Supporting information

Suppression of Protein Aggregation by Gold Nanoparticles: A New Way to Store and Transport Proteins

Anindita Das,[a] Abhijit Chakrabarti[b] and Puspendu K. Das[a,*]

[a]Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore 560012, India

[b]Crystallography & Molecular Biology Division, Saha Institute of Nuclear Physics, 1/AF Bidhannagar, Kolkata 700064, India

*To whom correspondence should be addressed: Puspendu K. Das, [a]Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore 560012, India

Email: pkdas@ipc.iisc.ernet.in; Tel: +918022932662; Fax: +918023600683.

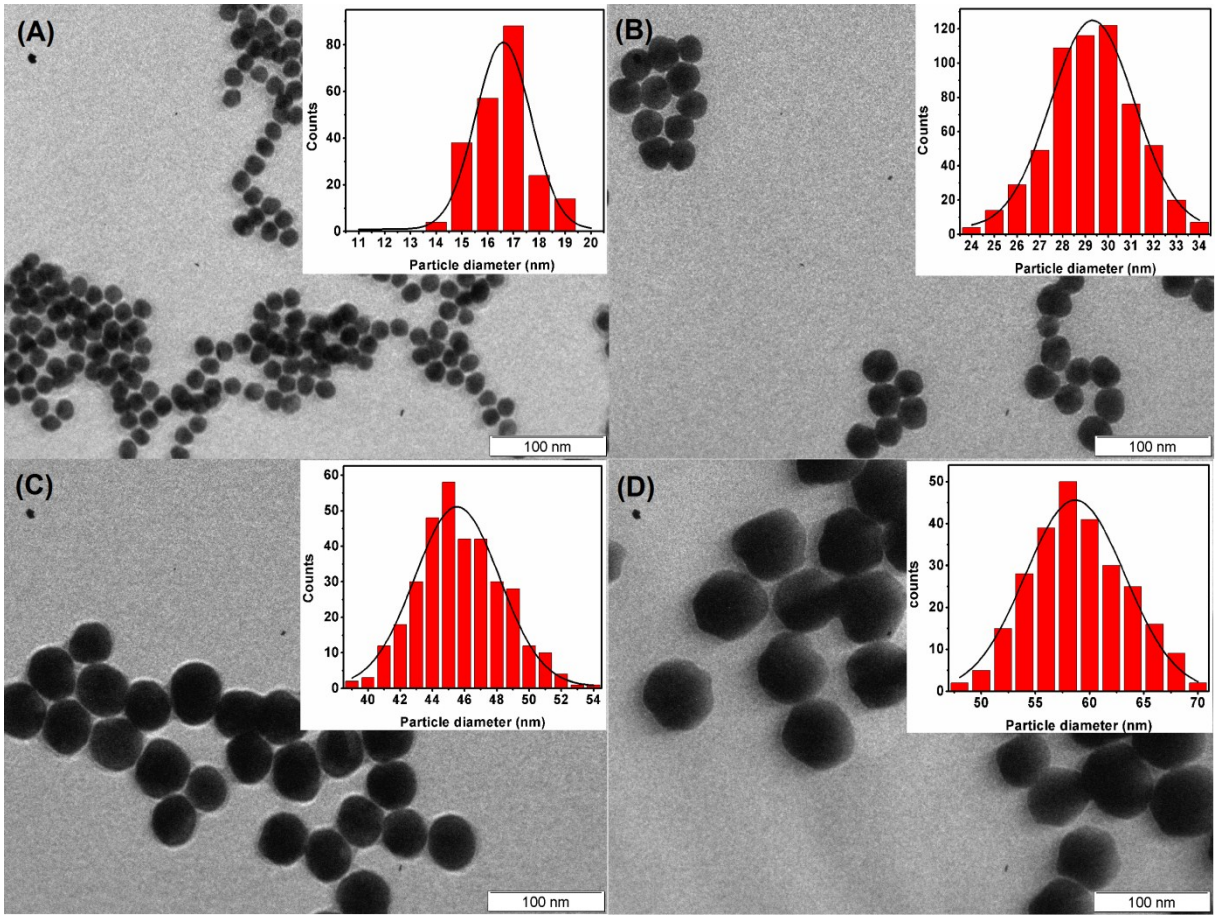

Fig. S1 TEM images of (A) 15 nm (16.6 ± 1.3 nm), (B) 30 nm (29.3 ± 2.3 nm), (C) 45 nm (45.5 ± 3.1 nm), and (D) 60 nm (58.6 ± 5.1 nm) gold nanoparticles (The inset are showing the histogram and size distribution of the Au-NPs).

