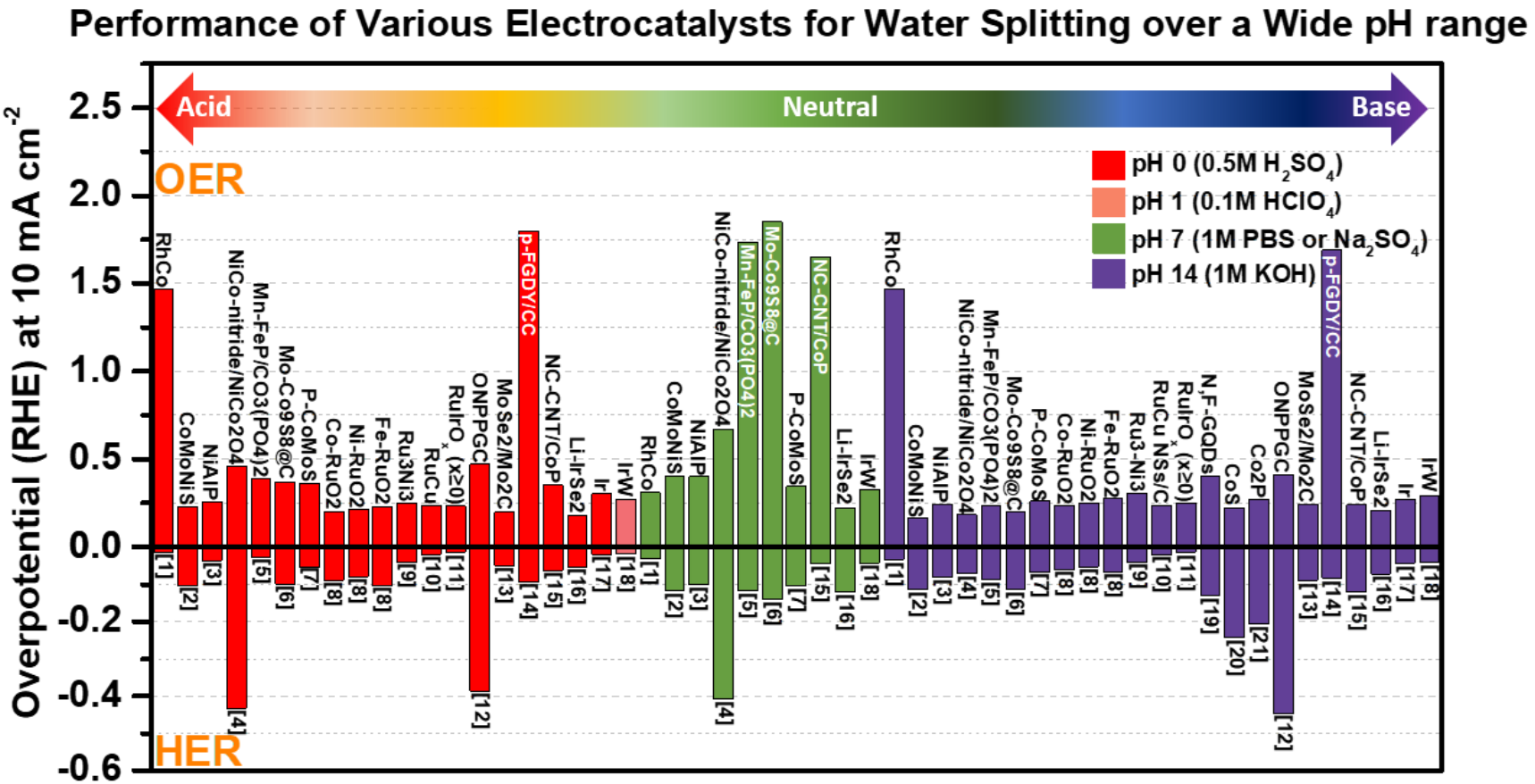
물분해 반응 시스템 및 관련 소재
Water Splitting Reaction System and Related Materials

Uk Sim, Ph. D.

