Electronic Supplementary Material (ESI) for Analyst.

Supporting Information

Designing Stimuli-Responsive Upconversion Nanoparticles Based on Mimetic Immunoassay for Potential Diabetic Nephropathy Accuracy Diagnosis

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1. Experimental details

1.1 Instrumentations

The selected area electron diffraction (SAED) pattern of the nanoparticles and Fourier transform of the transmission electron microscope (TEM) image were gained from JEM-2100 microscope (JOEL, Japan) operated at 200 kV acceleration voltage. The morphology and crystal lattice of the nanoparticles were achieved using a JEM-2100F microscope (JOEL, Japan), operated at a voltage of 200 kV. The X-ray diffraction pattern (XRD) of nanoparticles were analyzed by a X-ray diffractometer which model is Shimadzu XRD-6000 with Cu-Kα irradiation (λ = 0.15406 nm), the scanning range was 10° to 80° and the scanning rate was 2° per minute. Upconversion fluorescence spectra was obtained from an FS5 luminescence spectrometer (Edinburgh, UK) loaded with a 980 nm laser (WaveParticle Technology, China). Fourier transform infrared spectra (FT-IR) were measured by the IRAffinity-1 spectrophotometer (Shimadzu, Japan). The ^{1}H NMR spectrum of PAA-UCNPs were characterized by ^{1}H nuclear magnetic resonance (Mercury plus400, Agilent-Varian, USA). UV-Vis absorption spectrum were recorded by UH4150 (Hitachi, Japan). Zeta potential measurement of the samples were operated on a Nano particle Analyzer (Horiba SZ-100)

2. Supplemental Tables and Figures

Table S1. Core/shell UCNPs SAED measurement data.

Measured length (1/nm)	d spacing (Å)	Crystal plane
7.7115	2.5935	(200)
10.7416	1.8619	(204)
12.9364	1.5460	(303)
14.7868	1.2669	(118)

Table S2. The SA analysis results of the urea samples using the fluorescent method.

Sample Number	Analysis Results (Concentration, μmol/L)	Urine Concentration of SA (mg/dL)
1	5.6550±0.3615	8.7446±0.5590
2	6.0511±0.3103	9.3572±0.4798
3	4.6872±0.1512	7.2481±0.2338
4	6.3842±0.5504	9.8722±0.8511
5	6.1721±0.1894	9.5443±0.2929
6	6.1479±0.4798	9.5068±0.7420
7	7.8654±0.0406	12.1628±0.0628
8	6.8116±0.2450	10.5331±0.3788
9	6.7248±0.1903	10.3989±0.2943
10	5.6664±0.2460	8.7622±0.3804
11	6.0057±0.3593	9.2869±0.5556
12	7.1201±0.1873	11.0102±0.2896
13	7.2564±0.3091	11.2209±0.4780
14	6.9260±0.0610	10.7100±0.0944
15	7.4350±0.1861	11.4970±0.2877
16	4.1241±0.2696	6.3772±0.4169
17	6.1586±0.5123	9.5234±0.7923
18	6.5698±0.1974	10.1592±0.3052
19	4.1391±0.0476	6.4006±0.0736
20	5.1664±0.4808	7.9890±0.7434

*Analysis results were the post-treated urine sialic acid concentration.

Table S3. Descriptive statistics of the SA analysis results of healthy volunteers urea samples.

	Urine SA	**Std. Error of Detection**
N	20	20
Range	5.7855	0.7883
Minimum	6.3772	0.0628
Maximum	12.1618	0.8511
Mean	9.5152	0.4156
Std. Error of Mean	0.3559	0.0525
Std. Deviation	1.5915	0.2349
Variance	2.533	0.0550

