

Electronic Supplementary Information

Naked-eye detection of Cysteine/Homocysteine through silver nano resonators and specific identification of Homocysteine through nanoresonators-thiosulphate conjugate.

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S1 Methodology for Synthesis of AgNPs:

Three different solutions were prepared; trisodium citrate (1.0×10^{-2} M, 30 mL), Hydrazine hydrate (2.0×10^{-3} M, 20 mL), and silver nitrate (1.0×10^{-3} M, 5 mL). To a round bottom flask maintained at 40°C, 60°C, 80°C and 100°C separately on an oil bath, 30 mL of tri sodium citrate and 20 mL of hydrazine solutions were added and stirred for 10 minutes. The silver nitrate solution (5 mL) was further added in drop wise fashion to the same round bottom flask under stirred conditions. The stirring was further continued for 15-16. Resulting AgNPs are shown below;

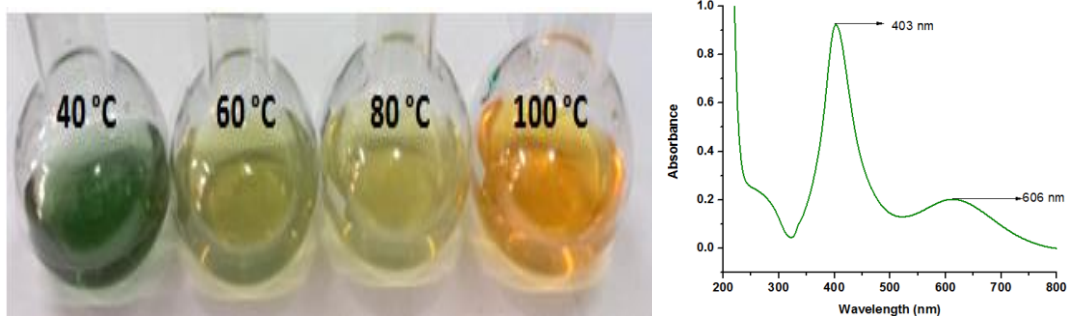


Fig. S2 image of AgNPs synthesized at 4 different temperature using same method. UV-Vis spectra of AgNPs synthesized at 40°C.

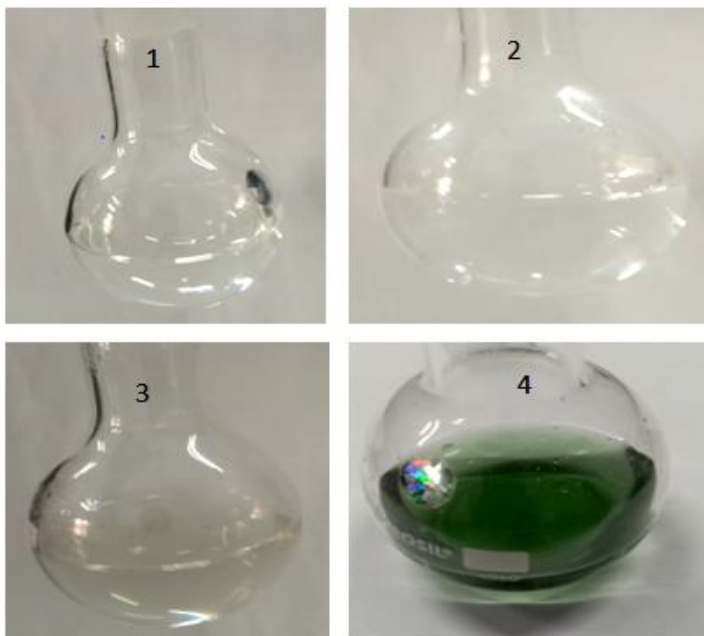


Fig. S3 Image showing (1) blank solution containing Trisodium citrate + Silver nitrate, (2) image showing blank solution containing Trisodium citrate + Hydrazine, (3) image showing blank solution containing Hydrazine + Silver nitrate, (4) silver nanoparticles solution(Trisodium citrate + Hydrazine + Silver nitrate).



Fig. S4 Image showing tyndall effect.

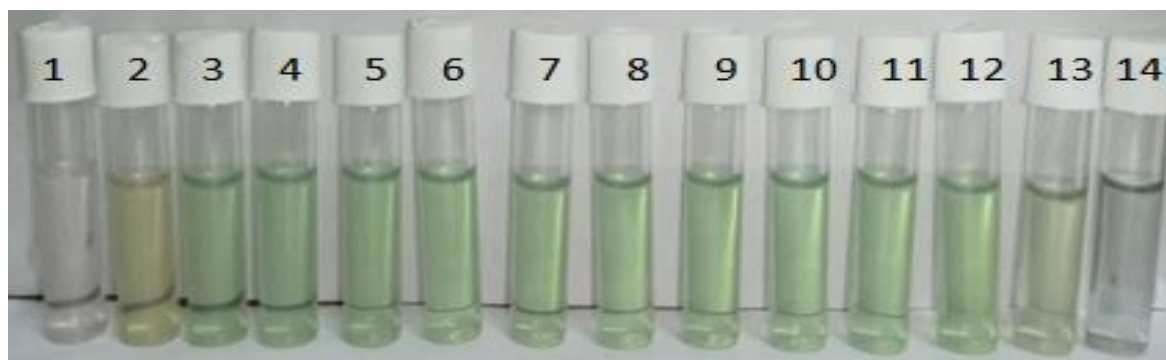


Fig.S5 visible response of pH metric titration of AgNPs from 1-14 pH.

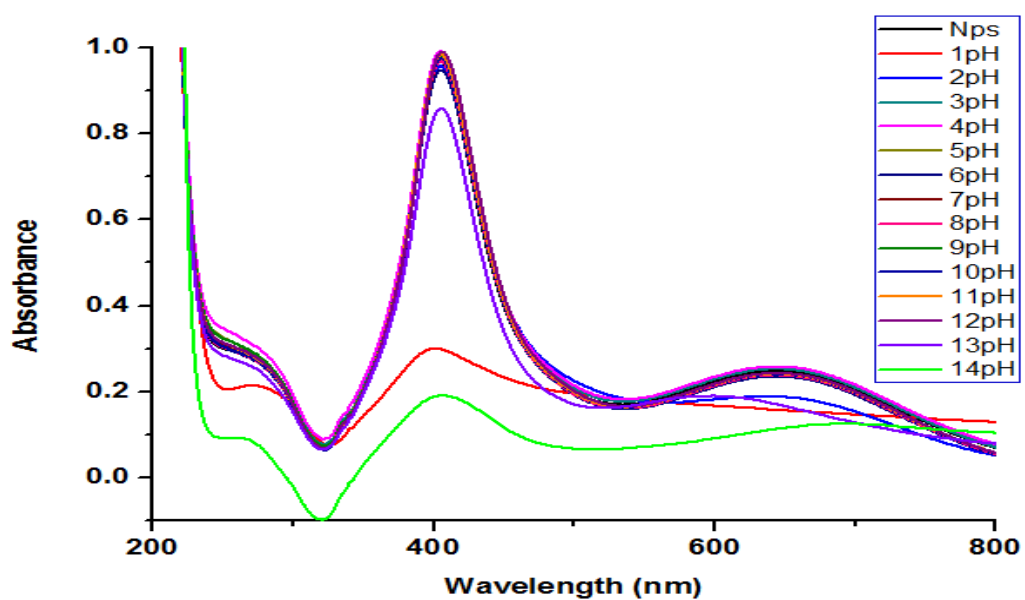


Fig.S6 UV-Vis response of pH metric titration from 1-14 pH.

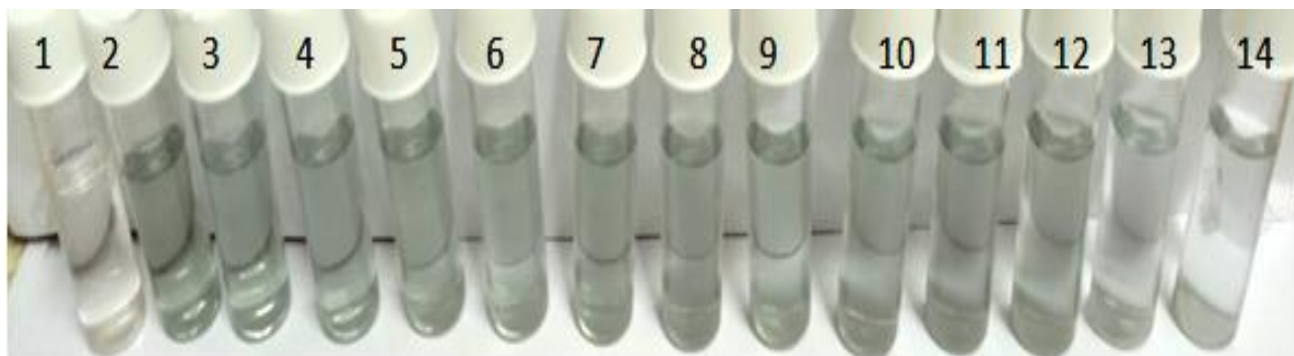


Fig.S7 Colorimetric response of pH metric titration with l-cysteine (from 1 to 14pH).

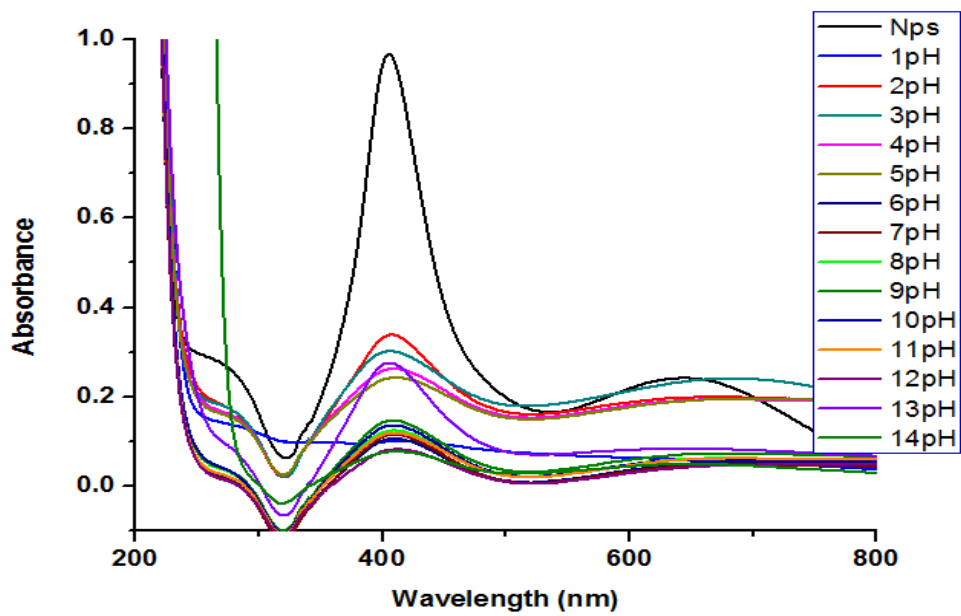


Fig.S8 UV-Vis response of pH metric titration with l-cysteine from 1-14 pH.

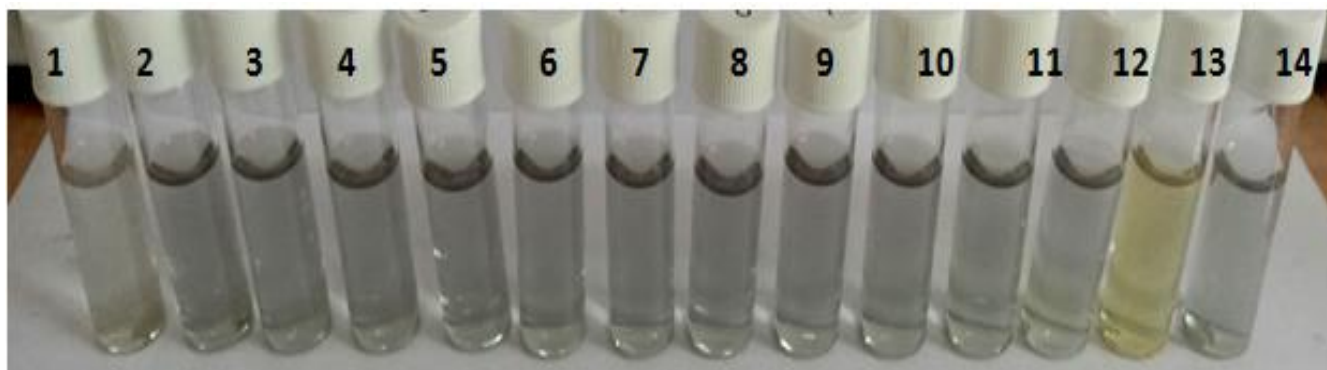


Fig.S9 Visible response of pH metric titration with L-homocysteine (from 1 to 14pH).