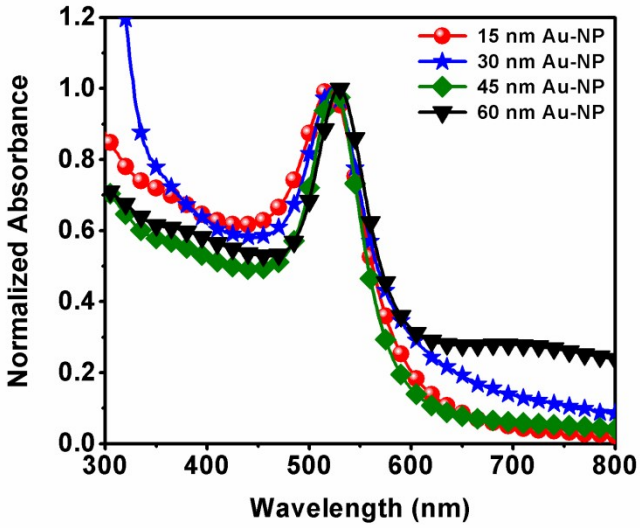

Fig. S2 UV-Vis spectra of gold sols of various particle size.

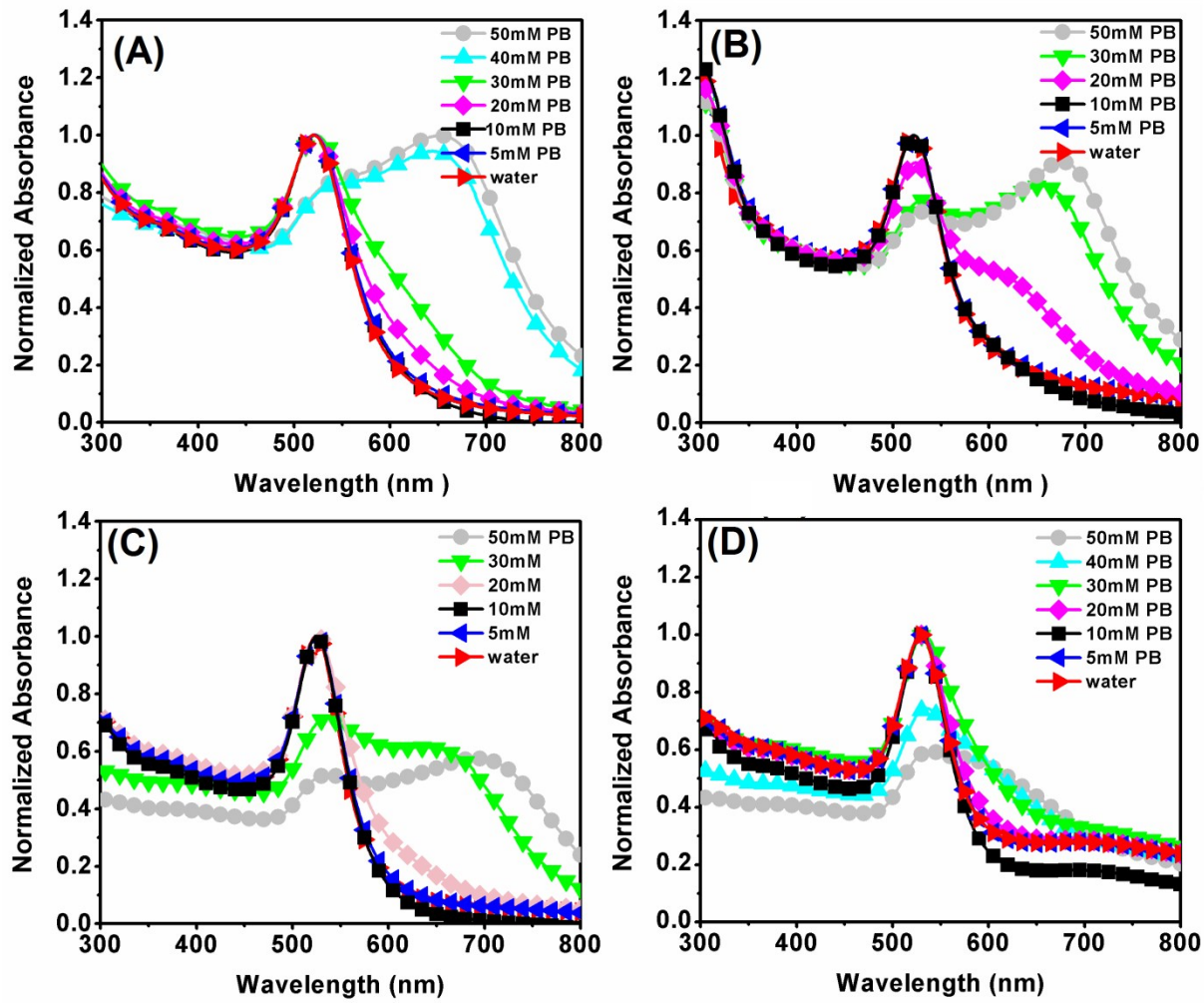

Fig. S3 Normalized absorption spectra of gold nanoparticles of (A) 15 nm, (B) 30 nm, (C) 45 nm, and (D) 60 nm, in phosphate buffer at pH = 7.0. With phosphate buffer concentration above 10 mM, the red shift and broadening of the SPR spectrum indicate the onset of aggregation of nanoparticles.

