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FCH2 2018 TECHNICAL CONFERENCE

Iron-based nanomaterials used as ORR catalyst in PEM Fuel Cell

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Fuel Cell

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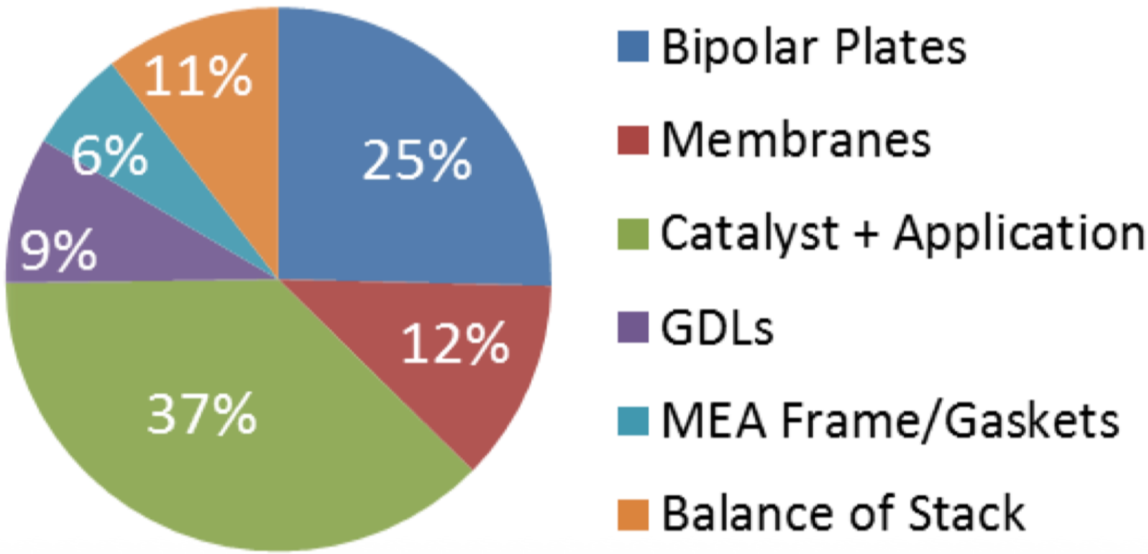
Fuel cell stack: 66%

100,000 Systems/Year (2017)[1]



1. Fuel Cell System Cost report, Strategic Analysis, Inc., 2017

Catalyst

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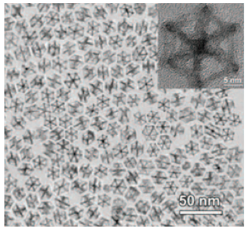
To reduce the cost of catalyst:

- ✓ Reduce the usage of Pt
- ✓ Non-precious metal group catalyst

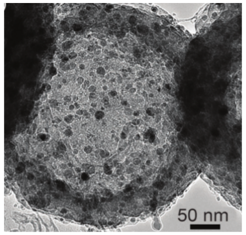
  e.g. M-N-C (M= **Fe**, Co, Ni *etc.*)

- ✓ Non-metal catalyst

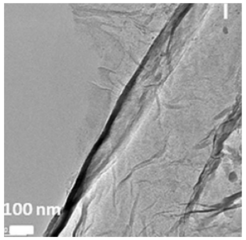
  e.g. Heteroatom-doped CNT/Gr



hollow Pt_3Ni nanoframes[1]



Fe_3C/C hollow spheres[2]



N,P-doped Graphene[3]

1. Chen, C. et al. *Science* **2014**, 343, 1339–1343. 2. Y. Hu, et al., *Angew. Chem., Int. Ed.* **2014,** 53, 3675–9. L.M.
3. Dai, *Angew. Chem., Int. Ed.* **2016**, 55 2230–2234.

