Supporting Information

Ultrasensitive Colorimetric Detection of Heparin Based on Self-assembly of Gold Nanoparticles on Graphene Oxide

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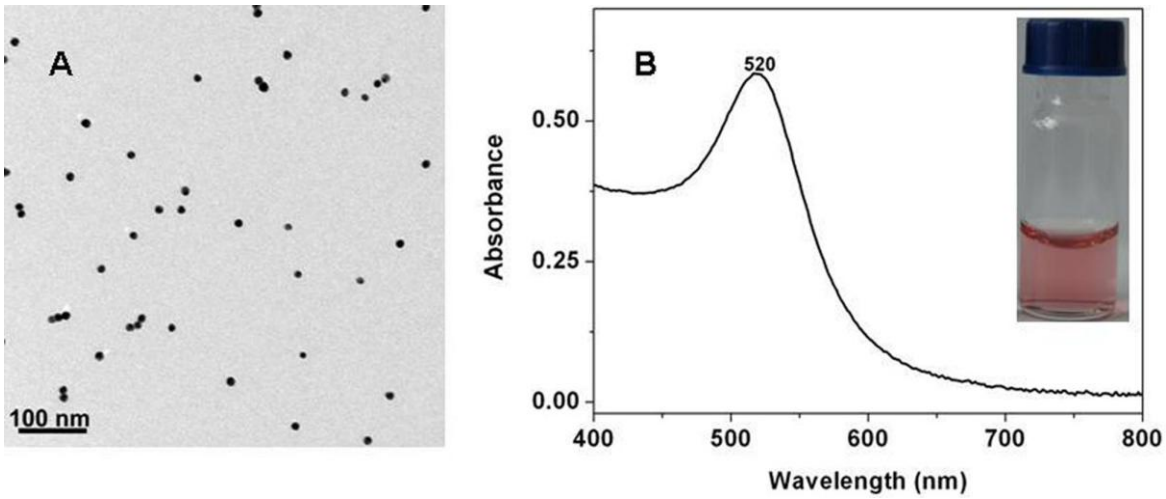

Fig. S1. TEM image (A) and UV-Vis absorption (B) of AuNPs. Inset of (B) shows the photographic image of AuNPs.

