Supporting Information

Ultra-Broad Plasma Resonance Enhanced Multicolor Emissions in Assembly Ag/$NaYF_4$:Yb,Er Nano-film

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Synthesis of 10-nm $NaYF_4$:Yb,Er NCs

The ~10nm-$NaYF_4$:Yb,Er NPs were synthesized following the routes described previously. Briefly, a mixture of CF_3COONa (2 mmol), 1 mmol (total amounts) of $(CF_3COO)_3Y$, $(CF_3COO)_3Yb$, and $(CF_3COO)_3Er$ were dissolved in OM (10 mL), the mixture was then heated to 120°C to remove water and oxygen, followed by 1h heating at 330°C in the presence of nitrogen protection. The transparent mixture was allowed to cool to 80°C before excessive ethanol was added. The NPs were isolated by centrifugation, then washed several times with hexane and deionized water.

Oleylamine (OM, Alpha) and CF_3COONa (Aladdin) were purchased and used without further purification. All the RE trifluoroacetates were prepared by dissolving the respective RE oxides in trifluoroacetic acid (CF_3COOH).

Synthesis of the 40-nm Ag NPs

The Ag NPs (~40-nm) were prepared by reducing $AgNO_3$ with ethylene glycol (EG) in the presence of poly (vinyl pyrrolidone) (PVP-40). In a typical synthesis process, 3.3 g PVP was first dissolved in EG at the room temperature, after that 0.14g $AgNO_3$ was added and stirred for ten minutes. The mixture was heated to 120°C for

an hour, then allowed to cool naturally. The whole process has the protection of nitrogen. The Ag NPs were isolated by centrifugation and washed several times with acetone and deionized water.

Preparation of Ag/$NaYF_4$:Yb,Er composite film

The Ag nano-film and Ag/$NaYF_4$:Yb,Er composite film were self-assembled through the solvent evaporation method. Firstly, the colloid suspension (0.05% solid content) of Ag NPs in a beaker was inserted into a glass substrate and placed in a 30℃ oven for 2 days. The Ag NPs slowly self-organized on the glass substrate, driven by surface tension of the liquid in the evaporating process. Then amounts of $NaYF_4$:Yb,Er NPs were dissolved in cyclohexane and further assembled on the glass substrate and Ag nano-film through the solvent evaporation method.

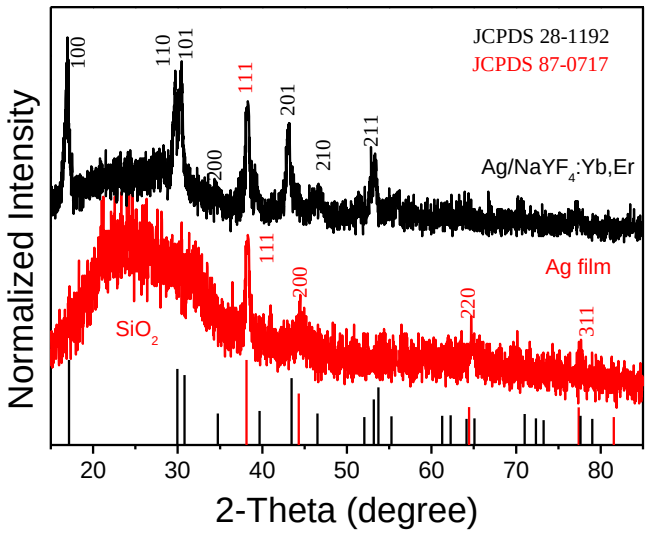

Fig.S1 XRD patterns of Ag nano-film and Ag/ $NaYF_4$:Yb,Er composite film.