M-N-C catalysts

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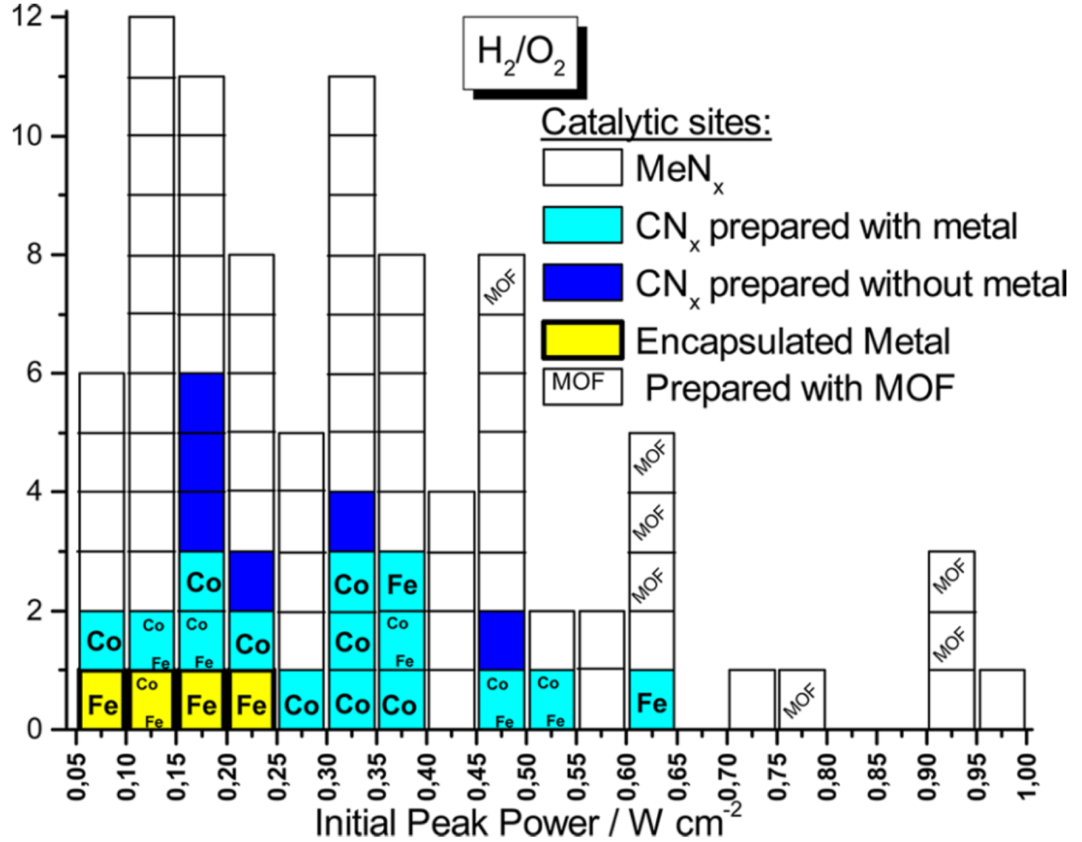