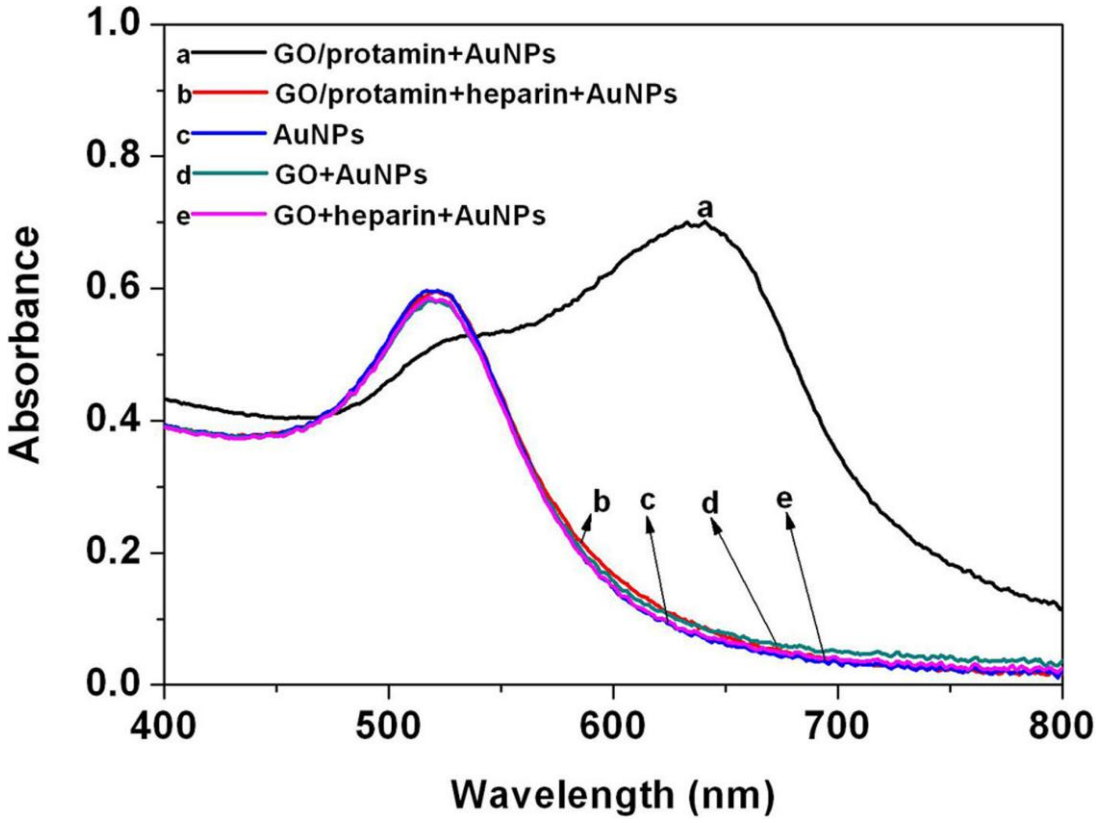

Fig. S2. UV-Vis absorption of AuNPs at different conditions: (a) GO/protamine+AuNPs, (b) GO/protamine+heparin+AuNPs, (c) AuNPs, (d) GO+AuNPs, (e) GO+heparin+AuNPs.