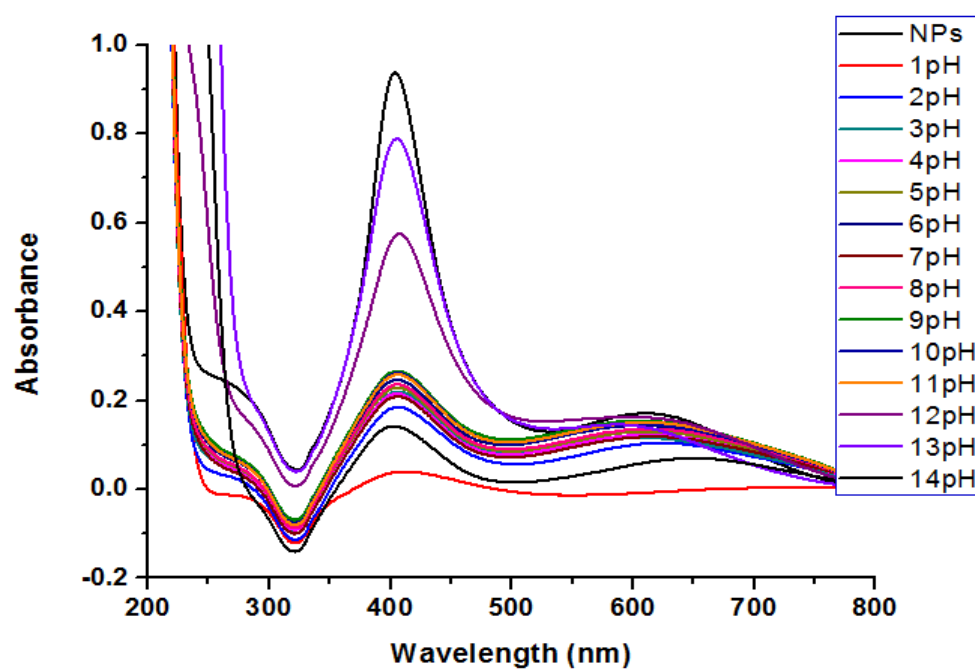


Fig.S10 UV-Vis response of pH metric titration with L-homocysteine from 1-14 pH.

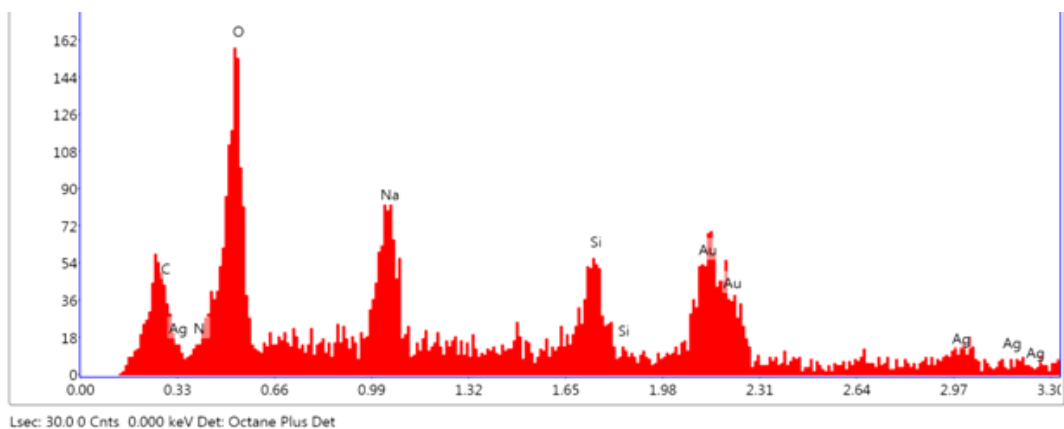


Fig.S11 EDAX of AgNPs synthesized at 40°C.

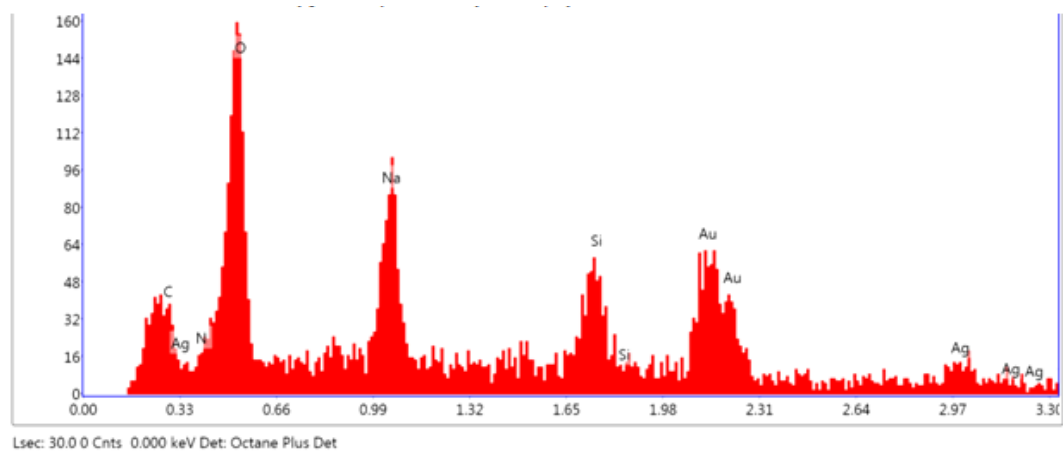


Fig.S12 EDAX of AgNPs synthesized at 60°C.

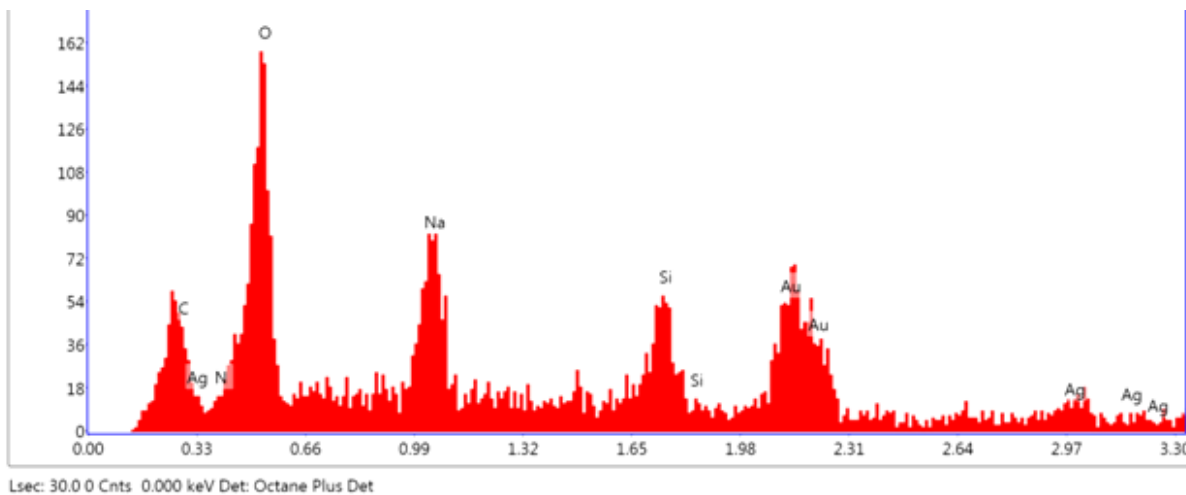


Fig.S13 EDAX of AgNPs synthesized at 80°C.

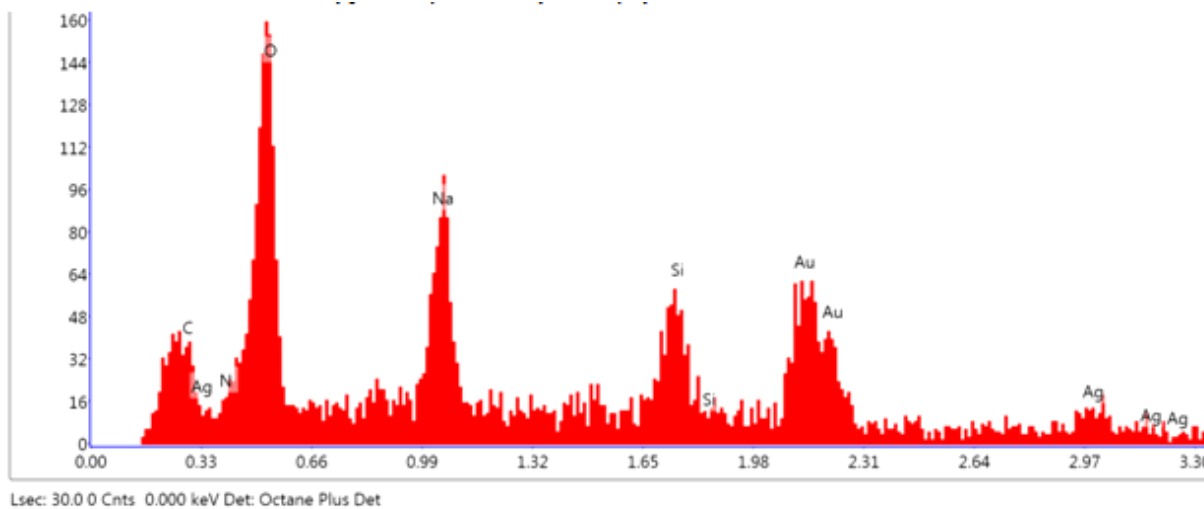


Fig.S14 EDAX of AgNPs synthesized at 100°C.

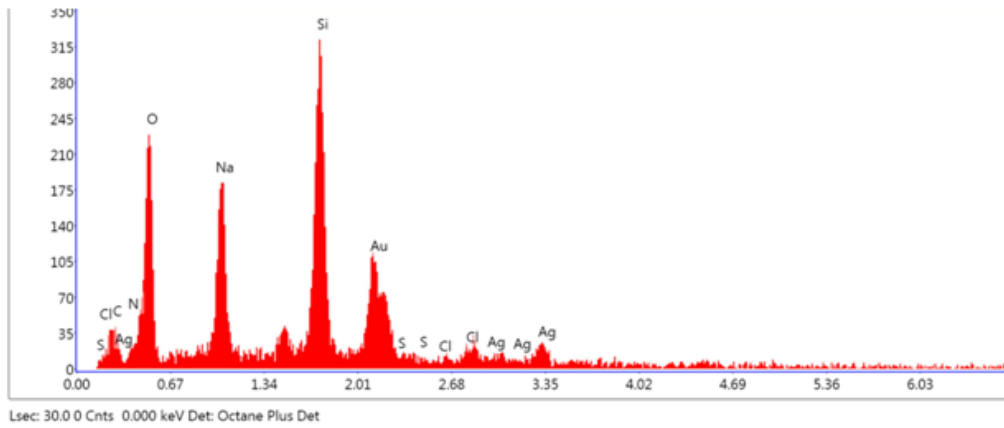


Fig.S15 EDAX of AgNPs (synthesized at 40⁰C) after addition of cysteine.

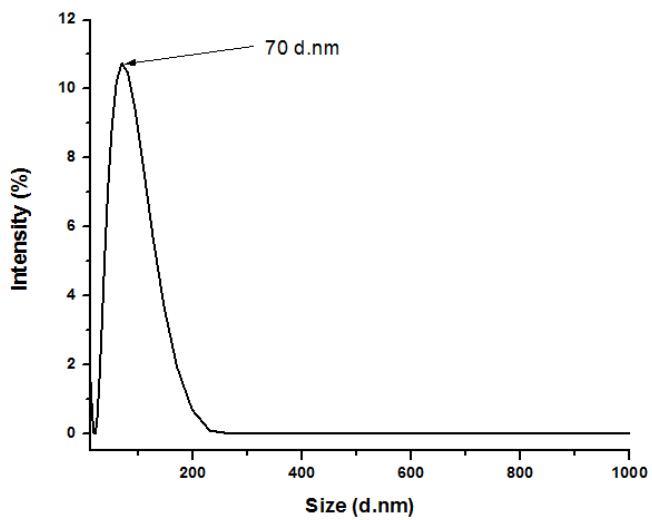


Fig.S16 DLS of AgNPs.

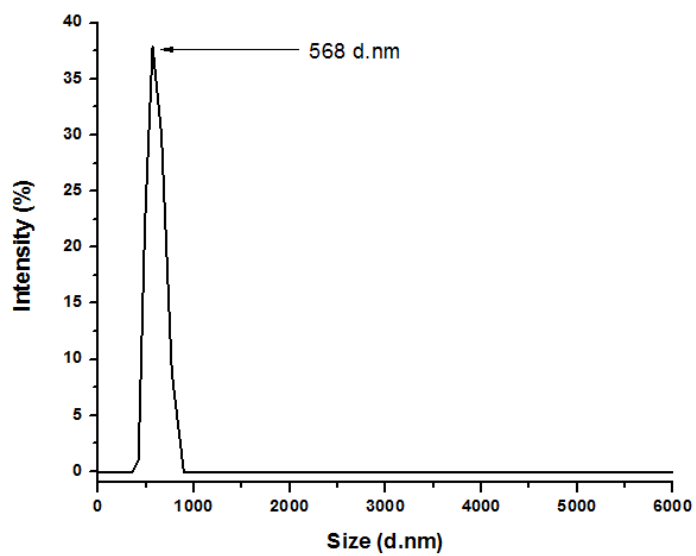


Fig.S17 DLS of AgNPs after addition l-cysteine.