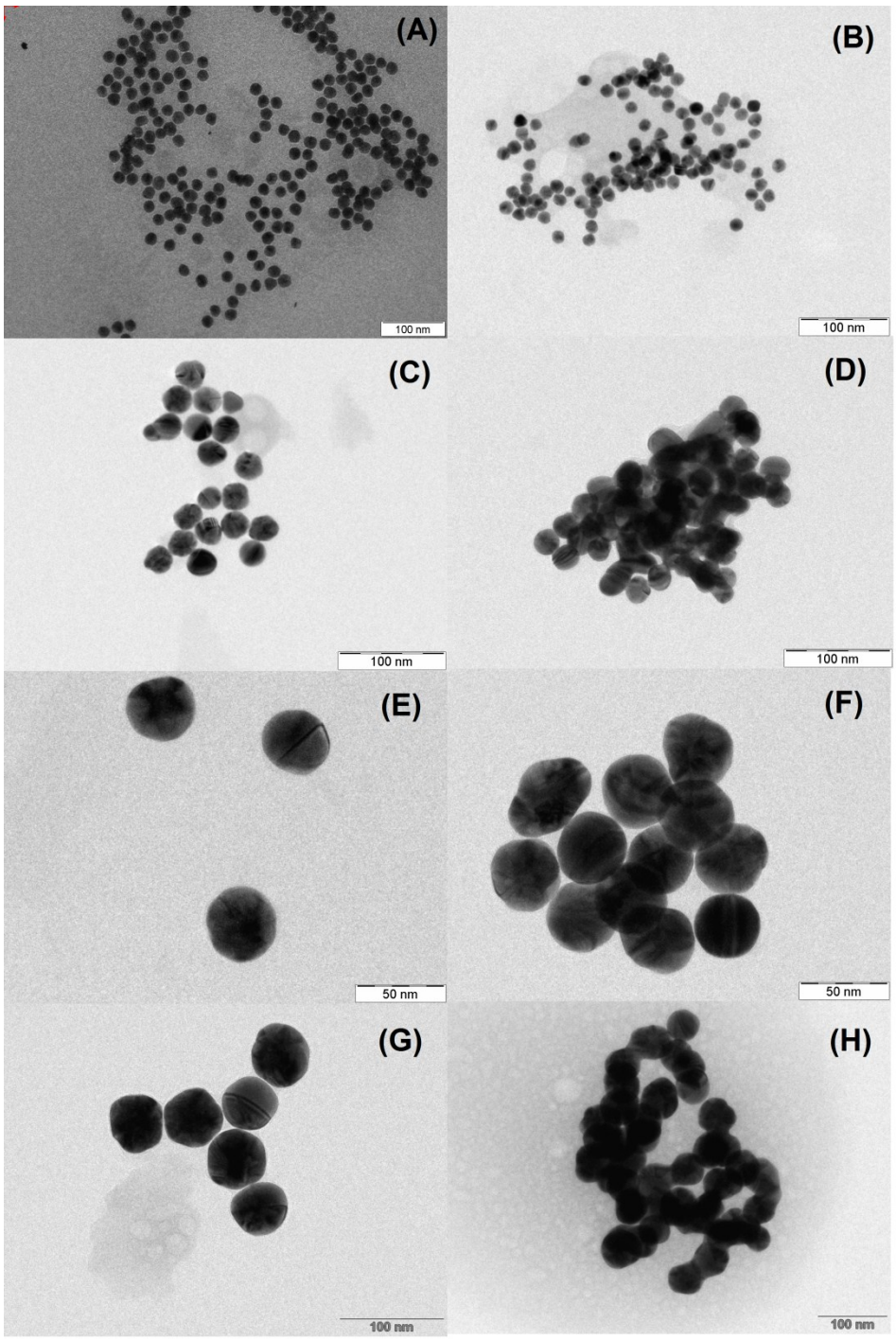

Fig. S4 TEM images of gold nanoparticles in solution with varied concentrations of the buffer: (A) 15 nm Au-NP in 10 mM phosphate buffer, (B) 15 nm Au-NP in 40 mM phosphate buffer, (C) 30 nm Au-NP in 10 mM phosphate buffer, (D) 30 nm Au-NP in 30 mM phosphate buffer, (E) 45 nm Au-NP in 10 mM phosphate buffer, (F) 45 nm Au-NP in 30 