Electronic Supplementary Material (ESI) for Analyst.

Supporting Information

A paper based microfluidic device for easy detection of uric acid using positively charged gold nanoparticles

All chemicals were received from Sigma Aldrich. HPLC grade water was used throughput.

Synthesis of positively chargedgold nanoparticles:Positively charged gold nanoparticles were synthesized by adding 50.0 µl of (0.1M) $NaAuCl_4$ and 50.0 µl ascorbic acid solution (24.0 mg/ml) to 10 ml of warm HPLC water stirred at 40°C. Color gradually turns to bright red indicating the formation of positively charged gold nanoparticles ((+)AuNPs)). The final gold nanoparticles were centrifuged with 5000 rpm for 9 minutes and suspended in water for characterization.

Size and charge (zeta potential) measurements of the gold nanoparticles: The charge and size of the +AuNPs were evaluated. The average diameter was measured by NS500 (Nanosight Instruments, UK) in aqueous medium at a temperature of 25°C. The surface charge was determined by zeta potential measurement according to the manufacturer's instructions for measurement in high ionic strength media at 25°C. All measurements were performed in triplicate following dilution of the nanoparticle by dispersing in high grade HPLC water (1mg/mL). The average size and charge of the particles were found to be 82 nm and +20 mV respectively (Fig. S1).The size of (+)AuNPs was also determined by FESEM as shown in Fig. S2. We checked the stability of these (+)AuNPs after long time storage at 4^0C. We found that (+)AuNPs remain active on paper even after 4 weeks.

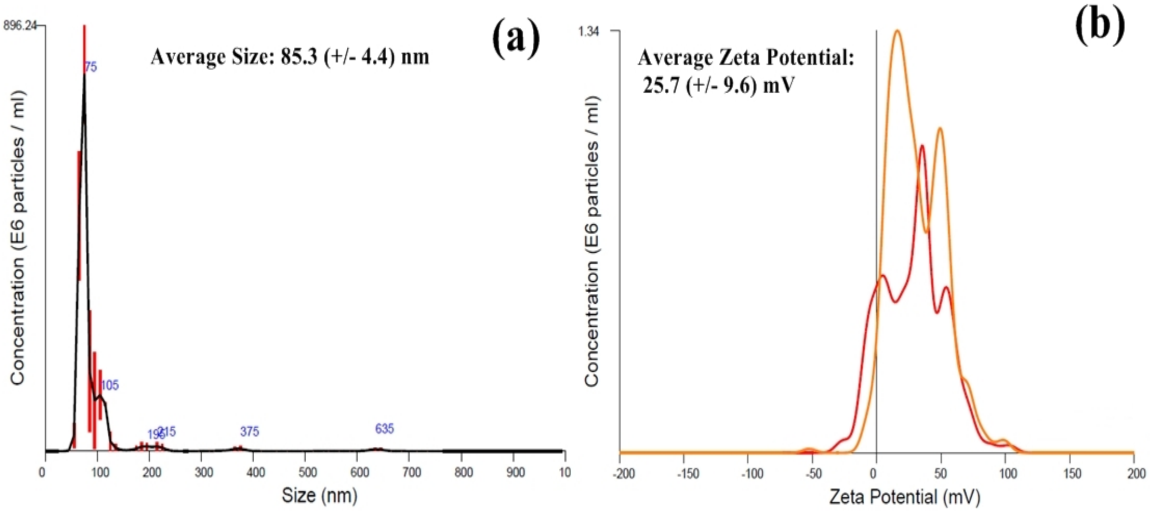

Fig. S1 Size and charge measurement of (+)AuNPs. (a) shows the size distribution and (b) shows the zeta potential distribution of (+)AuNPs for two consecutive runs of same sample.

