

补充材料

154208

构建 $\text{NaYF}_4:\text{Yb}^{3+}/\text{Ho}^{3+}/\text{Ce}^{3+}@\text{NaYF}_4:\text{Yb}^{3+}/\text{Nd}^{3+}$ 纳米核壳结构 增强 Ho^{3+} 离子的上转换红光发射*

董军 张晨雪 程小同 邢宇 韩庆艳 严学文 祁建霞

刘继红 杨祎 高伟[†]

(西安邮电大学电子工程学院, 西安 710121)

(2021 年 1 月 18 日收到; 2021 年 3 月 23 日收到修改稿)

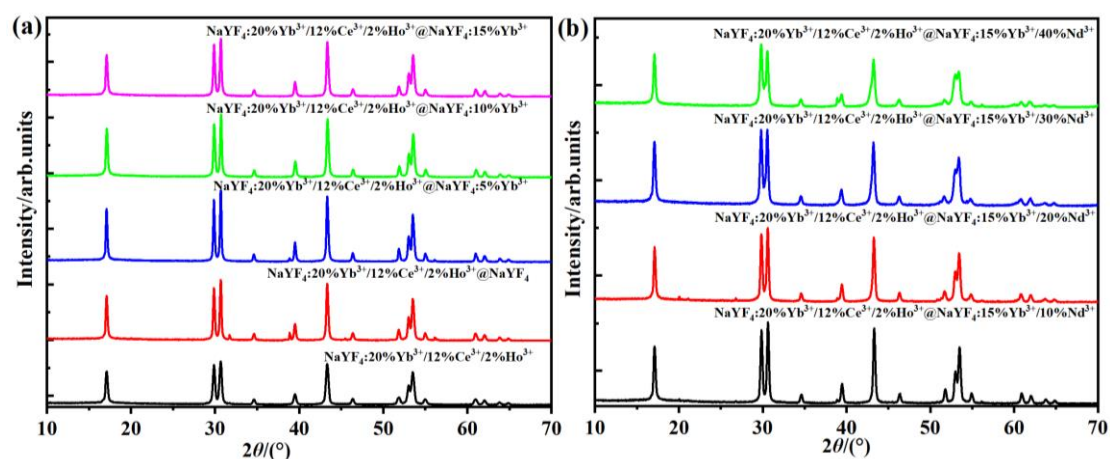


图 S1 (a) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}$ 纳米晶体和 $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:x\% \text{Yb}^{3+}$ ($x = 0, 5, 10, 15$) 核壳纳米晶体, (b) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:15\% \text{Yb}^{3+}/x\% \text{Nd}^{3+}$ ($x = 10, 20, 30, 40$) 核壳纳米晶体的 XRD 图

Fig. S1. The XRD patterns of (a) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}$ nanoparticles (NPs) and $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:x\% \text{Yb}^{3+}$ ($x = 0, 5, 10, 15$) core-shell (CS) NPs, (b) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:15\% \text{Yb}^{3+}/x\% \text{Nd}^{3+}$ ($x = 10, 20, 30, 40$) CS NPs.

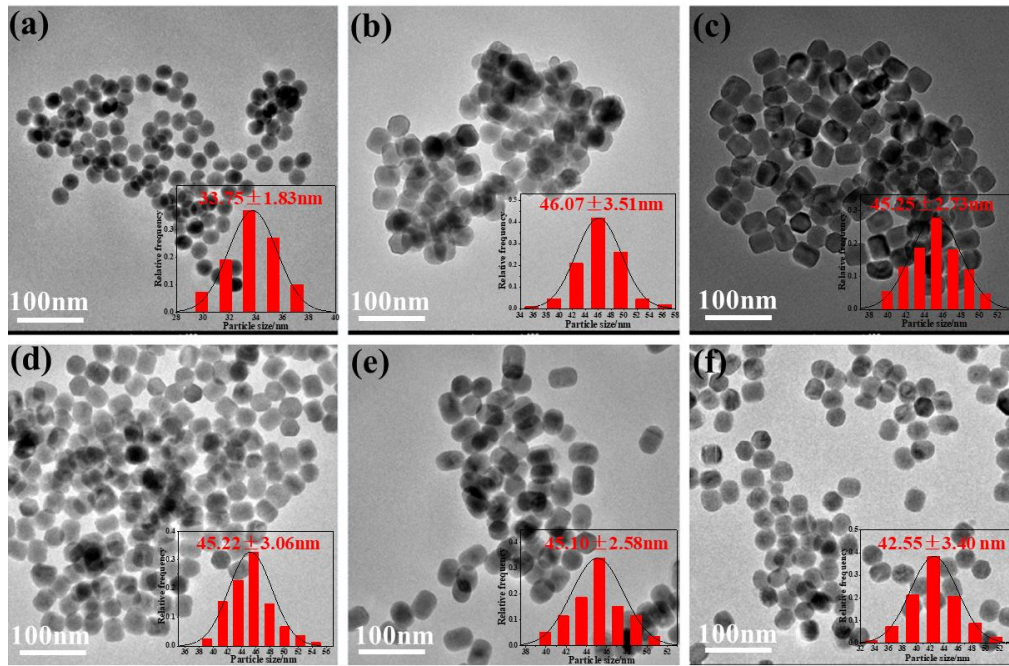


图 S2 (a) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}$ 纳米晶体, (b)–(e) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:x\% \text{Yb}^{3+}$ ($x=0, 5, 10, 15$)核壳纳米晶体和(f) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:15\% \text{Yb}^{3+}/10\% \text{Nd}^{3+}$ 核壳纳米晶体的 TEM 图, 插图分别为相应的粒径尺寸分布图

Fig. S2. The TEM images and size distribution (insert) of the (a) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}$ NPs, (b)–(e) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:x\% \text{Yb}^{3+}$ ($x = 0, 5, 10, 15$) CS NPs and (f) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:15\% \text{Yb}^{3+}/10\% \text{Nd}^{3+}$ CS NPs.

