Electronic Supplementary Material (ESI) for RSC Advances.
This journal is © The Royal Society of Chemistry 2016

Supporting information

Improving performance of MoS_2-based electrochemical sensors by decorating noble metallic nanoparticles on the surface of MoS_2 nanosheet

Shao Su,[a] Wenfang Cao,[a] Chi Zhang,[a] Xiaoyan Han,[a] Huan Yu,[a] Dan Zhu,[a] Jie Chao,[a] Chunhai Fan[a, b] and Lianhui Wang[a, *]

[a]Key Laboratory for Organic Electronics & Information Displays (KLOEID), Institute of Advanced Materials (IAM), Jiangsu National Syngerstic Innovation Center for Advanced Materials (SICAM), Nanjing University of Posts &Telecommunications, 9 Wenyuan Road, Nanjing 210023, China

[b]Division of Physical Biology, Shanghai Institute of Applied Physics, Chinese Academy of Sciences, Shanghai 201800, China.

Email: iamlhwang@njupt.edu.cn.

Synthesis of Au, Pt and Au@Pt nanoparticles

Au nanoparticles were prepared by using $Na_3C_6H_5O_7 \cdot 2H_2O$ and $HAuCl_4$. First, 700 μL $HAuCl_4$ (10 mM) was added into 49.3 mL ultrapure water. Then, the mixture was heated to approximately 150 °C on a hotplate. After that, 5 mL $Na_3C_6H_5O_7 \cdot 2H_2O$ (10 mM) was inject into the solution for reacting 25 minutes to get the Au nanoparticles.

For Pt nanoparticles synthesis, 100 μL (5 mM) K_2PtCl_4 were first added into 4.7mL ultrapure water. Then, 100 μL (30 mM) CTAB were added into the mixture. After that, 100 μL (50 mM) AA was added into the mixture and reacted for 1 minute. Then the reaction mixture was heated to 100 ºC for 5 minutes in the microwave reactor. Finally, the product of PtNPs was purified by centrifugation.

Au@Pt nanocomposite was synthesized by the Au nanoseeds. First, 0.3 mL Au nanoseeds were added into 2 mL ultrapure water to obtain Au nanoseeds solution. then, 0.5 mL 10 mM CTAB, 1 mL 100 mM AA and 100 μL 5 mM H_2PtCl_6 were injected into the solution, respectively. The mixture was then heated on a hotplate at 100 °C for 10 min to form Au@Pt nanocomposite.

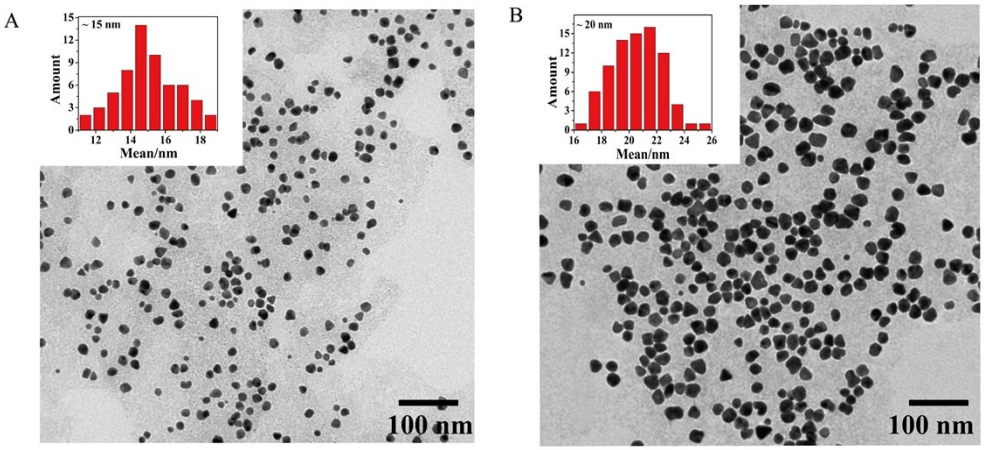

Figure S1. TEM images of (A) Au-MoS_2 nanoseed and (B) Au-MoS_2 nanocomposite.