mM phosphate buffer, (G) 60 nm Au-NP in 10 mM phosphate buffer, (H) 60 nm Au-NP in 50 mM phosphate buffer.

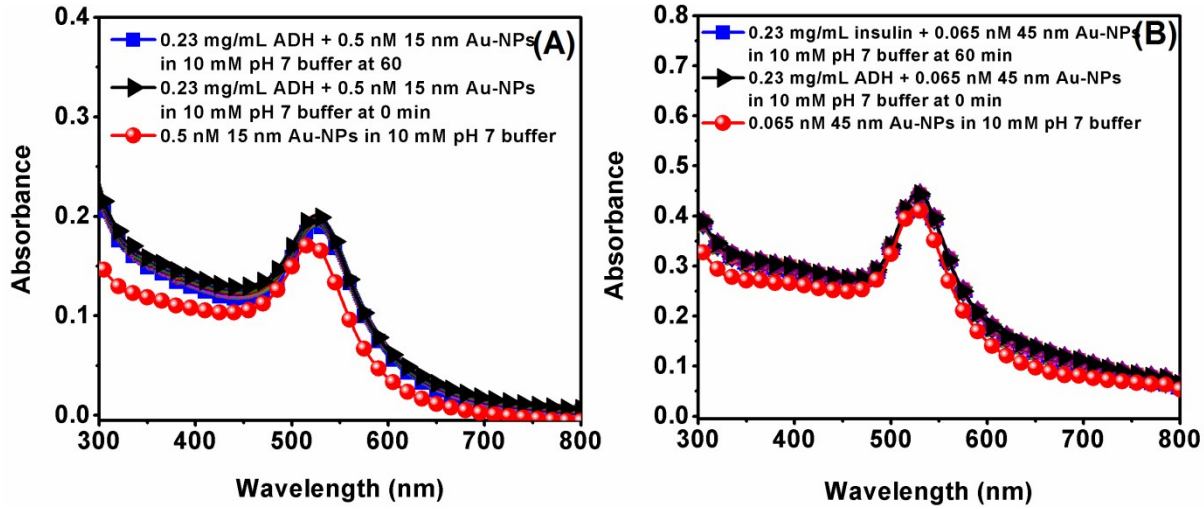

Fig. S5 Absorption spectra of A) 0.5 nM 15 nm Au-NPs and B) 0.065 nM 45 nm Au-NPs in the presence of 0.23 mg/mL ADH in 10 mM pH 7 phosphate buffer at 25 ^{o}C immediately after addition of ADH and after 1 hr. of addition.

