Electronic Supplementary Material (ESI) for Analytical Methods

Thioctic acid modified gold nanoparticles for highly specific and ultrasensitive detection of lanthanum in soil and water

Alok Pandya[a], Kuldeep V. Joshi[a], Pinkesh G. Sutariya[a] and Shobhana K. Menon[a]*

Department of Chemistry, School of Sciences, Gujarat University, Ahmedabad, Gujarat-380009, INDIA

E-mail: shobhanamenon07@gmail.com ,

Fax: +91 79 26308545; Tel: +91 79 26302286

Materials and methods:

All chemicals used are of analytical grade or of the highest purity available.. All solutions were prepared with double-distilled, deionised water. $HAuCl_4$ and lanthanum hexahydrate were purchased from Aldrich with high purity. Working standard solutions were prepared daily in deionised water. UV–Vis absorption spectra were acquired on a Jasco V-570 UV–vis spectrometer. IR spectra were measured with a Bruker Tensor-27 FT-IR spectrometer. Transmission electron micrograph (TEM) was recorded by JEOL, JEM-2100(200 kV). DLS measurements were performed using Nanotrac instrument. pH measurement were made by using model EQ-664 (Equip-tronics).

Microwave synthesis of gold nanoparticles:

The procedure was essentially the same as those developed by A. Pandya and et al[1] with difference only in the use of microwave for the synthesis .The molar ratio of $HAuCl_4$ to sodium citrate also has been changed accordingly. All glassware was thoroughly cleaned with freshly prepared 3:1 HCl/HNO_3 (aqua regia) and rinsed thoroughly with Milli-Q water prior to use. The synthesis was carried out in a modified CEM Discover microwave using single mode and continuous power at 2.45 GHz. The reactions were carried out in sealed reaction vessel containing 3 ml of 0.4 mM $HAuCl_4$ solution and 2 ml of 13 mM sodium citrate and was heated at 75 ^{0}C at a power up to 300 W for 4 min. The solution changed from pale yellow to burgundy to yield Au nanoparticles of 34 nm.

Preparation of Thioctic acid capped gold nanoparticles (TGNPs):

TGNPs nanoparticles were prepared by modifying a previously published method[2] First, citrate capped gold nanoparticles nanoparticles were filtered (0.45 μm filter, Whatman) and centrifuged at 5000 RPM (for 40 minutes) to remove large aggregates and excess citrate, respectively. Thioctic acid functionalization was carried out by adding 4 ml 1 mM thioctic acid to 6 mL aliquots of 0.4 mM gold nanoparticles. This solution was allowed to stir in the dark for at least 15 hrs at 20°C. Finally pink red color solution of thioctic acid capped gold nanoparticles(TGNPs) is obtained and confirmed by FT-IR and UV-Vis spectroscopy.