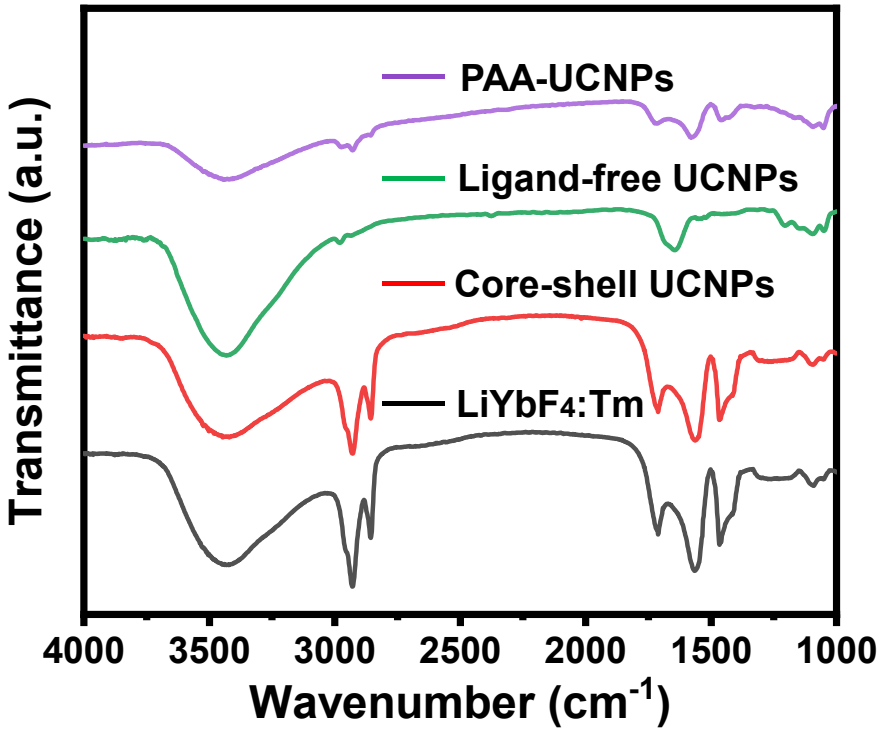

Fig. S1. Fourier transform infrared spectra (FTIR) of OA-capped core-only UCNPs, core/shell UCNPs, ligand-free core/shell UCNPs and PAA-UCNPs.

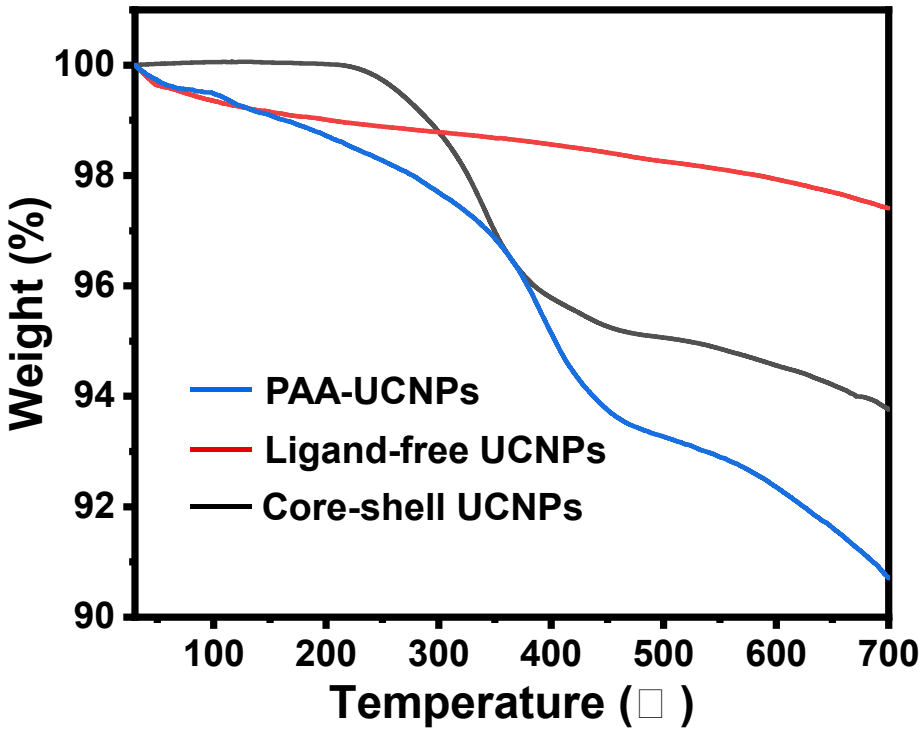

Fig. S2. Thermogravimetric analyses (TGA) curves of OA-capped core/shell UCNPs, ligand-free core/shell UCNPs and PAA-UCNPs conducted from 30°C to 700°C at a rate of 10°C/min under N2 atmosphere protection.

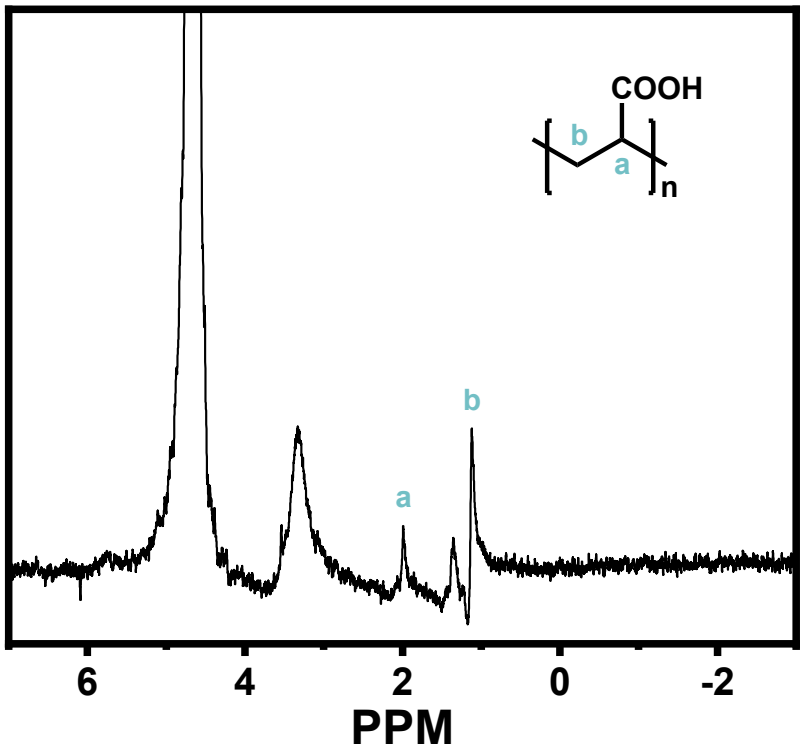

Fig. S3. ^{1}H NMR spectrum of PAA-UCNPs uesd deuterated water as solvent.