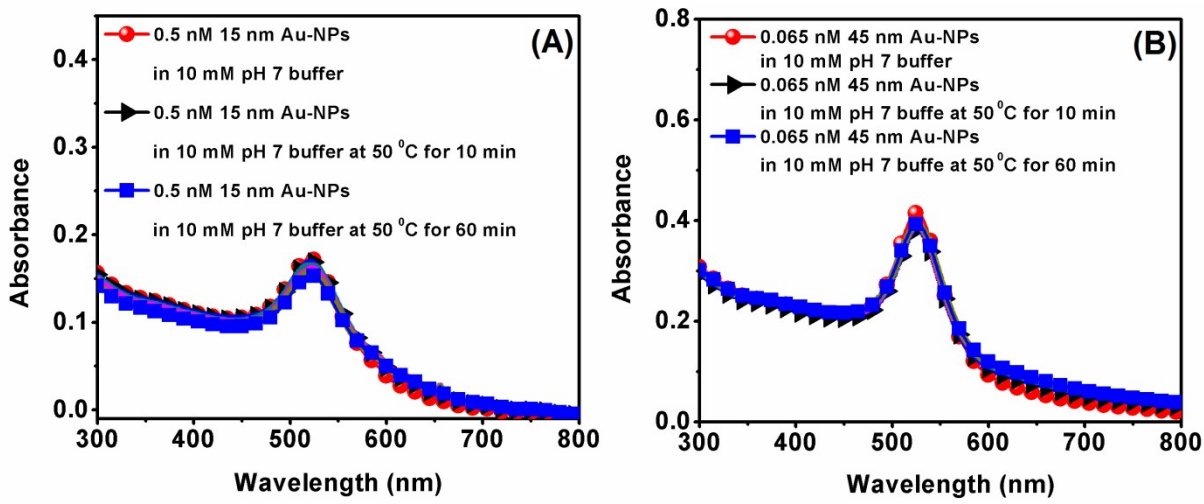

Fig. S6 Absorption spectra of A) 0.5 nM 15 nm Au-NPs and B) 0.065 nM 45 nm Au-NPs in 10 mM pH 7 phosphate buffer at 50 ^{o}C immediately after raising the temperature and after 1 hr. of raising the temperature..

