

**Smart Paper Transformer: New insight for enhanced catalytic
efficiency and reusability of noble metal nanocatalysts**

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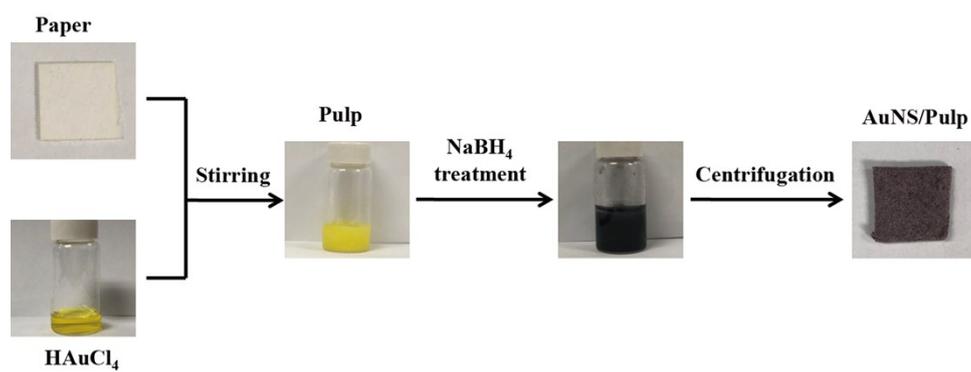
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Scheme.S1:



Scheme.S1 The actual preparation illustration of the *s*-PAT supported AuNS/pulp catalyst.

Fig.S1:

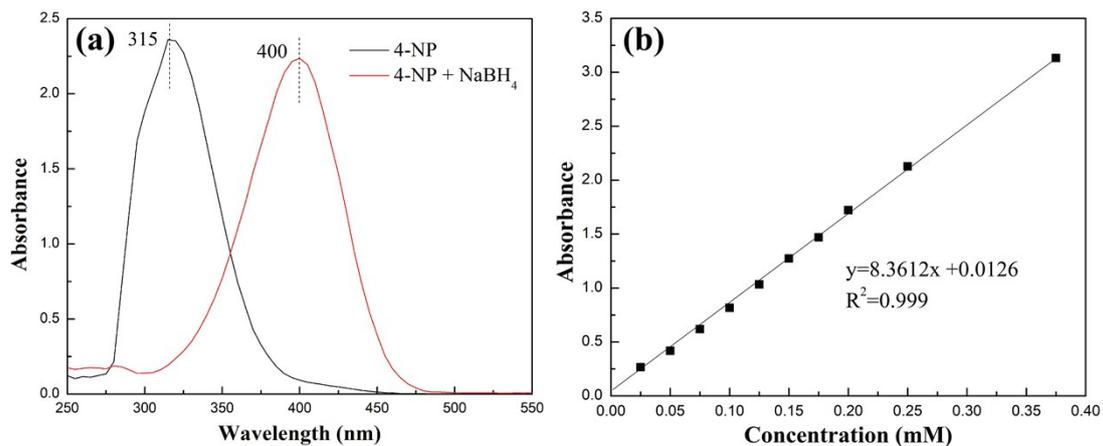


Fig.S1 (a) UV-vis absorption spectra of the 4-NP solution and 4-NP+NaBH₄ solution.

(b) The linear relationship between the absorbance and 4-NP concentration in this study. 4-NP concentrations were calculated based on this linear relationship.

Fig.S2:

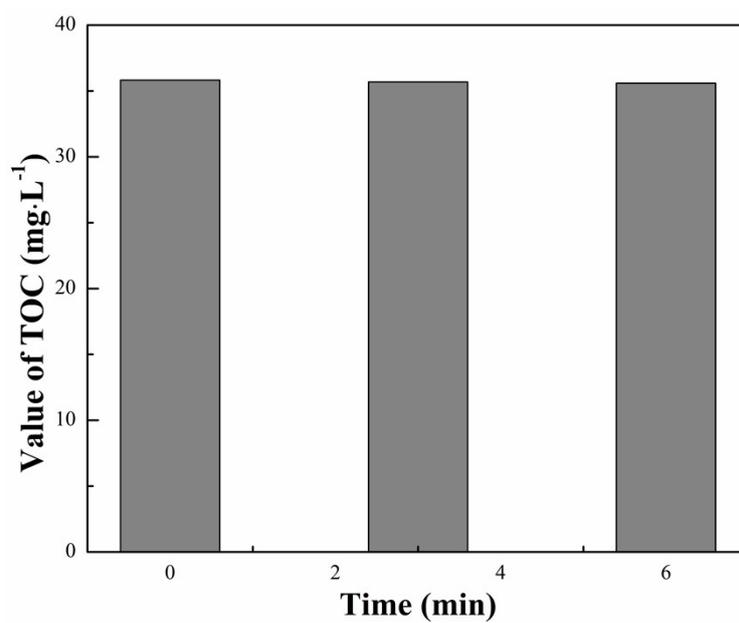


Fig. S2 The value of TOC for 4-NP reduction at different times. Reaction condition:
27 mg AuNS/pulp catalyst, 0.10 M NaBH₄ and 1 mM 4-NP.

Fig.S3:

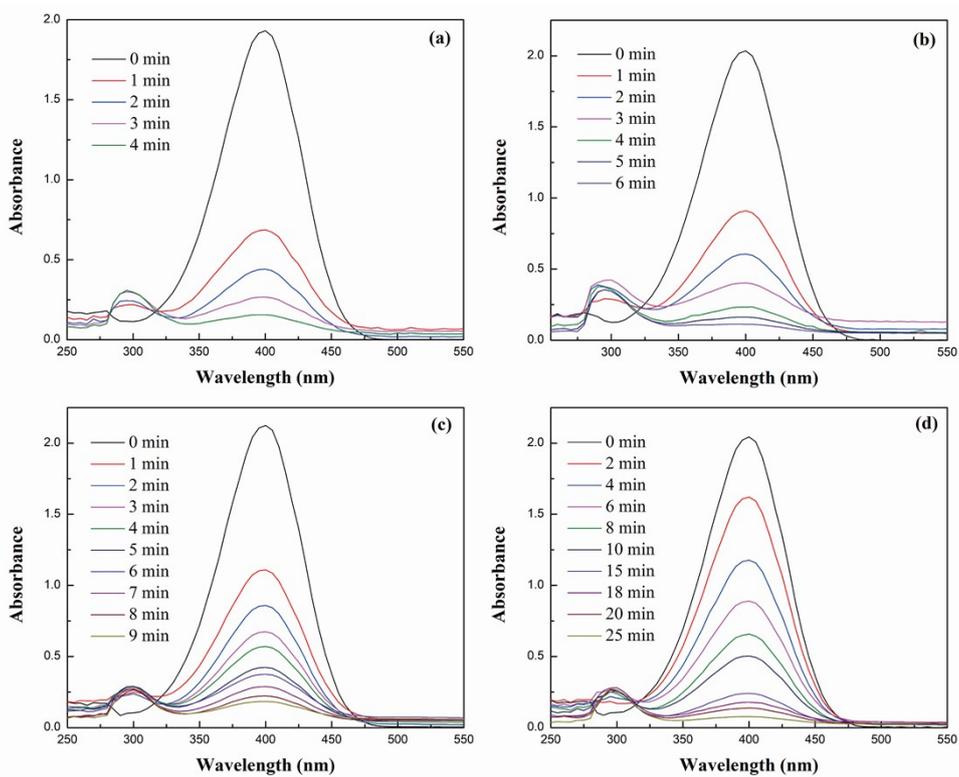


Fig.S3 UV-vis absorption spectra of the 4-NP reduction (1 mM) in the presence of (a) 0.20 M NaBH₄, (b) 0.10 M NaBH₄, (c) 0.05 M NaBH₄, and (d) 0.01 M NaBH₄.

