Electronic Supplementary Material (ESI) for RSC Advances.

Electronic Supporting Information

Ultralow loading palladium nanocatalysts prepared by atomic layer deposition on three-dimensional graphite-coated nickel foam to enhanced ethanol electro-oxidation reaction

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Table S1 Comparing to the catalytic activity of as-prepared catalysts

catalysts	ECSA (m^2/g)	Peaking current density (mA/cm^2)
ALD-Pd/GNF-5	17.72	6.2
ALD-Pd/GNF-10	63.88	16.9
ALD-Pd/GNF-15	14.70	4.2

Table S2 Fitting results of EIS.

catalysts	$R_S(\Omega)$	CPE (Y/s^n)	$R_{CT}(\Omega)$
ALD-Pd/GNF-5	3.82	1.52×10^{-4}	494.1
ALD-Pd/GNF-10	2.41	2.10×10^{-4}	246.6
ALD-Pd/GNF-15	2.81	1.40×10^{-4}	308.7

Table S3 Comparing the experimental conditions, certain morphologies, catalytic activity, etc. with this work and previous work on Pd, PdNi catalysts reported in recent literatures.

Sample	Experimental conditions	Certain morphologies	Surface compo-sitions	Peak current (mA/mg_{Pd})	Stability	Refer-ence
Pd/ h-ppy	Solvothermal reaction	Nanoparticles	Pd	700	28 % activity retention after 6000 s.	1
PdNCs/ G	Wet chemical method	Nanocubes	Pd	429.8	16 % activity retention after 700 s.	2
Pd/ TNTs	Atomic Layer Deposition	Nanoparticles	Pd, PdO_x	2250	12 % activity retention after 3600s.	3
Pd/ rGO	Electro-chemically deposited	Nanorod	Pd, PdO_x	725	27 % activity retention after 3600s.	4

Pd/GA/NF	Self-assembly aggregation method	Nanoparticles	Pd, PdO_x	874	74.9 % activity retention after 1030th cycle.	5
Pd/PDIL-NGS	Wet chemical method	Nanoparticles	Pd	1229.9	43 % activity retention after 7200s.	6
Pd-Ni/C	microwave-irradiation	Nanoparticles	Pd, Ni	770.7	47 % activity retention after 4800s.	7
PdNi-NNs/RGO	Wet chemical method	Nanowire -network	Ni, Pd PdO_x	604	Dropped to approximate zero after 2000s.	8
PdNi	Wet chemical method	Irregular porous nanoparticles	Ni, Pd PdO_x	1110	52 % activity retention after 1000s.	9
Pd/	Wet	Nanoparticles	Pd	2939	59 %	10

CNTs	chemical method				activity retention after 500th cycle.	
Pd/ CNTs	self-assembled and heat-treatment	Nanoparticles	Pd	2858	38 % activity retention after 1000s.	11
ALD-Pd/ GNF	Atomic Layer Deposition	Nanoparticles	Pd	920	4.1 % activity retention after 4000s.	This work

References

1. Z. Bai, Q. Zhang, J. Lv, S. Chao, L. Yang and J. Qiao, *Electrochimica Acta*, 2015, **177**, 107-112.
2. Y. Zhang, Q. Huang, G. Chang, Z. Zhang, T. Xia, H. Shu and Y. He, *Journal of Power Sources*, 2015, **280**, 422-429.
3. L. Assaud, N. Brazeau, M. K. S. Barr, M. Hanbücken, S. Ntais, E. A. Baranova and L. Santinacci, *ACS Applied Materials & Interfaces*, 2015, **7**, 24533-24542.
4. M. Sawangphruk, A. Krittayavathananon and N. Chinwipas, *J. Mater. Chem. A*, 2013, **1**, 1030-1034.
5. a. K. N. H. Chi-Him A. Tsang, K. S. Hui, L. Rend, *J. Mater. Chem. A*, 2014, **2**, 17986–17993.
6. S. Li, H. Yang, R. Ren, J. Ma, J. Jin and J. Ma, *Journal of Power Sources*, 2015, **294**, 360-368.

7. R. S. Amin, R. M. A. Hameed and K. M. El–Khatib, *Applied Catalysis B: Environmental*, 2014, **148-149**, 557-567.
8. B. Y. Duan Bin, Fangfang Ren, Ke Zhang, Ping Yang, Yukou Du, *J. Mater. Chem. A*, 2015, **3**, 14001–14006.
9. C. Zhu, D. Wen, M. Oschatz, M. Holzschuh, W. Liu, A.-K. Herrmann, F. Simon, S. Kaskel and A. Eychmüller, *Small*, 2015, **11**, 1430-1434.
10. M. S. Ahmed and S. Jeon, *Journal of Power Sources*, 2015, **282**, 479-488.
11. Y. C. Jin Zhang, Shanfu Lu, Lichao Jia, Pei Kang Shenc, San Ping Jian, *Chem. Commun.,*, 2014, **50**, 13732--13734.