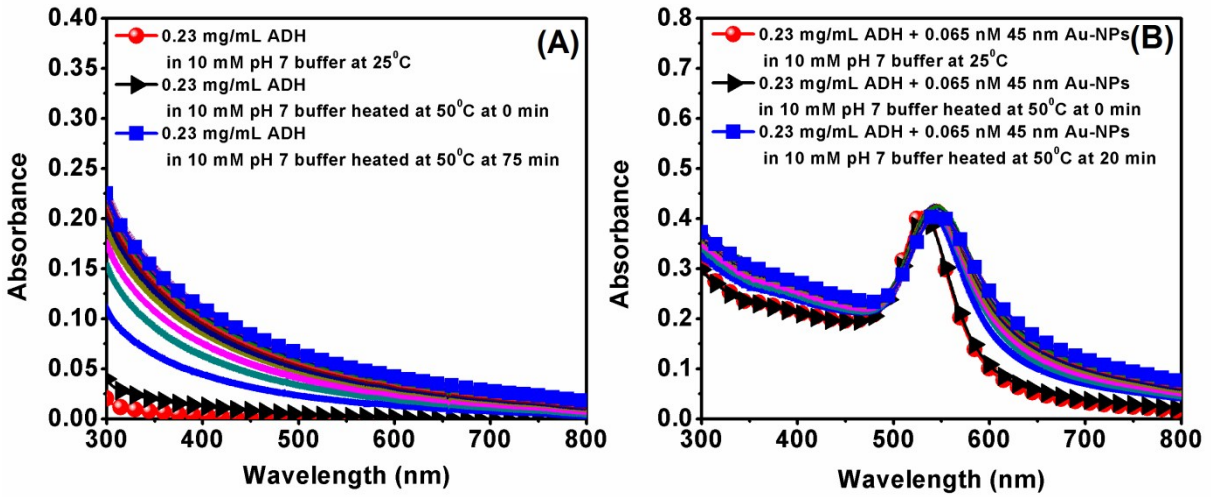

Fig. S7 UV-Vis spectra during the thermal aggregation of 0.23 mg/mL ADH at 50 °C A) in the absence and B) in the presence of 0.065 nM 45 nm Au-NPs in 10 mM pH 7 phosphate buffer as a function of time. The scattering signal at 360 nm increases as a function of time with heating at 50 °C.

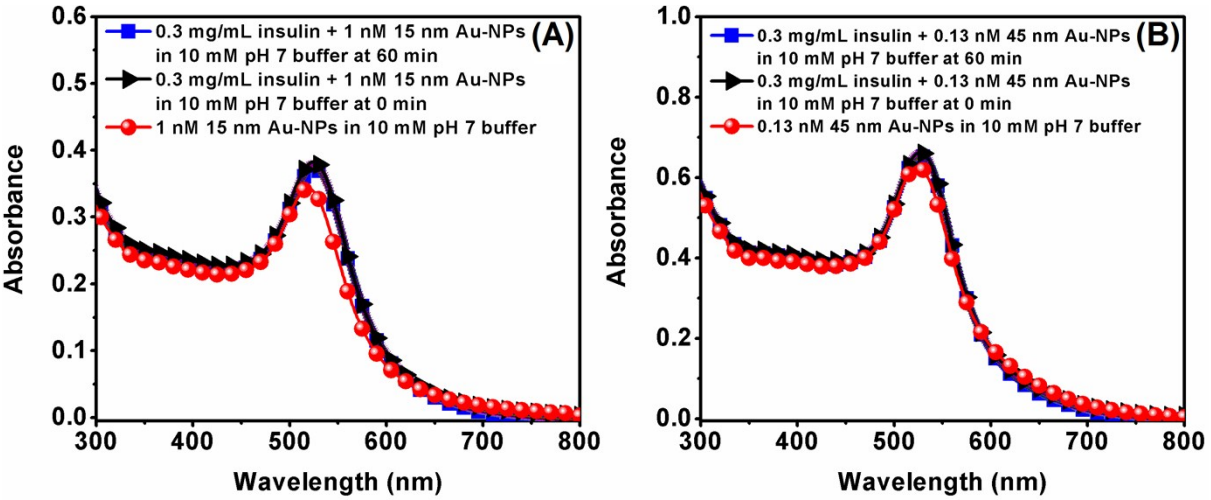

Fig. S8 Absorption spectra of A) 1 nM 15 nm Au-NPs and B) 0.13 nM 45 nm Au-NPs after addition of 0.3 mg/mL insulin in 10 mM pH 7 phosphate buffer at 25 °C.