Fig.S4

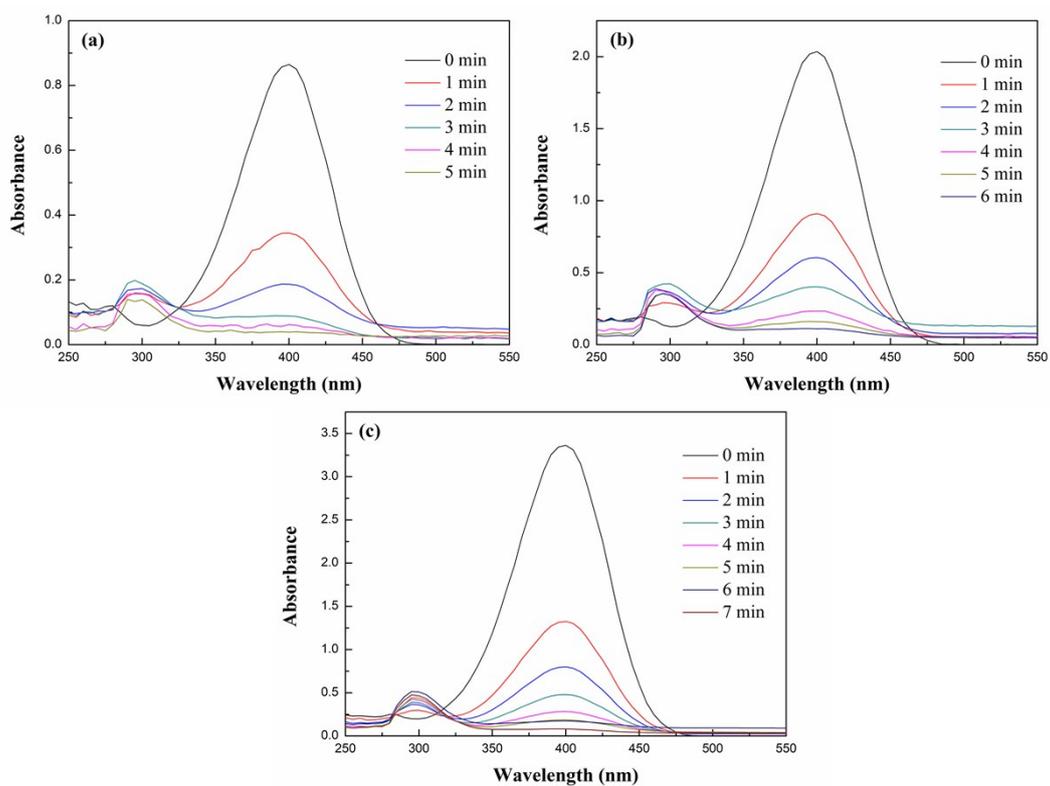


Fig.S4 UV-vis absorption spectra of the 4-NP reduction in the presence of (a) 0.5 mM, (b) 1.0 mM and (c) 2.0 mM 4-NP. NaBH_4 : 0.01M.

Table S1 The correlated data of the 4-NP reduction with different conditions.

Number	Catalyst amount (mg)	NaBH ₄ concentration (M)	4-NP concentration (mM)	t _{95%} (min)	k (s ⁻¹)
1	54	0.10	1	3	0.0158
2	27	0.10	1	4.5	0.0106
3	13	0.10	1	8	0.0068
4	27	0.01	1	25	0.0029
5	27	0.05	1	10	0.0049
6	27	0.20	1	3.7	0.0132
7	27	0.10	0.5	3	0.0188
8	27	0.10	2	6	0.0133

t_{95%} refers to the time when the catalytic efficiency is higher than 95%.