Figure S 1

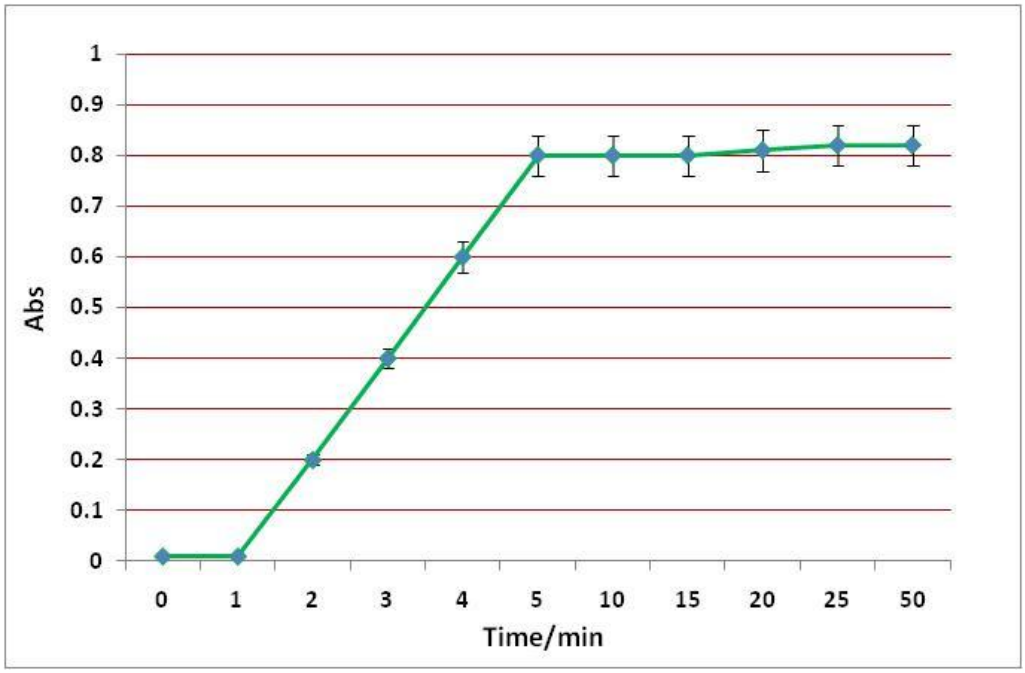

Fig.S1 Shows the response behaviour after addition of lanthanum in TGNPs

Figure S2

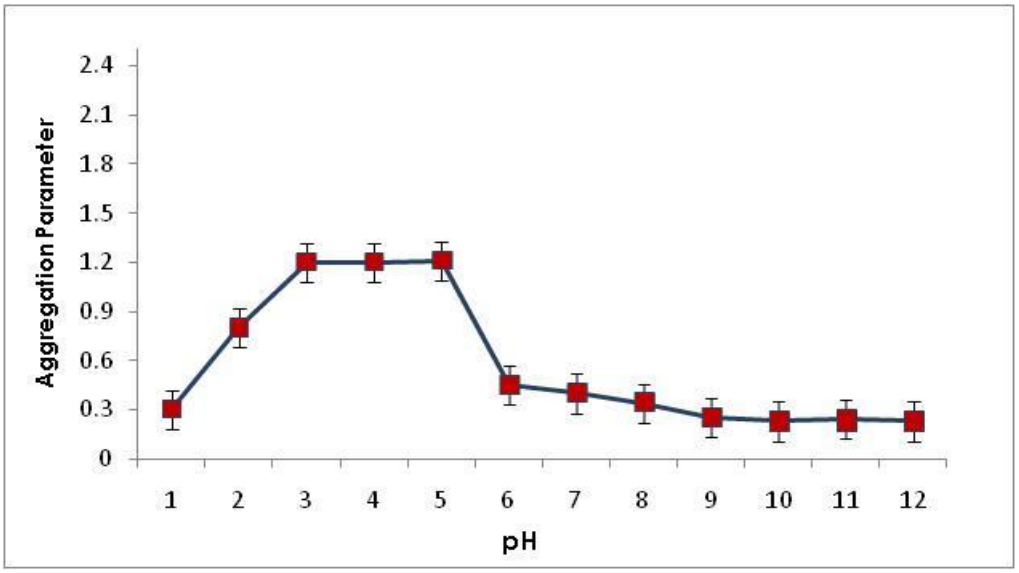

Fig. S2 Shows the plot after addition of lanthanum concentration into the TGNPs at different pH