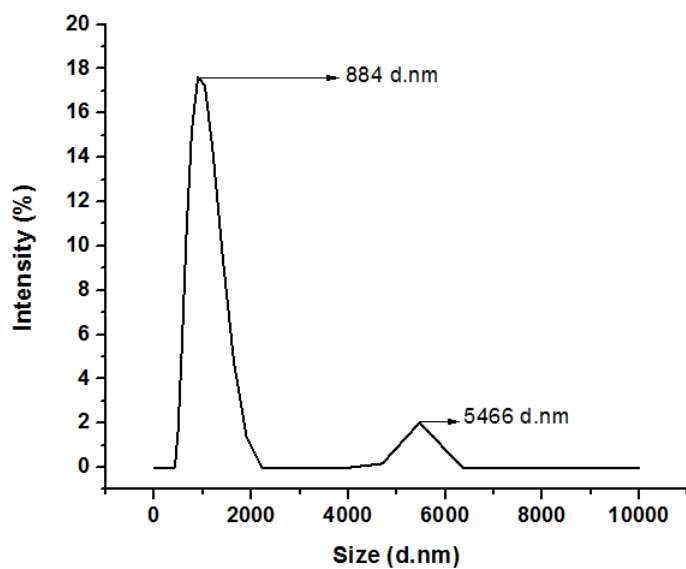


Fig. S18 DLS of AgNPs after addition l-homocysteine.

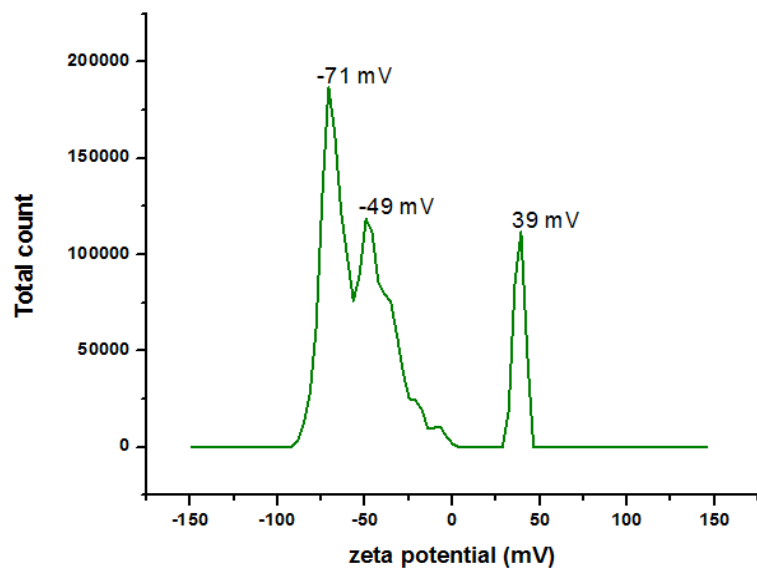


Fig.S19 Zeta potential of AgNPs.

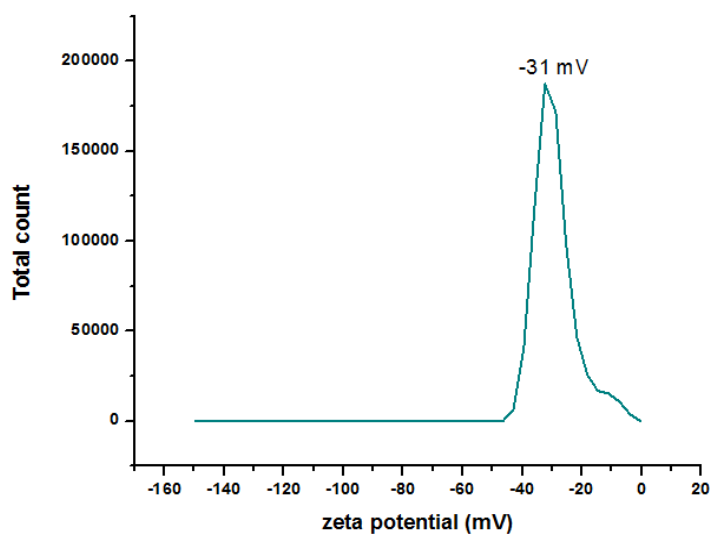


Fig. S20 Zeta potential of AgNPs after the addition of l-cysteine.

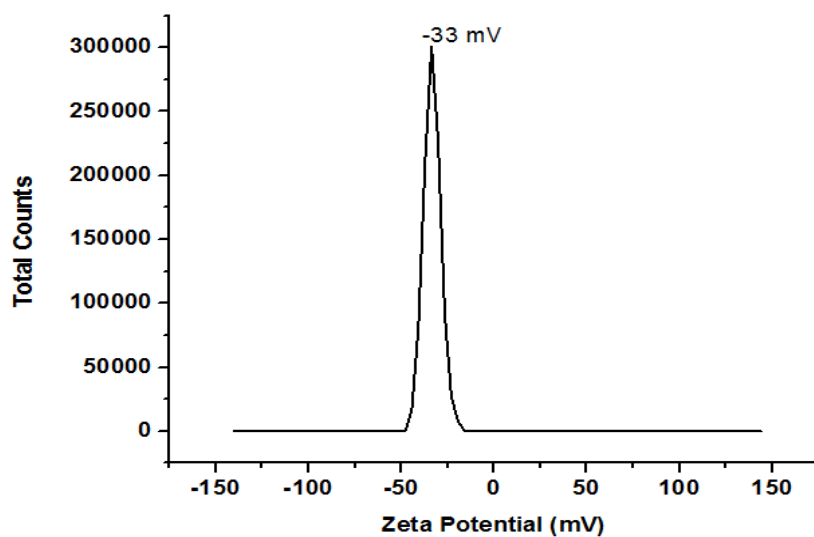


Fig. S21 Zeta potential of AgNPs after the addition of L-homocysteine.

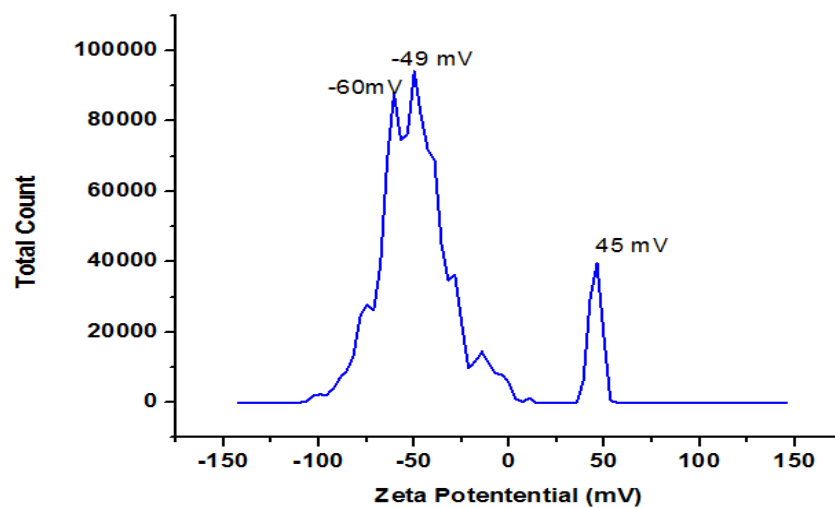


Fig. S22 Zeta potential of AgNPs conjugate.

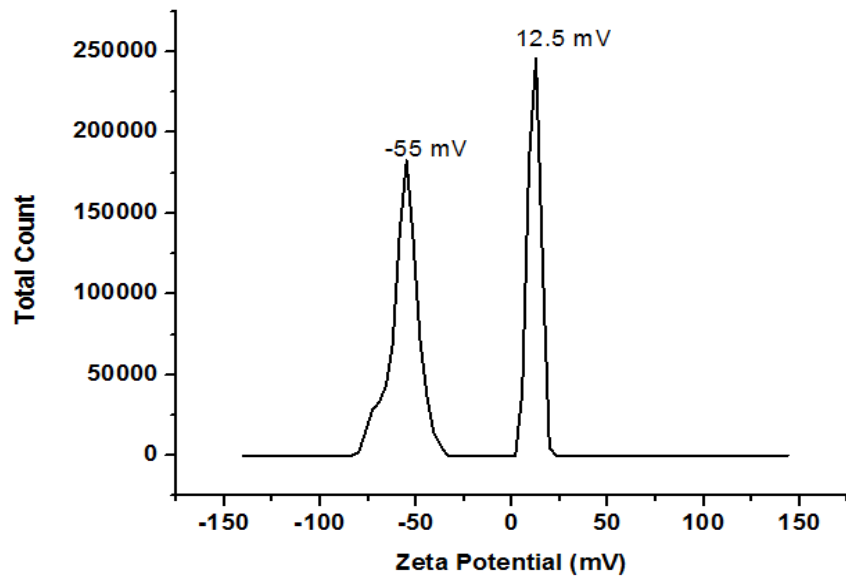


Fig. S23 Zeta potential of AgNPs conjugate + cysteine.

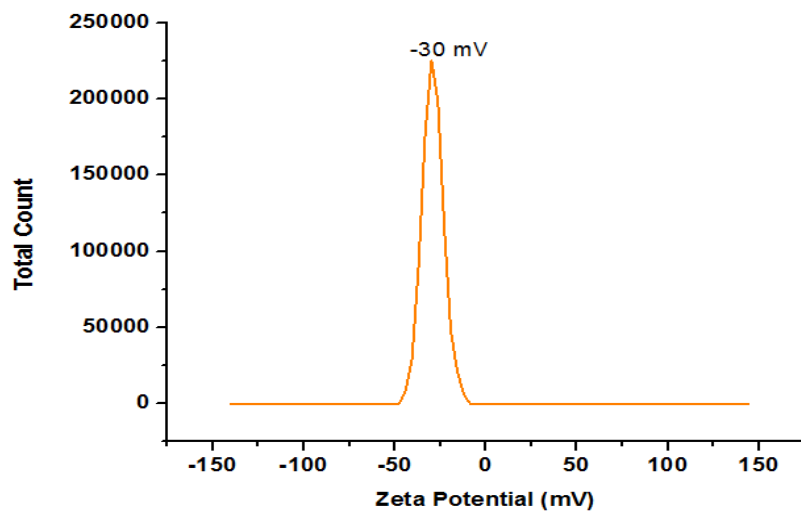


Fig. S24 Zeta potential of AgNPs conjugate + homocysteine.

Fig. S25 Table for Zeta Potential comparison:

Sample	Peak 1st	Peak 2nd	Peak 3 rd
Nps	-71mV	-49mV	39mV
Nps + Cys	-	-31mV	-
Nps + Hcys	-	-33	-
Conjugate of Nps	-60mV	-49mV	45mV
Conjugate of Nps + Cys	-55mV	-	12.5mV
Conjugate of Nps + Hcys	-	-30mV	-

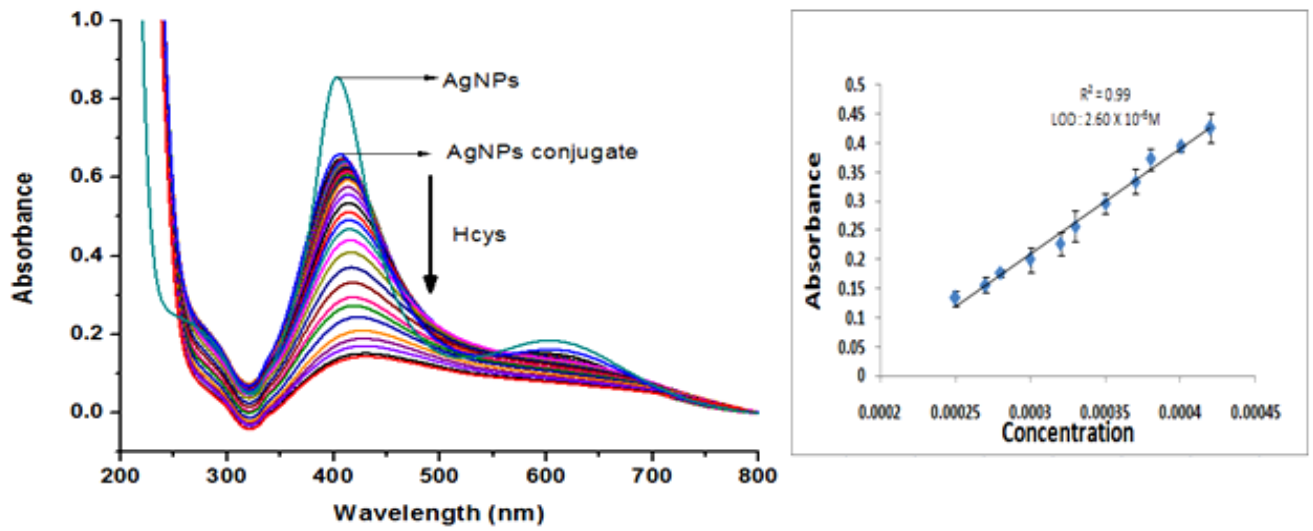


Fig. S26 UV-Vis titration of AgNPs conjugate with l-homocysteine (lod = $2.60 \times 10^{-6} \text{ M}$).