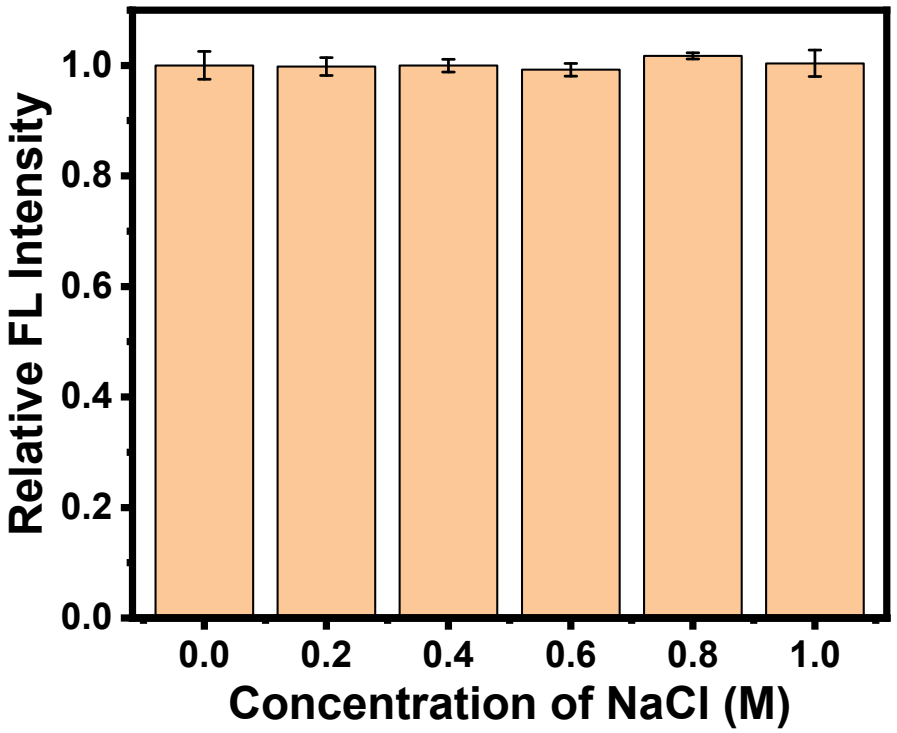

Fig. S4. Effect of ionic strength on fluorescence intensity of detection system. Conditions: detection of 5 μmol/L SA under 980 nm laser excitation (1.0 W).

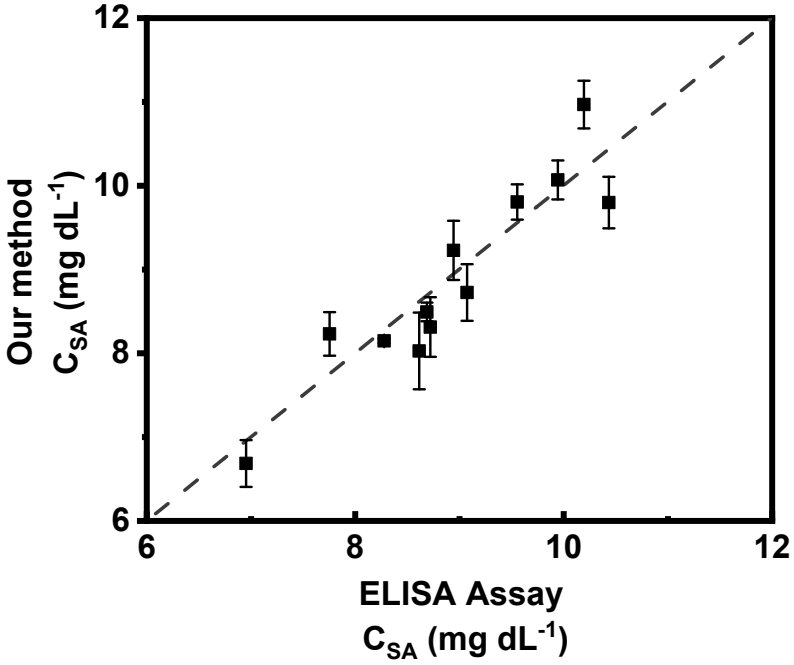

Fig. S5. Correlation plots between the determined values of SA in urine samples obtained using our proposed method and that from the conventional ELISA assay.