Nanomaterials for Energy & Environment Laboratory
www.uksim.org

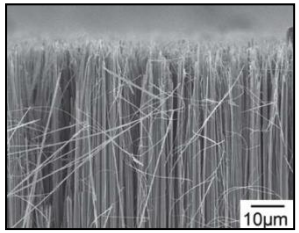
Rational Design of Efficient Electrocatalyst for Full Water Splitting across all pH conditions



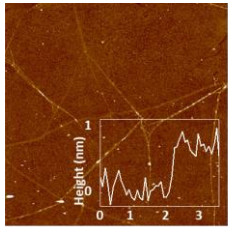
G. Janani, Uk Sim et al., MRS Bulletin 2020, 45:7, 539-547*

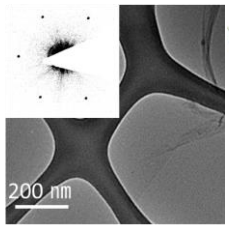
(Photo)Electrochemical Fuel Production using Low-Dimensional Catalyst

Carbon-based catalyst for photoelectrochemical hydrogen production

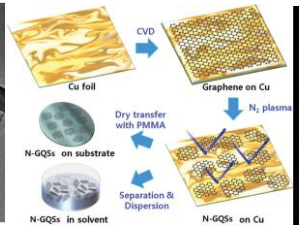


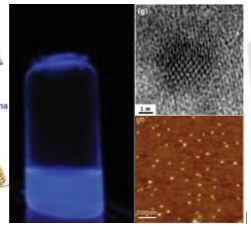
JMCA (2013)



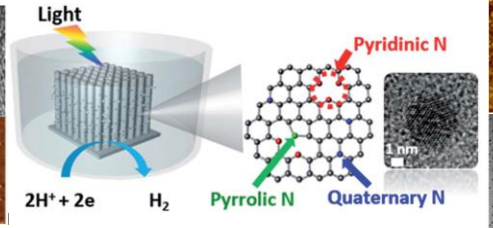


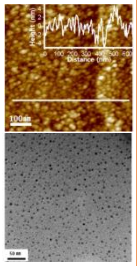
Energy Environ. Sci. (2013)



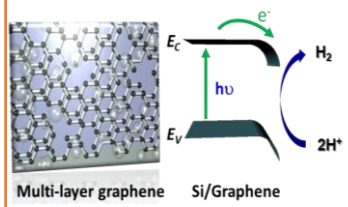


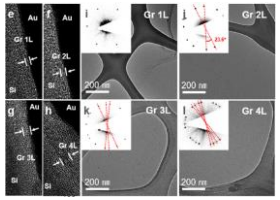
Adv. Mater. (2014)



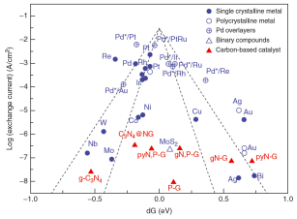


Energy Environ. Sci. (2015)

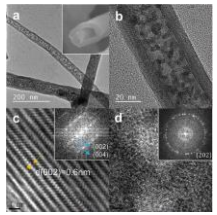




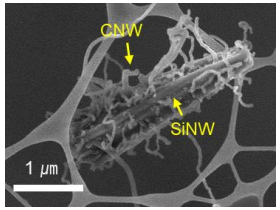
ACS Appl. Mater. Inter. (2017)



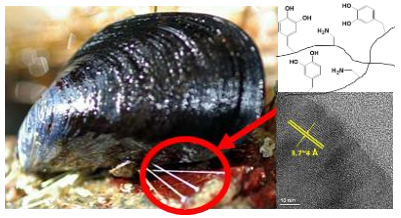
Handbook, Wiley (2015)



Adv. Mater. (2017)

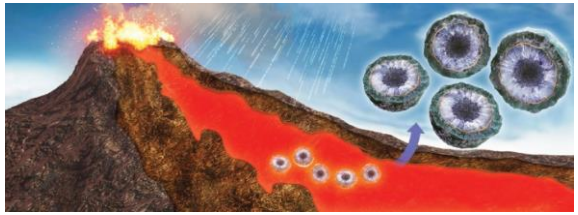


Nanoscale (2018)