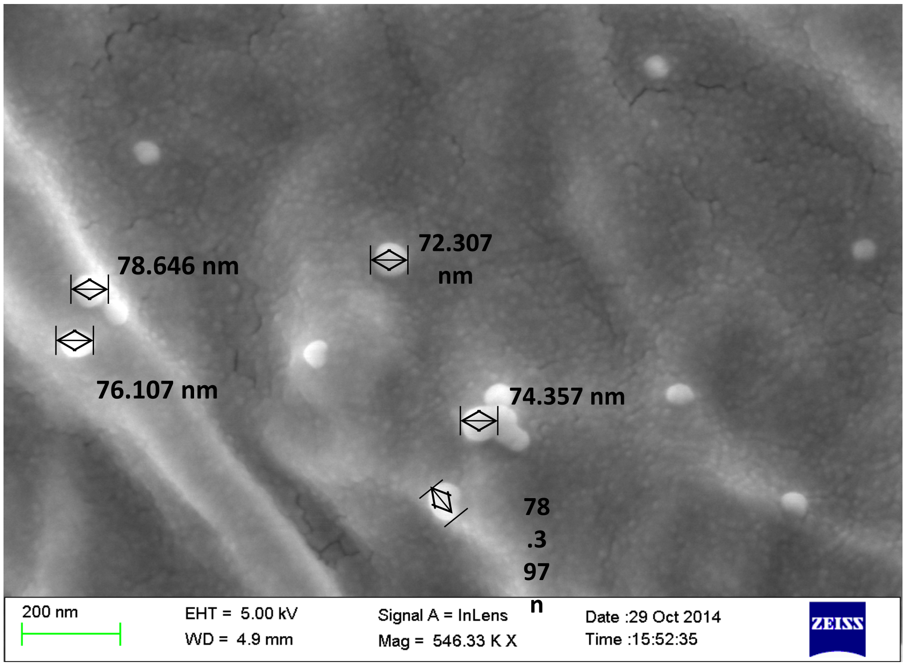

Fig. S2 FESEM image of (+)AuNP with their sizes.

UV-Vis spectroscopic measurements: Different colors of the liquid phase solutions as well as solid state papers were analyzed by UV-Vis spectroscopy (Cary 60; Agilent). Following figure shows the UV-Vis spectrum of (+)AuNPs solution.

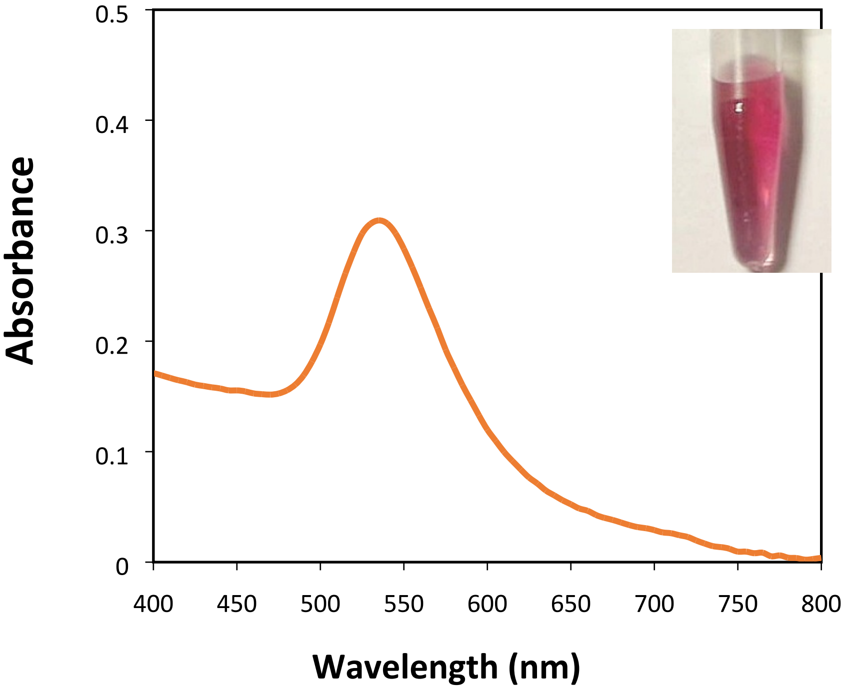

Fig. S3 UV-Vis absorption spectra of the prepared (+)AuNPs. (Inset image shows the color of the (+)AuNPs solution)

Fabrication of Paper strip: Filter papers were cut into pieces of proper dimension with a circular head with the help of CO_2 laser engraving machines. The paper strips were washed with boiled HPLC water and dried. The dried strips were then coated with 0.5% poly-vinyl alcohol (PVA) which helps the paper to retain aqueous sample that would otherwise spread more rapidly on hydrophilic paper. After PVA coating, the strip heads were soaked with positively charged gold nanoparticles. Next it was characterized by Field-emission scanning electron microscopy (SEM, Zeiss Sigma HD) technique. Fig. S4 shows the differences in physical structures of the paper matrix before and after PVA coating.

