Supplementary material

Temperature and rhodamine B sensing based on fluorescence intensity ratio of Er^{3+} upconversion emissions

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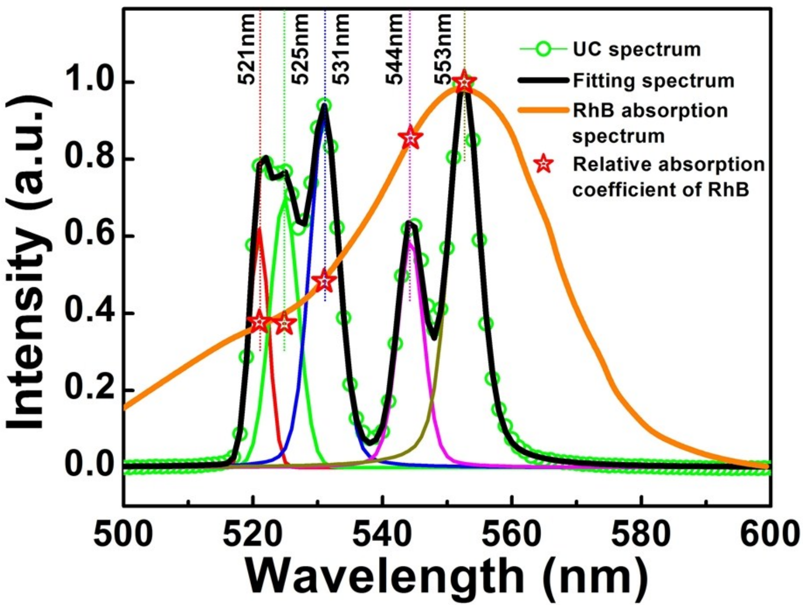

Fig. S1. Peak fitting of the green UC emission spectrum of the $Ag/ZnO/Er^{3+}:YbMoO_4$ composite film. The UC spectrum can be well fitted by the Stark split at the wavelengths of 521, 525, 531, 544, and 553 nm. The normalized RhB absorption spectrum (orange line) is presented for comparison. The asterisks calculated by Eq. (6) denote the relative RhB absorption coefficients for the above five wavelengths. The calculated RhB absorption coefficients fit well with the RhB absorption spectrum.

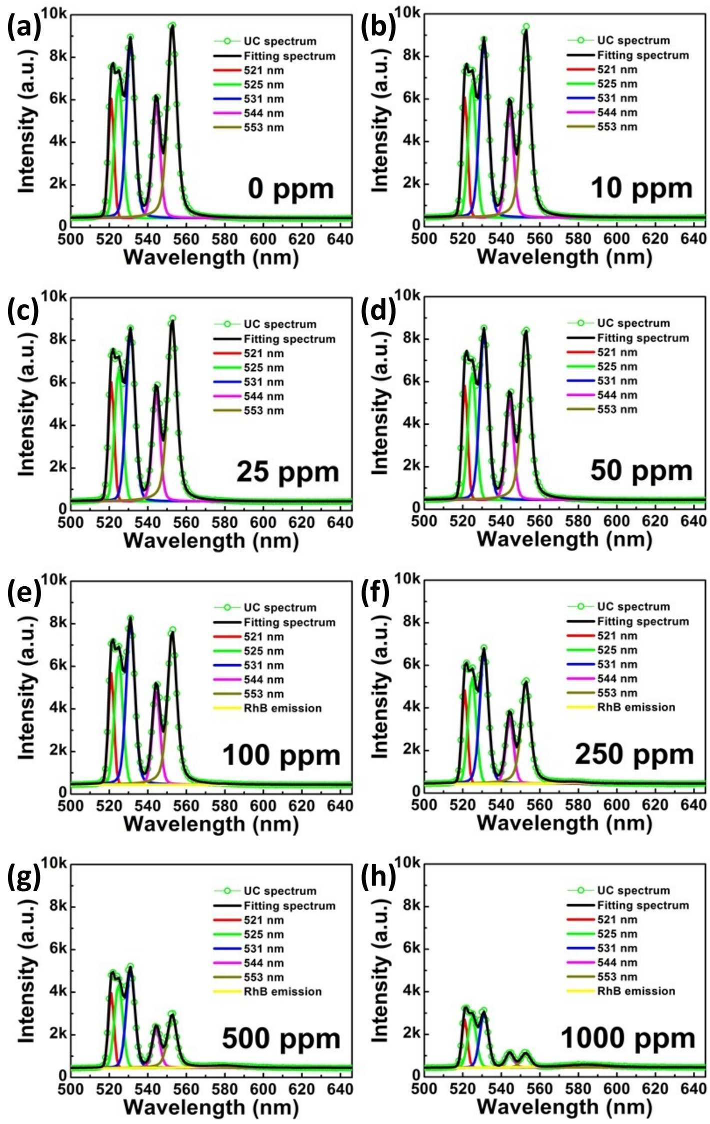

Fig. S2. Peak fitting of the fluorescence spectra of the composite film at different RhB concentration. The fluorescence spectra can be well fitted by the Stark split at the wavelengths of 521, 525, 531, 544, 553 nm and the RhB emission. Note that there is no fitting of the RhB emission at low concentration (<100 ppm).