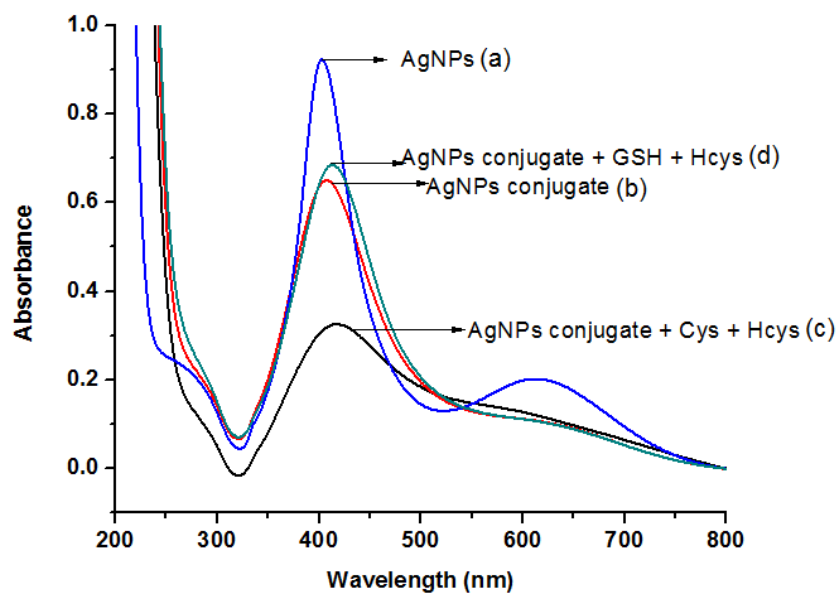
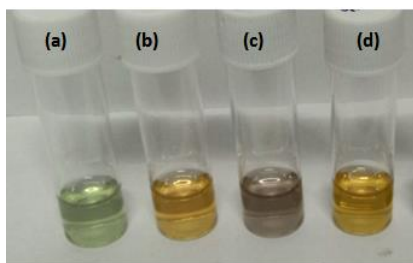


Fig. S27 image showing colorimetric and UV-Vis response of l-homocysteine (Hcys) with AgNPs conjugate in presence of l-cysteine (Cys) and Glutathione (GSH).

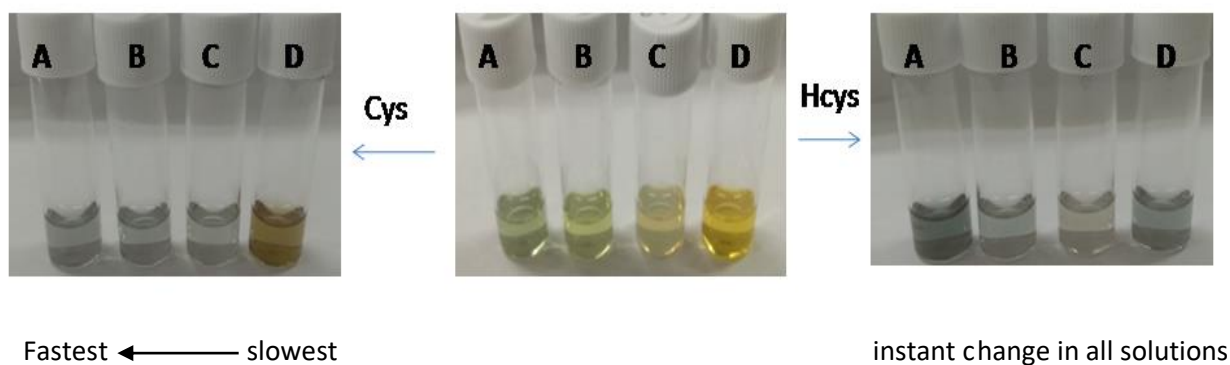


Fig. S28 Image showing visible response of cysteine and homocysteine with AgNPs synthesized at different temperatures viz., A= 40°C, B= 60°C, C= 80°C and D= 100°C.



Fig.S29 Image of musicnac 600 tablet containing 600mg of acetylcysteine.

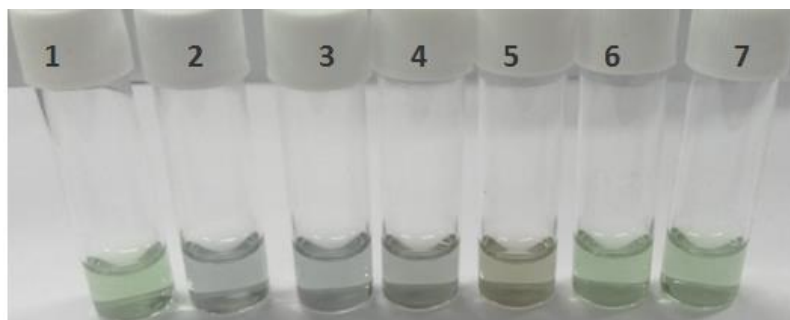


Fig.S30 Visible response of AgNPs with different ppm solution of acetylcysteine tablet i.e, (1) AgNPs, (2) AgNPs + 60×10^3 ppm, (3) AgNPs + 50×10^3 ppm, (4) AgNPs + 40×10^3 ppm, (5) AgNPs + 30×10^3 , (6) AgNPs + 20×10^3 ppm, (7) AgNPs + 10×10^3 ppm.

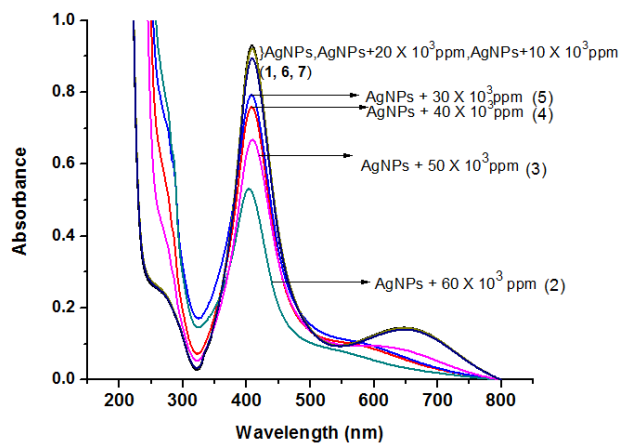


Fig.S31 UV-Vis response of different ppm solution of acetylcysteine tablet (musinac 600) on interaction with silver nanoparticles.

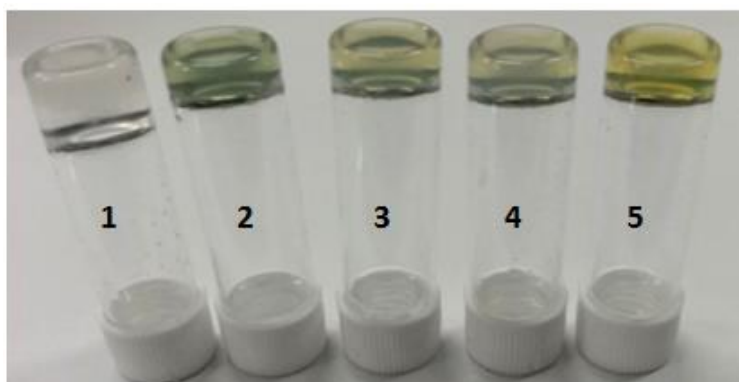


Fig.S32 Gel formation of AgNPs synthesized at different temperature using agar-agar; (1) 3% Agar-agar solution in millipore water (blank), (2) AgNPs (40°C) having 3% agar-agar, (3) AgNPs (60°C) having 3% agar-agar, (4) AgNPs (80°C) having 3% agar-agar, (5) AgNPs (100°C) having 3% agar-agar.

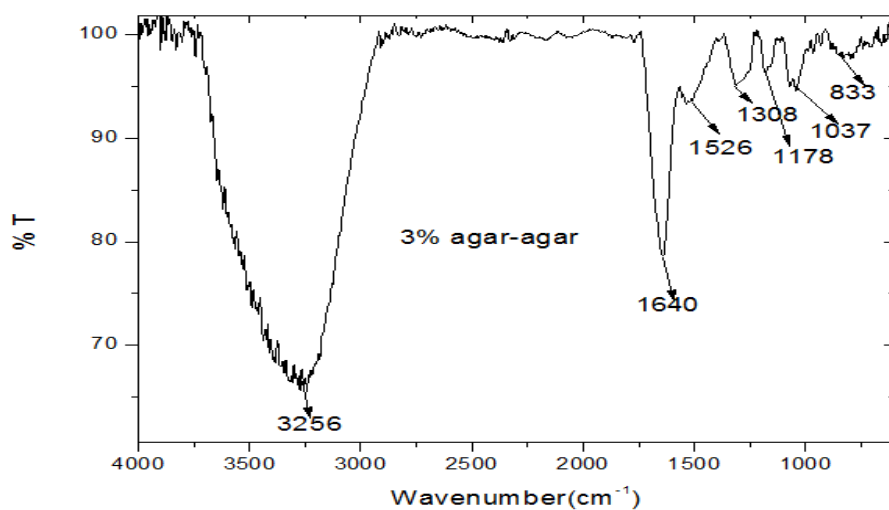


Fig.S33 IR spectrum of 3% agar-agar in millipore water (blank).

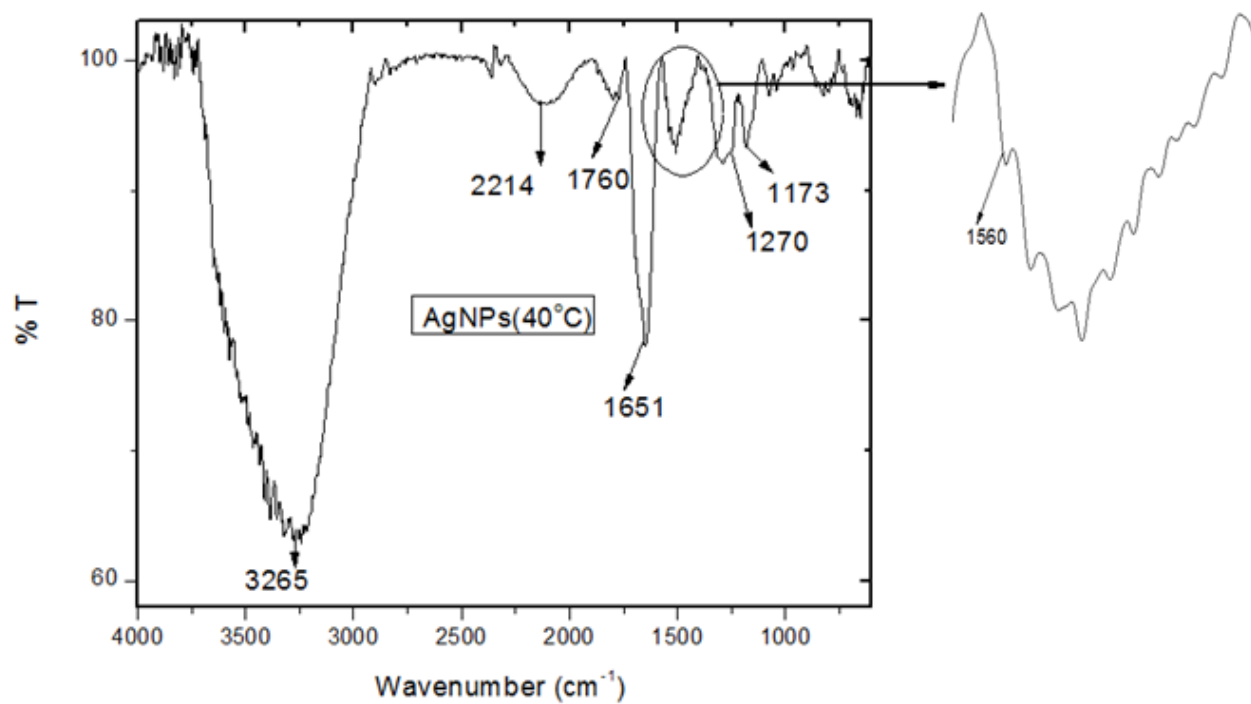


Fig.S34 IR spectrum of AgNPs synthesized at 40°C (3% agar-agar).

