Supporting Information

Real-Time Monitoring of Plasmon Induced Proton Transfer to Hypoxanthine in Serum

Binbin Zhou, [‡a,b] *Shaofei Li,* [‡a,b] *Xianghu Tang,* [a] *Pan Li,* [a] *Xiaomin Cao,* [a,b] *Borong Yu,* [a,b] *Liangbao Yang,* [a,b] * *and Jinhuai Liu* [a,b]

[a] Institute of Intelligent Machines, Chinese Academy of Sciences, Hefei 230031, China.

[b] Department of Materials Science and Engineering, University of Science and Technology of China, Hefei 230026, China

Part S1: Experimental Section

Reagents. Sodium citrate, Hydrogen tetrachloroaurate ($HAuCl_4 \cdot 4H_2O$), Silver nitrate, and (3-Aminopropyl) trimethoxysilane were bought from Shanghai Chemicals Company. The Millipore water purification was used to produce ultrapure water (18.2 MΩ cm).

Experimental:

Synthesis of Au nanoparticles[1]**:**

A solution of $HAuCl_4$(1 mL, 1% w/v) in Milli-Q water (99 mL)was heated with a heating mantle in a 250 mL three-necked round-bottomed flask for 15 min under vigorous stirring. After boiling had commenced, 1 mL of sodium citrate (1% w/v) was injected. The color of the solution changed from yellow to bluish gray and then to soft pink in 15 min.

Synthesis of Au/SiO_2[2]:

Seed particle solutions were synthesis by citrate reduction of $HAuCl_4$.[1] 0.4 ml freshly prepared aqueous solution of 1 mM (3-Aminopropyl) trimethoxysilane was added to the 30 ml seed sol under vigorous magnetic stirring in 15 min, ensuring complete complexation of the amine groups with the gold surface. Then 3.2 ml 0.54 wt % sodium silicate solution was added to the above solution, again under vigorous magnetic stirring. To accelerate the synthesis procedure and make the ultra-thin silica shell, we elevated the reaction temperature from room temperature to 90℃.

Characterization:

All the Raman spectra were obtained on a laboratory Raman spectrometer. For the Lab-RAM HR800, a 633 nm laser was used as the excitation source. Different objective and laser intensity were chosen in different experiments. The morphologies and structures of the products were investigated by using a 200FEG field emission scanning electronic microscope (FESEM) and a JEM-2010F high-resolution transmission electron microscope (HRTEM) with a field emission gun operating at 200 kV.

Part S2: Monitor and control intramolecular proton transfer by by surface plasmons

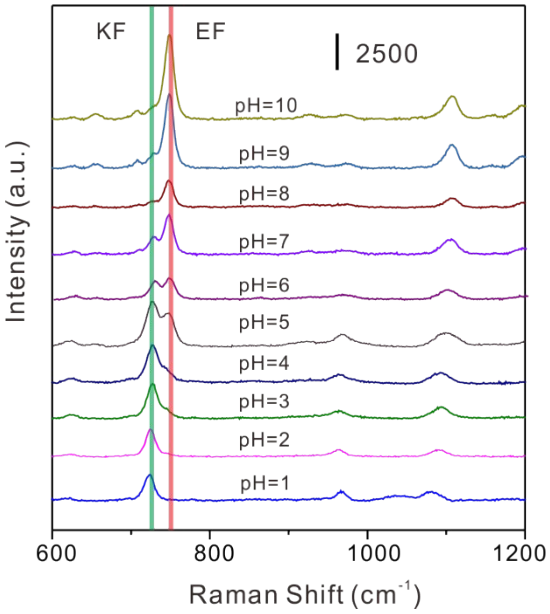

Fig. S1 SERS spectra of different pH hypoxanthine solution in the presence of Au NPs.

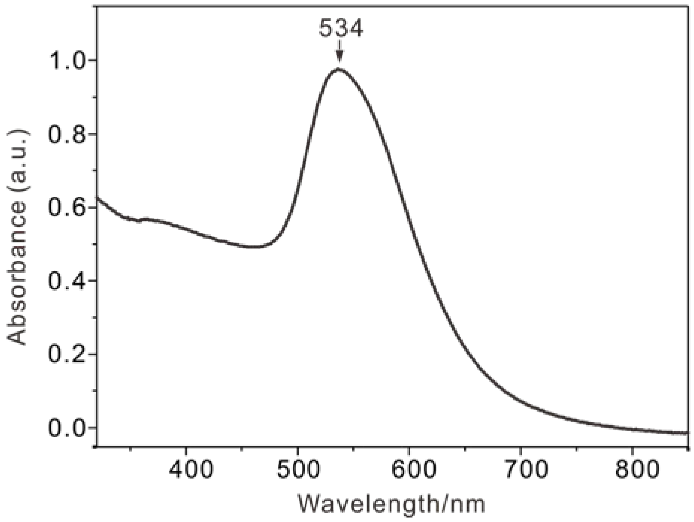

Fig. S2 The UV-Vis absorption spectrum of the Au NPs.