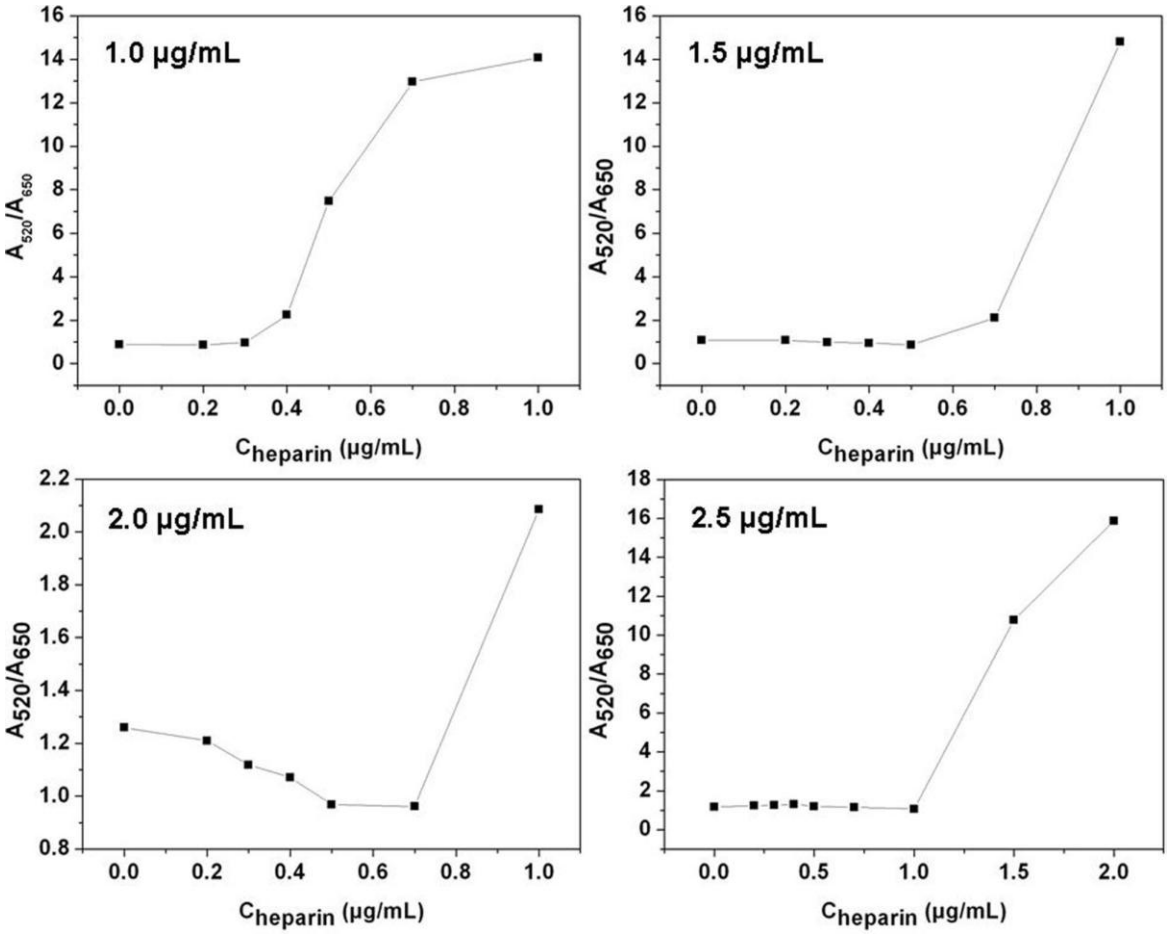

Fig. S3. Plots of A_{520}/A_{655} versus the concentrations of heparin for AuNPs in different concentrations of GO/protamin mixed solutions in 10 mM HEPES solution (pH 7.4).