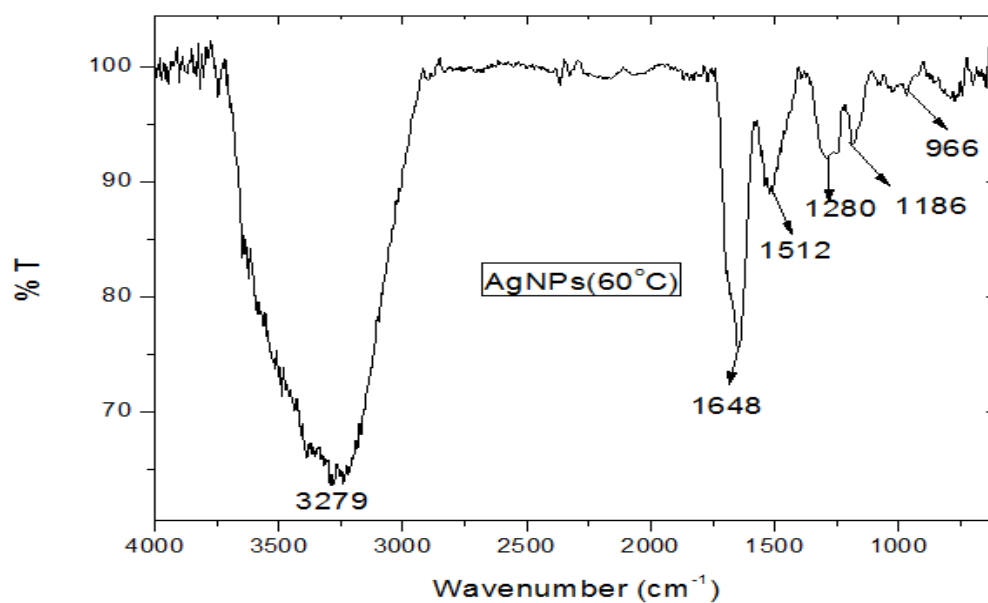


Fig.S35 IR spectrum of AgNPs synthesized at 60°C (3% agar-agar).

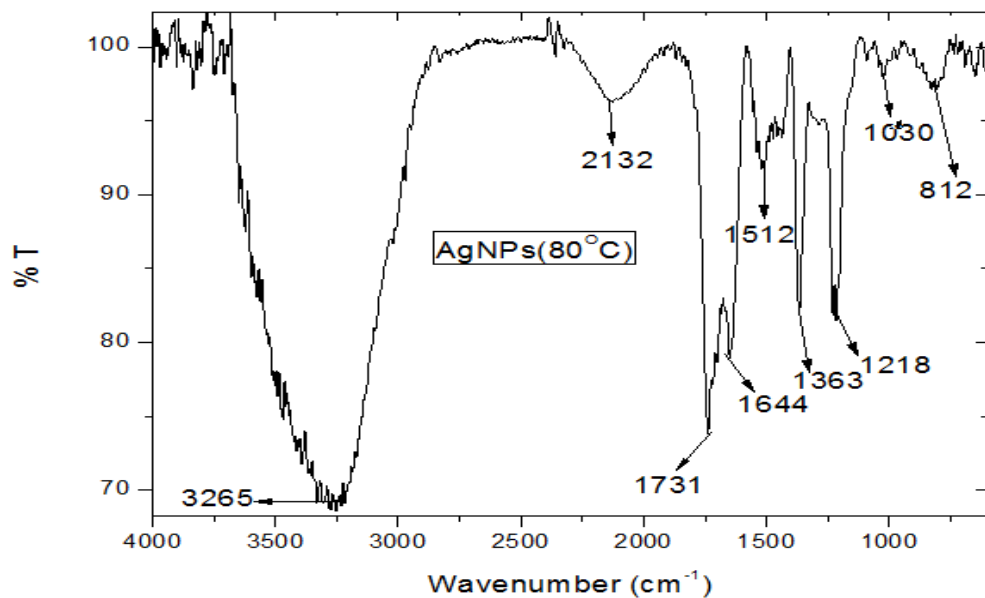


Fig.S36 IR spectrum of AgNPs synthesized at 80°C (3% agar-agar).

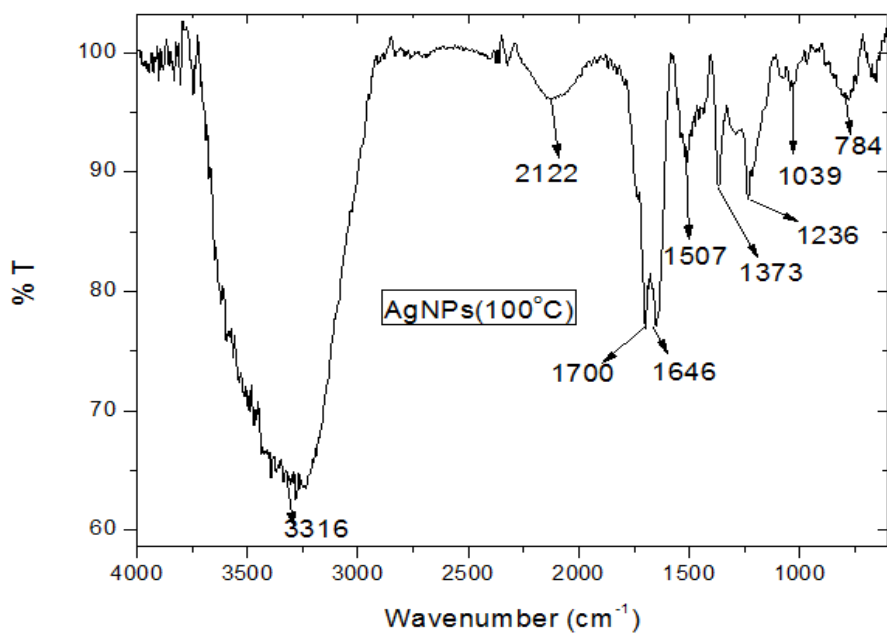


Fig.S37 IR spectrum of AgNPs synthesized at 100°C (3% agar-agar).

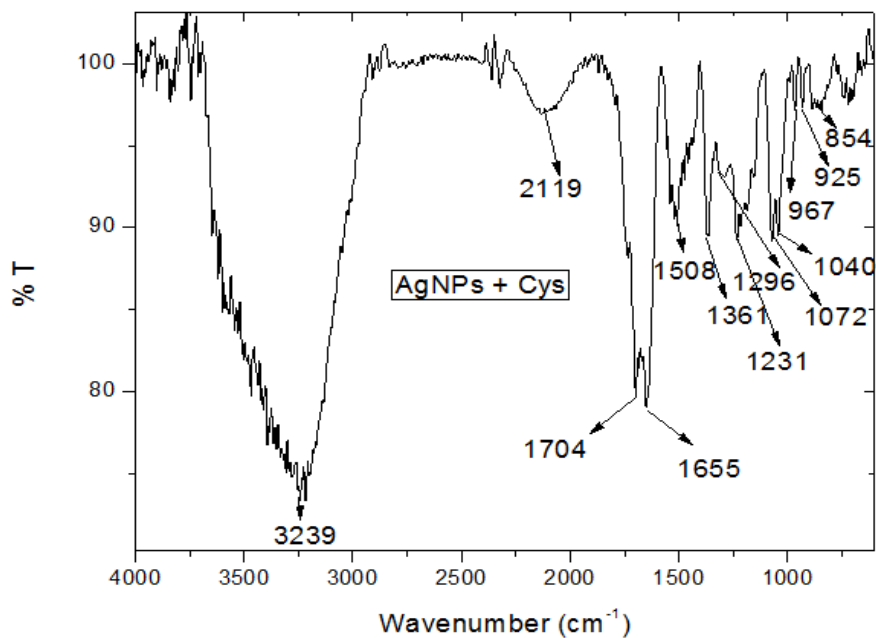


Fig.S38 IR spectrum of AgNPs (synthesized at 40°C) + Cys (3% agar-agar).

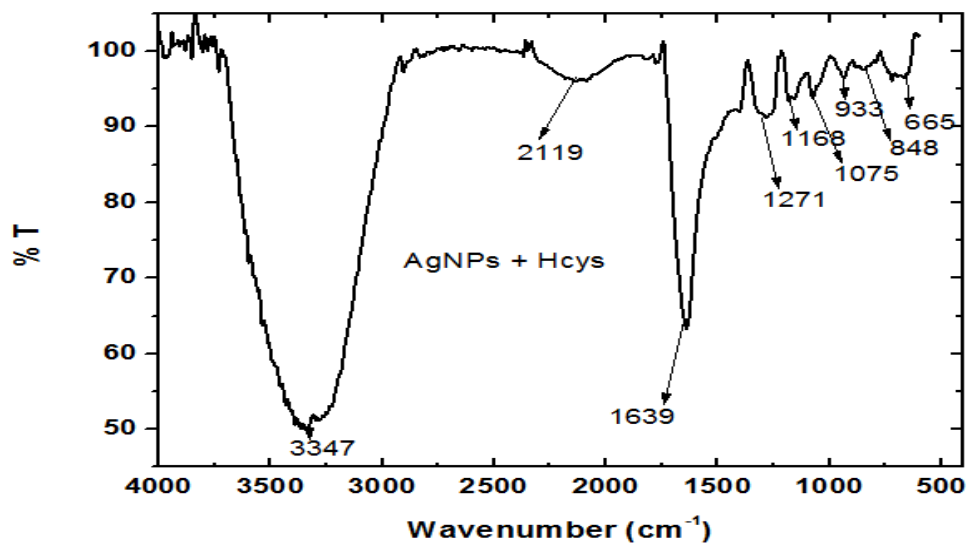


Fig. S39 IR spectrum of AgNPs(synthesized at 40°C) + Hcys (3% agar-agar).

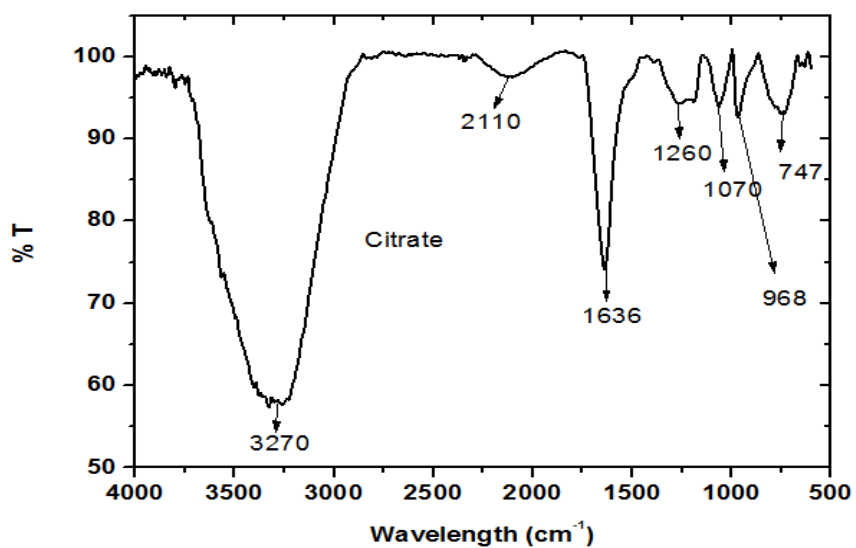


Fig. S40 IR spectrum of Trisodium Citrate(CA) (3% agar-agar).

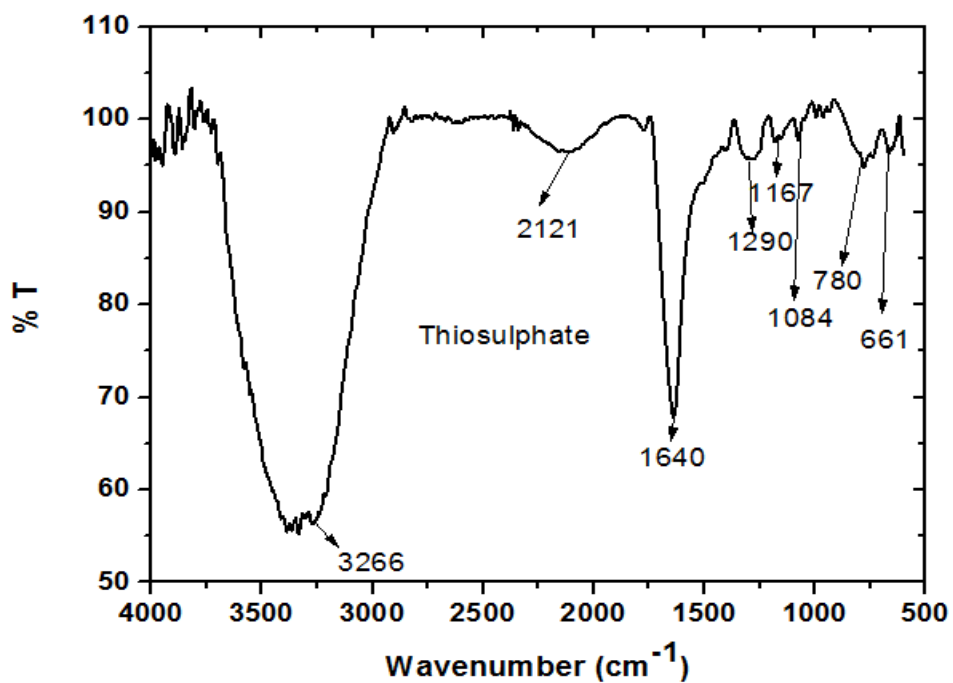


Fig. S41 IR spectrum of Thiosulphate (3% agar-agar).

