하이드로카본 시스템 효율/안정성 유지 이슈

Efficiency and Stability Issues in Hydrocarbon Reaction System

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Nanomaterials for Energy & Environment Laboratory
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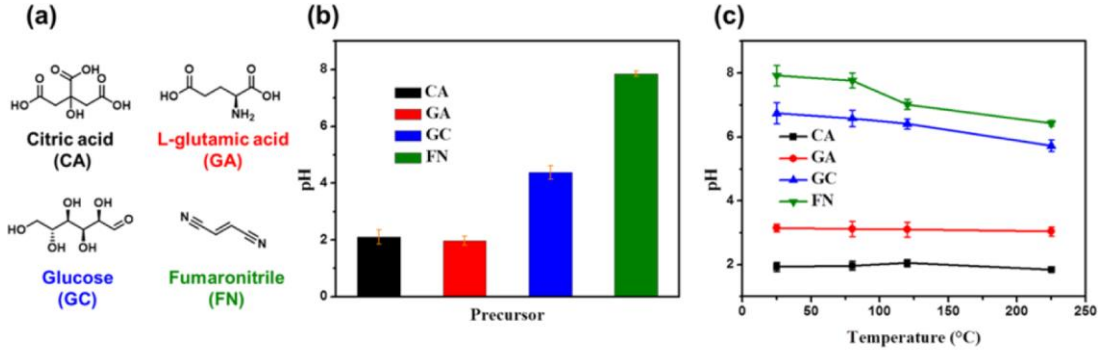
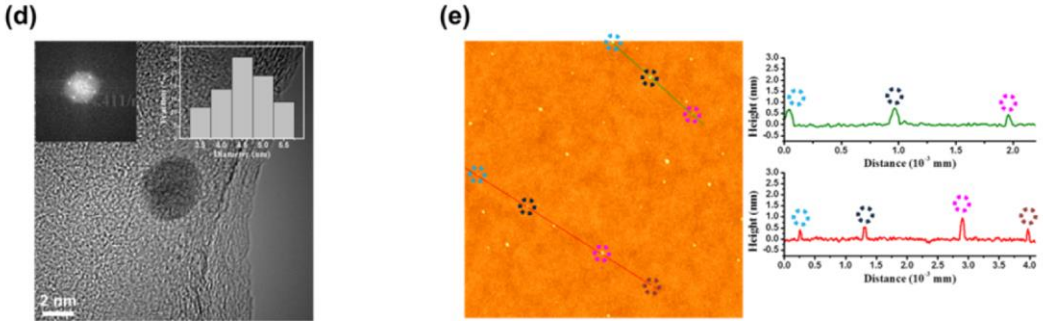
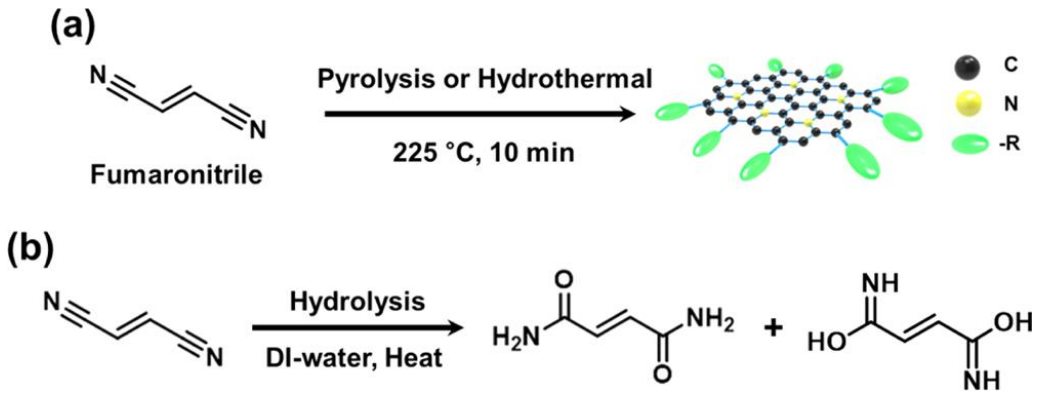
Research of electrochemical CO_2RR