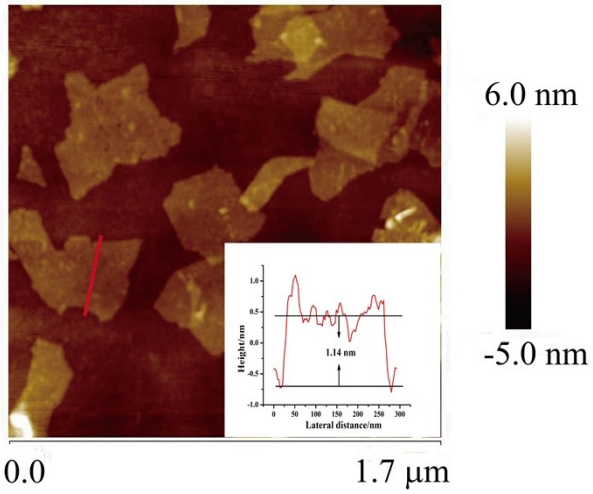

Figure S2. AFM image of the MoS_2 nanosheet.

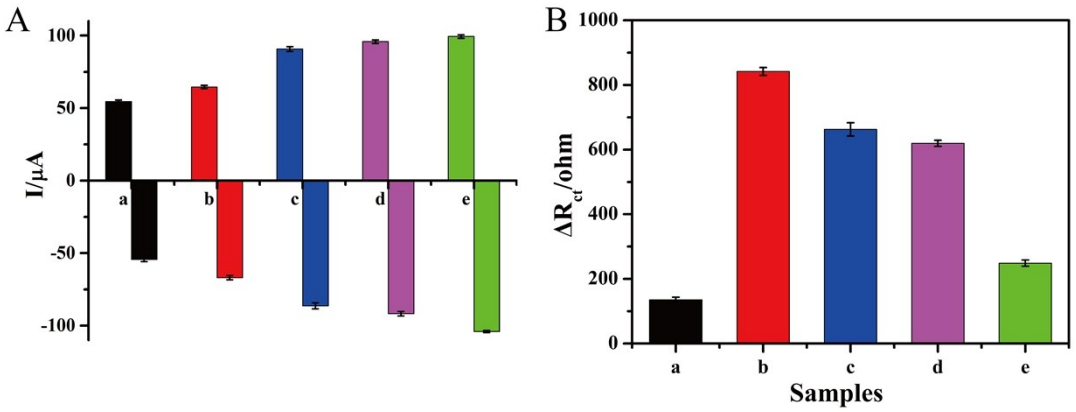

Figure S3. The reproducibility of MoS_2-based modified electrodes in 5 mM $[Fe(CN)_6]^{3-/4-}$ solution containing 0.1 M KCl. Scan rate: 100 mV/s. Error bar represents the standard deviation of triple measurements.

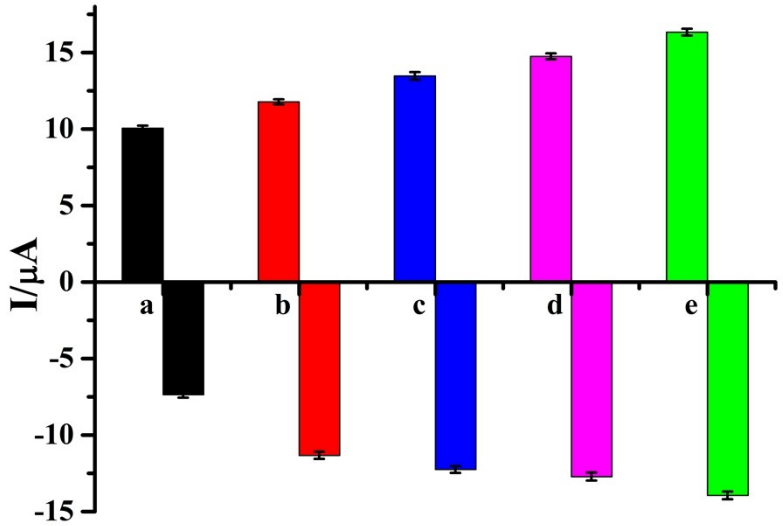

Figure S4. The reproducibility of electrocatalytic signals of CC at MoS_2-based modified electrodes. Error bar represents the standard deviation of triple measurements.

