were observed immediately. After stirring for few minutes, oil drops emerged in the bottle. That is to say sodium oleate was hydrolyzed and oleic acid and OH^- were obtained, then the OH^- reacted with Re^{3+} to form Re $(OH)_3$ precipitation. It can be concluded that OH^- preferred to react with Re $(NO_3)_3$ and form the Re $(OH)_3$.

S2.To further certify the role of NaOH in the reaction process was not reacted with oleic acid to form sodium oleate, sodium oleate was also used as ligands for synthesis $NaYF_4$: Yb, Er nanocrystals. The upconverted spectrum of the product was measured. The results indicated that under the same conditions with that in Figure 1A, the emission peaks were nearly unobservable. So the spectrum was recorded under excitation of 400 mW/cm^2 and both excitation and emission slit was 2.5 nm wide (Figure S1). That is to say, the upconverted fluorescence properties of sample directly using sodium oleate as ligand were greatly different from that of samples using oleic acid and NaOH.

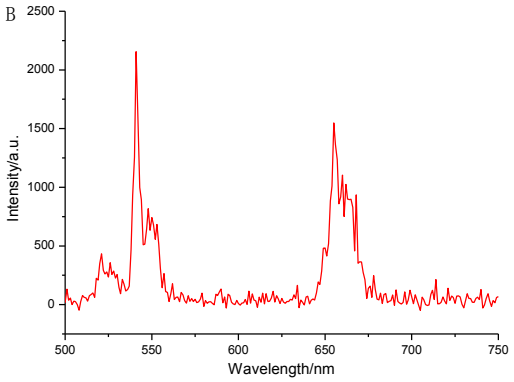

Figure S1 Upconverted fluorescence spectra of $NaYF_4$: Yb^{3+}, Er^{3+} nanocrystals prepared with sodium oleate excited with same power laser (400 mW/cm^2, the concentration of $NaYF_4$: Yb^{3+}, Er^{3+} was the same with that in Figure 1, both excitation and emission slit was 2.5 nm wide