Synthesis and properties of N-CQD





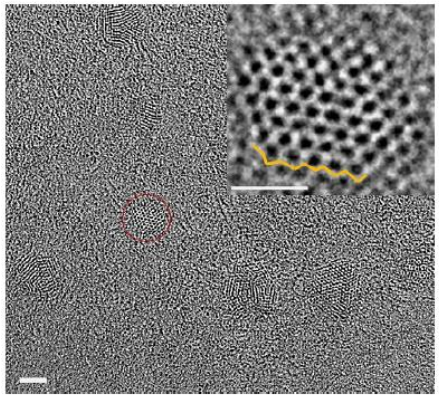


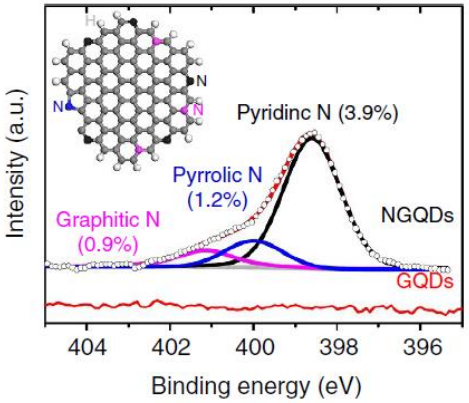
- Facile and eco-friendly synthesis of amphiphilic N-doped graphitic carbon dots with a highly ordered graphitic structure (high sp2/sp3 ratio).
- Excellent stability in various solvents.
- During the pyrolysis, nitrile groups are expected to undergo thermal oxidative degradation and cyclization steps, whereby they become carbonized and finally form relatively hydrophobic NGCDs.
- when using a hydrothermal process, the FN powders are partially converted to either amides or imidic acids in DI water at 225 °C and then form amphiphilic GCDs doped with nitrogen via dehydration and condensation reactions.

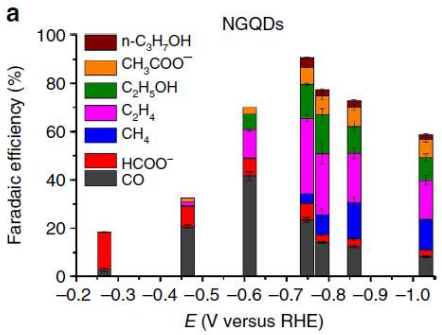
Byung Joon Moon et al., ACS Catal. (2016)

