

## Supporting Information

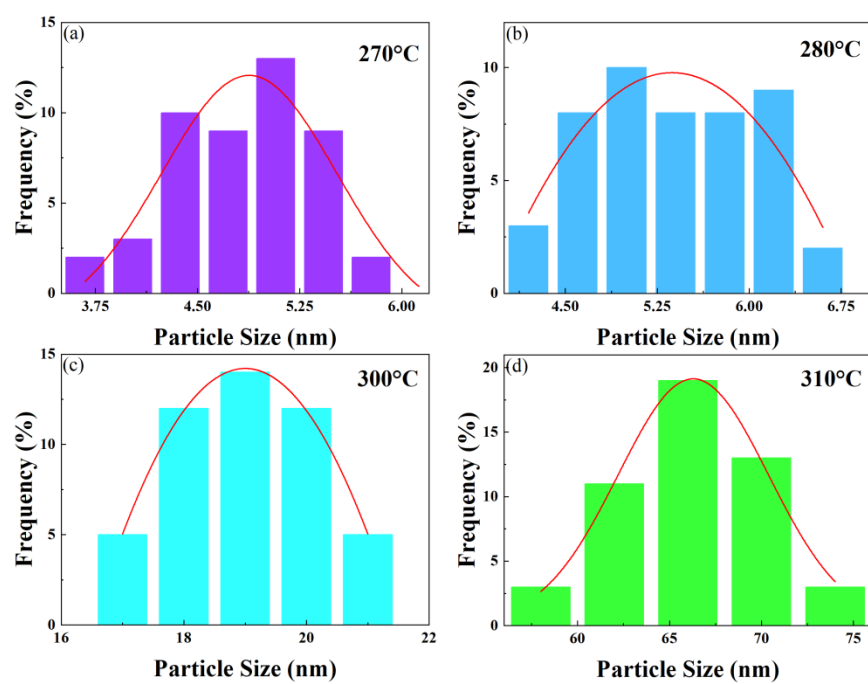
# The Combination of Upconversion Nanoparticles and Perovskite Quantum Dots with Temperature-Dependent Emission Colors for Dual-Mode Anti-Counterfeiting Applications

Qun Zhang <sup>1</sup>, Yuefeng Gao <sup>2,\*</sup>, Lihong Cheng <sup>1,\*</sup>, You Li <sup>1</sup>, Sai Xu <sup>1,\*</sup> and Baojiu Chen <sup>1</sup>

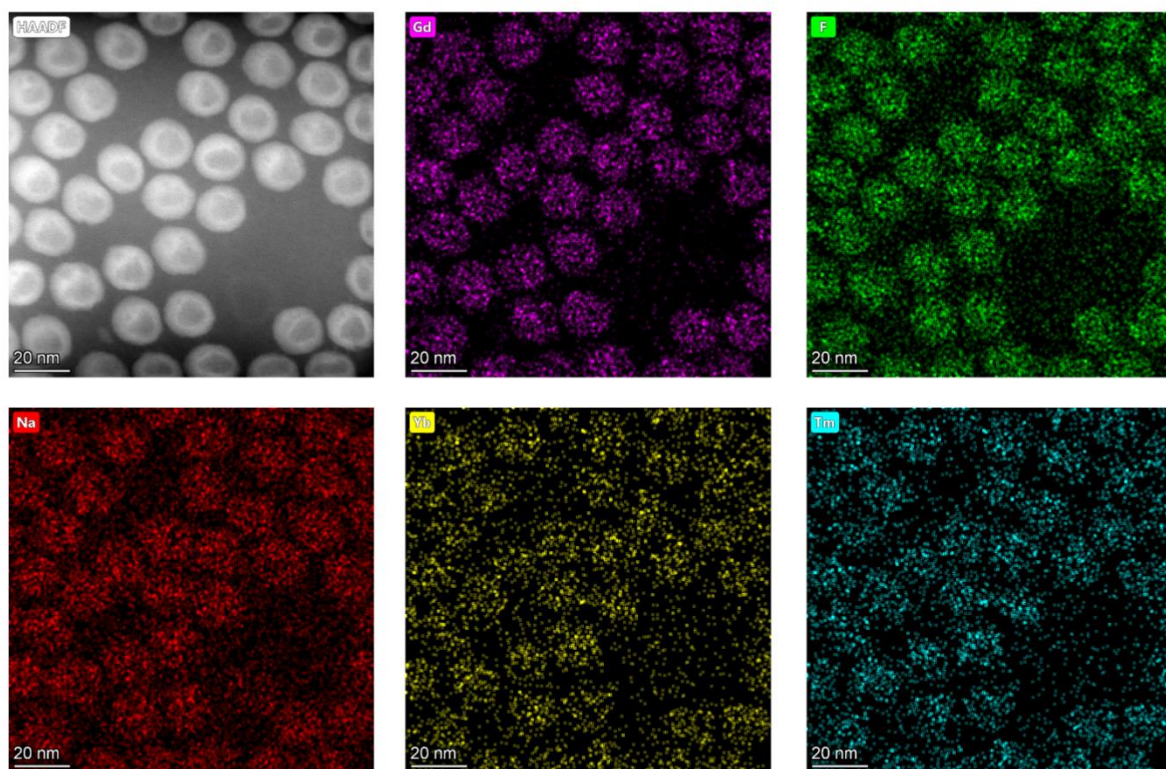
<sup>1</sup> School of Science, Dalian Maritime University, Dalian 116026, China; qunmay529@sina.com (Q.Z.); lyzhx0519@163.com (Y.L.); bjchen@dlmu.edu.cn (B.C.)