Fe-N-C usually are the best among all the M-N-C catalysts

1. M. Shao et al., Chem. Rev. 116 (2016) 3594–3657.

Fe-N-C catalysts

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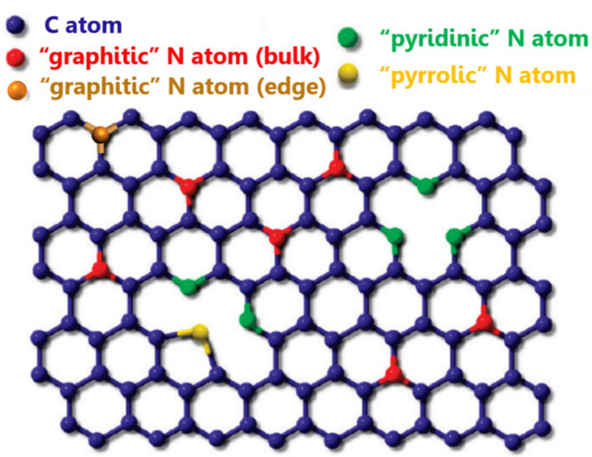
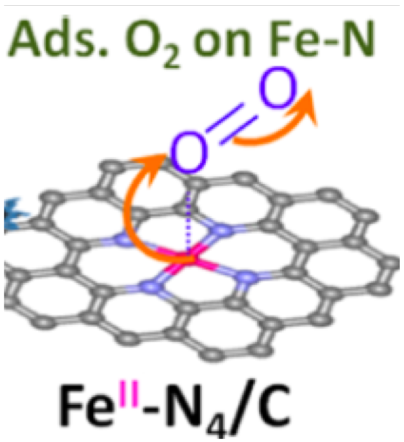
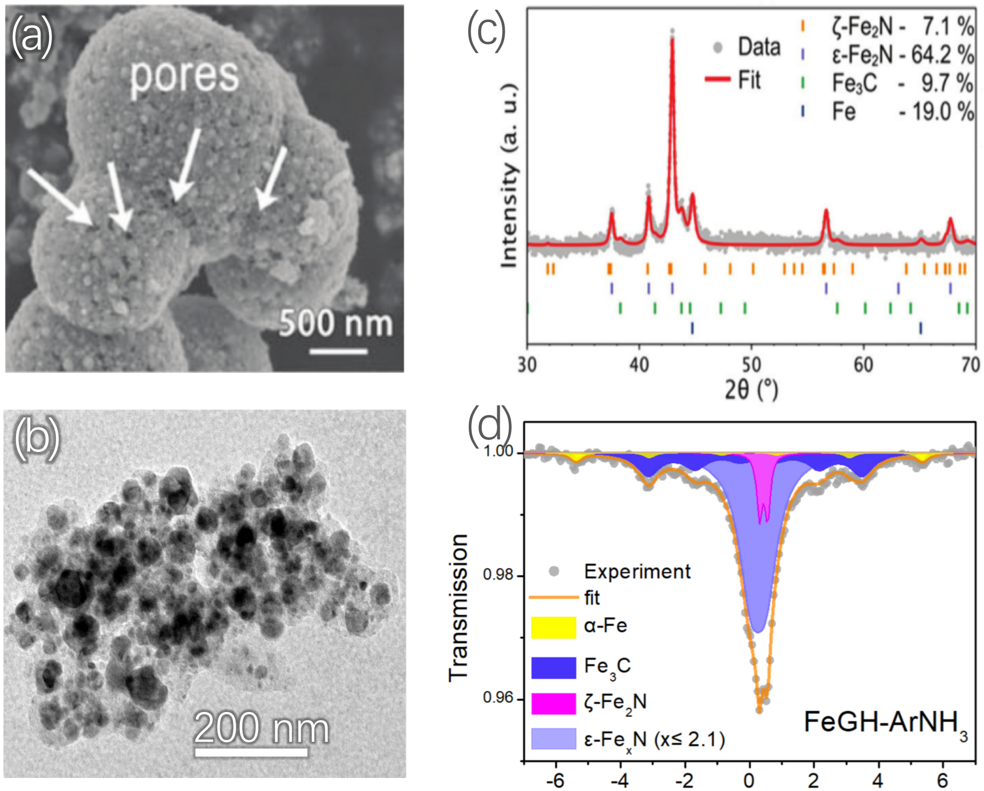
Possible active species:

1. Fe-N4 moieties (most active catalytic sites)
2. N-doped carbon (pyridinic N)
3. Iron compounds (debatable)





Study on Fe-N-C catalyst I



Structure:

- ✓ N-carbon nanospheres
- ✓ Fe_2N nanoparticles
- ✓ Without Fe-N4 moieties

Study on Fe-N-C catalyst I

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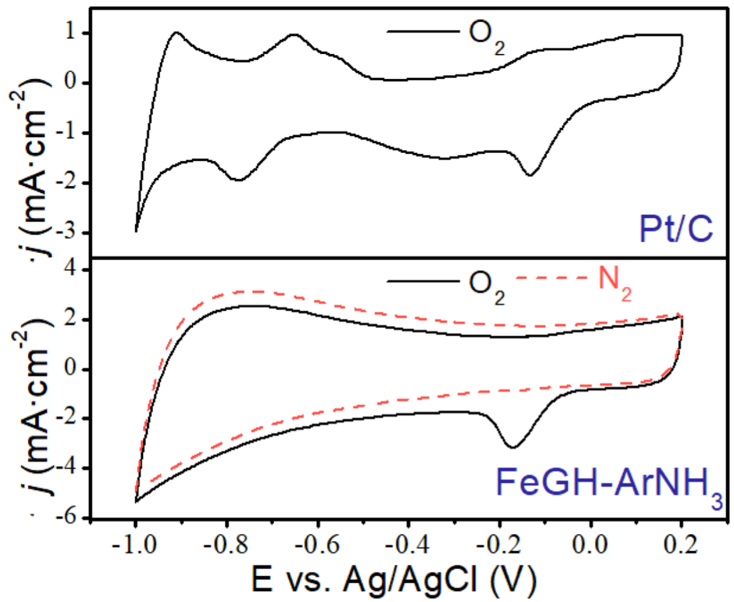