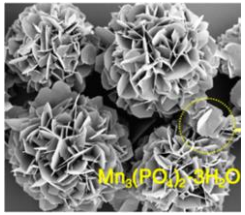


BKCS (2018)

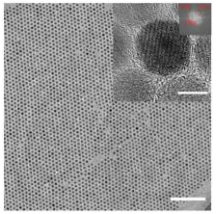
(Photo)electrochemical water oxidation using biomimetic Fe, Mn or Carbon-based catalyst



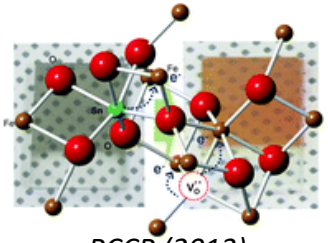
Small (2017)



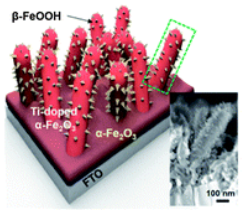
JACS (2014)



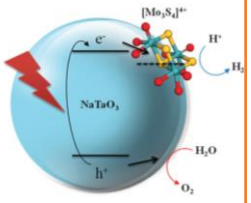
Sci. Rep. (2015)



PCCP (2013)

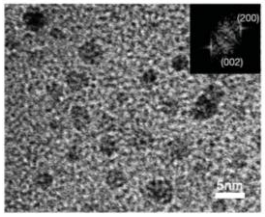


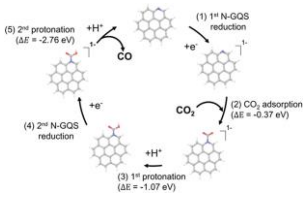
JMCA (2013)



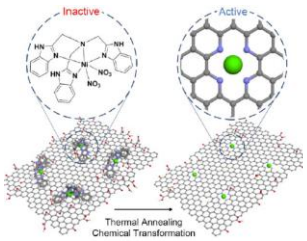
Chem. Comm. (2013)

(Photo)electrochemical CO_2 reduction

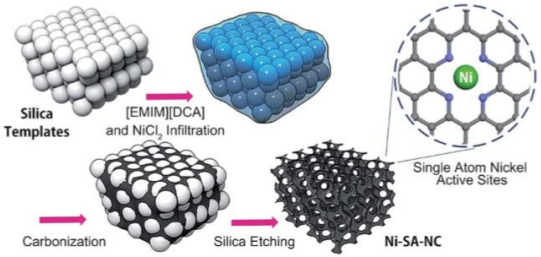




Adv. Funct. Mater. (2016)

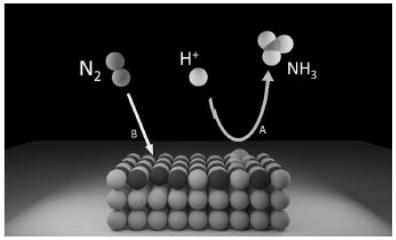


Chem. Eur. J. (2018)



JMCA (2019)

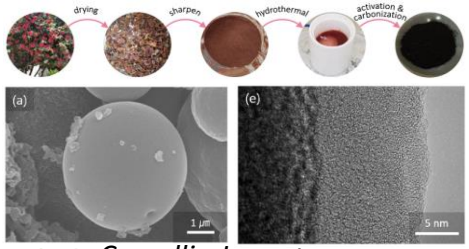
Nitrogen Reduction



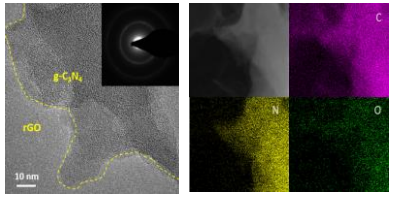
JKES (2019), JKCerS (2021), Nano Convergence (2019)

