

**One-pot self-assembled bimetallic sulfide nanoparticle
cluster supported three-dimensional graphene aerogel as
efficient electrocatalysts for oxygen reduction reaction**

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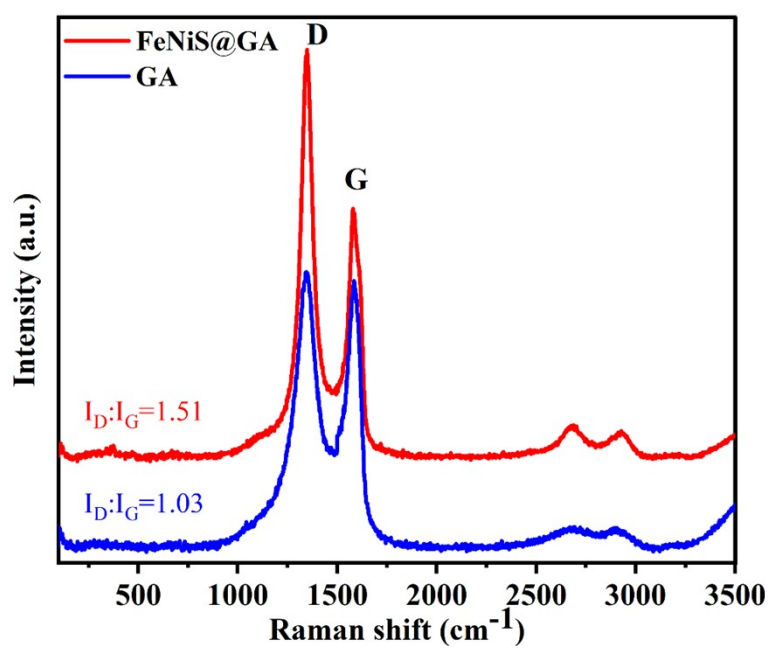


Figure S1. Raman spectrum of FeNiS@GA and GA.

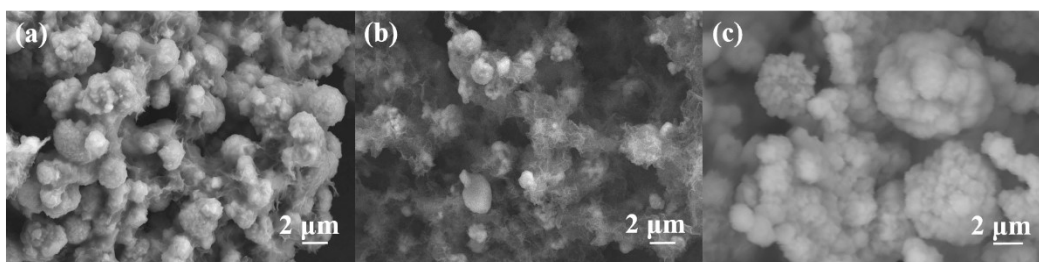


Figure S2. SEM images of NiS₂@GA, FeS₂@GA and FeNiS.

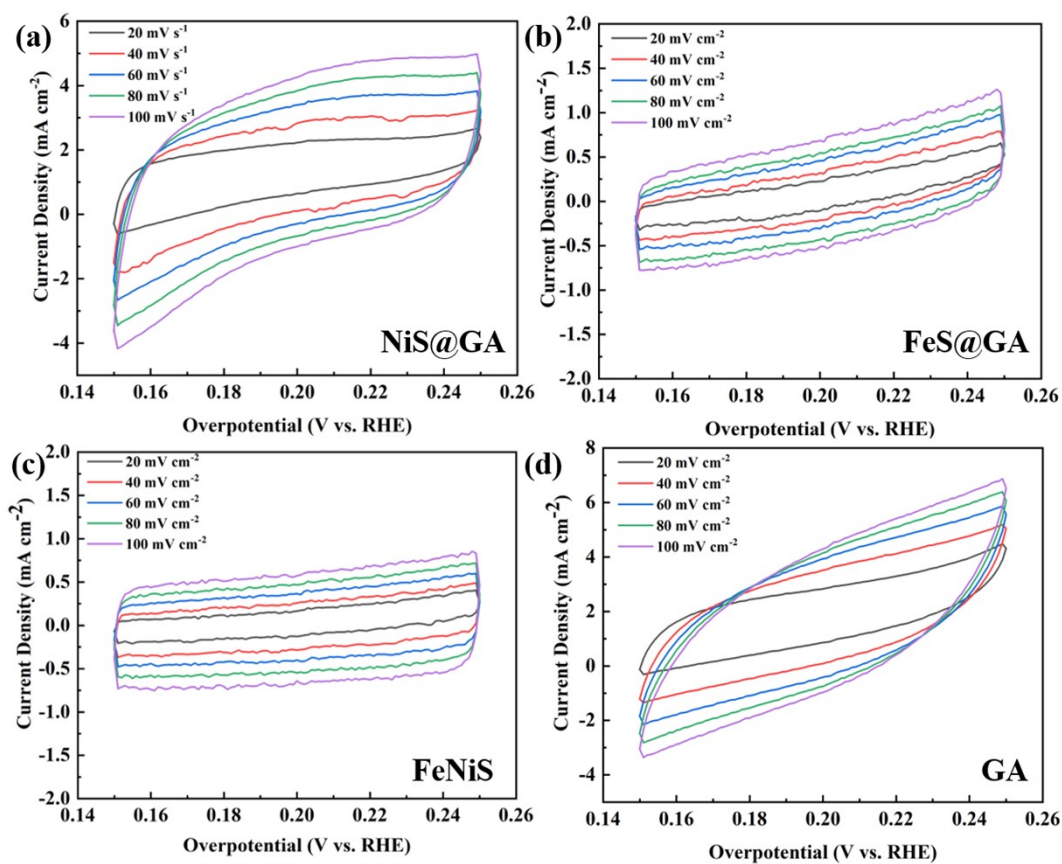


Figure S3. CV curves of NiS@GA (a), FeS@GA (b), FeNiS (c) and GA (d) at different scan rates from 10 mV s⁻¹ to 100 mV s⁻¹.