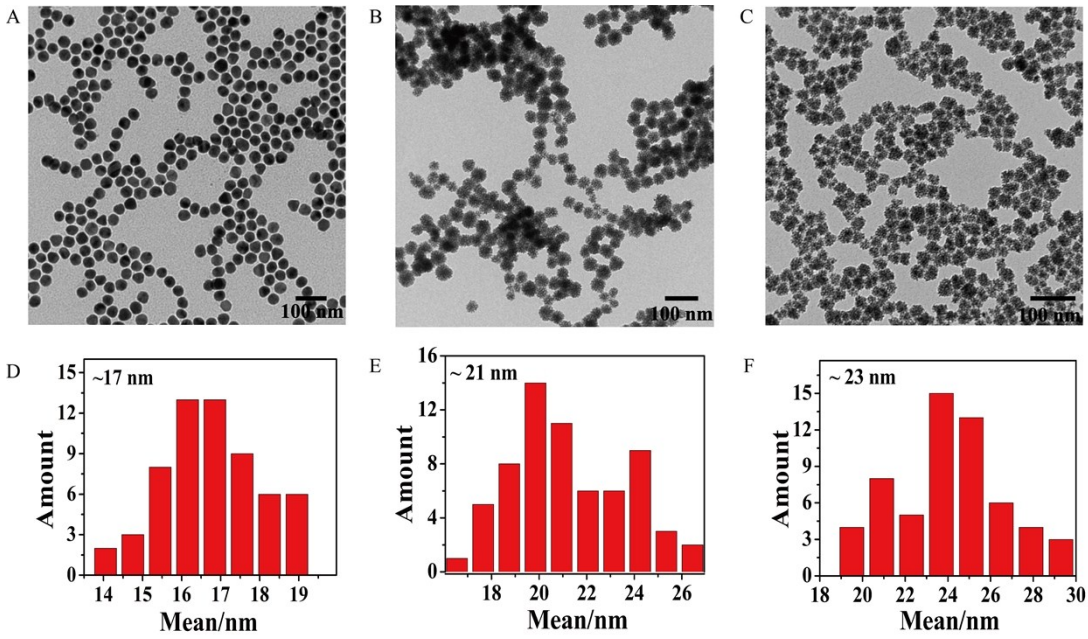

Figure S5. TEM images of (A) Au nanoparticles, (B) Pt nanoparticles and (C) Au@Pt nanoparticles, histograms of (D) Au nanoparticle size, (E) Pt nanoparticle size and (F) Au@Pt nanoparticle size.