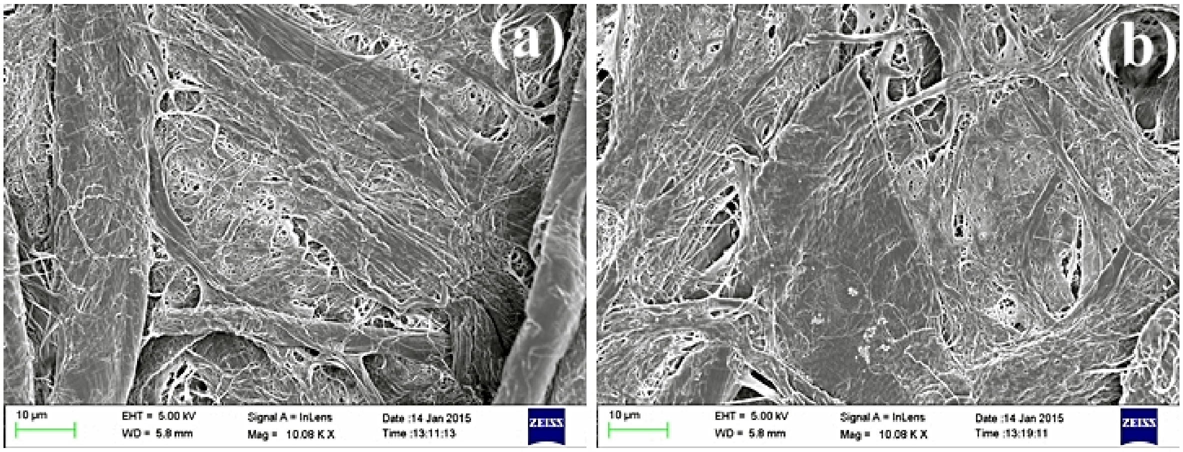

Fig S4 FESEM images of paper substrate without (a) and with (b) PVA coating.

Variation of colour intensity with changing amount of gold nanoparticles:

Following figure (Fig. S5) shows the change of color intensity with varying amount of (+)AuNPs. It is seen that with the increase of (+)AuNPs, intensity of red followed by bluish-green color increases. But with the increase of bluish-green intensity, colour disappearence time due to addition of uric acid also increases which is not desirable for fast detection. Hence,10 µl of (+)AuNPs which shows detectable color change is sufficient for the present purpose.

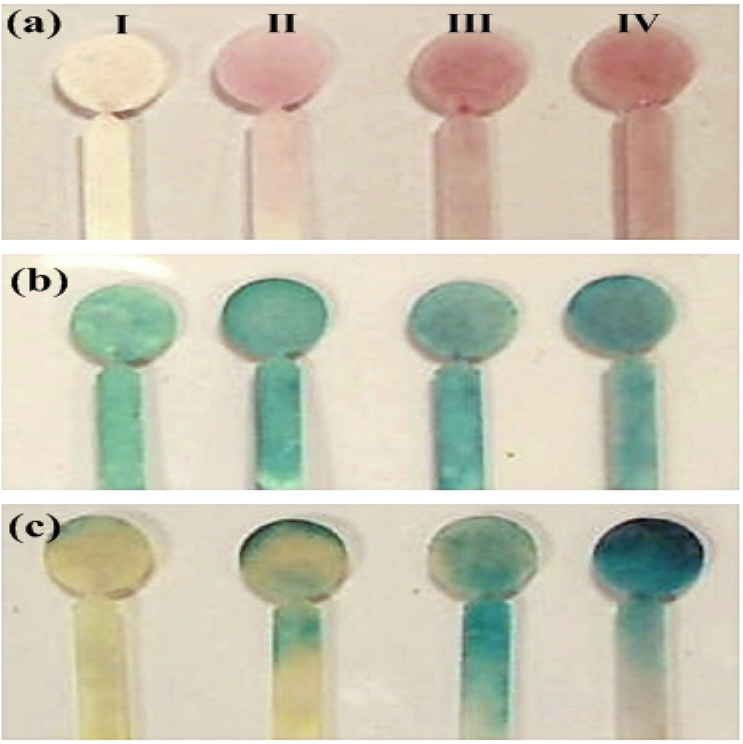

Fig. S5 Variation of colour of paper strips with changing amount of positively charged gold nanoparticles. Top row (a) shows the colour change of paper strip from I to IV due to addition of 10 µl, 20 µl, 30 µl and 40 µl of (+)AuNP solution (1.93 X 10^9 particles/ml concentration) respectively. Middle row (b) shows the variation of bluish-green colour of the same strips after addition of 20 µl TMB and H_2O_2 solution. Bottom row(c) shows the final states of the same strips after adding uric acid solution of a particular strength (100 ppm).