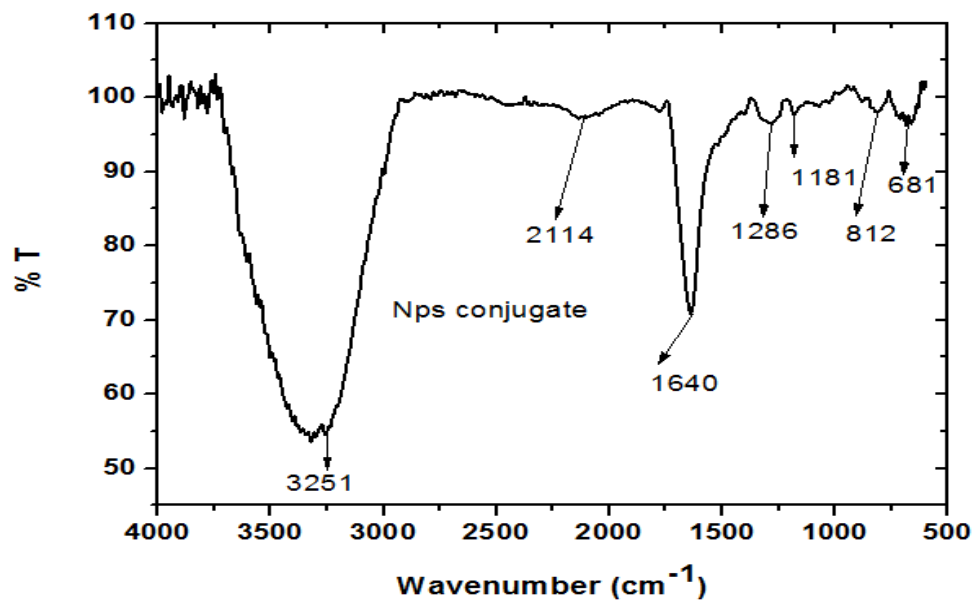


Fig. S42 IR spectrum of Nps conjugate (3% agar-agar).

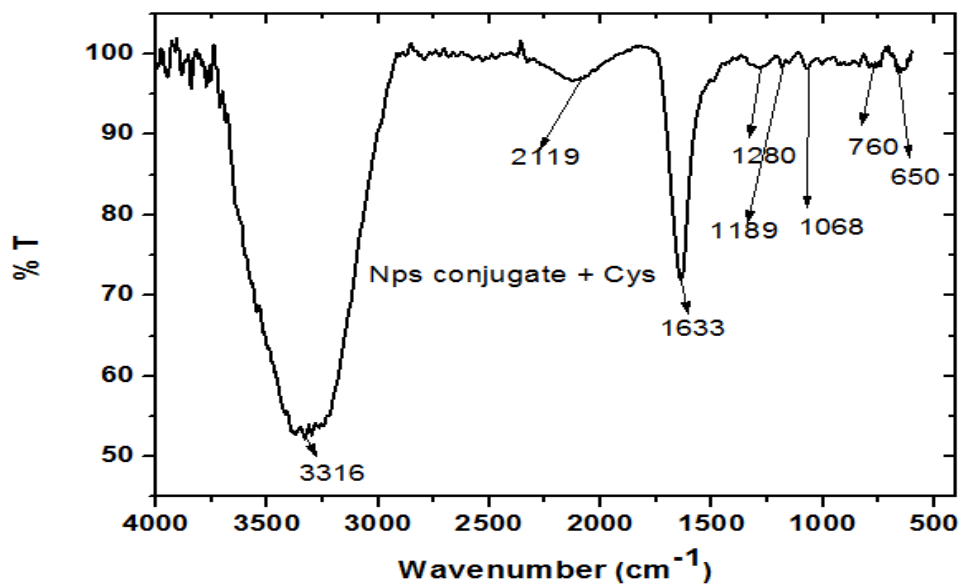


Fig. S43 IR spectrum of Nps conjugate + Cys (3% agar-agar).

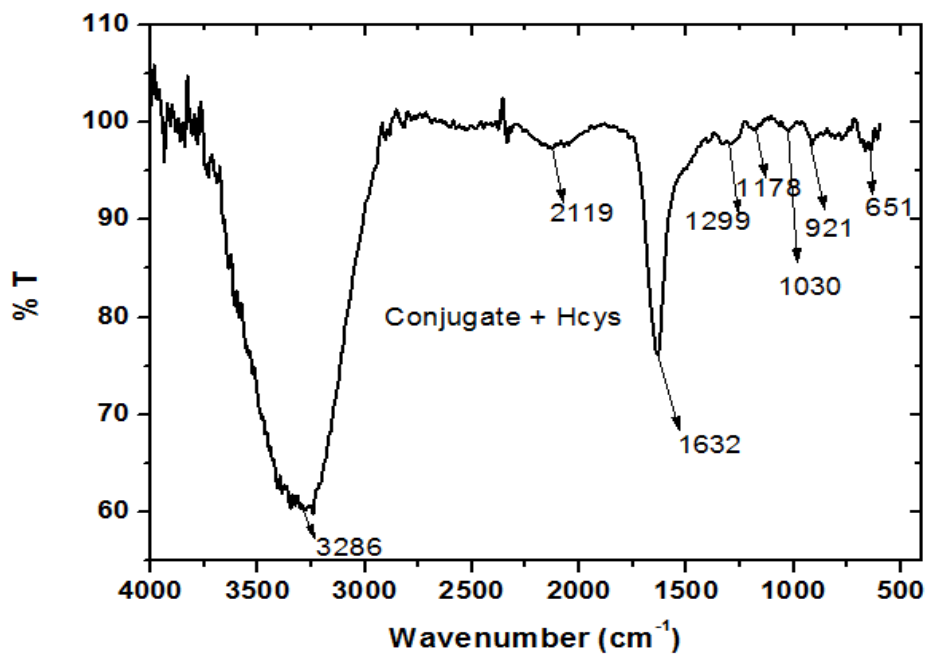


Fig. S44 IR spectrum of Nps conjugate + Hcys (3% agar-agar).

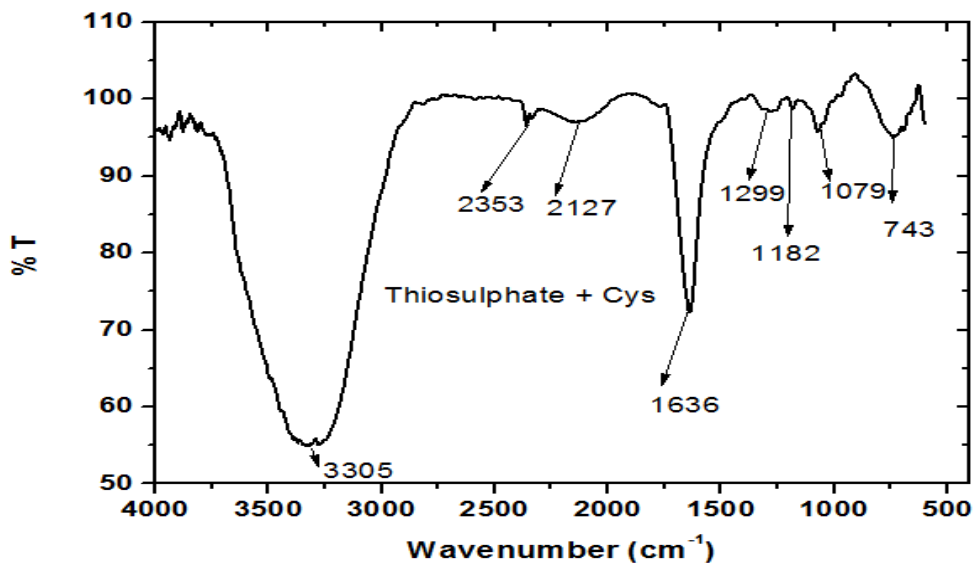


Fig. S45 IR of thiosulphate + cysteine (3% agar-agar).

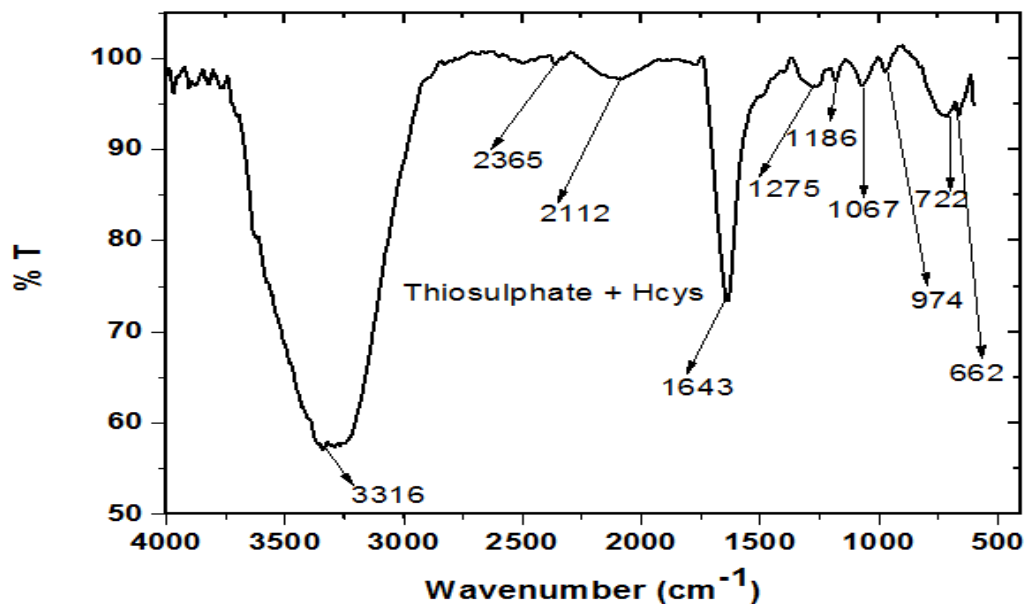


Fig. S46 IR of thiosulphate + homocysteine (3% agar-agar).

Fig. S47 Table for FT-IR:

sample	Peaks (cm ⁻¹)
AgNPs	1760, 1651, 1560, 1270
AgNPs + Cys	1704, 1655, 1508, 1361
AgNPs + Hcys	- , 1639, 1271
AgNPs conjugate	- , 1640, 1286
AgNPs conjugate + Cys	- , 1633, 1280
AgNp Conjugate + Hcys	- , 1632, 1299
Only Thiosulphate + Cys	- , 1636, 1299
Only thiosulphate + Hcys	- , 1643, 1275