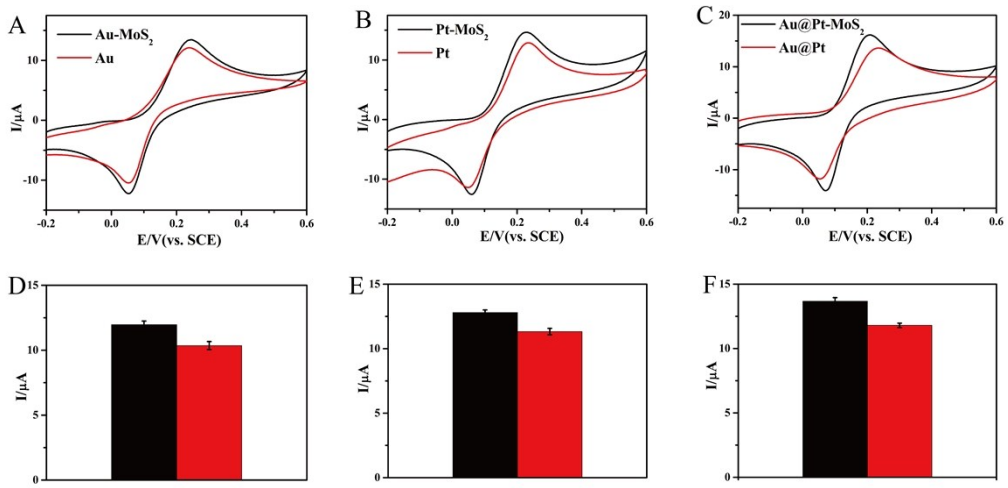

Figure S6. Cyclic voltammograms of (A) AuNPs/GCE and Au-MoS_2/GCE, (B) PtNPs/GCE and Pt-MoS_2/GCE, (C) Au@Pt/GCE and Au@Pt-MoS_2/GCE in 0.1 M PB (pH 7.0) solution containing 400 μM catechol. Scan rate: 100 mV/s. The reproducibility of electrocatalytic signals of CC at (D) AuNPs/GCE, (E) PtNPs/GCE, (F) Au@Pt/GCE. Error bar represents the standard deviation of triple measurements.

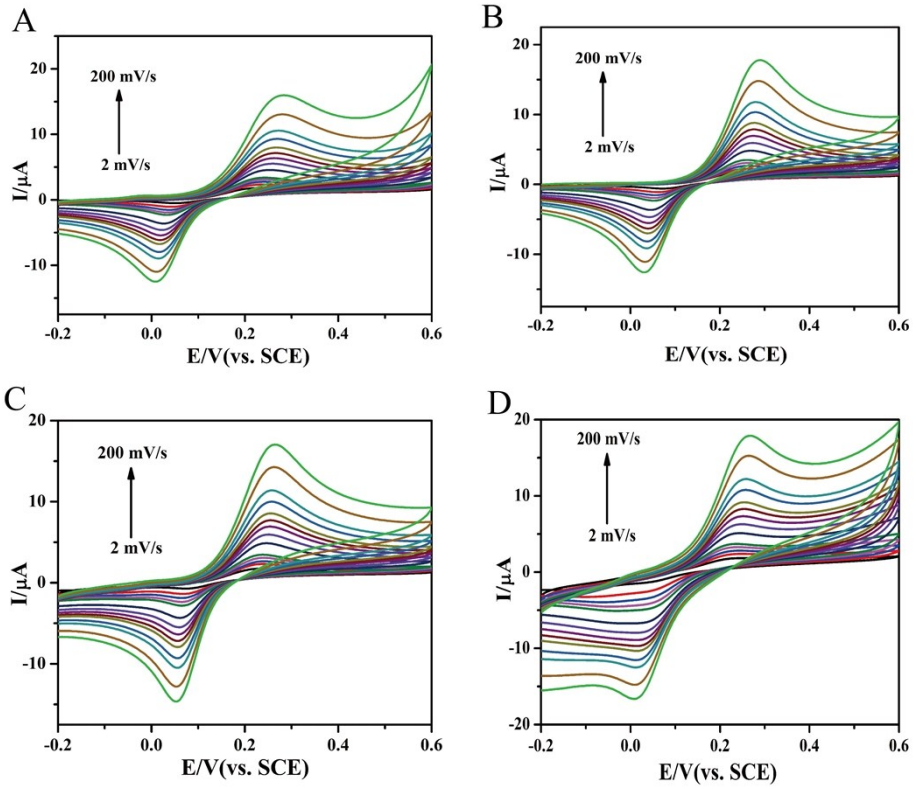

Figure S7. Cyclic voltammograms of the (A) MoS_2/GCE, (B) Au-MoS_2/GCE, (C) Pt-MoS_2/GCE and (D) Au@Pt-MoS_2/GCE in 0.1 M PB (pH 7.0) solution containing 400 μM catechol at scan rates ranging from 2 mV/s to 200 mV/s.