Nanomaterials for Energy Conversion and Storage

Carbon-based materials

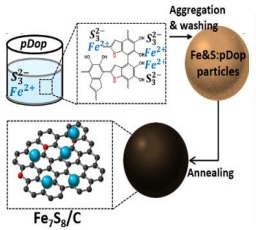


Camellia Japonica

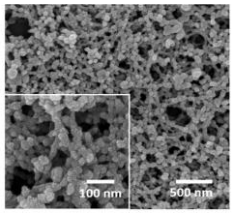


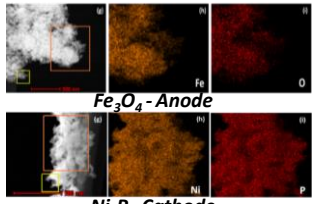
g-C_3N_4/rGO

Transition metal-based materials

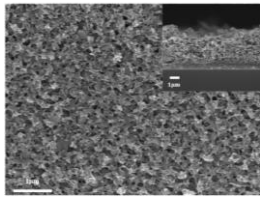


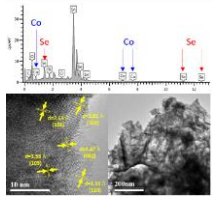
Iron Sulfide (Fe_7S_8)



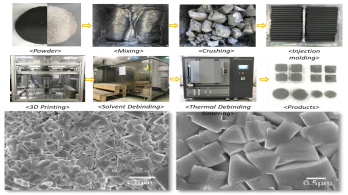


Anodic Iron Oxide and Cathodic Nickel Phosphide



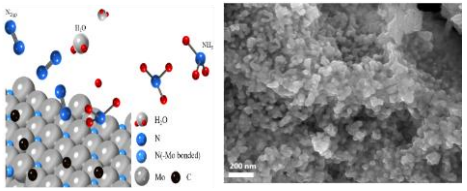


Cobalt Selenide (CoSe)

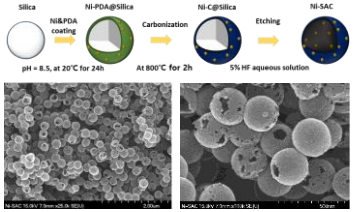


3D printed WC-10Co

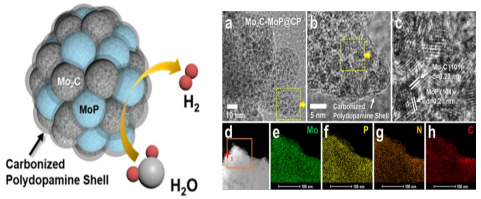
Metal-carbon hybrid materials



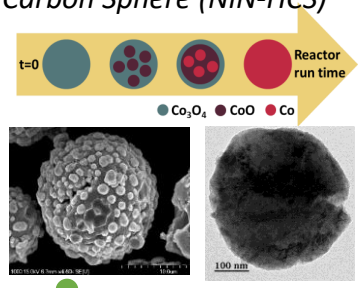
Mo_2C-Mo_2N



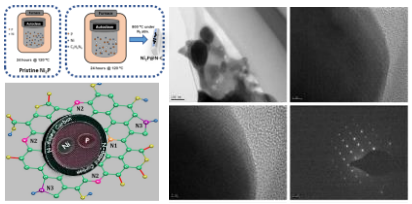
Ni and N doped Hollow Carbon Sphere (NiN-HCS)



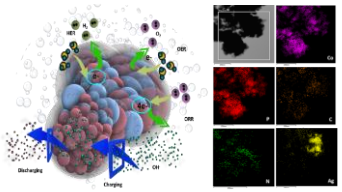
Mo_2C-MoP @ Carbonized Polydopamine



Co-MnO@C

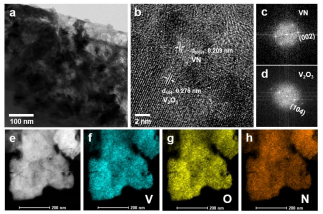


Ni_2P@N-C by Hydrothermal Method

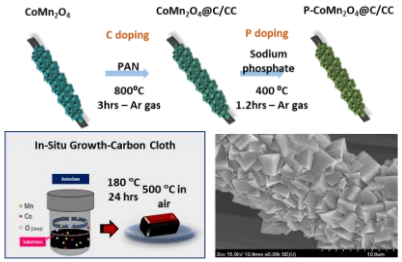


N-doped Carbon Enriched Hybrid CoP/Ag Nanocomposites

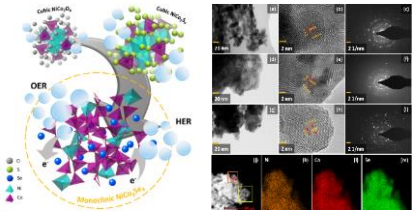
Bimetallic materials



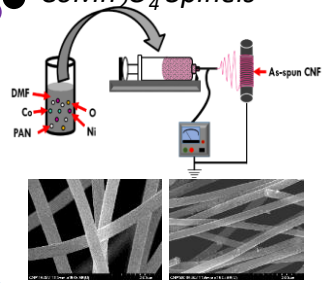
Vanadium Nitride and Oxide (VN and V_2O_3)