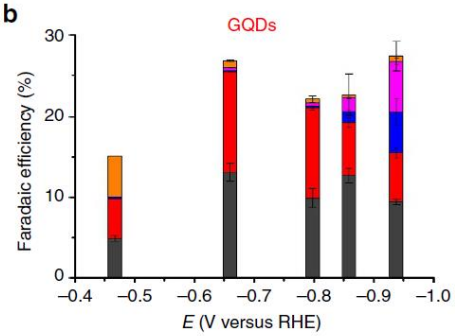
Research of electrochemical CO_2RR

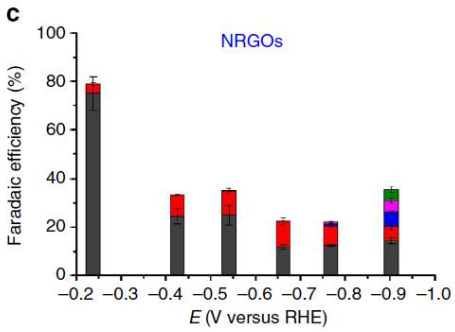
Effect of N-CQD on CO_2RR

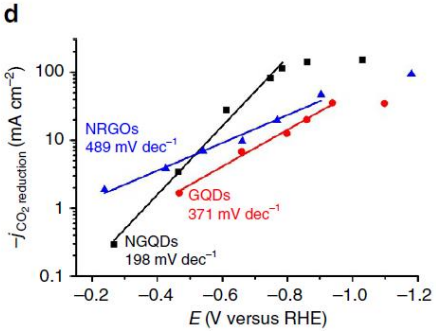










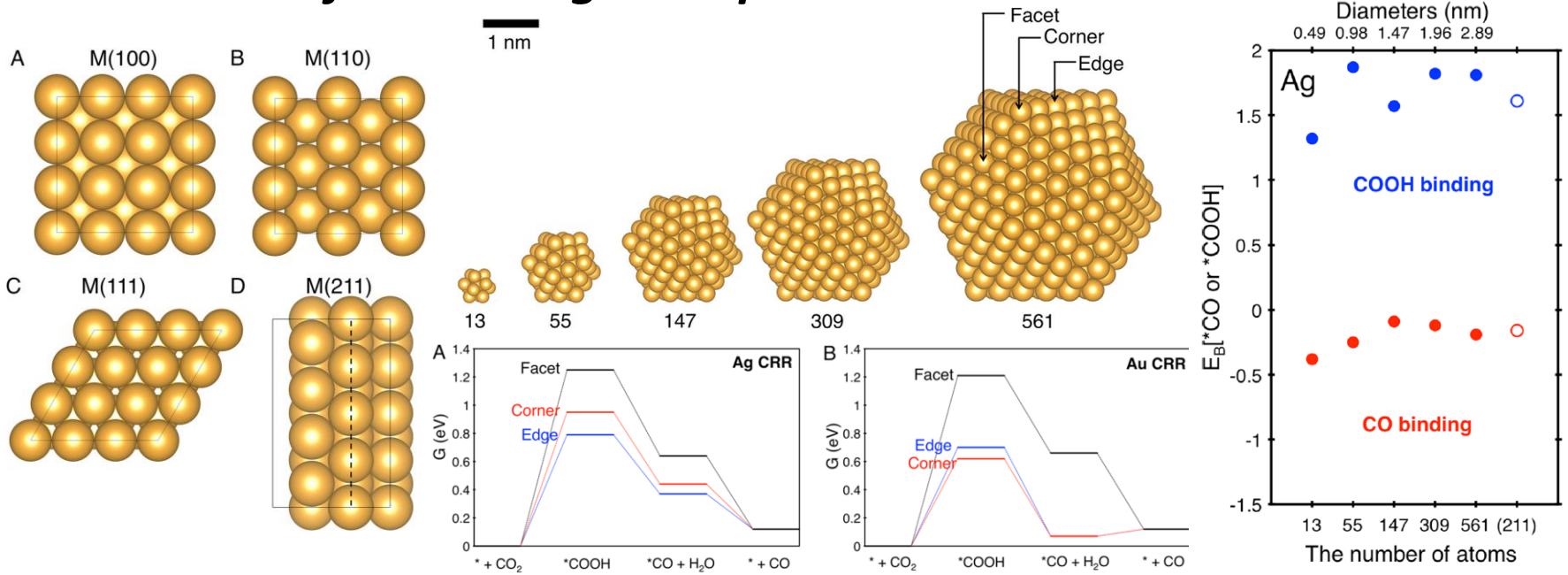


- The NGQDs show a high total Faradaic efficiency of carbon dioxide reduction of up to 90%, with selectivity for ethylene and ethanol conversions reaching 45%.
- The acidic CO_2 molecule prefers adsorbing onto the Lewis basic pyridinic N group in carbon nanostructures
- The pyridinic N at the edge site is believed to be more active to induce C–C bond formation than those at the basal plane, which leads to a higher yield of C2 and C3 products on NGQDs electrode than on NRGOs electrode.
- The kinetics for CO_2 reduction on NRGOs is also slower than that on NGQDs, for example, a Tafel slope of 489mVdec1 for NRGOs versus 198mVdec1 for NGQDs

Xiaolong Zou et al., ACS Catal. (2017)

Research of electrochemical CO_2RR

Active Sites of Au and Ag Nanoparticle

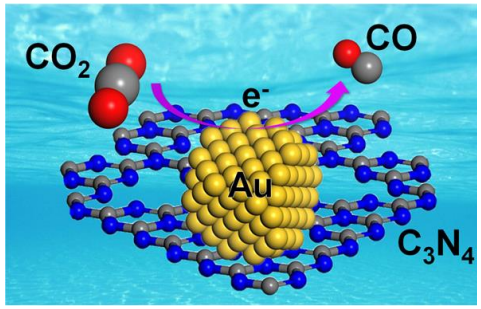


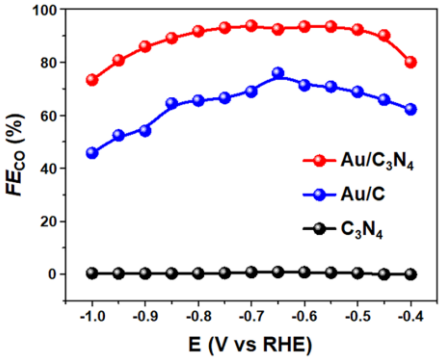
- For Ag and Au that bind reaction intermediates weakly at their low-index facets, the under-coordinated sites are the main active sites for the CO_2 reduction reaction.
- In particular, for Au, the corner sites are the main active sites, whereas for Ag, the edge sites are the most active.
- Ag NPs become more active compared to the polycrystalline phase for CO_2RR due to an increase in the number of highly active edge sites.
- Ag nanoparticles are an efficient and inexpensive alternative to Au catalysts for electrochemical CO production from CO_2.