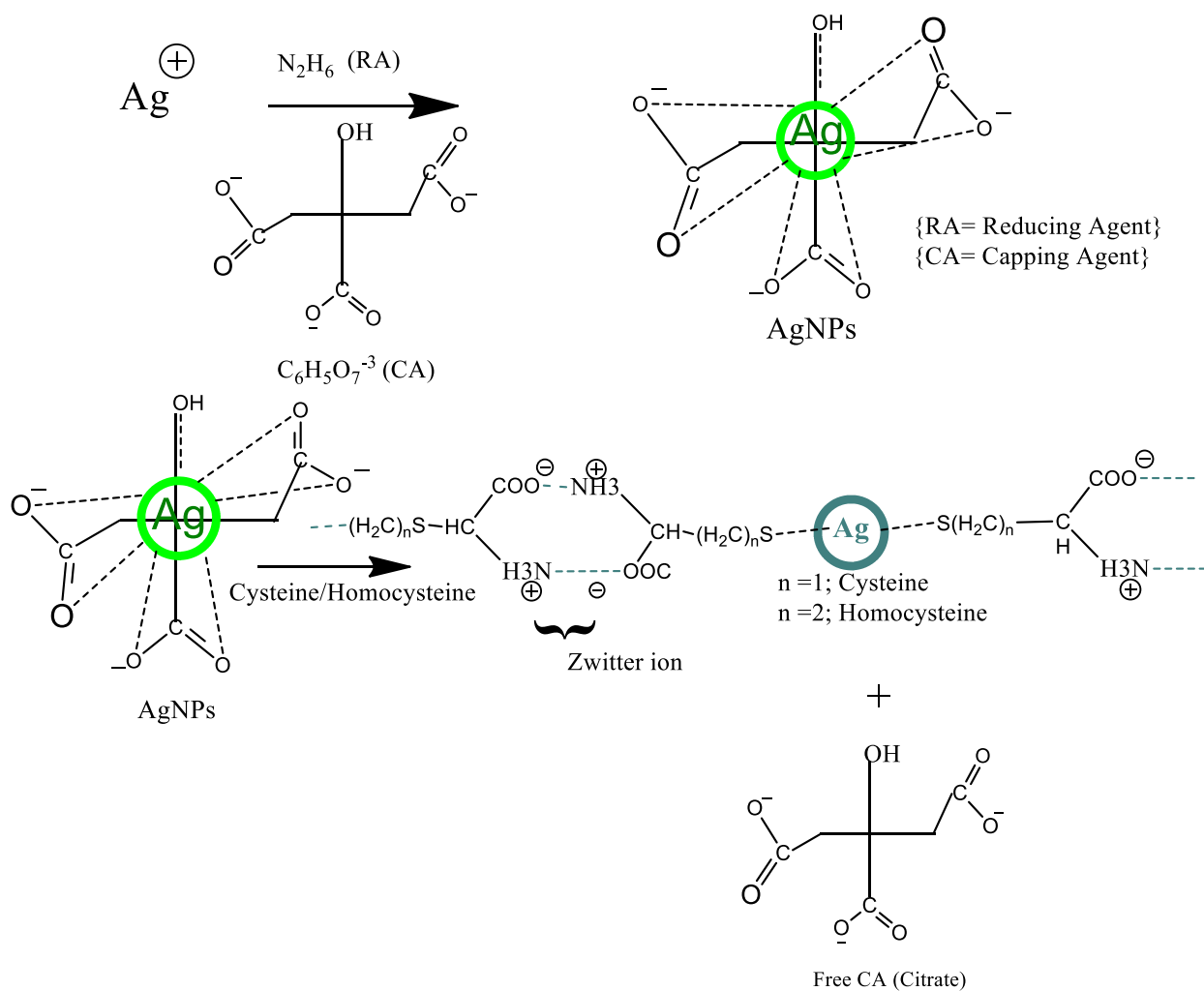
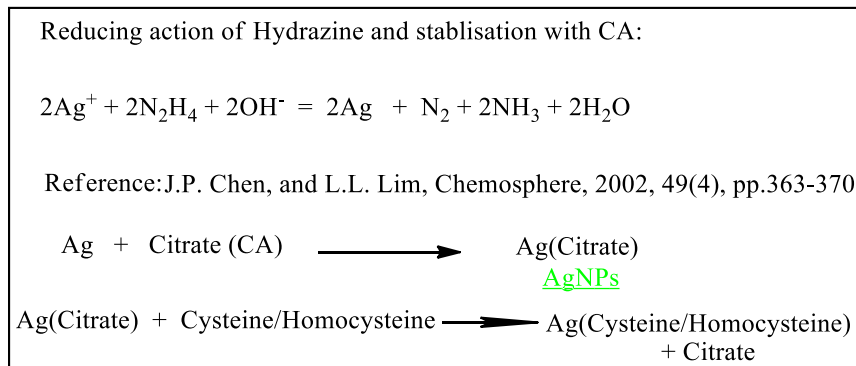


Fig. S48 Probable mechanism for AgNPs formation and sensing.

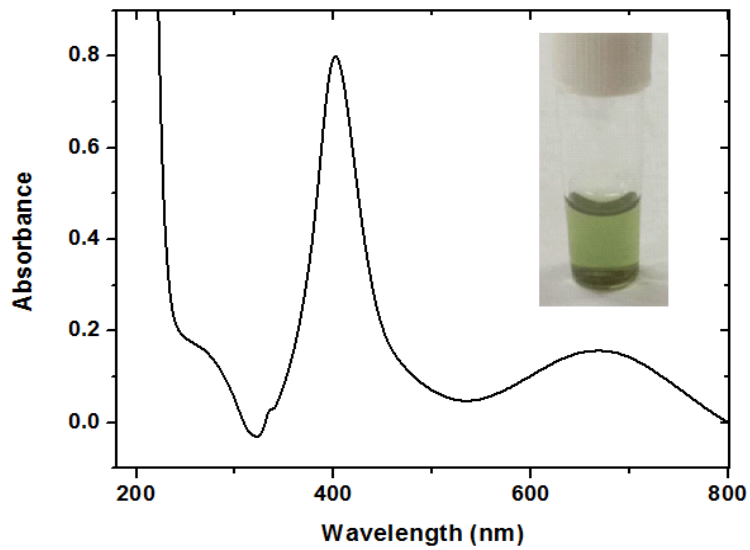


Fig.S49 Stability check of AgNPs after 6 months.

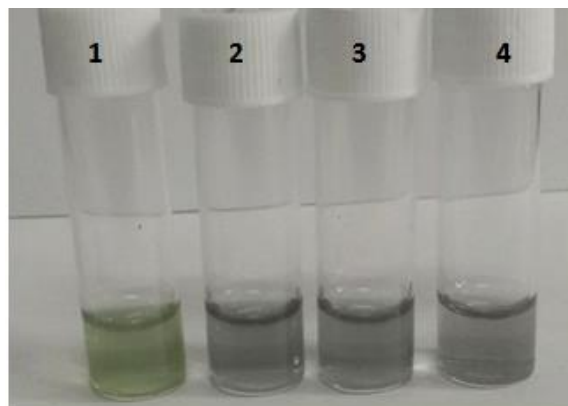


Fig. S50 Matrix study; (1) AgNPs + mixture {solution} containing different amino acids i.e., Gly, Ala, Val, His, Arg, Leu, Lys, Gsh, Met, Phe, Thr, Trp. (2) AgNPs + solution containing above amino acid + Cys. (3) AgNPs + solution containing above amino acids + Cys + Hcys. (4) AgNPs + solution containing above amino acid + Hcys.

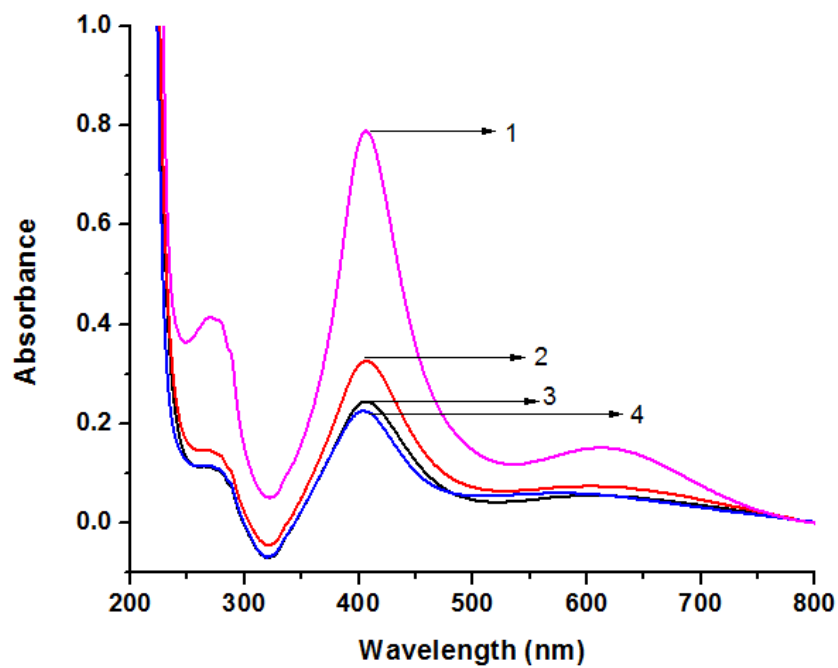


Fig. S51 U.V-Vis response of above matrix study.

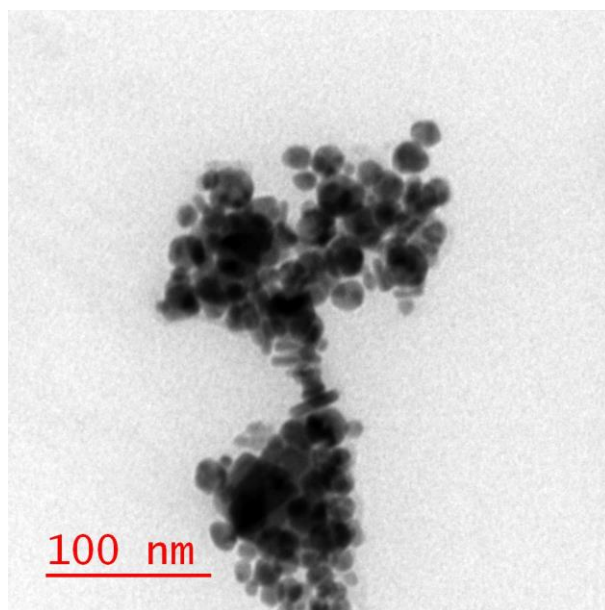


Fig. S52 TEM image of AgNPs synthesized at 40°C.

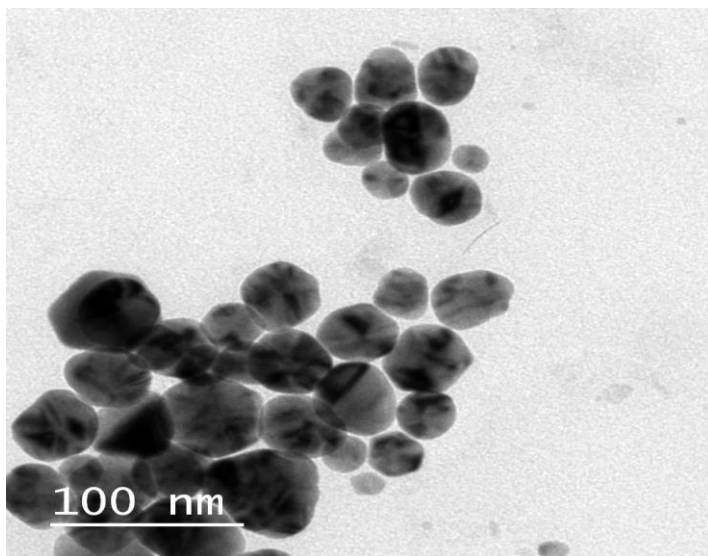


Fig. S53 TEM image of AgNPs synthesized at 60°C.

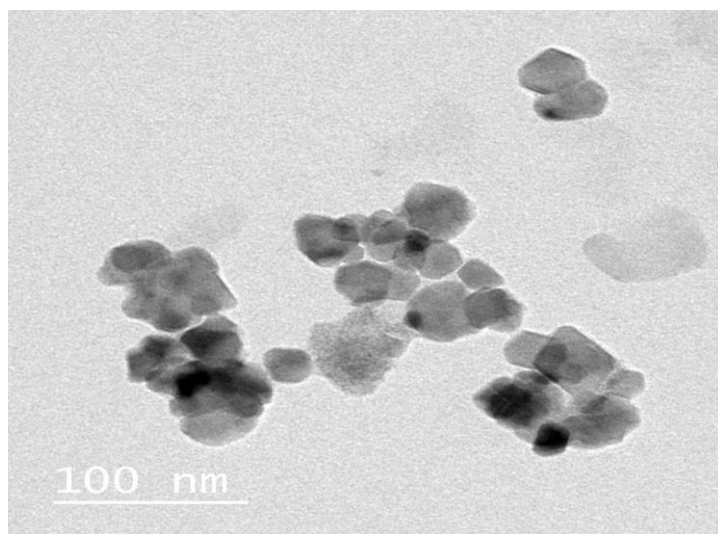


Fig. S54 TEM image of AgNPs synthesized at 80°C.

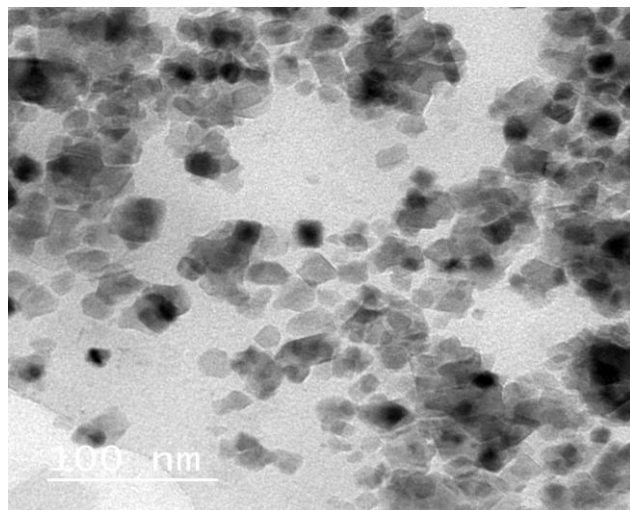


Fig. S55 TEM image of AgNPs synthesized at 100°C.