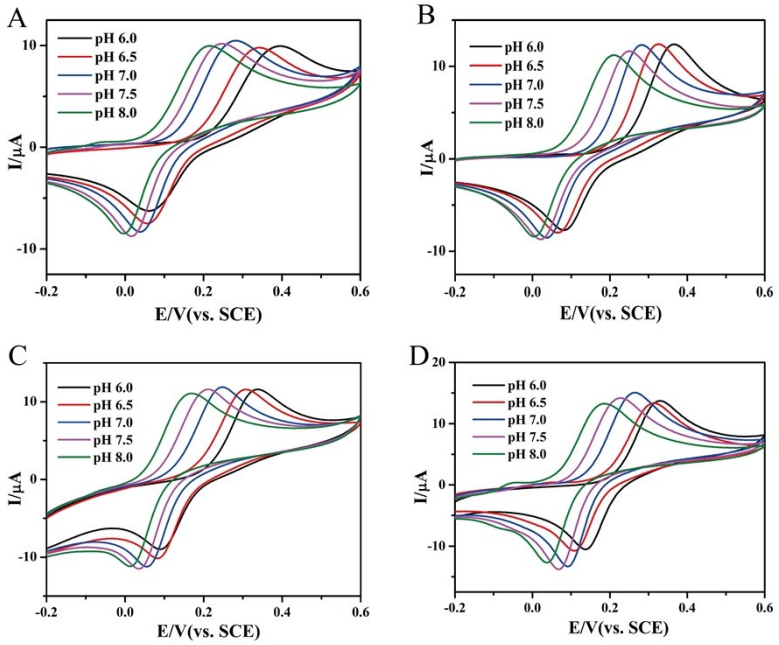

Figure S8. Cyclic voltammograms of the (A) MoS_2/GCE, (B) Au-MoS_2/GCE, (C) Pt-MoS_2/GCE and (D) Au@Pt-MoS_2/GCE in 0.1 M PB with various pH values.

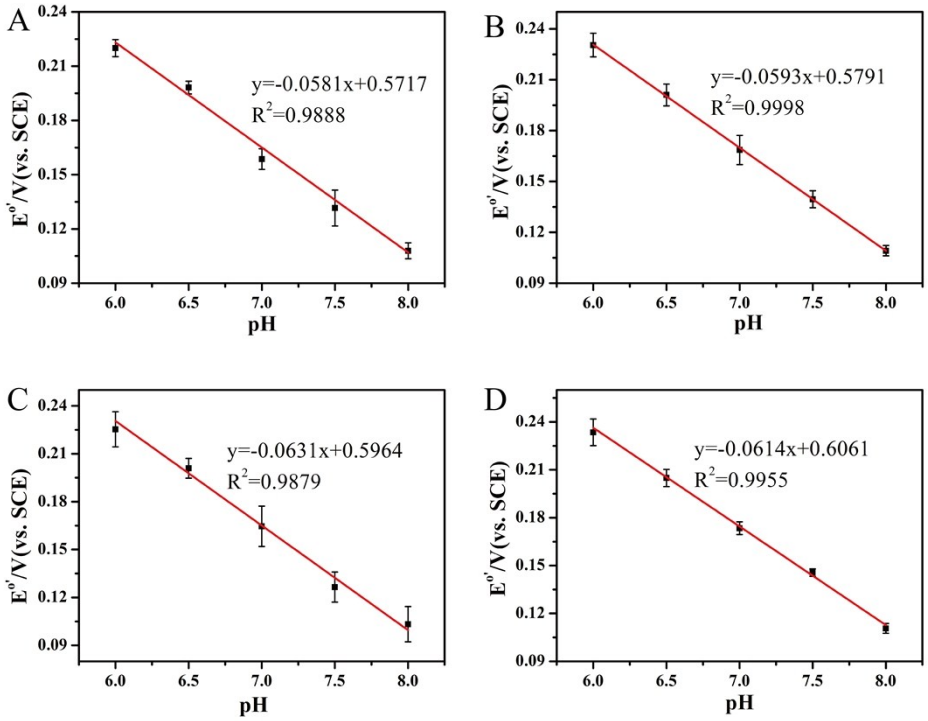

Figure S9. Plot of the formal potential of (A) MoS_2/GCE, (B) Au-MoS_2/GCE, (C) Pt-MoS_2/GCE and (D) Au@Pt-MoS_2/GCE vs. pH values. Scan rate: 100 mV/s. Error bar represents the standard deviation of triple measurements.