Figure S3

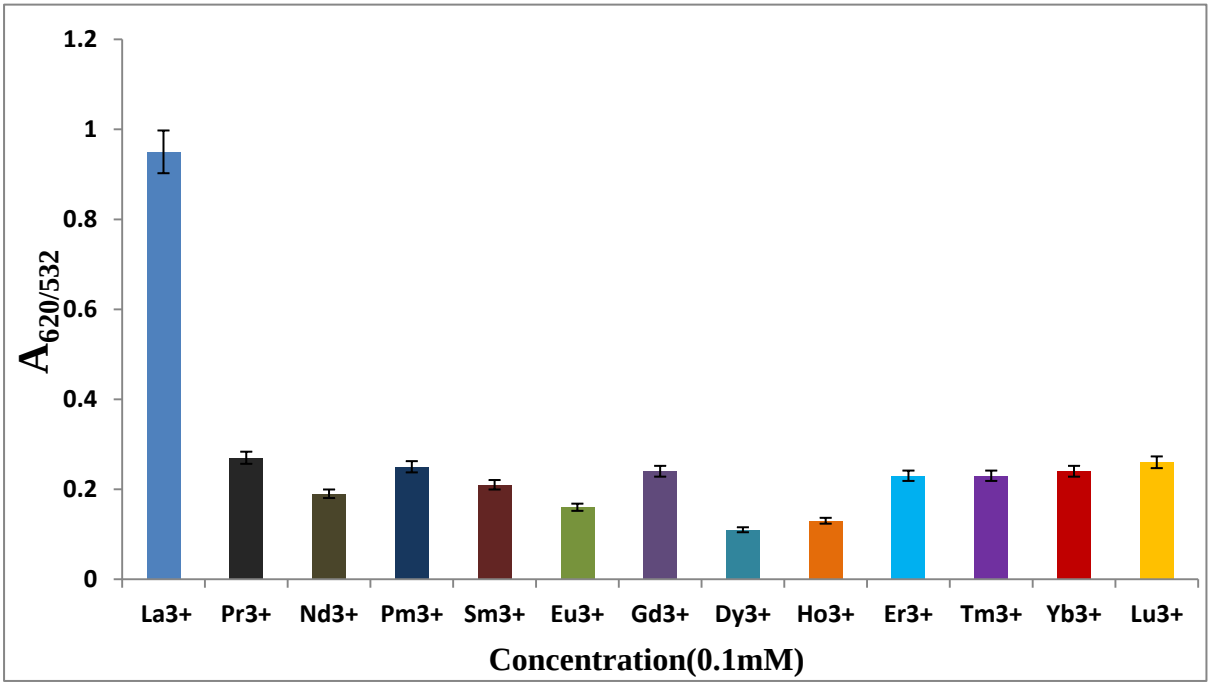

Fig. S3 The relative absorbance change of TGNPs at 532 nm in the presence of 0.1 mM lanthanum ion over other closely associated ions

Figure S4

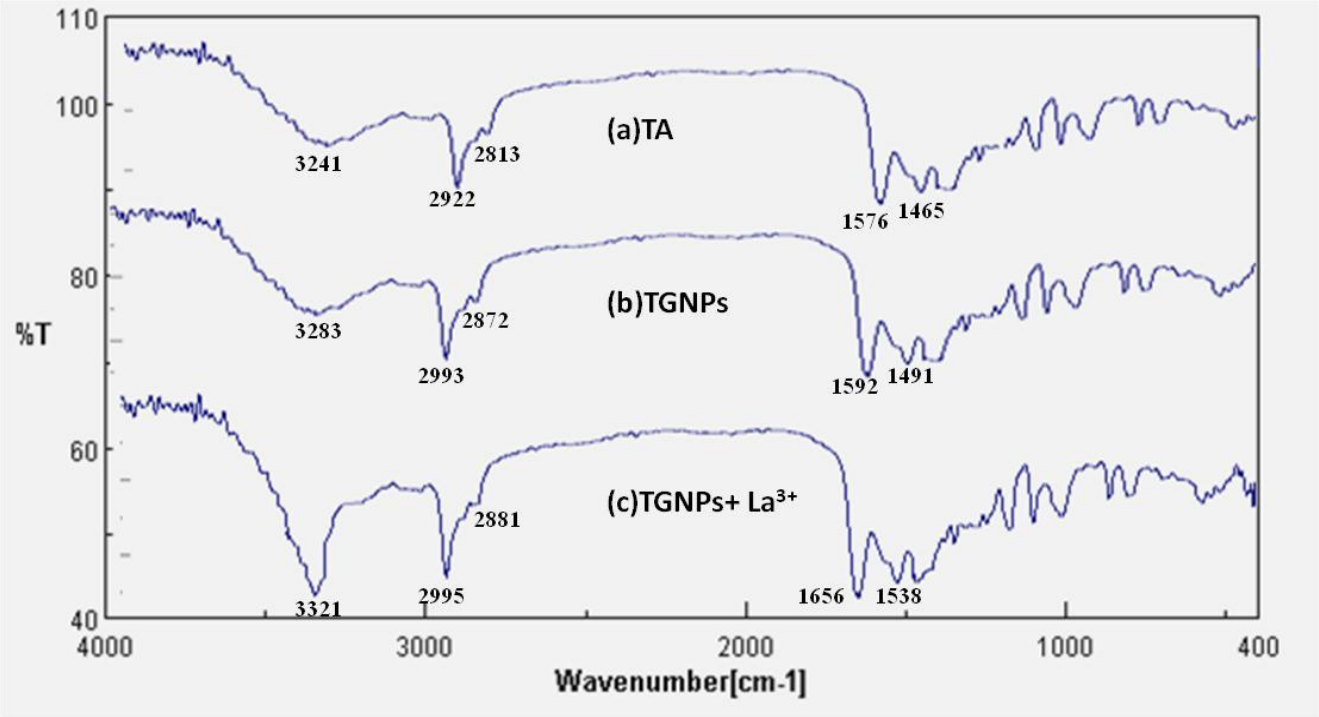

Fig.S4.Transmission IR spectra of (a)Thioctic acid(TA)(b) Thioctic acid modified gold nanoparticles(TGNPs) (c) TGNPs-La^{3+} complex formation

Table 1

Solution of pH	2	4	6	8	10
Stability of TGNPs	5 h	7 h	Weeks	Months	Months

Table 1 Stability of TGNPs assembly at different pH conditions

References:

1. A. Pandya, K.V. Joshi, N.R. Modi, S. K. Menon, *Sensors and Actuators*,2012, **168**, 54– 61.

2 M. R. Ivanov, H.R. Bednar, A.J. Haes. *ACS Nano*.(2009) **3**,386–394