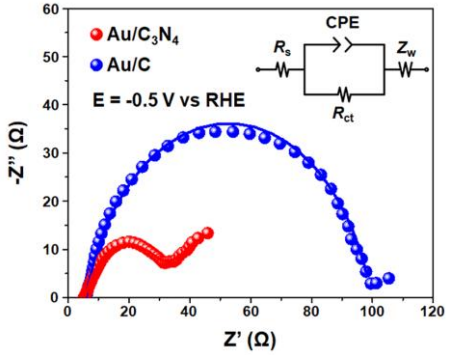
Seoin Back et al., ACS Catal. (2015)

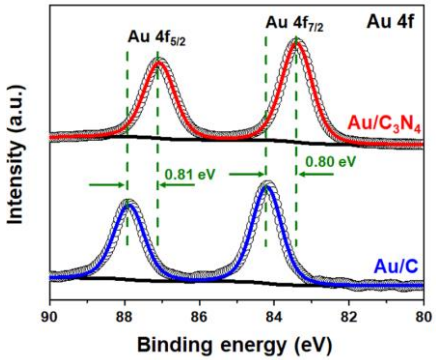
Research of electrochemical CO_2RR

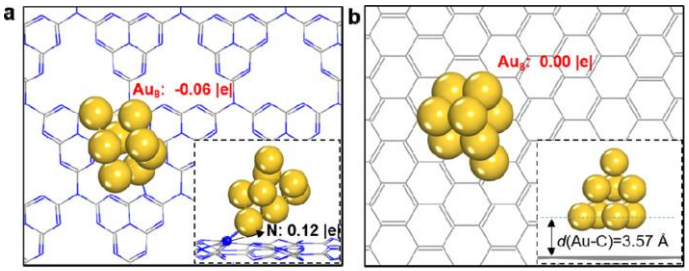
Au/g-C3N4

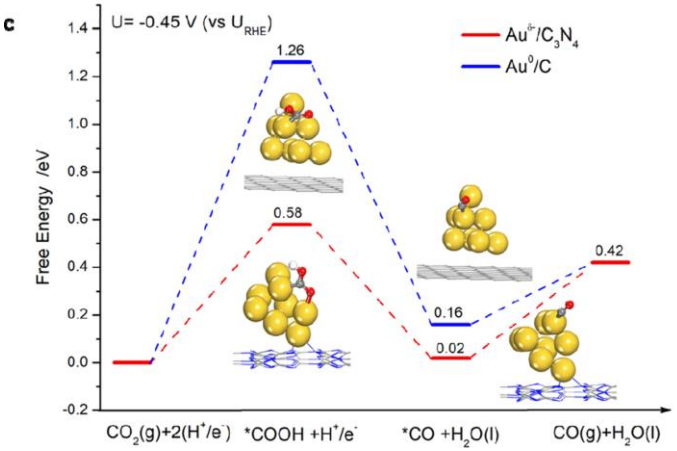










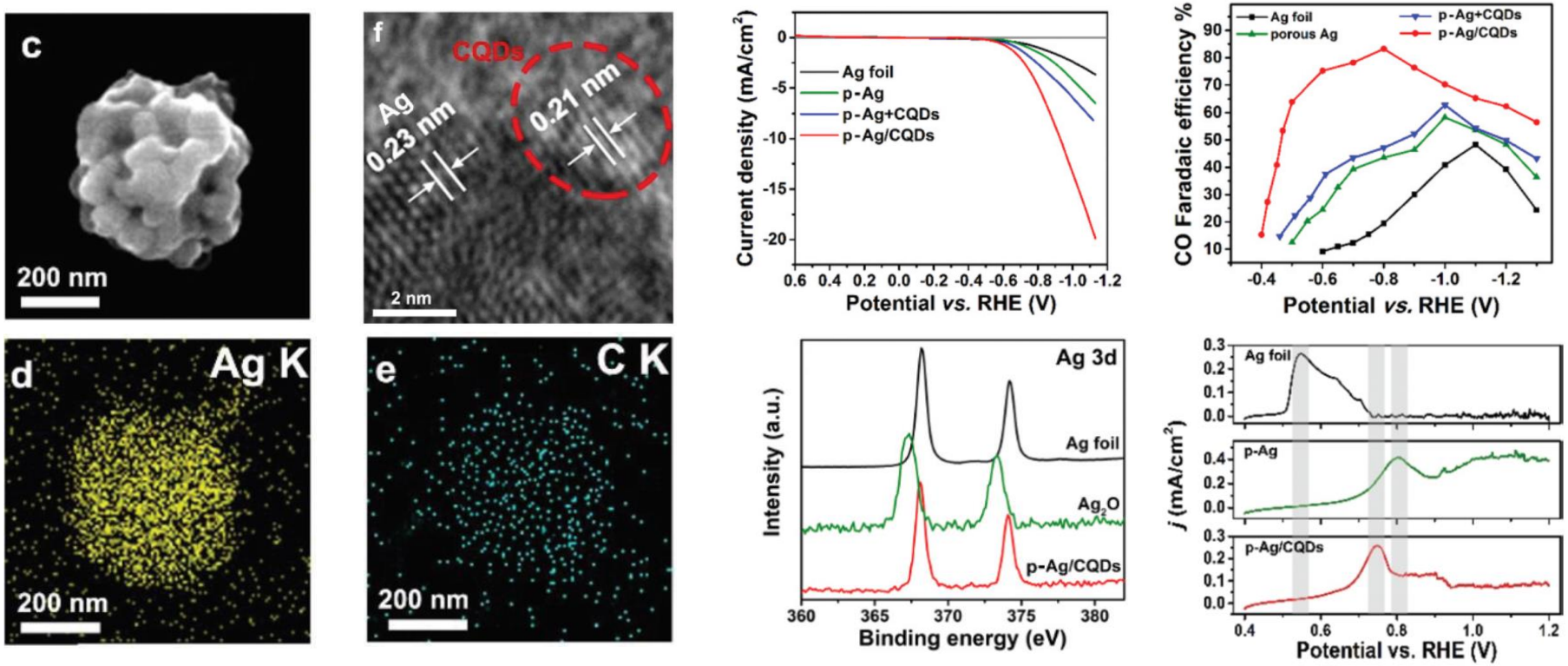


- The fitted R_{ct} of Au/C_3N_4 (19.96 Ω) is much lower than that of Au/C (93.71 Ω), suggesting a faster electron transfer between Au/C_3N_4 and CO_2.
- the Au $4f_{5/2}$ and Au $4f_{7/2}$ peaks of Au/C_3N_4 both shift to lower binding energies. Such a shift of binding energy indicates that the Au surface in Au/C_3N_4 is enriched with electrons.
- In comparison with Au^0/C, one can evidently see that $Au^{\delta-}/C_3N_4$ largely facilitates the electroreduction of CO_2 into *COOH, corresponding to a lower free-energy change of 0.58 eV (vs 1.26 eV for Au^0/C), rationalized