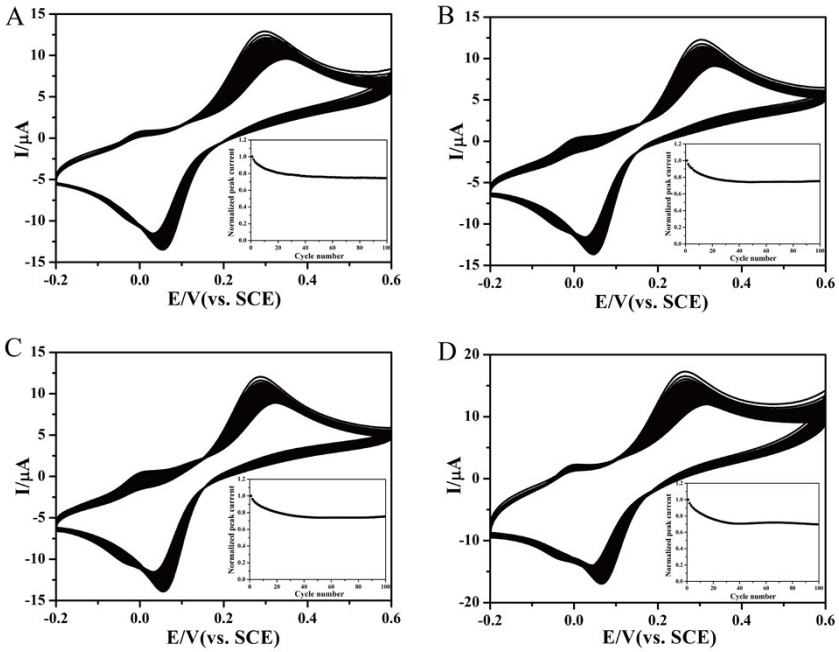

Figure S10. Successive 100 Cyclic voltammograms of (A) MoS_2/GCE, (B) Au-MoS_2/GCE, (C) Pt-MoS_2/GCE and (D) Au@Pt-MoS_2/GCE in 0.1 M PB (pH 7.0) solution containing 400 μM catechol. Scan rate: 100 mV/s. Insert figures: Stability of different figures on continuous cyclic voltammetric response. The normalized peak current was calculated by comparing the response of the electrode with that of the first cycle.

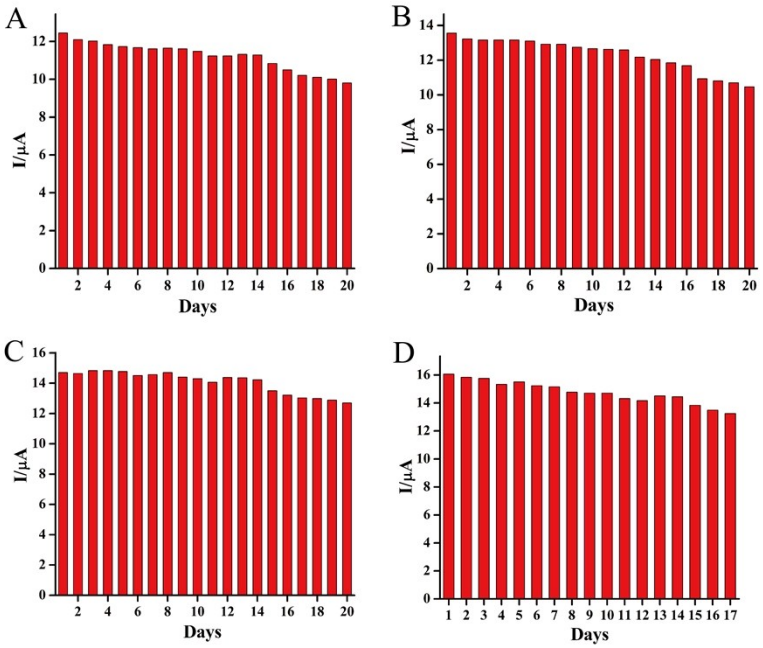

Figure S11. Long-term stability of the (A) MoS_2/GCE, (B) Au-MoS_2/GCE, (C) Pt-MoS_2/GCE and (D) Au@Pt-MoS_2/GCE within 20 days.