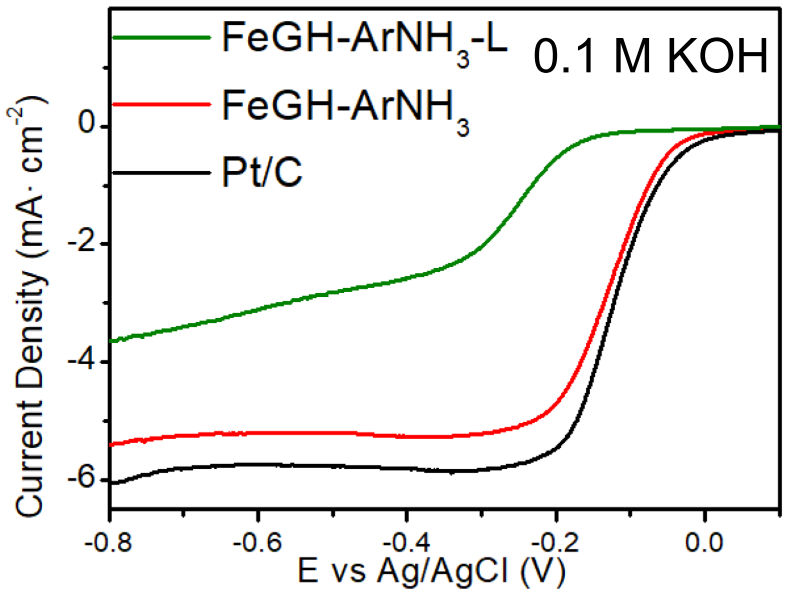

Conclusion: Fe_2N do has contribution to catalysis of ORR

Study on Fe-N-C catalyst II

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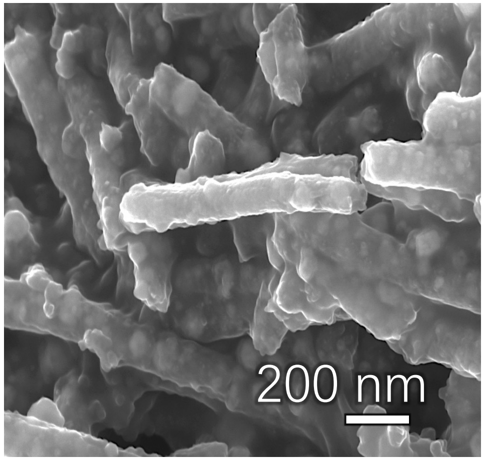