$CoMn_2O_4$ Spinels



Spinel-type Bimetallic Oxides, Sulphides, and Selenides

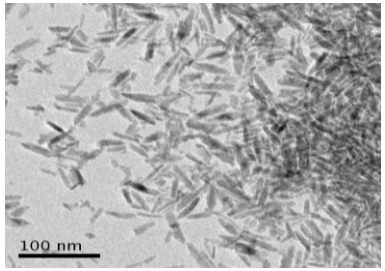


NiCoO-Carbon nanofiber

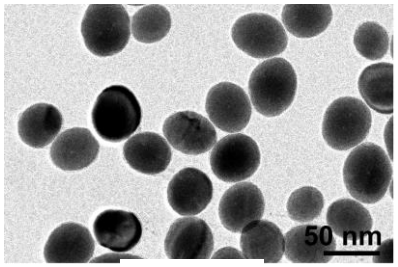
HER OER ORR CO_2RR NRR Supercapacitor Battery

Nanomaterials for Energy Conversion and Storage

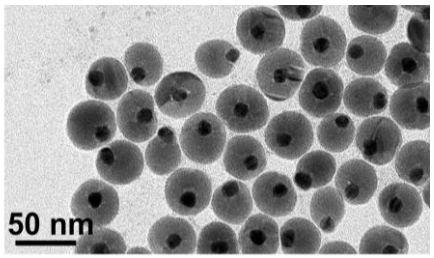
Thermoelectric materials



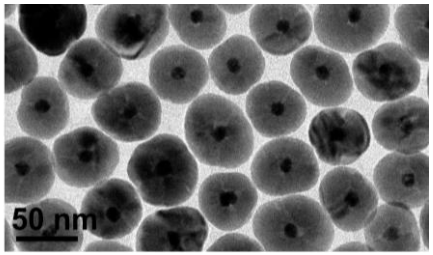
Bi_2S_3



Cu_2Se

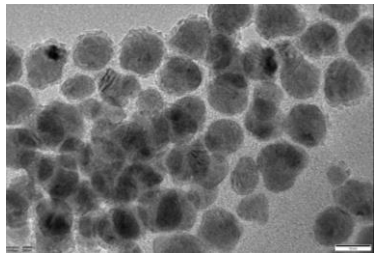


Au@Cu_2Se Core-shell NPs

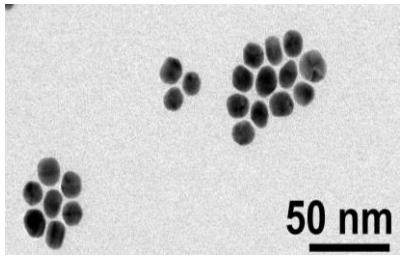


Au@Cu_2Se Core-shell NPs

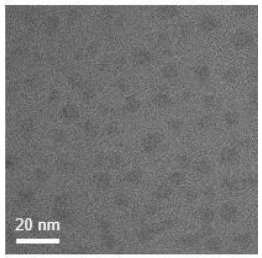
Monodisperse nanoparticles



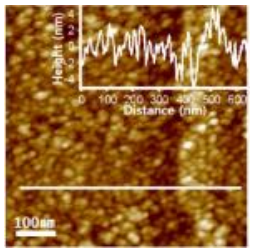
Co ~10nm

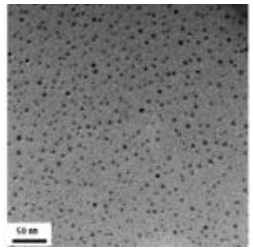


Au ~5nm



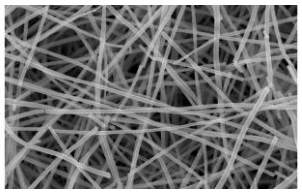
CQD



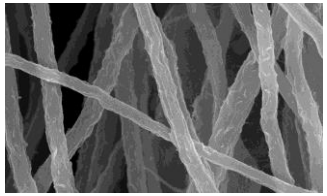


Graphene Quantum Sheets ~5nm

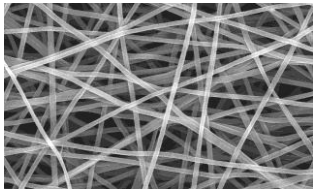
Porous fibers for solid electrolyte templates