<sup>2</sup> Marine Engineering College, Dalian Maritime University, Dalian 116026, China

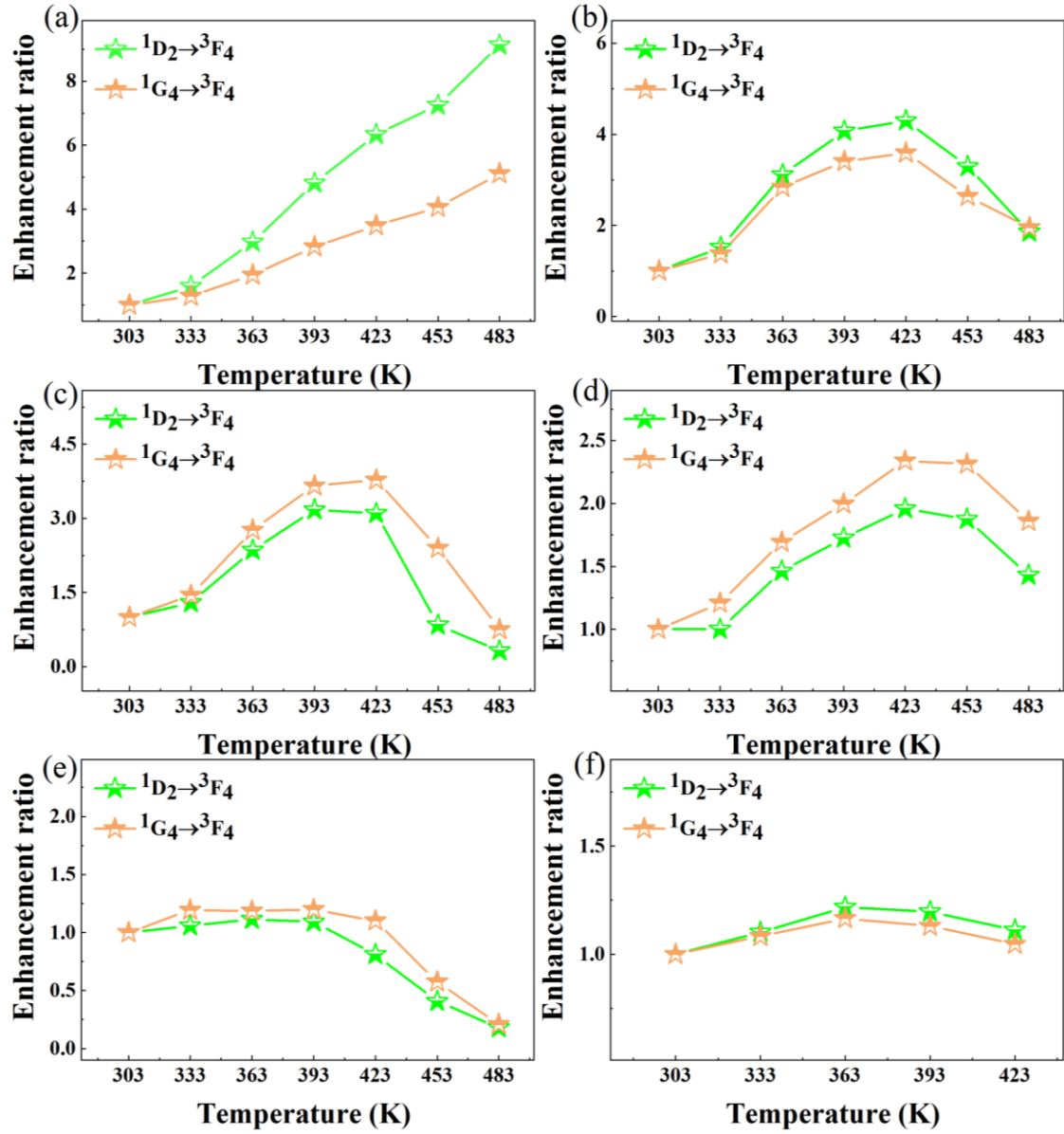
\* Correspondence: gaoyuefeng@dlmu.edu.cn (Y.G.); clh6833@dlmu.edu.cn (L.C.); xsjlu@126.com (S.X.)