by the improved binding ability of $Au^{\delta-}/C_3N_4$ toward the key *COOH intermediate, relative to Au^0/C, and thus enhance the CO_2RR.

Le Zhang et al., ACS Catal. (2018)

Research of electrochemical CO_2RR

CQD covered porous Ag

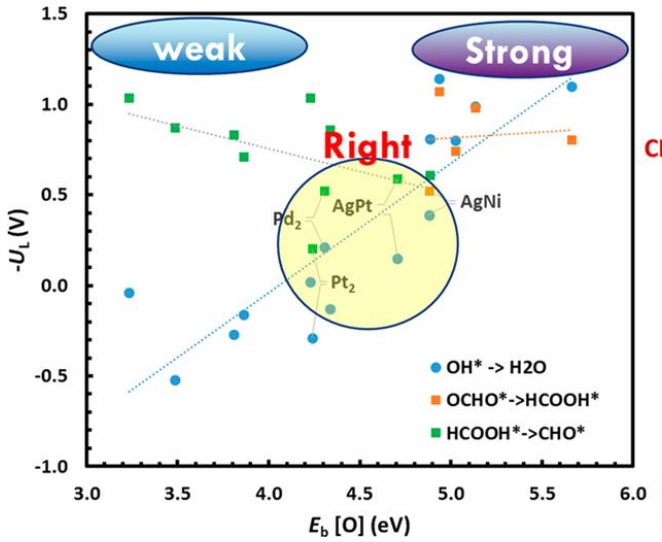


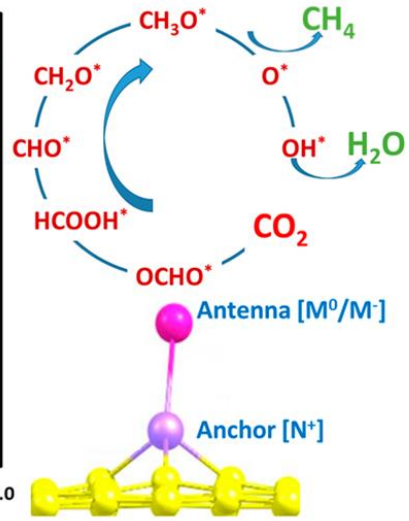
- The positive shift in the peak potential indicates that it is difficult for the CO to be released from the porous structure Ag compared with flat Ag (Ag foil)
- The negative shift in the peak potential and the reduced current density suggest the weaker adsorption of CO on the surface of the p-Ag/CQD composite compared to p-Ag.
- This result indicates that the produced CO is easier to be desorbed from the surface of the p-Ag/CQD composite compared with p-Ag, avoiding the further reduction and promoting the other CO2 molecules to be reduced.