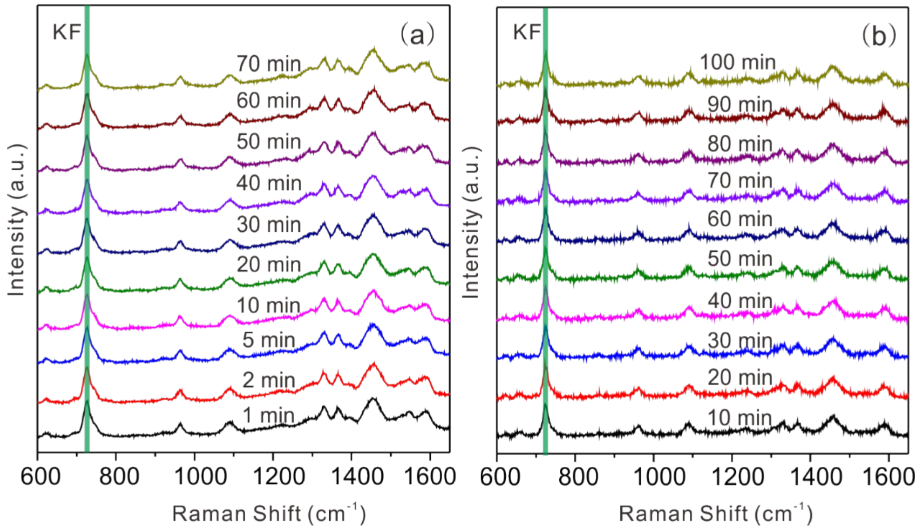

Fig. S3 (a) Raman spectra of Hypoxanthine solution was exposed to 633 nm laser excitation for different time periods. It shows that without the presence of noble metal nanoparticles, enolic form (EF) would not be converted to ketonic form (KF) of Hypoxanthine under laser excitation. (b) SERS spectra of Hypoxanthine solution was absorbed on the Au nanoparticles for different time periods. It shows that without continuous exposure to a laser, proton transfer reaction cannot be observed on the Au nanoparticles. SERS measurement was carried out with a 50× objective, a maximum power densities of 2.80 mW/μm^2 and an acquisition time of 1 s.