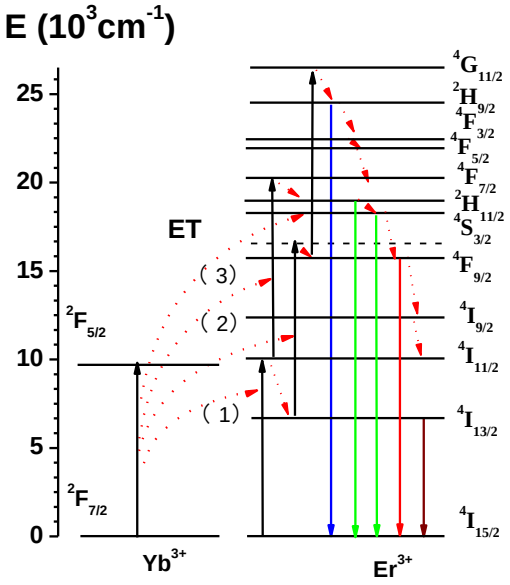

Fig.S2 The corresponding energy-level diagram of Yb^{3+}/Er^{3+} co-doped $NaYF_4$:Yb, Er.

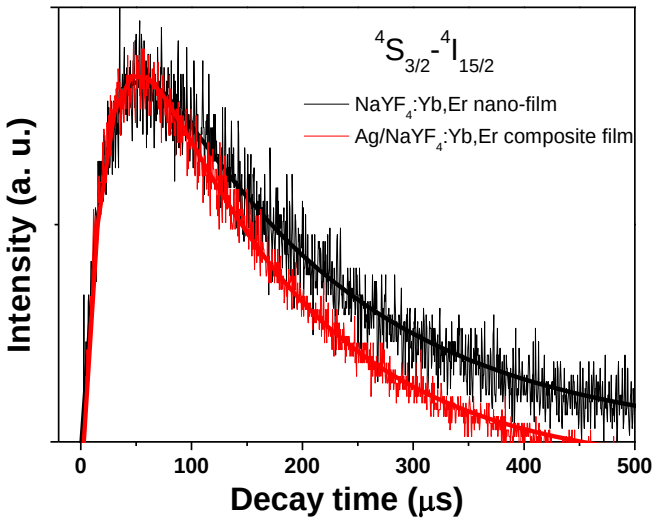

Fig.S3 The rising and decay processes of the $^4S_{3/2}$-$^4I_{15/2}$ transition in $NaYF_4$:Yb,Er nano-film and Ag/$NaYF_4$:Yb,Er composite film.

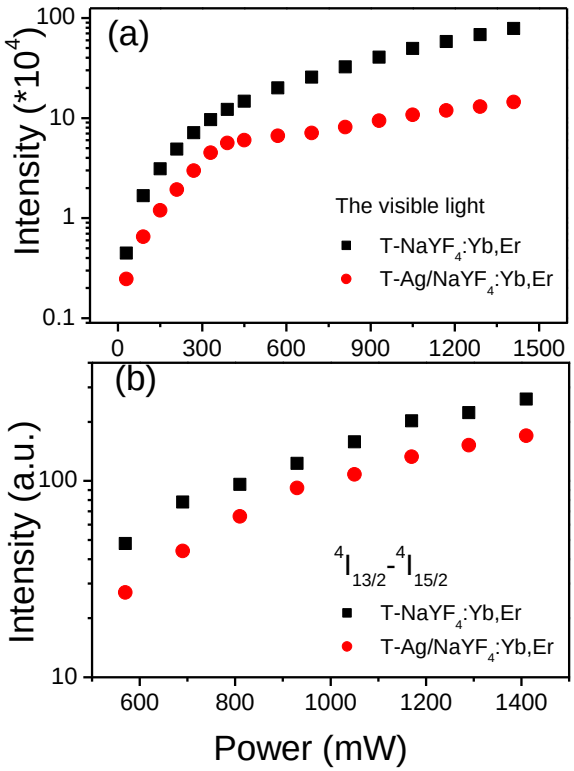

Fig.S4 The multicolor emissions (collected by transmittance) including the visible (a) and infrared transitions ($^4I_{13/2}$-$^4I_{15/2}$) (b) of $NaYF_4$:Yb,Er nano-film and Ag/$NaYF_4$:Yb,Er composite film, respectively.