Jin Gao et al., Inorg. Chem. Front. (2019)

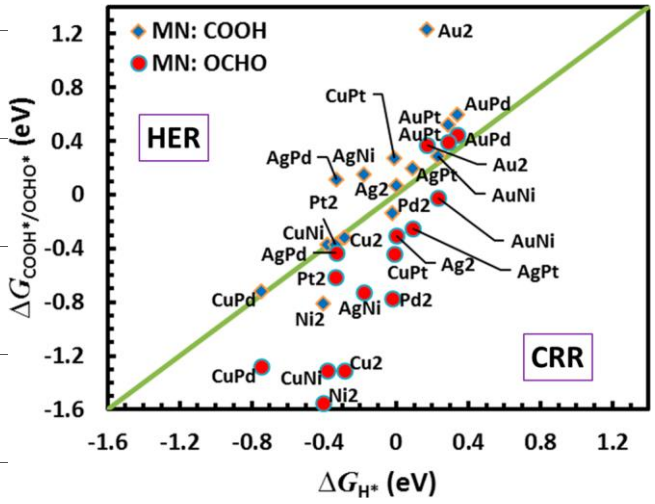
Research of electrochemical CO_2RR

Graphene-Supported Dimers





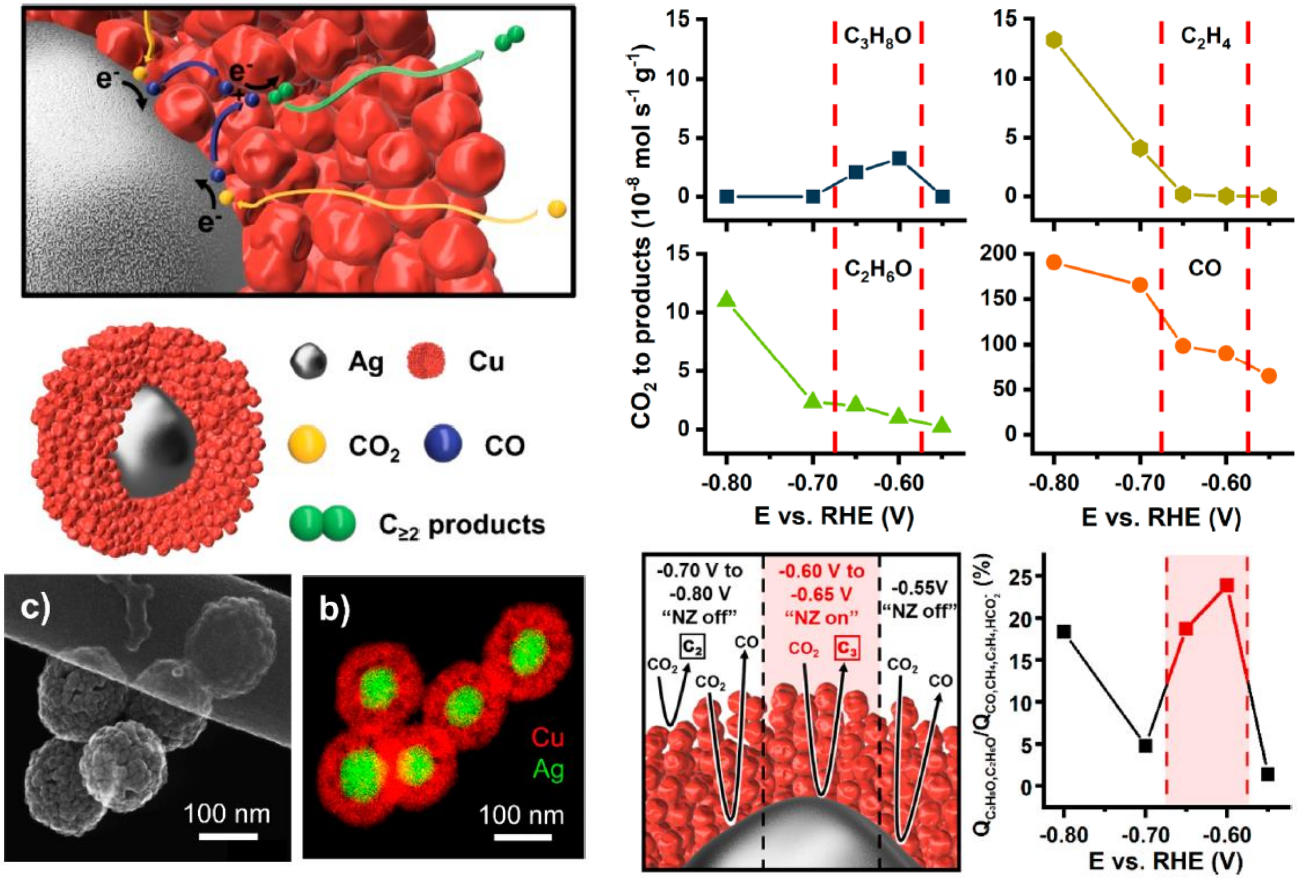
M_2/MN	Ni_2	Pd_2	Pt_2
E_b [MN] (eV)	7.23	6.98	7.90
Q [M] (e), Q [N] (e)	0.08, 0.45	-0.02, 0.30	-0.20, 0.34
R [M-N] (Å)	2.25	2.60	2.53
Cu_2	CuNi	CuPd	CuPt
3.82	6.17	5.17	6.63
0.19, 0.47	0.12, 0.45	-0.16, 0.28	-0.09, 0.20
2.32	2.21	2.31	2.28
Ag_2	AgNi	AgPd	AgPt
2.03	6.04	5.21	6.65
-0.18, 0.33	-0.14, 0.49	-0.17, 0.31	-0.15, 0.25
2.60	2.40	2.57	2.54
Au_2	AuNi	AuPd	AuPt
3.61	6.46	5.70	7.37
-0.30, 0.32	-0.42, 0.57	-0.40, 0.40	-0.33, 0.42
2.52	2.34	2.48	2.46