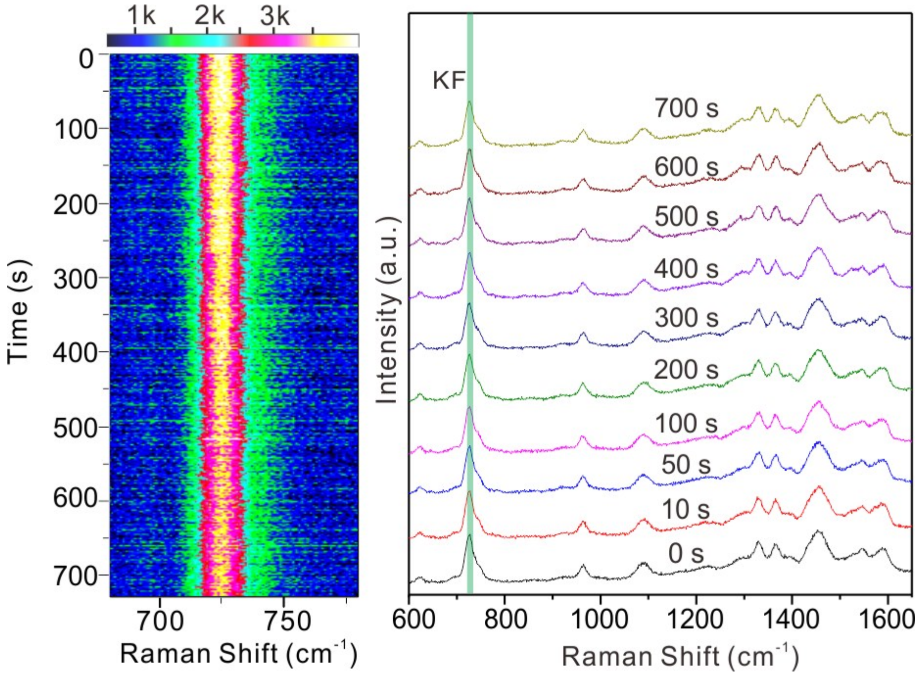

Fig. S4 (a) the alteration of 2D SERS mapping at 700-780 cm^{-1} with increasing time. (b) The time-dependent SERS spectra of Hypoxanthine under 785 nm laser radiation

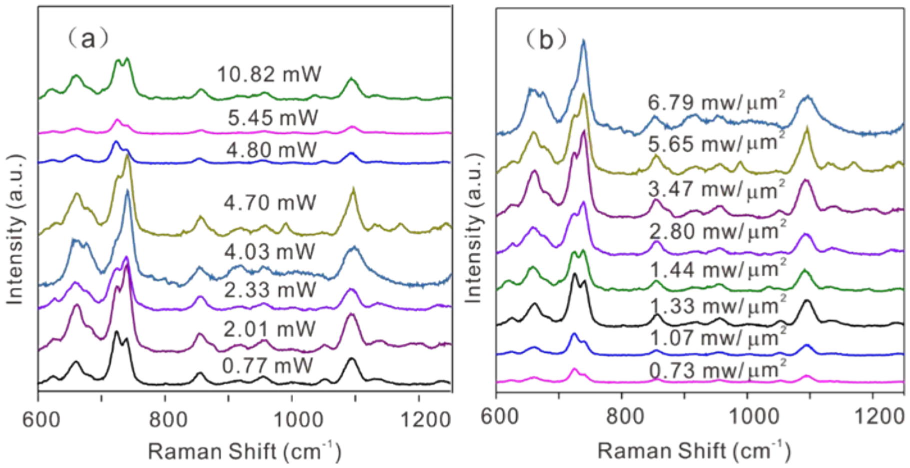

Fig. S5 (a) Power-dependent SERS spectra of Hypoxanthine (b) Power densities-dependent SERS spectra of Hypoxanthine. Laser Power is direct detected by Power meter.

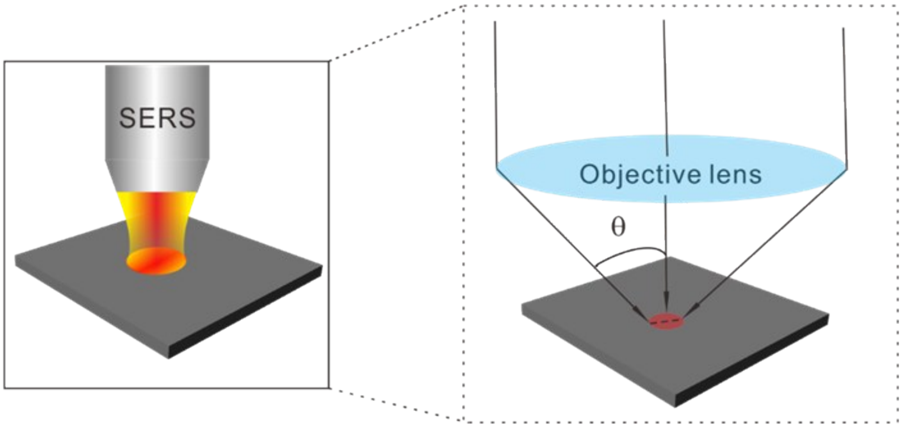

Fig. S6 The diagram of the Objective lens and spot size.

According to the diffraction limit formula, the spot size satisfy the following relations:

$$\text{Spot size} = 1.22\lambda / \sin\theta$$ □□□

Collect Angle (θ) is a feature constant of the Objective lens, as shown in Figure S1.

When the λ=633nm, according to the Collect Angle of the different objective, we can get the following results:

$$\text{Spot size (x 100)} = 0.57789\ \mu m^2$$

$$\text{Spot size (x 50)} = 0.83119\ \mu m^2$$

$$\text{Spot size (x 10)} = 7.94\ \mu m^2$$

So different objective will lead to different spot sizes under the same laser wavelength.