Table S1. Comparison of the electrochemical performances of CC at different nanomaterials modified electrodes.

Electrodes	Detection limit (μM)	Liner range (μM)	Reference
WS_2-Gr/GCE	0.2	1～80	[1]
PEDOT-GO/GCE	1.6	10～400	[2]
ECF-CPE	0.2	1～200	[3]
MWCNT/GCE	0.6	2～100	[4]
AuNP-CNFg/GCE	0.36	5～350	[5]
Graphene-chitosan/GCE	0.75	1～400	[6]
LDHf/GCE	1.2	3~900	[7]
PASA-MWNTs/GCE	1	6~180	[8]
PEN/GCE	0.6	25~175	[9]
Gr-Chitosan/GCE	0.75	1~400	[10]
Au/TiO_2/BDD	1.4	5~200	[11]
MoS_2/GCE	0.6	20～600	This work
Au-MoS_2/GCE	0.57	10～1000	This work
Pt-MoS_2/GCE	0.47	10～800	This work
Au@Pt-MoS_2/GCE	0.44	2～1000	This work

Abbreviation:

[Gr]: graphene, [PEDOT]: poly(3,4-ethylenedioxy-thiophene), [ECF-CPE]: electrospun carbon nanofiber-modified carbon paste electrode, [MWCNT]: multi-wall carbon nanotubes, [CNF]: carbon nanofiber, [LDHf]: layered double hydroxide film, [PASA]: poly-amidosulfonic acid, [PEN]: penicillamine, [BDD]: boron-doped diamond.

References:

1 K.-J. Huang, L. Wang, Y.-J. Liu, T. Gan, Y.-M. Liu, L.-L. Wang and Y. Fan. *Electrochimica Acta*. 2013, 107**,** 379-387.

2 W. Si, W. Lei, Y. Zhang, M. Xia, F. Wang and Q. Hao. *Electrochimica Acta*. 2012, 85**,** 295-301.

3 Q. Guo, J. Huang, P. Chen, Y. Liu, H. Hou and T. You. *Sensors and Actuators B: Chemical*. 2012, 163**,** 179-185.

4 Y.-P. Ding, W.-L. Liu, Q.-S. Wu and X.-G. Wang. *Journal of Electroanalytical Chemistry*. 2005, 575**,** 275-280.

5 Z. Huo, Y. Zhou, Q. Liu, X. He, Y. Liang and M. Xu. *Microchimica Acta*. 2011, 173**,** 119-125.

6 H. Yin, Q. Zhang, Y. Zhou, Q. Ma, T. liu, L. Zhu and S. Ai. *Electrochimica Acta*. 2011, 56**,** 2748-2753.

7 M. Li, F. Ni, Y. Wang, S. Xu, D. Zhang, S. Chen and L. Wang. *Electroanalysis*. 2009, 21**,** 1521-1526.

8 D. M. Zhao, X. H. Zhang, L. J. Feng, L. Jia and S. F. Wang. *Colloids Surf B Biointerfaces*. 2009, 74**,** 317-321.

9 L. Wang, P. F. Huang, J. Y. Bai, H. J. Wang, L. Y. Zhang and Y. Q. Zhao. *Microchimica Acta*. 2006, 158**,** 151-157.
10 H. Du, J. Ye, J. Zhang, X. Huang and C. Yu. *Journal of Electroanalytical Chemistry*. 2011, 650**,** 209-213.
11 Y. L. Min Wei, Zhong-Ze Gub, and Zhong-Dong Liua. *Journal of the Chinese Chemical Society*. 2011, 58.