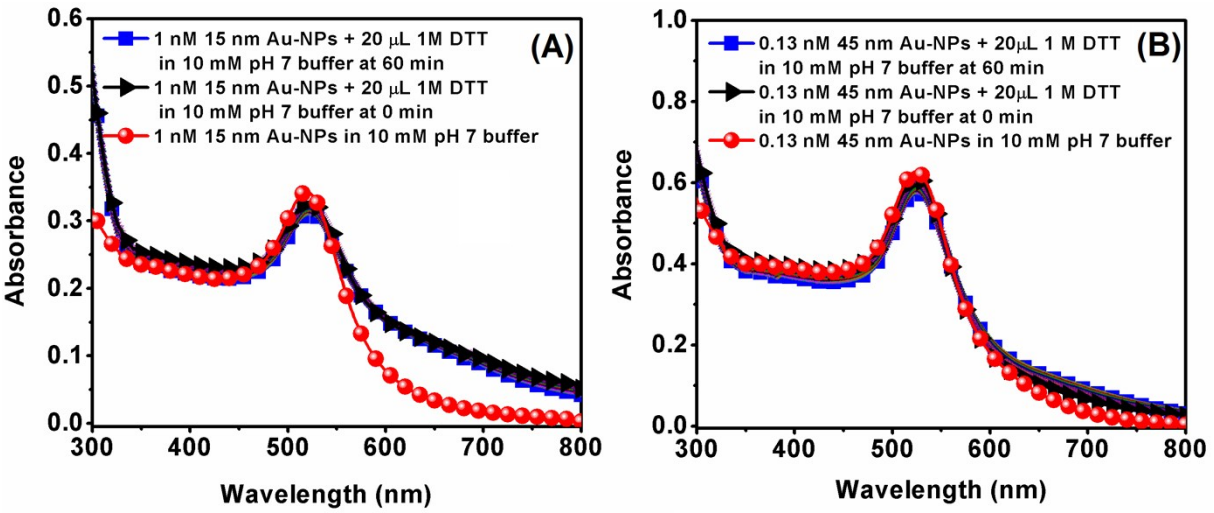

Fig. S9 Absorption spectra of A) 1 nM 15 nm Au-NPs and B) 0.13 nM 45 nm Au-NPs in the presence of 20 μL 1 M DTT in 10 mM pH 7 phosphate buffer at 25 ^{0}C.

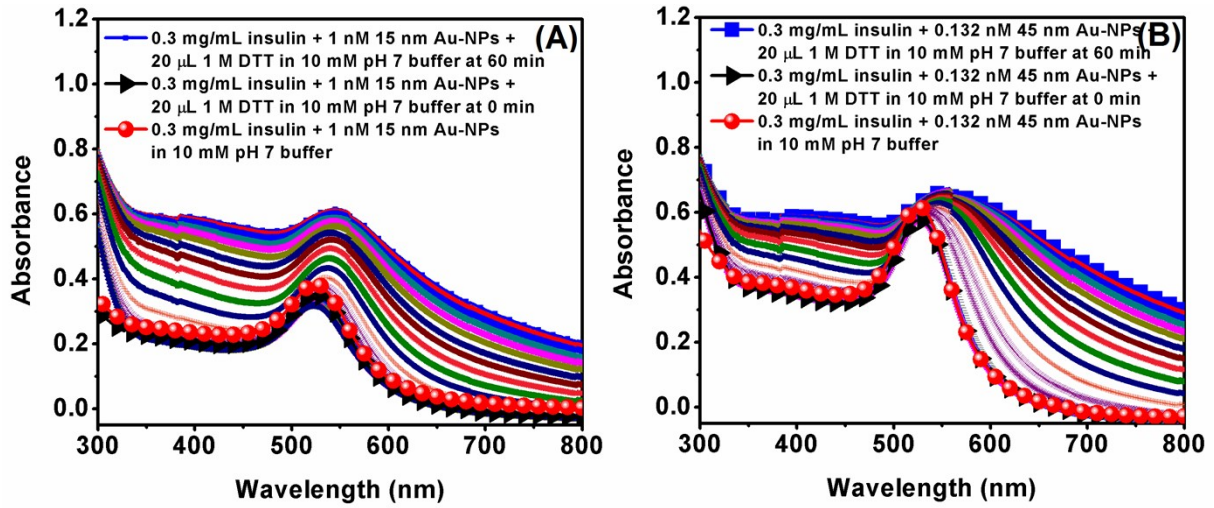

Fig. S10 Absorption spectra recorded as a function of time during the DTT induced aggregation of 0.3 mg/mL insulin at 25 ^{o}C A) in the presence of 1nM 15 nm Au-NPs and B) 0.13 nM 45 nm Au-NPs in 10 mM pH 7 phosphate buffer till saturation.