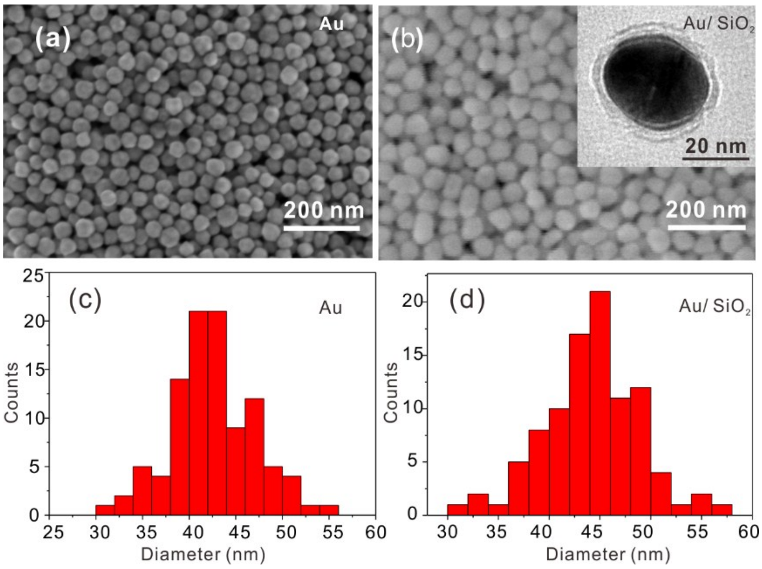

Fig. S7 The SEM of the different materials. (a) Au NPs (b) Au/SiO_2 The inset shows the TEM of the Au/SiO_2.The size-distribution histogram of (c)Au nanoparticles and (d) Au/SiO_2.

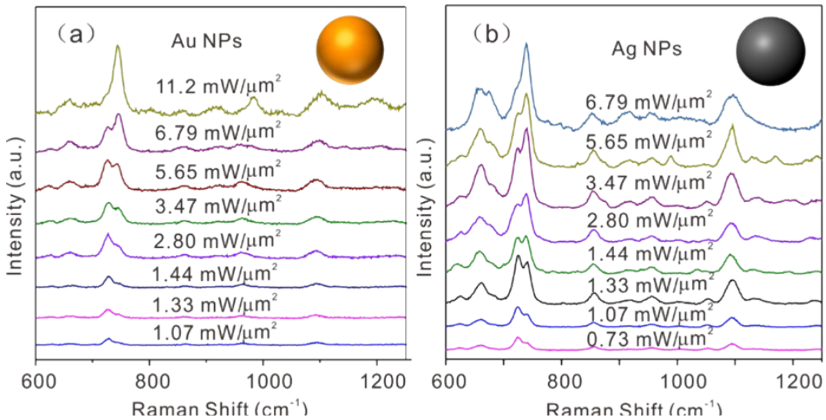

Fig. S8 Power densities-dependent SERS spectra of Hypoxanthine at different SERS structure. (a) Au NPs (b) Ag NPs The all SERS spectra were collected with 1 s integration time.

Part S3: Monitor proton transfer of Hypoxanthine in the serum.

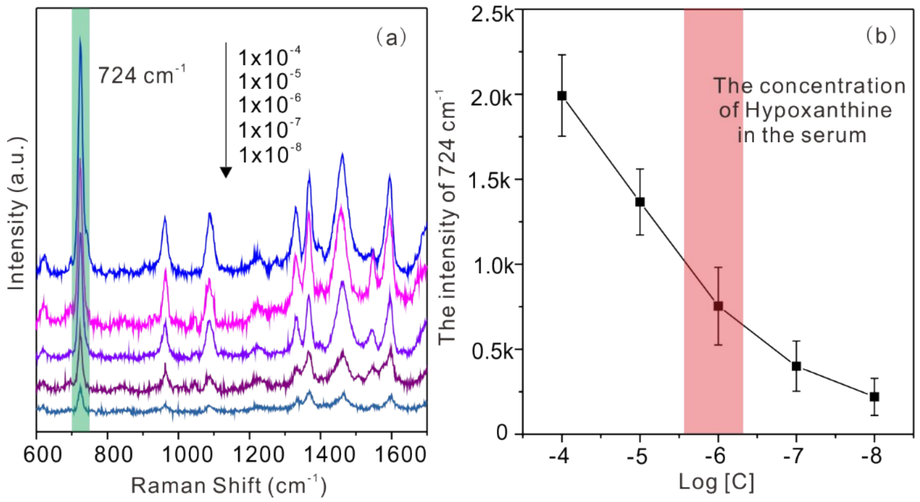

Fig. S9 (a) Hypoxanthine SERS spectra at different concentrations. (Between 10 nM and 100 μM with tenfold-increase steps) (b) SERS intensity of band at 724 cm^{-1} as a function of the concentration. Red rectangle shows the concentration range of Hypoxanthine in the serum.[3]