Haiying He et al., J. Phys. Chem. C. (2018)

Research of electrochemical CO_2RR

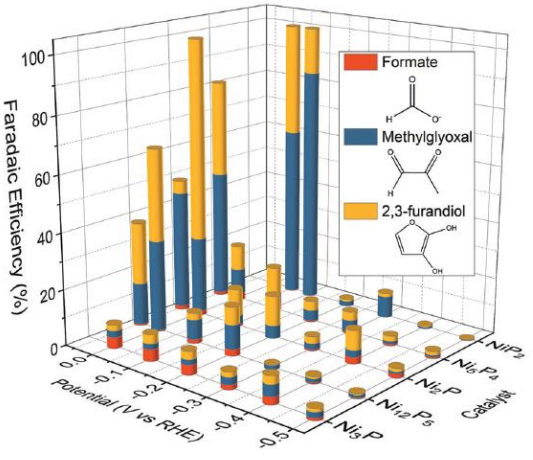
Cascade Reaction in Nanozymes

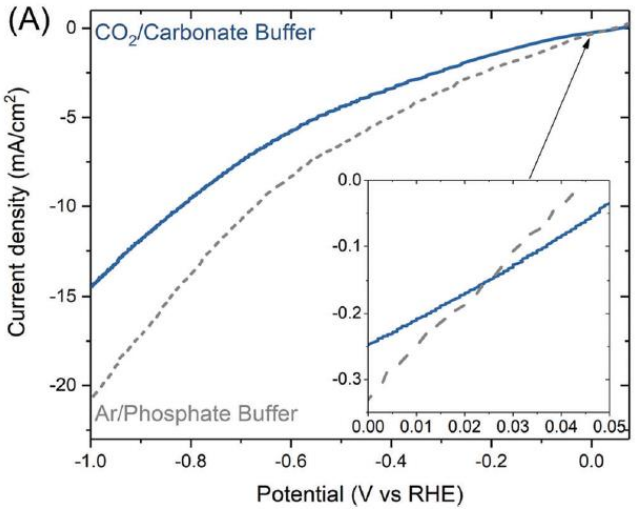


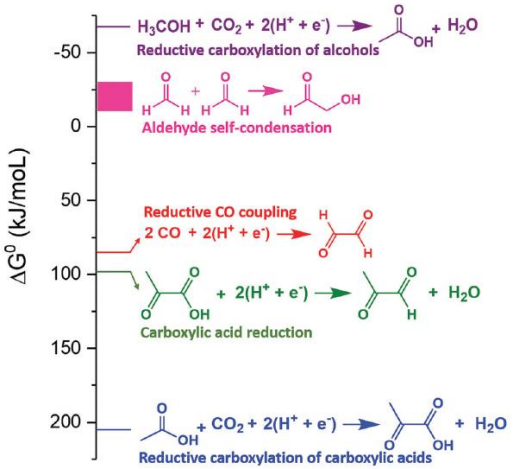
Peter B. O'Mara et al., Energy J. Am. Chem. Soc. (2019)