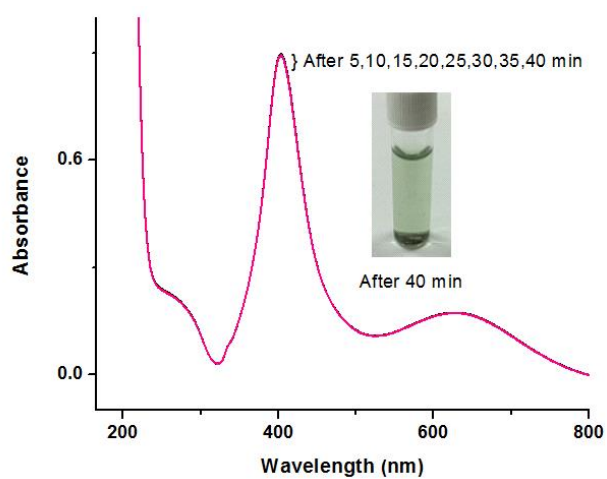


Fig. S56 Stability check through electrolyte addition (NaCl, .00 1M), repeated 8 UV-Vis readings at the interval of 5 min.

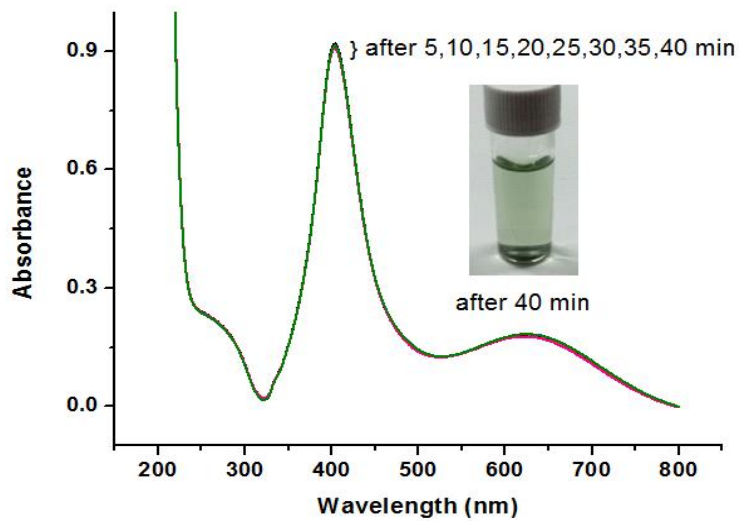


Fig. S57 Stability check through electrolyte addition (NaCl, 0.1M), repeated 8 UV-Vis readings at the interval of 5 min.

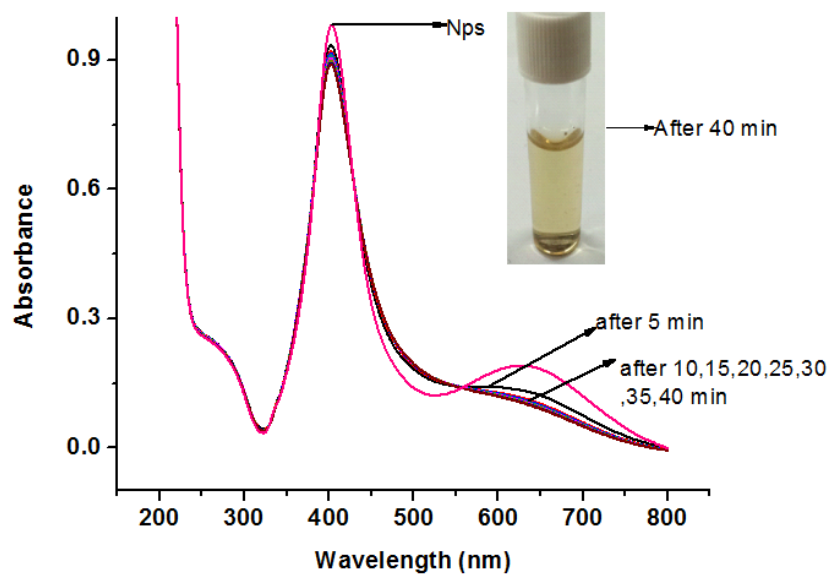


Fig. S58 Stability check through electrolyte addition (NaCl, 1M), repeated 8 UV-Vis readings at the interval of 5 min.

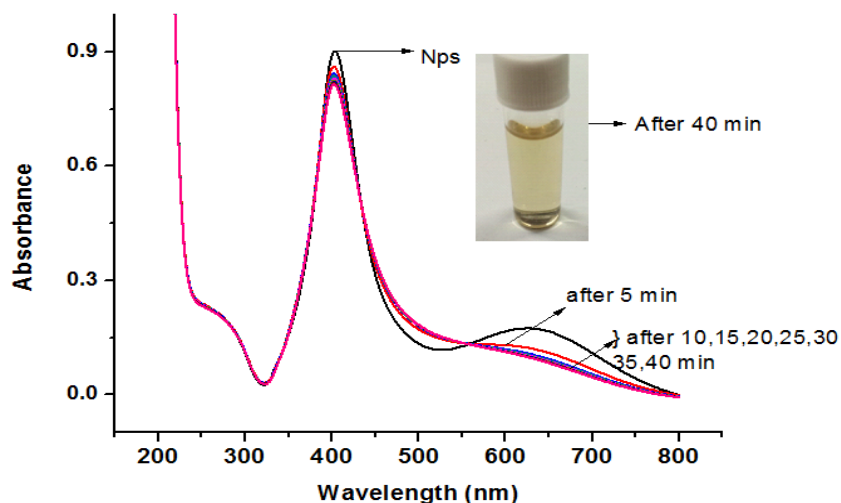


Fig. S59 Stability check through electrolyte addition (NaCl, 2M), repeated 8 UV-Vis readings at the interval of 5 min.

Fig. S60 Table for comparison of present work with previous works for sensing of cysteine and homocysteine through nanoparticles in terms detection limit.

Analyte	Detection limit (Iod)	References
1 Cysteine Homocysteine	0.16 μM 0.25 μM	1
2 Cysteine	0.05 μM	2
3 Cysteine Homocysteine	0.260 μM 0.010 μM	3
4 Cysteine/Homocysteine	0.4 μM	4
5 Cysteine	25.37 μM	5
6 Cysteine	4nm	6
7 Cysteine Homocysteine	1.14 μM 0.637 μM	Present study

- 1 S. Shariati and G. Khayatian, *RSC Adv.*, 2021, 11, 3295.
- 2 S. Chen, H. Gao, W. Shen, C. Lu and Q. Yuan, *Sens. Actuators B: Chem.*, 2014, 190, 673-678.
- 3 Reference 34 main text.
- 4 H. Gao, W. Shen, C. Lu, H. Liang and Q. Yuan, *Talanta*, 2013, 115,1-5.
- 5 A. D. Viana, E. T. Nobrega, E. P. Moraes, A. O. W. Neto, F. G. Menezes and L. H. Gasparotto, *Mater. Res. Bull.*, 2020, 124, 110755.
- 6 Reference 25 main text.

Fig. S61 Table for comparison of specific detection of homocysteine with previous works in terms of detection limit.

Analyte	Detection limit (lod)	reference
Hcys	0.2 μM	1
Hcys	2.6 μM	Present study

1. Reference 29 main text.

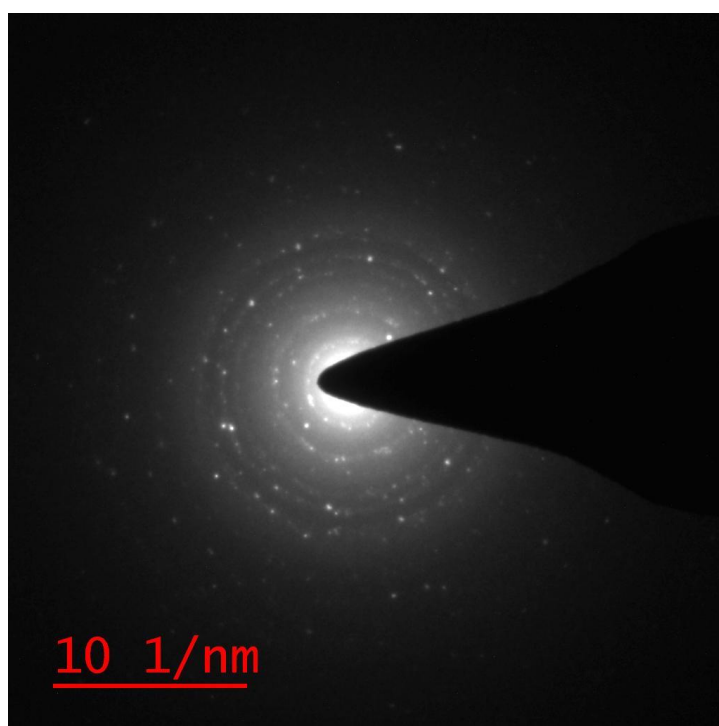


Fig. S62 SAED pattern of AgNPs after addition of L-Cysteine.

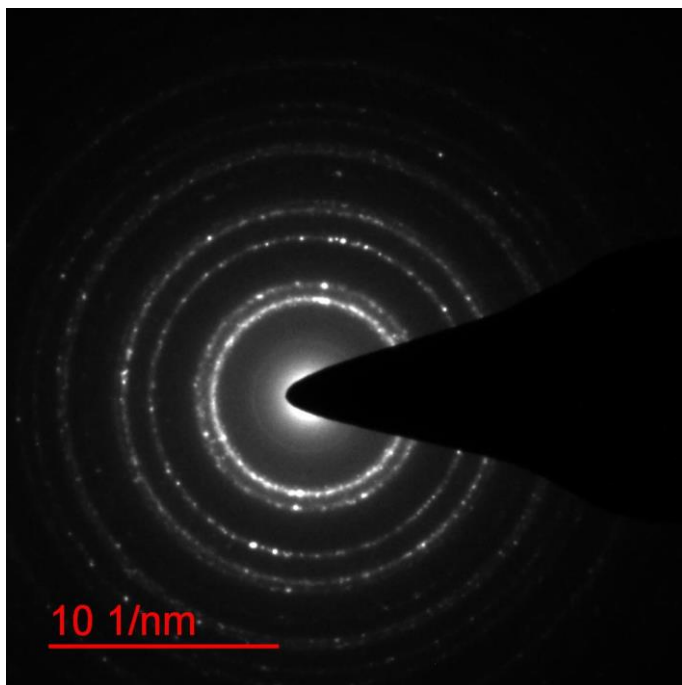


Fig. S63 SAED pattern of AgNPs after addition of l-homocysteine.

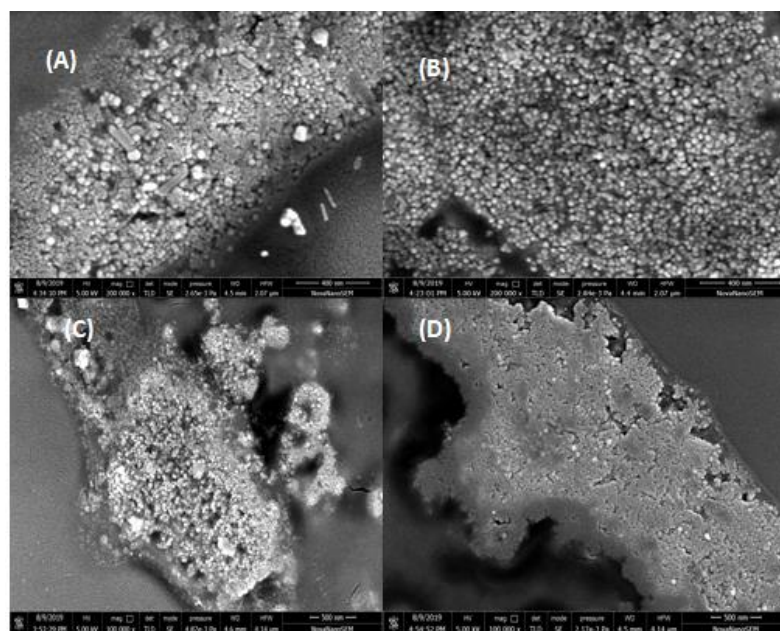


Fig. S64 SEM images of AgNPs synthesized at 4 different temperatures viz., (A) 40°C, (B) 60°C, (C) 80°C and (D) 100°C.

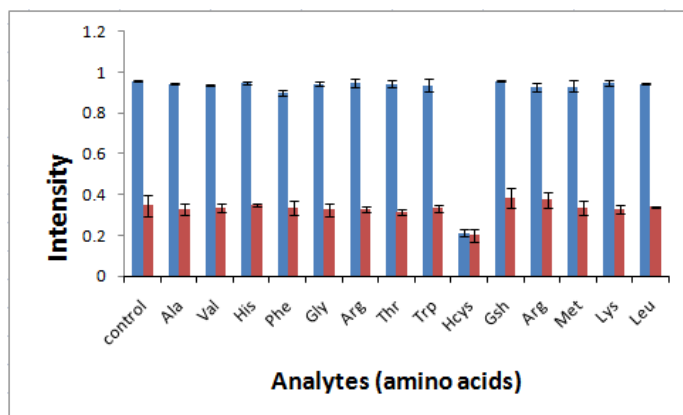


Fig. S65 Interference study of AgNPs (synthesized at 40°C) with various amino acids; blue bar: AgNPs + amino acids, red bars: AgNPs + amino acids + Cys, Control: Only AgNPs (blue bar) and AgNPs + Cys (Red bar).