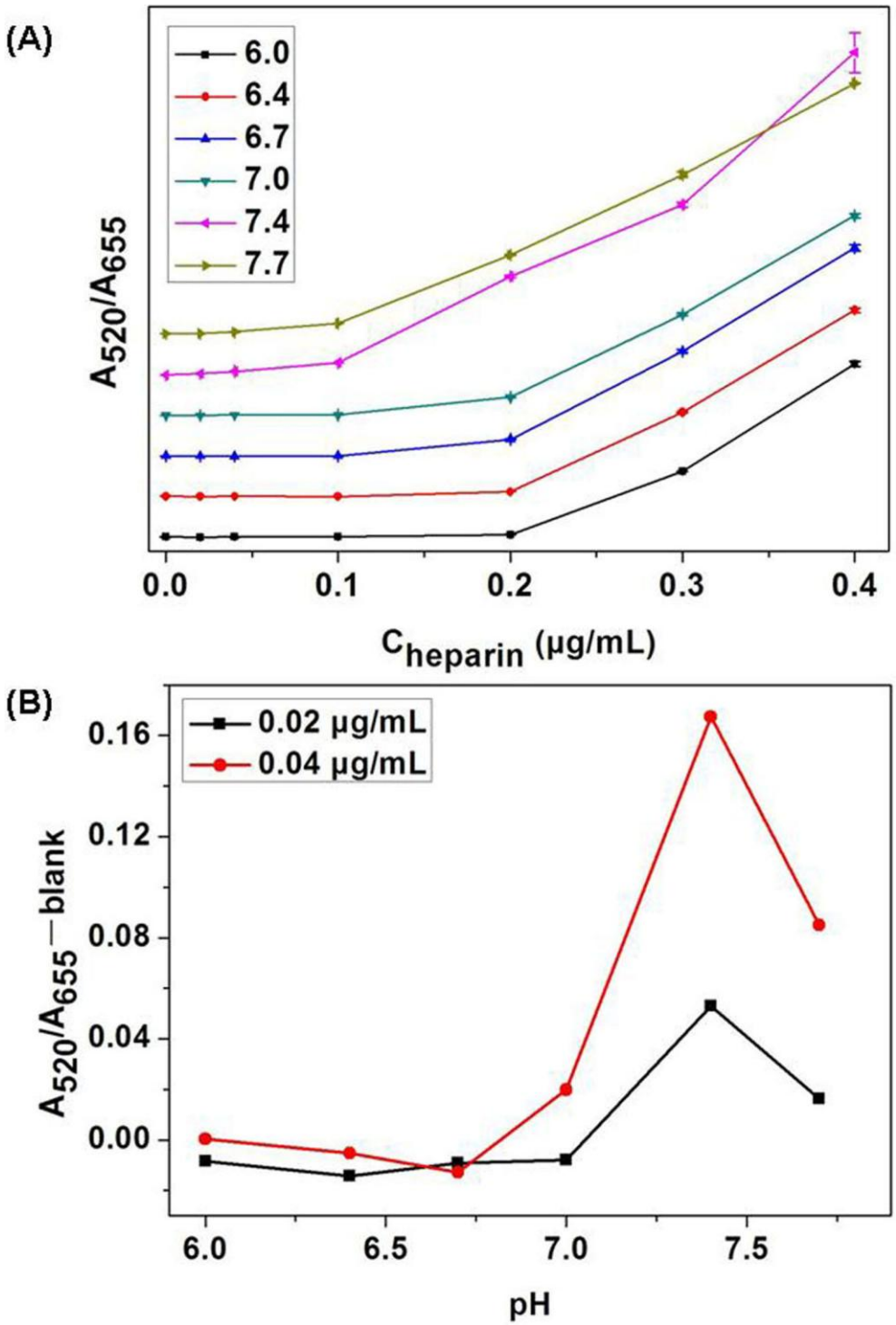

Fig. S4. (A) Plots of A_{520}/A_{655} versus the concentrations of heparin in 10 mM HEPES solution; (B) Polts of the value of A_{520}/A_{655}–blank versus pH values in the presence of 0.02 and 0.04 μg/mL of heparin.