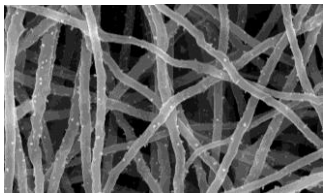
$La_2Zr_2O_7$ nanowires



$LaVO_4$ nanowires

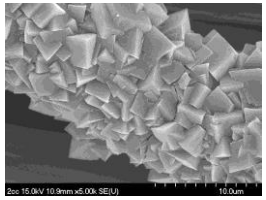


Carbon Nanofibers

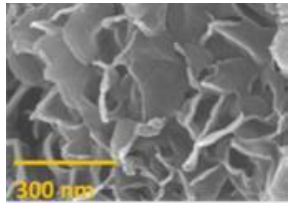


Ni_2P@ Carbon fibers

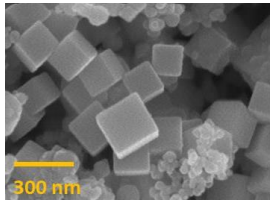
Photocatalytic materials



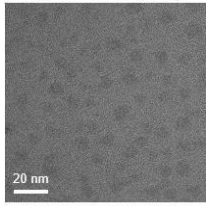
$CoMn_2O_4$/CC



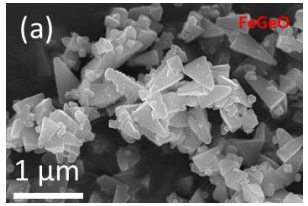
$MoSe_2$



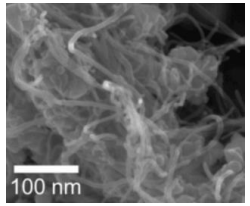
TiN



CQD



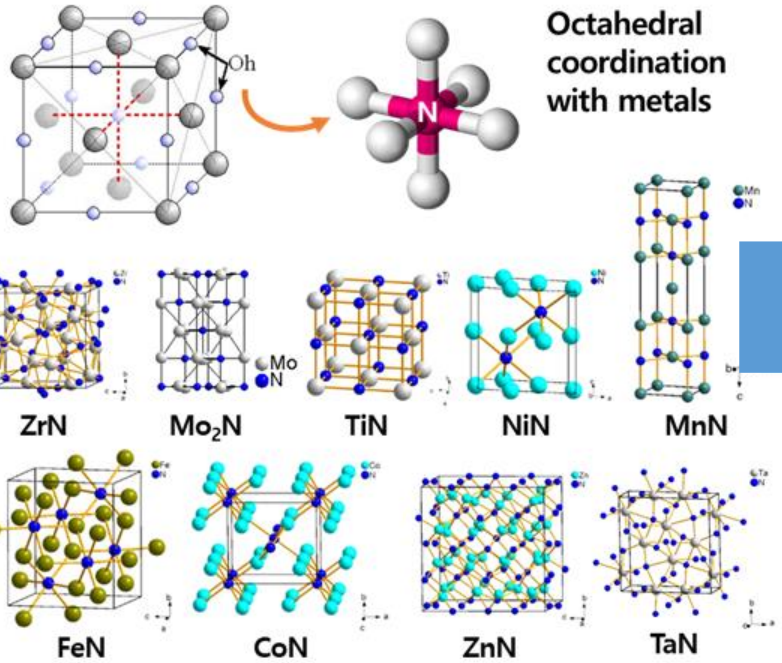
FeGeO



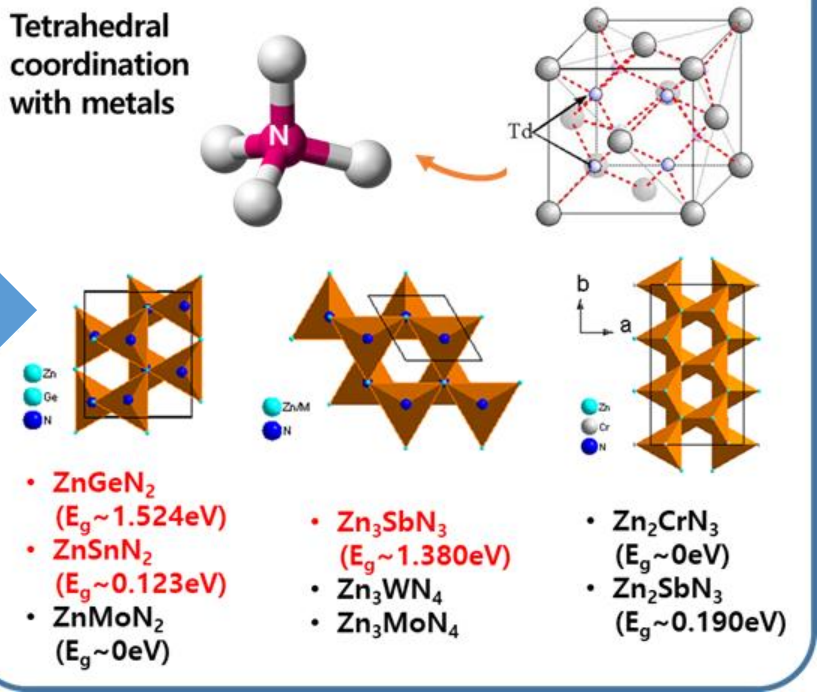
Mo_2C-MoP @CNT

Metal nitride-based materials