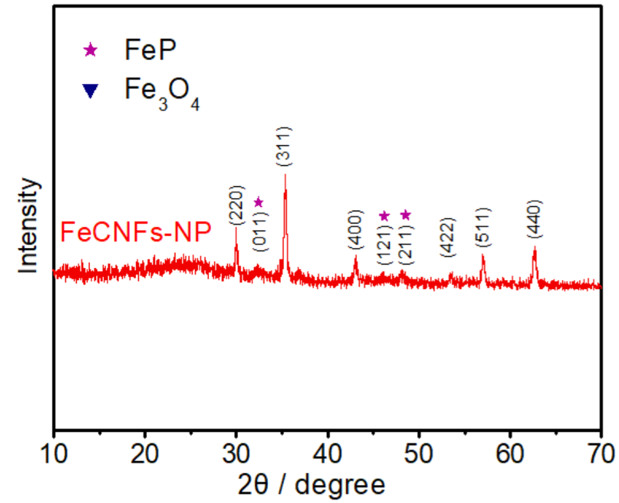

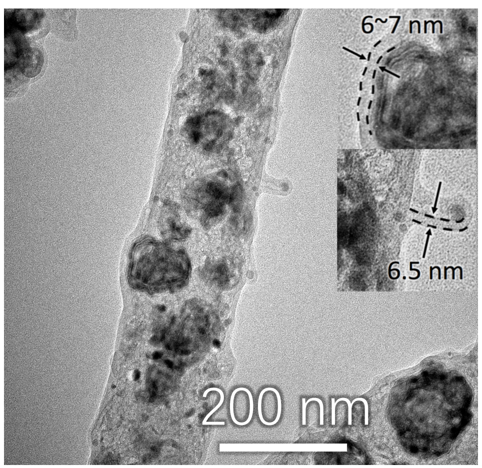

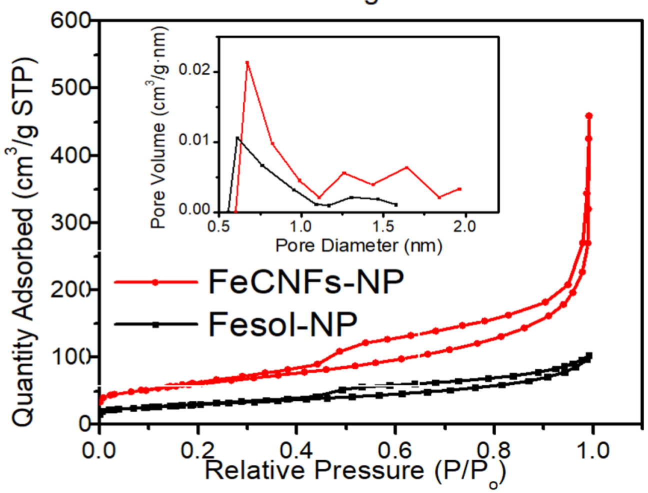

Structure:

- ✓ Core-shell NFs
- ✓ Fe_3O_4 and FeP NPs
- ✓ N,P-carbon NFs
- ✓ Microporous

Study on Fe-N-C catalyst II

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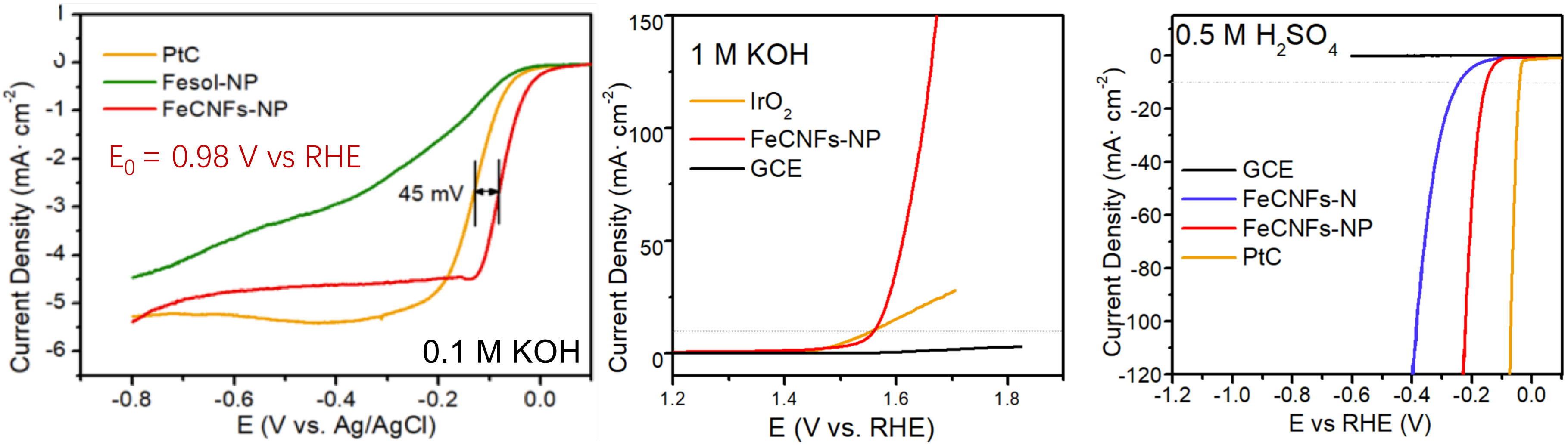

Tri-functional catalyst toward ORR, OER and HER

Summary of Fe-N-C

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Iron-doping can obviously improve the ORR catalytic activity:

- ✓ Activate surrounding carbon
- ✓ Formation of Fe-N_4 moieties which is highly active to ORR
- ✓ Improve conductivity

How to optimize the performance of Fe-N-C catalysts ?

- ✓ Core-shell structure
- ✓ High surface area
- ✓ N doping
- ✓ Uniform dispersing of Fe

Problem:

Iron-doped non-Pt catalysts have insufficient activities in acid solution as well as real-life operation.

Work in the future

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Fe,N-CNTs + Pt (alloy) NPs

Advantages:

✓ Compared with traditional carbon support, Fe,N-CNTs themselves have good ORR activity

→ improve overall performance

✓ Fe and N in CNTs create many defects as anchor for Pt NPs

→ improve stability

Thanks for your listening !

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