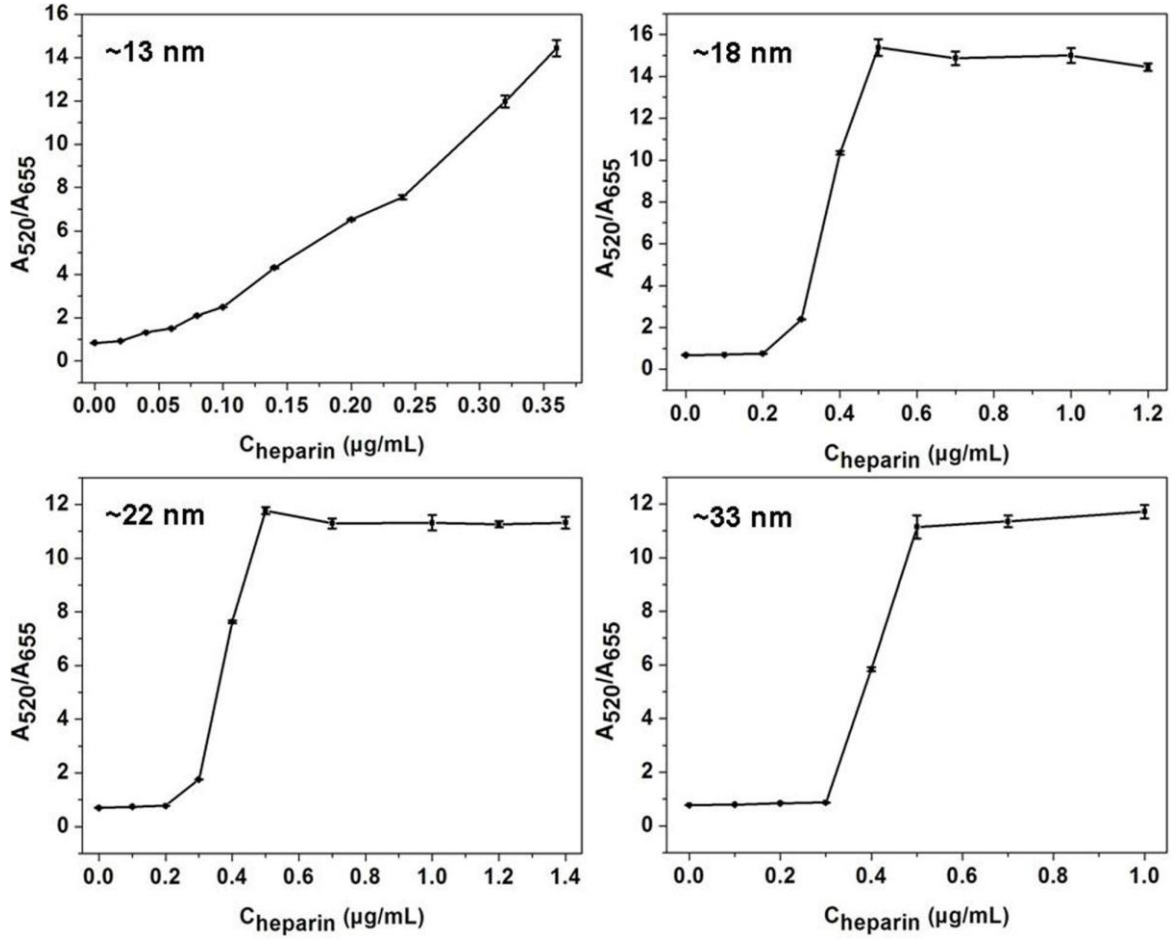

Fig. S5. Plots of A_{520}/A_{655} versus the concentrations of heparin using different sizes of AuNPs in 1 μg/mL of GO/protamin mixed solutions in 10 mM HEPES buffer solution (pH 7.4).

Table S1. Comparisons of analytical performances of various typical methods for heparin detection.

Methods	Technique in detail	Linear range	Detection limit	Test media	Applications	Ref.
Colorimetry	Self-assembly of AuNPs on the surface of GO	0.06–0.36 μg/mL	3.0 ng/mL (0.000555 U/mL)	HEPES (10 mM, pH 7.4)	Fetal bovine serum (detection limit 1.7 ng/mL)	Present work
Colorimetry	Color quenching of gold nanorods by GO	0.02–0.28 μg/mL	5 ng/mL (0.0009 U/mL)	HEPES (10 mM, pH 7.4)	NA	1
Colorimetry	Electrostatic interaction leading to the aggregation of positively-charged AuNPs	0.09–3.12 μg/mL	0.03 μg/mL	Britton–Robinson (pH 3.6)	Human serum samples	2
Colorimetry	Electrostatic interaction leads to the absorbance change of a water-soluble polymer and color change	0–6.7 U/mL	0.01 U/mL	Methanol–water (3:2, v/v)	Fetal bovine serum (detection limit: 0.15 U/mL)	3
Colorimetry	Reversible aggregation and de-aggregation of nano-sized AuNPs	0.6–10 μg/mL	0.6 μg/mL	PBS (2 mM, pH 7.2)	NA	4
Fluorometry	Ratiometric fluorescence detection based on aggregation-induced fluorescence quenching and enhancement	1.0–15 μM	20 nM	HEPES (5 mM, pH 7.4, containing 2‰ DMSO)	Horse serum matrix	5
Fluorometry	Fluorescent detection using a cationic conjugated polyfluorene probe containing aggregation-induced emission units	0–0.7 μM	30 nM	HEPES (2 mM, pH 7.4)	NA	6
Fluorometry	Turn-on fluorescent detection using NIR-emissive alkynylplatinum (II)	UFH: 0–0.56 IU mL^{-1};	NA	HEPES (5 mM, pH 7.4)	Foetal bovine serum	7

	terpyridyl complex by induced helical self-assembly behaviour	LMWH: 0–0.36 IU mL^{-1}				
Fluorometry	Coupled using of butterfly-shaped conjugated oligoelectrolyte and GO for light-up fluorescence detection	0–1.76 U/mL	0.046 U/mL	PBS (10 mM, pH 7.4)	NA	8
Fluorometry	Ratiometric fluorescence sensor based on a pyrene derivative	5–30 μM	0.157 μM	HEPES (10 mM, water/ethanol, 85/15, v/v, pH 7.4)	Fetal bovine serum medium (detection limit: 0.53 μM)	9
Light scattering	Turn-on room temperature phosphorescence assay based on target induced self-assembly of (PEI) capped Mn-doped ZnS QDs	Tunable	0.014 μM (the highest sensitivity)	Tris–HCl (10 mM, pH 7.4)	Human serum samples (detection limit: 0.15 μM)	10
Electrochemistry	Reversible potentiolmetric detection using pulsed chronopotentiometric polymer membrane electrode	1–20 U/mL	NA	PBS (10 mM, pH 7.4)	NA	11
Electrochemistry	Cyclic voltammetry detection using a poly(thionine) modified glassy carbon electrode	4.0–22.0 μg/mL	0.28 μg/mL	$HClO_4$ (0.1 M)	Heparin sodium injection	12

PEI: polyethyleneimine; QDs: quantum dots; UFH: unfractionated heparin; LMWH: low molecular weight heparin; NA: not available.

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