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Supporting information

Immune sandwich assay of carcinoembryonic antigen based on the joint use of upconversion phosphors and magnetic beads

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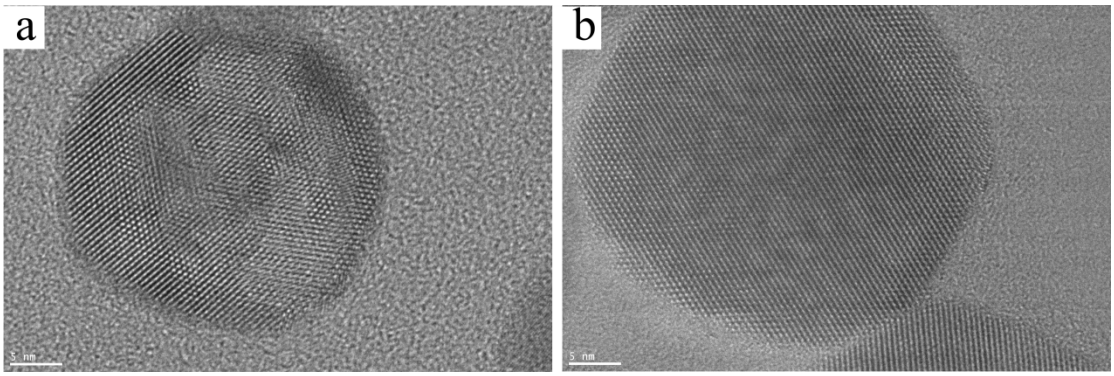

Figure S1 HRTEM images of (a) OA-$NaYF_4$: Yb, Er and (b) OA-$NaYF_4$: Yb, Er@$NaYF_4$.

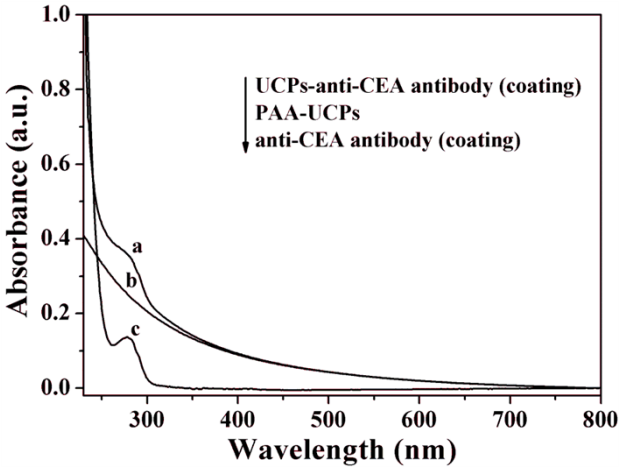

Figure S2 UV-vis absorption spectra of UCPs-anti CEA antibody (coating) (a), PAA-UCPs (b) and anti-CEA antibody (coating) (c).

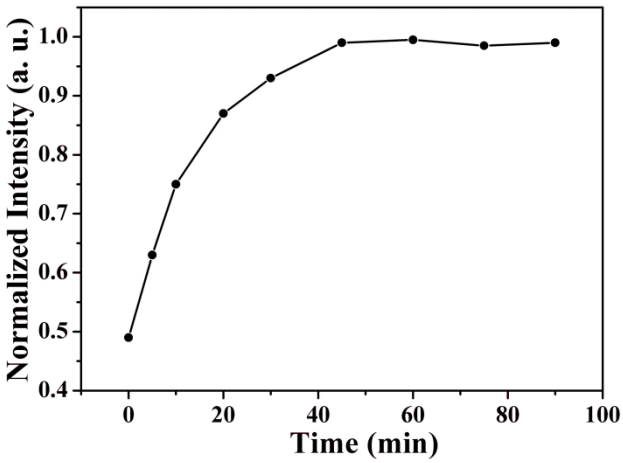

Figure S3 Time dependence of the combination of MBs-anti-CEA antibody with CEA.

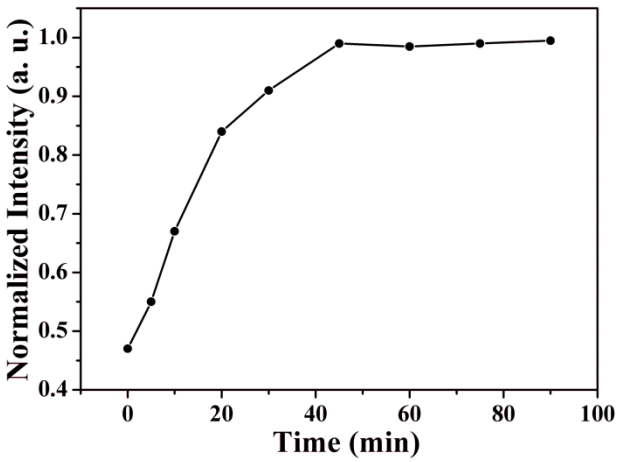

Figure S4 Time dependence of the combination of MBs-anti-CEA antibody-CEA complex with UCPs-anti-CEA antibody (coating).

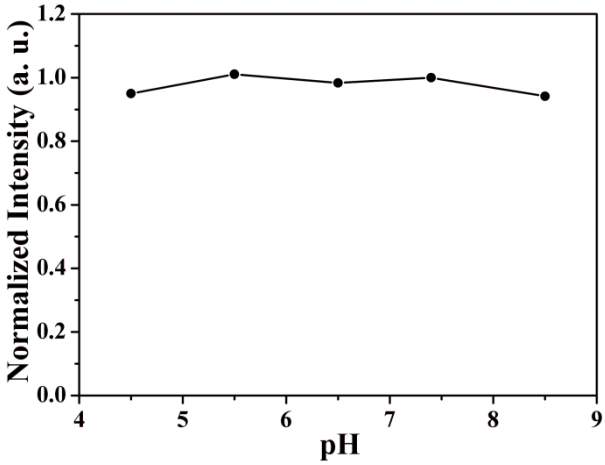

Figure S5 The stability of the immunosensor in the different pH buffer solution.

Table S1. Recoveries of CEA in spiked human serum samples with the constructed immunosensor.

Sample (No.)	Added (ng/mL)	Found (ng/mL)	Recovery	RSD (n=3)
1	0.5	0.48	96 %	5.9 %
2	3.0	3.19	106 %	4.8 %
3	15	15.7	105 %	7.2 %