Table S1. Comparison of the OER catalytic performance of FeNiS@GA with those of other Fe-based and Ni-based catalysts.

Catalysts	Current density (mA·cm ⁻²)	Overpotential (mV)	Electrolyte	Ref.
FeNiS@GA	10	276	1 M KOH	This work
FeNi ₃ /MnFe ₂ O ₄ /N-RGO	10	341	1 M KOH	1
MoxC-FeNi@NC	10	306	1 M KOH	2
FeNi/PNG	10	353	1 M KOH	3
FeNi@NC	10	298	1 M KOH	4
NiFe-LDH-0.4M HMS	10	290	1 M KOH	5
Br-Ni-MOF	10	306	1 M KOH	6
NP/NiO	10	332	1 M KOH	7
NiFe-Se/CFP	10	281	1 M KOH	8
NiCo-1.0Fe	10	285	1 M KOH	9
NiCo-2.0-800HP	10	320	1 M KOH	10

Reference

1. Jia, X.; Zhang, Y.; Zhang, L.; Wang, L.; Zhou, L., Fabrication and bifunctional electrocatalytic performance of FeNi₃/MnFe₂O₄/nitrogen-doping reduced graphene oxide nanocomposite for oxygen electrocatalytic reactions. *Ionics* **2019**, *26* (2), 991-1001.
2. Liu, Z.; Ma, Y.; Gu, W.; Yuan, C.; Teng, F., Facile synthesis of MoxC-FeNi@NC with an OER activity superior to RuO₂ and IrO₂/C. *Journal of Physics and Chemistry of Solids* **2020**, *147*: 109578.
3. Wang, H.; Feng, X.; Zhou, M.; Bo, X.; Guo, L., FeNi Nanoparticles Embedded in Porous Nitrogen-Doped Graphene for Electrocatalytic Evolution of Hydrogen and Oxygen. *ACS Applied Nano Materials* **2020**, *3* (7), 6336-6343.
4. Zhang, X.; Chen, Y.; Wang, B.; Chen, M.; Yu, B.; Wang, X.; Zhang, W.; Yang, D., FeNi nanoparticles embedded porous nitrogen-doped nanocarbon as efficient electrocatalyst for oxygen evolution reaction. *Electrochimica Acta* **2019**, *321*: 134720.
5. Zhong, H.; Liu, T.; Zhang, S.; Li, D.; Tang, P.; Alonso-Vante, N.; Feng, Y., Template-free synthesis of three-dimensional NiFe-LDH hollow microsphere with enhanced OER performance in alkaline media. *Journal of Energy Chemistry* **2019**, *33*, 130-137.
6. Cheng, W.; Xi, S.; Wu, Z. P.; Luan, D.; Lou, X. W. D., In situ activation of Br-confined Ni-based metal-organic framework hollow prisms toward efficient electrochemical oxygen evolution. *Science Advances* **2021**, *7*, eabk0919.
7. Bhanja, P.; Kim, Y.; Paul, B.; Kaneti, Y. V.; Alothman, A. A.; Bhaumik, A.; Yamauchi, Y., Microporous nickel phosphonate derived heteroatom doped nickel oxide and nickel phosphide: Efficient electrocatalysts for oxygen evolution reaction. *Chemical Engineering Journal* **2021**, *405*: 126803.
8. Guo, Y.; Zhang, C.; Zhang, J.; Dastafkan, K.; Wang, K.; Zhao, C.; Shi, Z., Metal–Organic Framework-Derived Bimetallic NiFe Selenide Electrocatalysts with Multiple Phases for Efficient Oxygen Evolution Reaction. *ACS Sustainable Chemistry & Engineering* **2021**, *9* (5), 2047-2056.
9. Septiani, N. L. W.; Kaneti, Y. V.; Guo, Y.; Yulianto, B.; Jiang, X.; Ide, Y.; Nugraha, N.; Dipojono, H. K.; Yu, A.; Sugahara, Y.; Golberg, D.; Yamauchi, Y., Holey Assembly of Two-Dimensional Iron-Doped Nickel-Cobalt Layered Double Hydroxide Nanosheets for Energy Conversion Application. *ChemSusChem* **2020**, *13* (6), 1645-1655.
10. Septiani, N. L. W.; Kaneti, Y. V.; Fathoni, K. B.; Guo, Y.; Ide, Y.; Yulianto, B.; Jiang, X.; Nugraha; Dipojono, H. K.; Golberg, D.; Yamauchi, Y., Tailorable nanoarchitecturing of bimetallic nickel–cobalt hydrogen phosphate via the self-weaving of nanotubes for efficient oxygen evolution. *Journal of Materials Chemistry A* **2020**, *8* (6), 3035-3047.