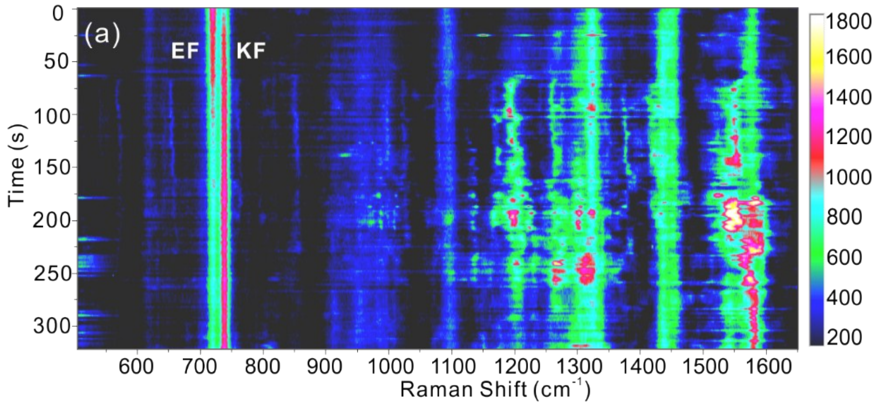

Fig. S10 The time-dependent SERS spectra of the serum. SERS measurement was carried out with a 50×objective, a maximum power densities of 2.80 mW/m^2 and an acquisition time of 1.8s.

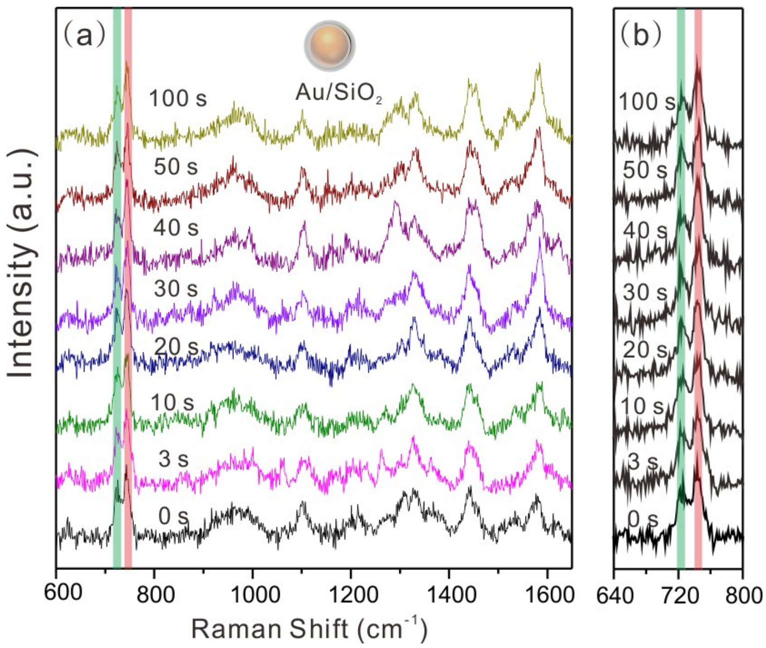

Fig. S11 (a) SERS spectra of serum was absorbed on the Au/SiO_2 for different time periods.; (b) zoom in peaks 640 and 800 cm^{-1} in part a; It shows that proton transfer reaction cannot be observed on the Au/SiO_2. SERS measurement was carried out with a 50× objective, a maximum power densities of 2.80 mW/μm^2 and an acquisition time of 1 s.

REFERENCES

1 G. Frens, *Nature-Phys. Sci.*, 1973, **241**, 20-22.

2 J. F. Li, Y. F. Huang, Y. Ding, Z. L. Yang, S. B. Li, X. S. Zhou, F. R. Fan, W. Zhang, Z. Y. Zhou, D. Y. Wu, B. Ren, Z. L. Wang and Z. Q. Tian, *Nature*, 2010, **464**, 392-395.

3 W. E. Wung and S. B. Howell, *Cancer Res.*, 1984, **44**, 3144-3148.