Electronic Supplementary Material (ESI) for RSC Advances.

Red Up-conversion Emission in α-KYb_3F_{10}:Er^{3+} Films Made by Electrodeposition

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Detailed Experimental Procedure

1. Electrodeposition of α-KYb_3F_{10}:Er^{3+} Films

The solution for electrodeposition was prepared using following procedure: one solution containing 10 mM $Yb(NO_3)_3$ and 10 mM EDTA was stirred and formed stable Yb-EDTA complex. And then, another solution containing 100 mM ascorbic acid and 100 mM KF was added into above solution. Finally, the pH of the solution was adjusted to 5.30 using 0.01 M KOH and HNO_3. The solution for electrodepositon of Er^{3+} ions doped KYb_3F_{10} films was prepared using same procedure except by adding certain proportion of $Er(NO_3)_3$. A three-electrode cell which contains a platinum (Pt) plate as counter electrode, tin doped indium oxide (ITO) glass as working electrode and Ag/AgCl electrode as reference electrode was used for electrodeposition. The temperature of the deposition solution was maintained at 60 ^oC with water bath. Before the deposition, the ITO electrodes were cleaned with acetone in an ultrasonic bath for 15 min and then rinsed with distilled water. The electrodepositition was carried out on CHI 660E Electrochemical Workstation (Shanghai, China) with applied potential 0.8 V vs Ag/AgCl without stirring and the total applied charges were 5 C/cm^2. For annealed films, the as electrodeposited films were annealed in air at 300 ^oC for 2 hours.

2. Characterization of the electrodeposited α-KYb_3F_{10}:Er^{3+}Films

X-ray diffraction (XRD) measurements were carried out with a D/max-2550/PC diffractometer (Rigaku) using CuK_α radiation at step of 0.02 degree per second. The surface morphology of the electrodeposited films was observed by a Hitachi SU-70 scanning electron microscope (SEM) with incident electron energy of 25 kV. Gold powders were sputtered on the surface of the films before the measurement for the sake of increasing conductivity of films. The photo luminescent (PL) spectra of the films were recorded on Edinburgh FLS920 luminescence spectrophotometer equipped with a 980 nm laser as the excitation source. Energy Dispersive X-ray Spectrum (EDX) and elemental mapping analysis were used to determine the element compositions and distributions of the films. Fourier transform infrared (FTIR) spectra of samples prepared in pellet form were recorded on a Nickel Magna-750 FT-IR spectrometer.

Fig.S1

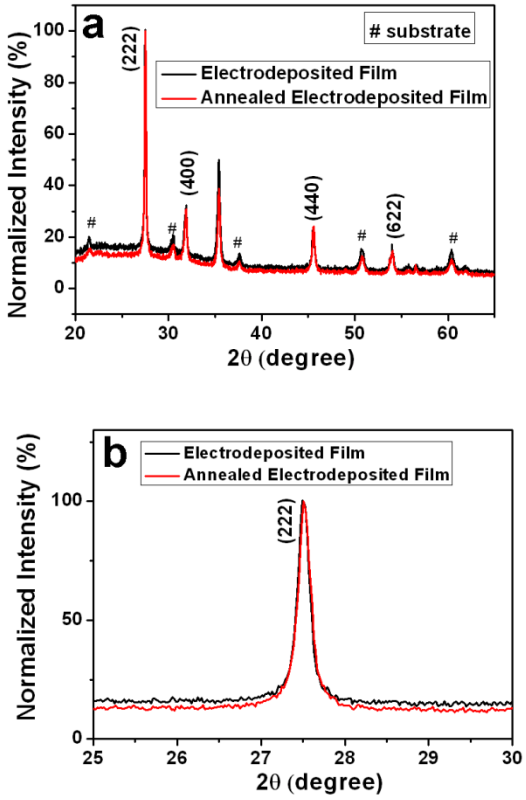

Fig.S1 XRD patterns of the electrodeposited and annealed electrodeposited α-KYb_3F_{10} films. a, the normalized full XRD patterns of both films, b, (111) peaks of α-KYb_3F_{10} for both films, where the black line denotes as electrodeposited α-KYb_3F_{10}:Er^{3+}(2 mol %) films and red line denotes electrodeposited α-KYb_3F_{10}:Er^{3+}(2 mol %) films annealed in air at 300 ^oC for two hours.

Fig.S2

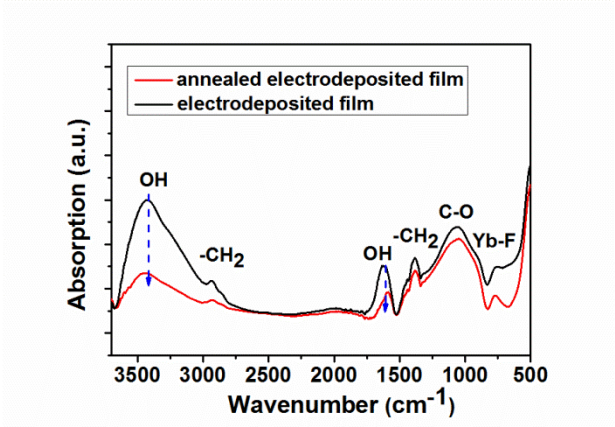

Fig.S2 FTIR spectra of the electrodeposited and annealed electrodeposited α-KYb_3F_{10} films, where the black line denotes as electrodeposited α-KYb_3F_{10}:Er^{3+}(2 mol %) films and red line denotes electrodeposited α-KYb_3F_{10}:Er^{3+}(2 mol %) films annealed in air at 300 ^oC for two hours.