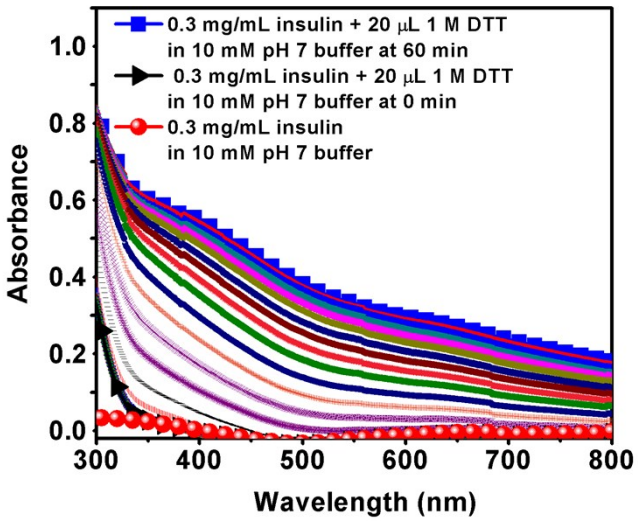

Fig. S11 UV-Vis spectra of 0.3 mg/mL insulin in 10 mM pH 7 phosphate buffer at 25 °C in presence of 20 μL 1 M DTT.

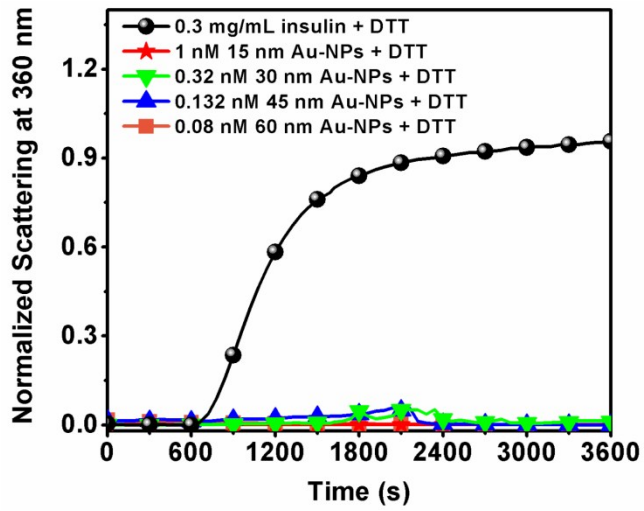

Fig. S12 Scattered light intensity at 360 nm from 1 mL of solution containing A) 15 nm (1 nM), B) 30 nm (0.32 nM), C) 45 nm (0.132 nM), D) 60 nm (0.08 nM) Au-NPs in 10 mM pH 7 phosphate buffer at 25 °C in presence of 20 μL 1 M DTT. The scattered light intensity was normalized w.r.t. the maximum scattered light intensity at the completion of aggregation of insulin (0.3 mg/mL in 1 mL 10 mM pH 7 phosphate buffer) which was induced by the addition of 20 μL 1 M DTT at 25 °C.

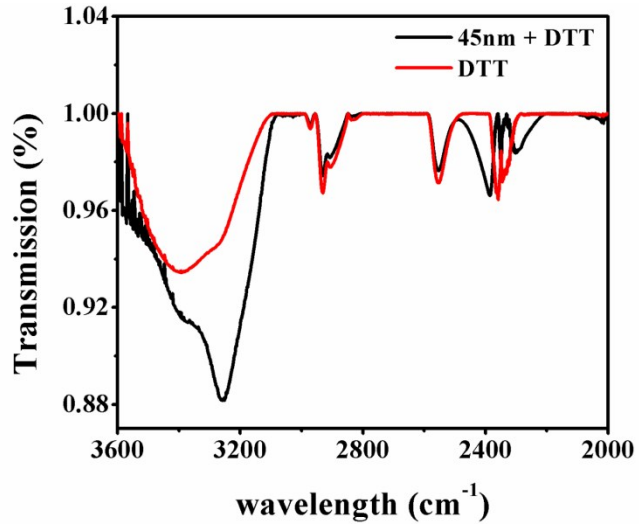

Fig. S13 FT-IR spectra of DTT in 10 mM phosphate buffer at pH 7.0 in the absence and presence of 0.16 nM 45 nm Au-NPs. The intensity of the S-H stretching mode at ~2550 cm^{-1} in both the spectra remains more or less the same indicating that even if DTT interacts with Au-NPs through S-H bonds still there is sufficient amounts of free DTT present in solution which can reduce the disulfide bond in insulin. In other words, the reason for the reduction of extent of DTT induced aggregation of insulin is not due to reduction in the amounts of DTT in the solution by interaction with Au-NPs, rather due to adsorption of insulin onto surface of Au-NPs.