Fig.S5:

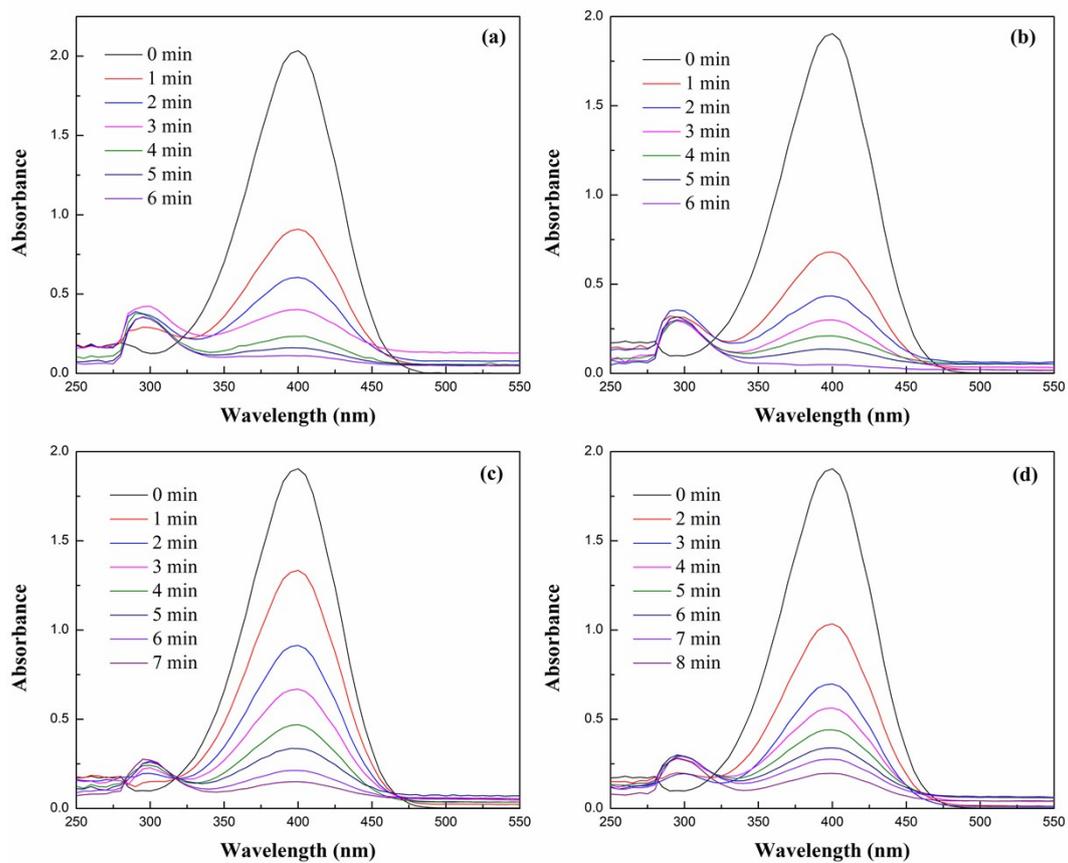


Fig.S5 UV-vis absorption spectra of the 4-NP reduction with different recycling times ranging from (a) the first time, (b) the fifth time, (c) the tenth time to (d) the fifteenth time.

Fig.S6:

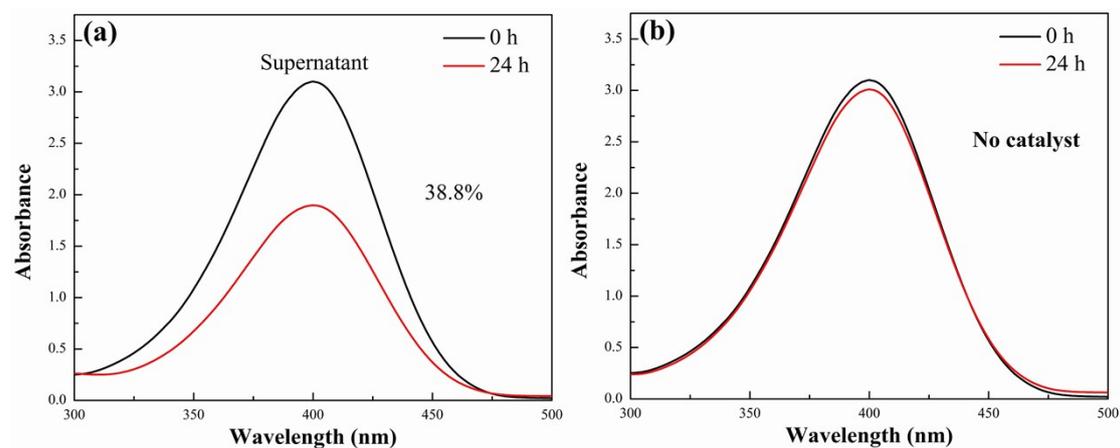


Fig.S6 UV-vis absorption spectra of the 4-NP reduction: (a) with the supernatant from last catalytic reduction and (b) without the supernatant (i.e. the catalyst). Details of the experiment: Firstly, the Au/pulp catalyst was used for the 4-NP reduction, and 1 mL supernatant was obtained by centrifugation. Then the supernatant was added to a mixed solution of 5 mL of 4-NP (1 mM) and 5 mL of NaBH₄ (0.1M). After 24 h, the absorbance of the solution was tested. As shown in Fig. S6(a), the catalytic efficiency was 38.8%, indicating that the supernatant contained a small amount of AuNS. We also used the mixed solution of 5 mL of 4-NP (1 mM) and 5 mL of NaBH₄ (0.1M) in the absence of the supernatant as a comparison. It could be seen that there was almost no catalytic efficiency without the catalyst. According to the catalytic experiment, a small amount of AuNS could be detached from the catalyst support owing to a weak interaction between the Au species and the pulp. Different from other catalytic experiments in this manuscript, herein, 3 mL mixed solutions were pumped in cuvette, and the cuvette was placed in a UV-visible spectrophotometer to measure the absorbance spectra.

Table S2 The Au content in the supernatant after the catalytic reaction measured by ICP

Sample	Element	Concentration (mg·L ⁻¹)
Supernatant	Au	0.47

The Au/pulp catalyst was first used for the 4-NP reduction, and 1 mL supernatant was obtained by centrifugation. Then the sample was tested by ICP to confirm the Au content in the supernatant. According to the Au content, it can be calculated that approximately 4.7 μg Au was detached from the Au/pulp catalyst during each cycle (10 mL of liquid). The weight of the detached Au was about 0.05 wt.% of Au content in the Au/pulp catalyst. Because of this, the Au/pulp catalysts still exhibited excellent reusability.

Fig.S7:

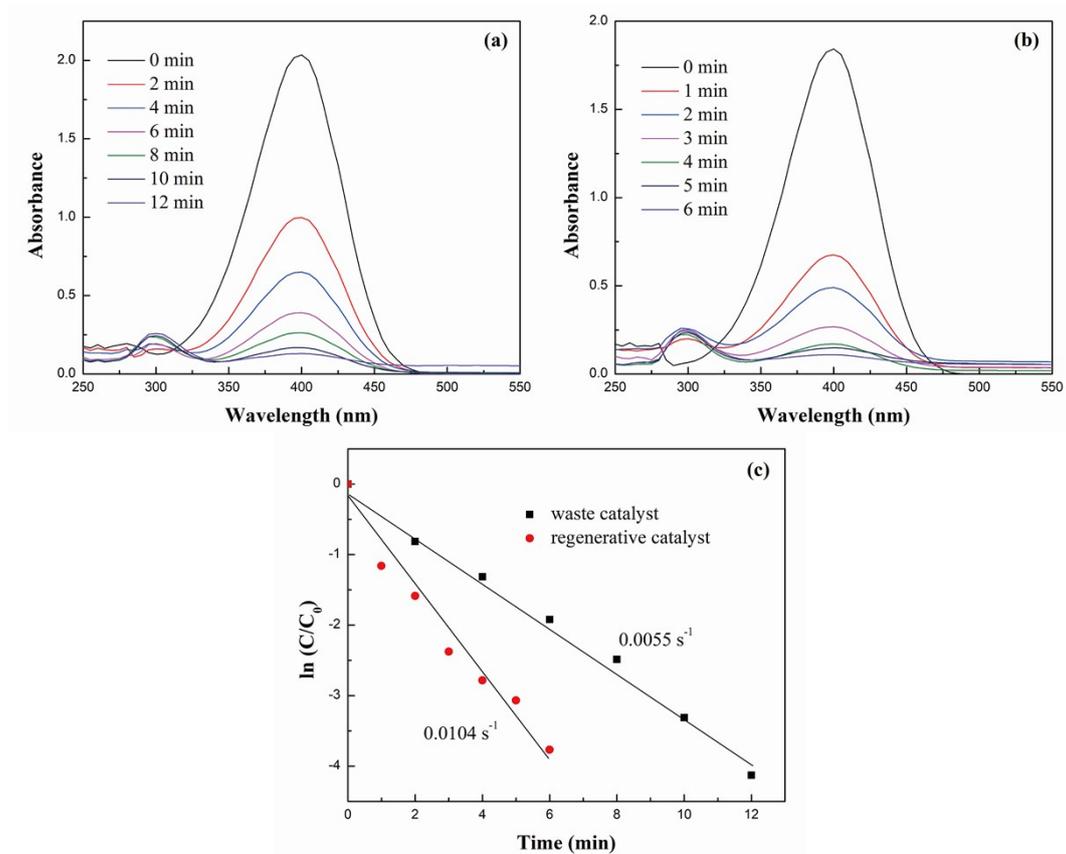


Fig.S7 UV-vis absorption spectra of the 4-NP reduction (a) the sixteenth recycling time and (b) regenerated catalyst. (c) $\ln(C_t/C_0)$ vs. time plot representing first-order kinetics.

Fig.S8:

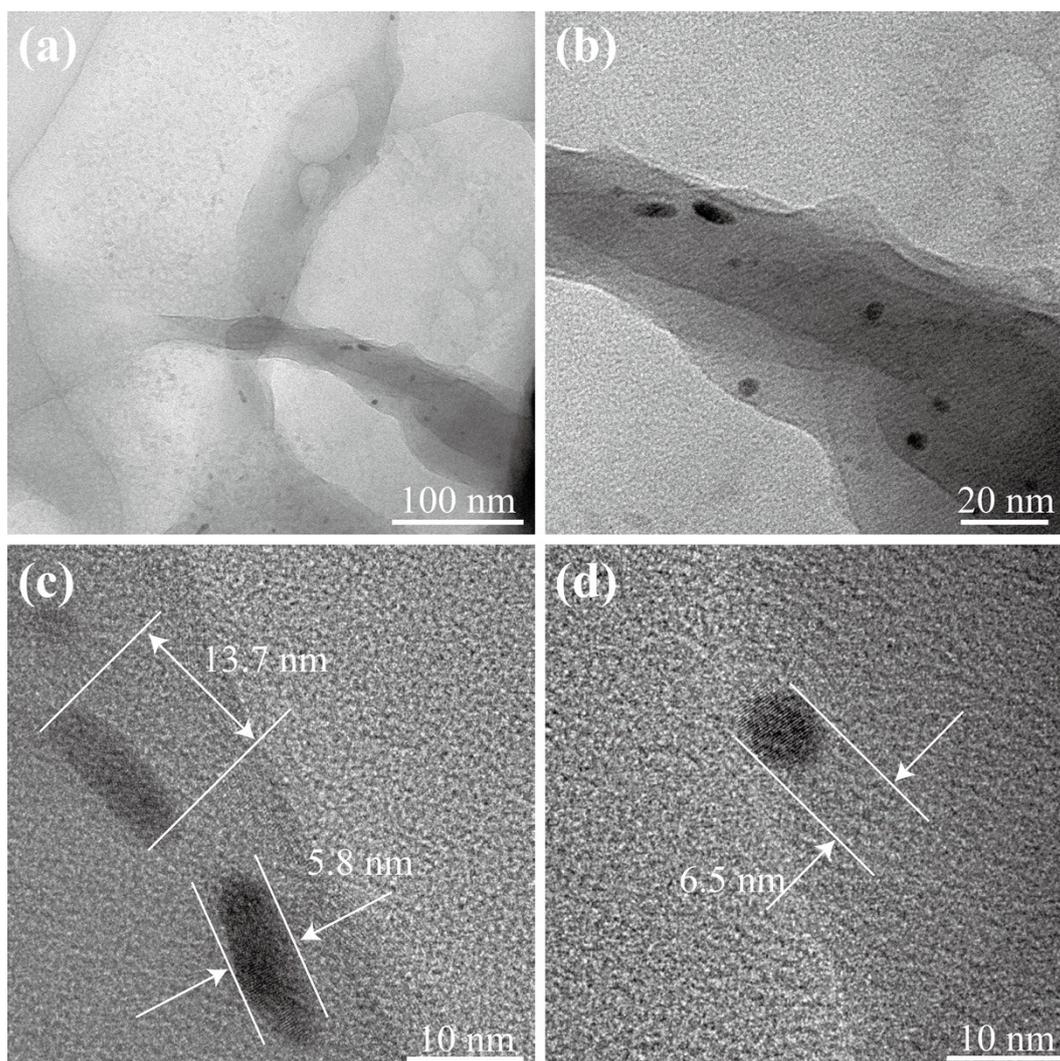


Fig.S8 TEM micrographs of a fresh AuNS/pulp catalyst.

Fig.S9:

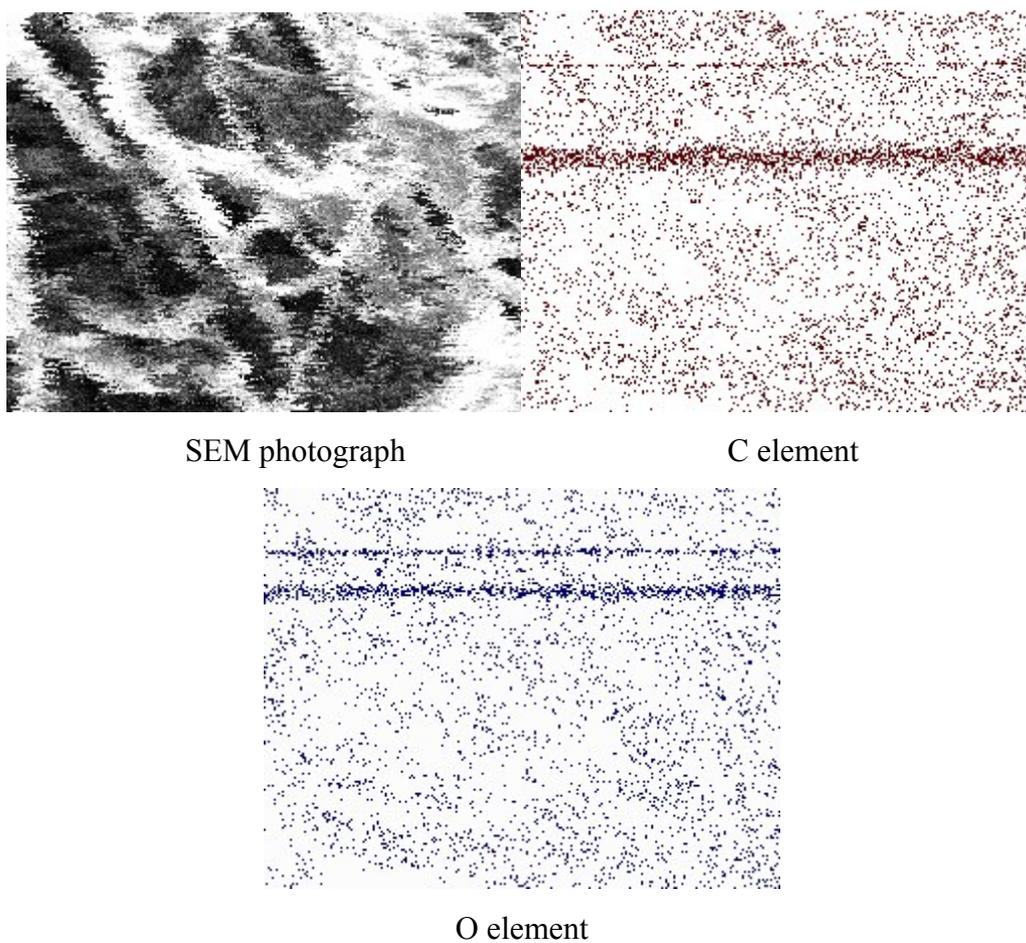


Fig.S9 The element mapping of C and O on the chromatography paper.

Fig.S10:

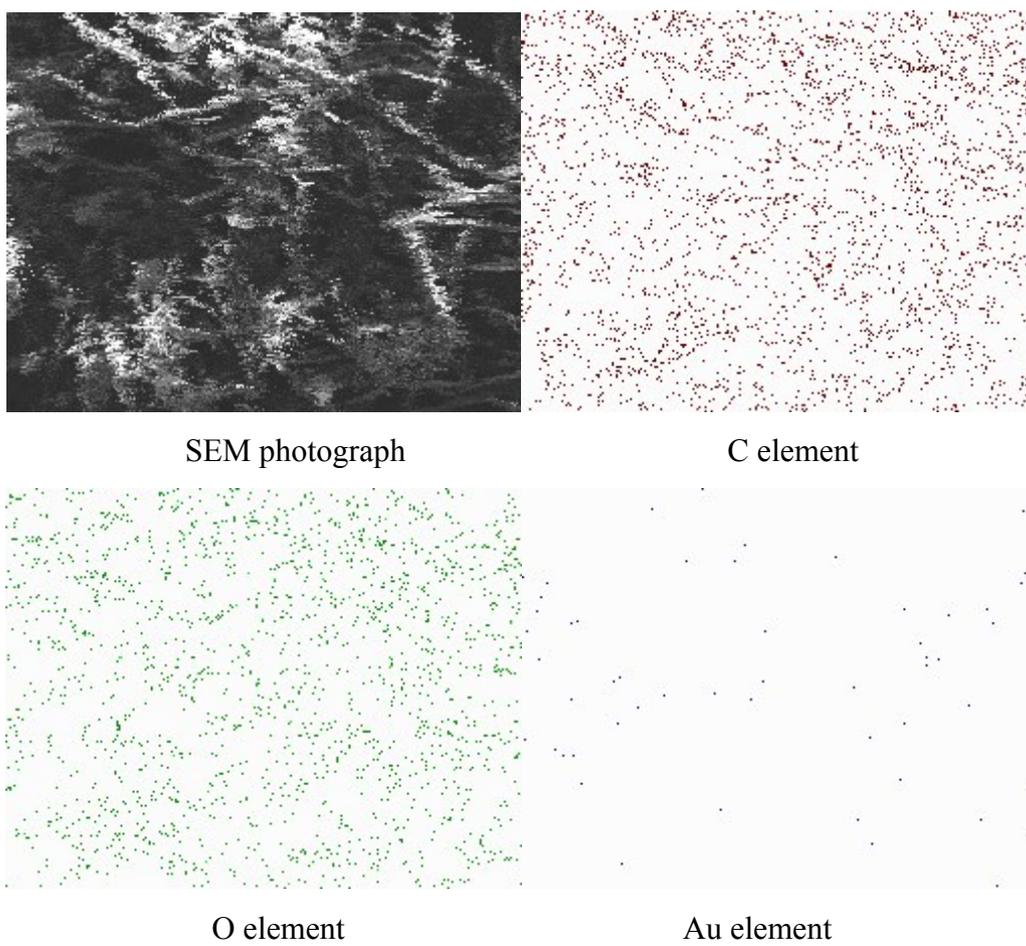


Fig.S10 The element mapping of C, O, and Au on AuNS/pulp.