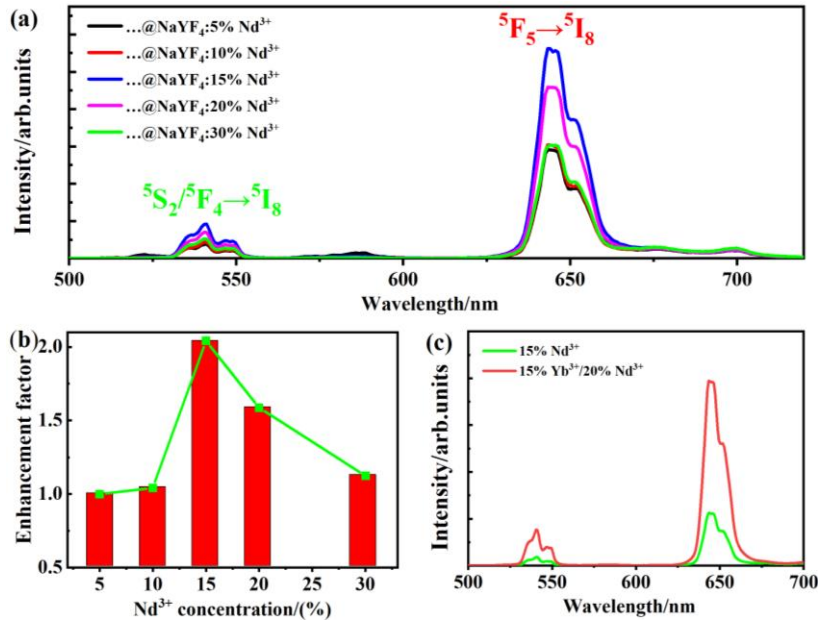


图 S3 在 800 nm 近红外光激发下, $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}@\text{NaYF}_4:x\% \text{Nd}^{3+}$ ($x = 5, 10, 15, 20, 30$)核壳纳米晶体的(a)上转换发射光谱和(b)增强因子, (c) $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}@\text{NaYF}_4:15\% \text{Nd}^{3+}$ 和 $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}@\text{NaYF}_4:15\% \text{Yb}^{3+}/20\% \text{Nd}^{3+}$ 核壳纳米晶体的上转换发射光谱

Fig. S3. (a) The upconversion (UC) emission spectra, (b) enhancement factor of $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}@\text{NaYF}_4:x\% \text{Nd}^{3+}$ ($x=5, 10, 15, 20, 30$) CS NPs, (c) the UC emission spectra of $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}@\text{NaYF}_4:15\% \text{Nd}^{3+}$ and $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+}@\text{NaYF}_4:15\% \text{Yb}^{3+}/20\% \text{Nd}^{3+}$ CS NPs under the excitation of an 800 nm NIR laser.

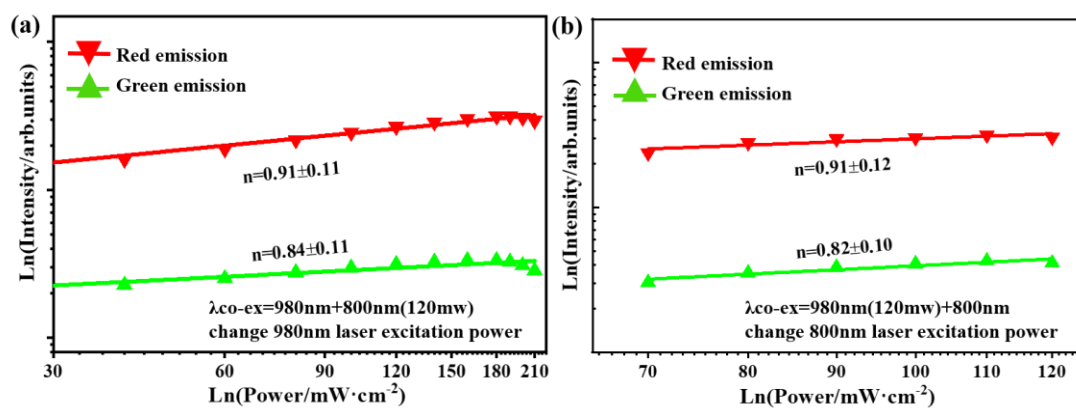


图 S4 在 980 nm 和 800 nm 共同激发下， $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:15\% \text{Yb}^{3+}/20\% \text{Nd}^{3+}$ 核壳纳米晶体红色和绿色荧光强度分别与(a) 980 nm 激光功率的依赖关系和(b)800 nm 激光功率的依赖关系

Fig. S4. Dependences of the red and green emission intensity of $\text{NaYF}_4:20\% \text{Yb}^{3+}/12\% \text{Ce}^{3+}/2\% \text{Ho}^{3+} @ \text{NaYF}_4:15\% \text{Yb}^{3+}/20\% \text{Nd}^{3+}$ CS NPs on the excitation power of 980 nm (a) and 800 nm (b) under simultaneous 980 nm + 800 nm excitation.