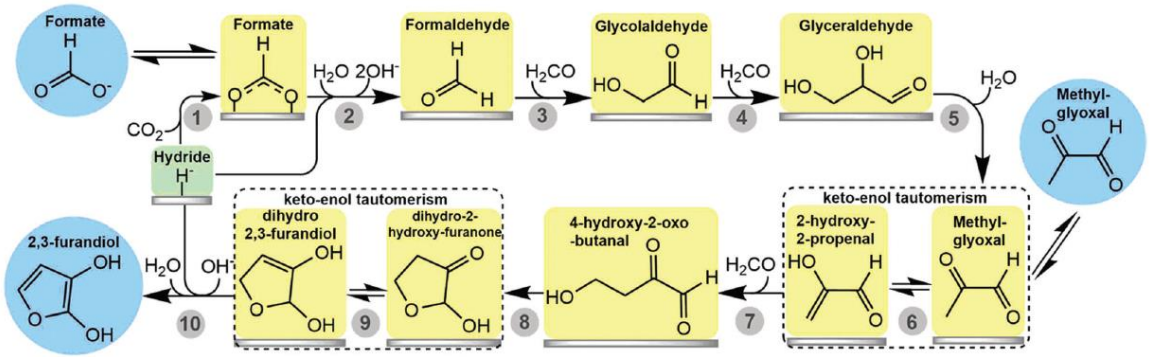
Research of electrochemical CO_2RR

C3 and C4 oxyhydrocarbons on Ni_xP_y





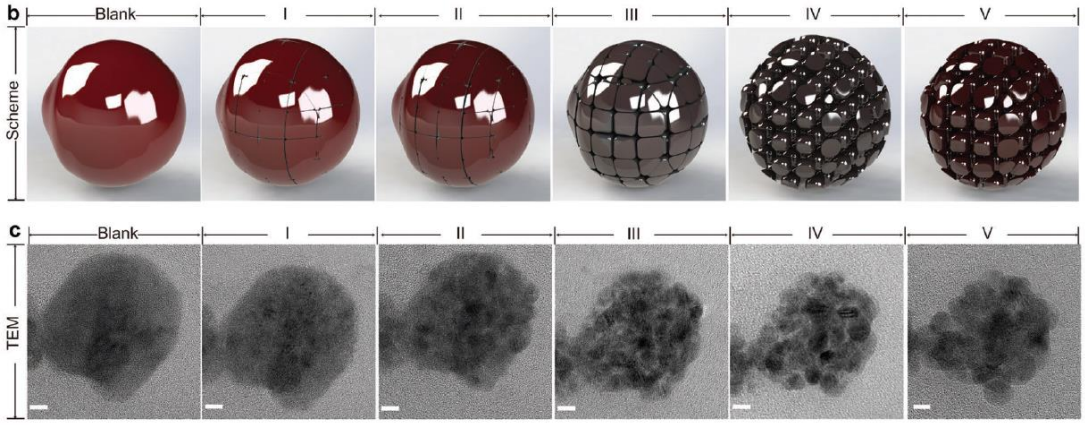


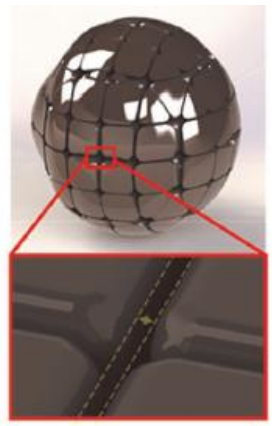


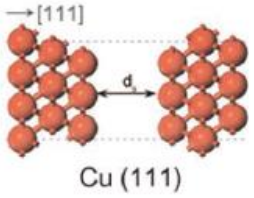
Karin U. D. Calbinho et al., Energy Environ. Sci. (2018)

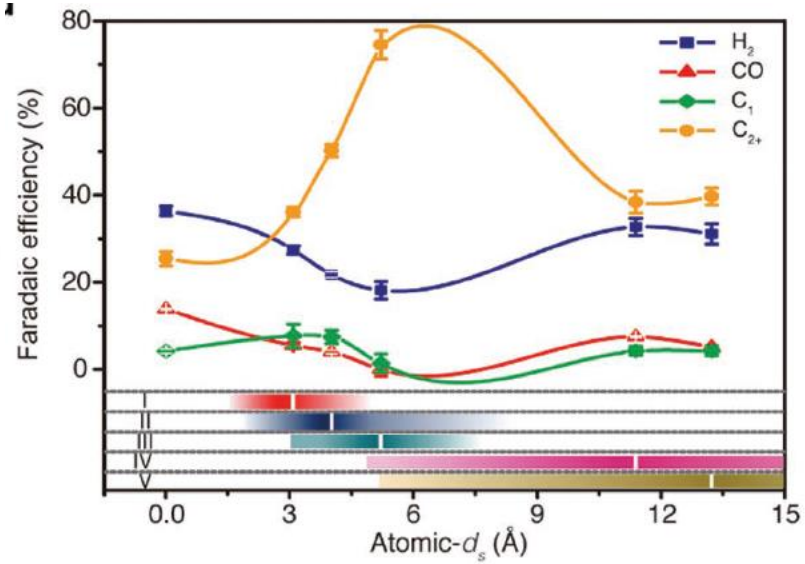
Research of electrochemical CO_2RR

Atomic-Scale Spacing (Defect control)









Hyung Mo Jeong et al., Adv. Energy Mater. (2020)