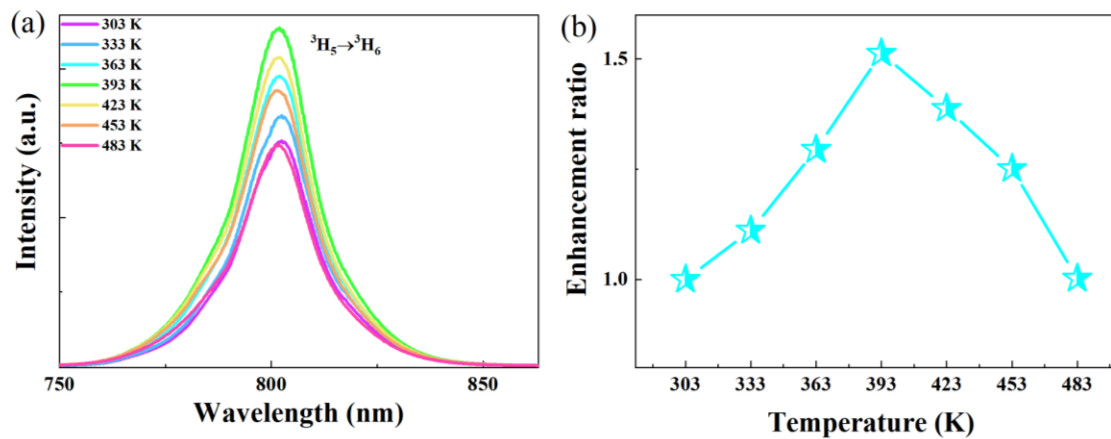
**Figure S1.** Corresponding particle size distributions of NaGdF<sub>4</sub>: Yb/Tm synthesized at (a) 270 °C, (b) 280 °C, (c) 300 °C, (d) 310 °C.



**Figure S2.** EDS mapping images of UCNPs synthesized at 300 °C



**Figure S3.** Integral luminescence intensities of  $^1D_2 \rightarrow ^3F_4$  and  $^1G_4 \rightarrow ^3F_4$  of NaGdF<sub>4</sub>:Yb/Tm UCNP samples with size of (a) 4.94 nm, (b) 5.43 nm, (c) 18.98 nm, (d) 66.09 nm. Integral luminescence intensities of  $^1D_2 \rightarrow ^3F_4$  and  $^1G_4 \rightarrow ^3F_4$  of (e) core @ active shell UCNP; (f) core @ inert shell UCNP.



**Figure S4.** (a) Temperature-dependent infrared emission spectra of NaGdF<sub>4</sub>: Yb/Tm UCNP synthesized at 300°C; (b) Integral luminescence intensities of  $^3H_5 \rightarrow ^3H_6$  of NaGdF<sub>4</sub>: Yb/Tm UCNP synthesized at 300°C