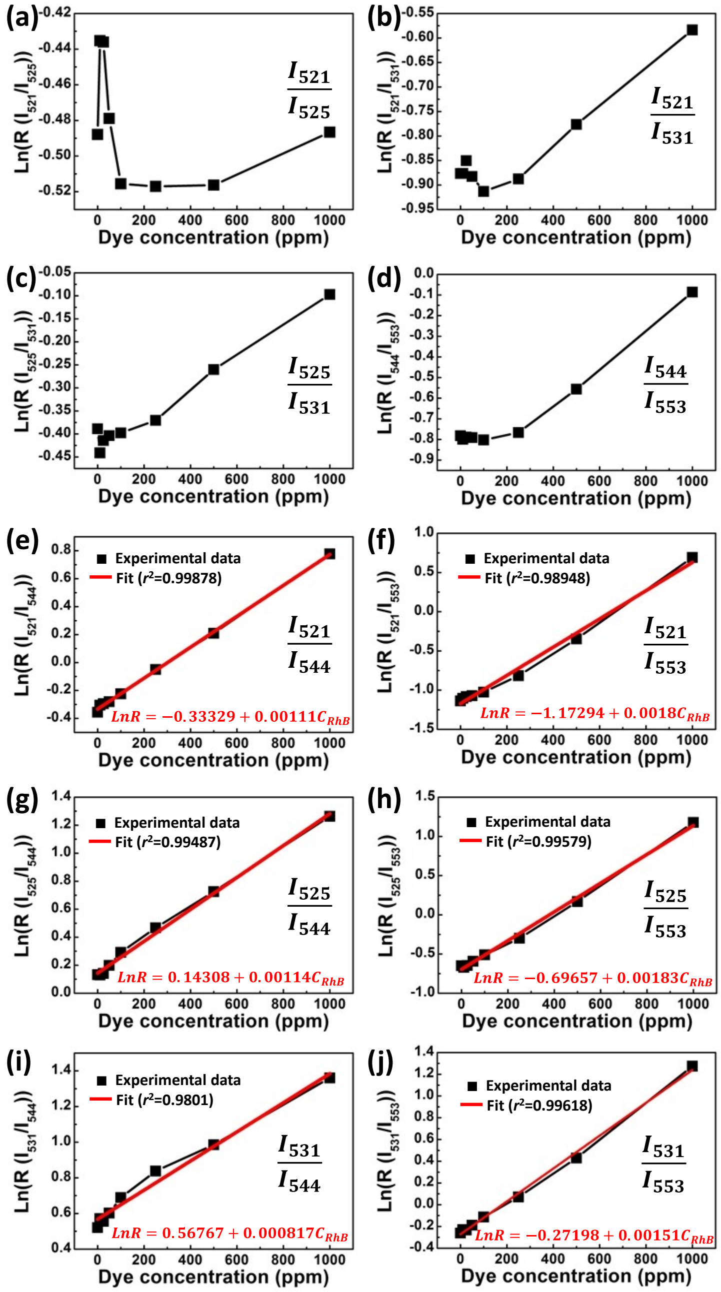

Fig. S3. Monolog plots of the FIR of the two different Stark green UC emissions as a function of the RhB concentration. For the two Stark emissions with larger ΔK (e-j), there is a linear relationship between LnR and the RhB concentration.

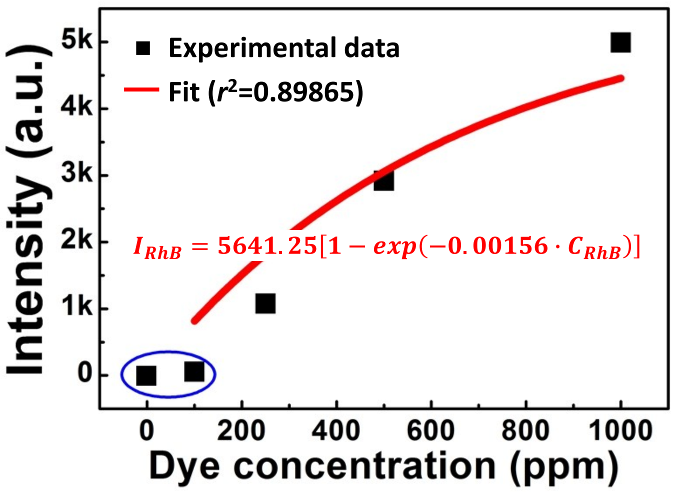

Fig. S4. RhB emission intensity as a function of the RhB concentration. The RhB emission intensity is fitted with the equation of $I_{RhB} = \Phi I_0 [1 - \exp(-2.303 K l C_{RhB})]$, where I_{RhB} is the RhB emission intensity at the concentration of C_{RhB}, I_0 is the initial intensity of the green UC emission, Φ is the fluorescence efficiency, K and l are the average absorption coefficient of RhB and the optical length, respectively. The fitting of Φ is about 2.82% indicating the low fluorescence efficiency of RhB caused by the RET process. Both the large fitting error (r^2=0.89865) and the unmeasurable RhB emissions at lower concentration (blue circle) indicate that it is unsuitable for the RhB sensing based on the RhB emissions in this work.