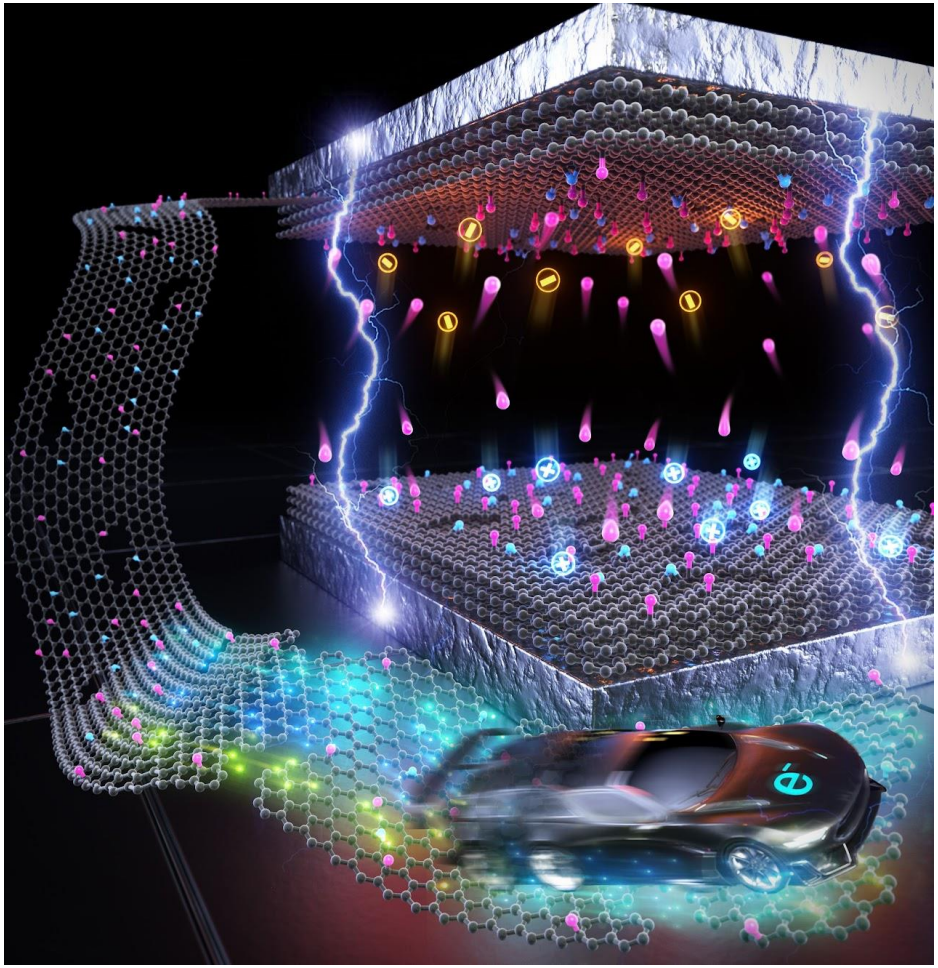
Binary metal nitride

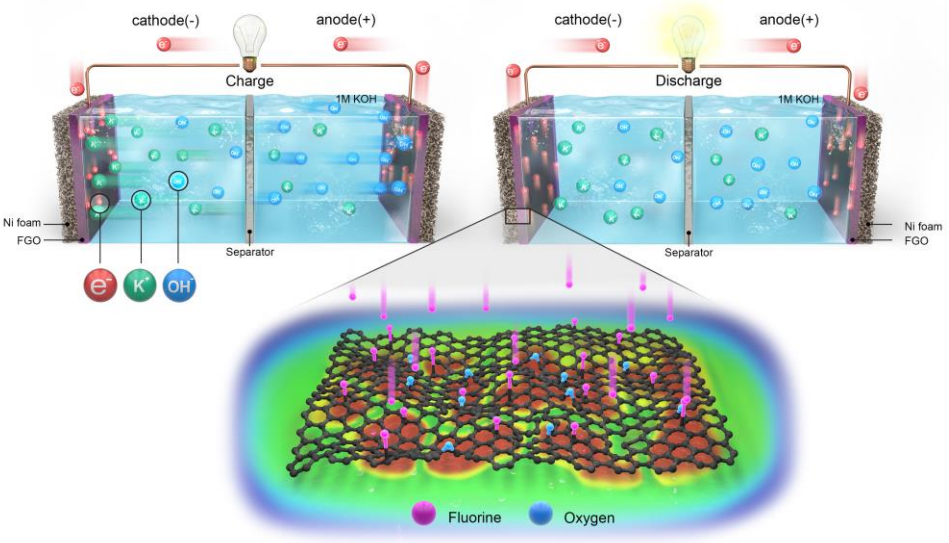


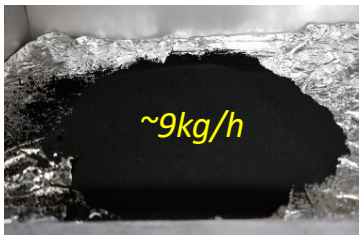
Ternary metal nitride

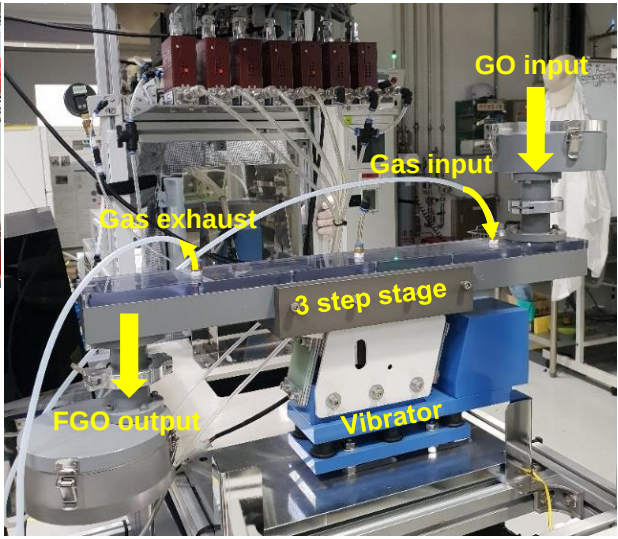


Fluorine-doped Graphene Oxide Prepared by Direct Plasma Treatment





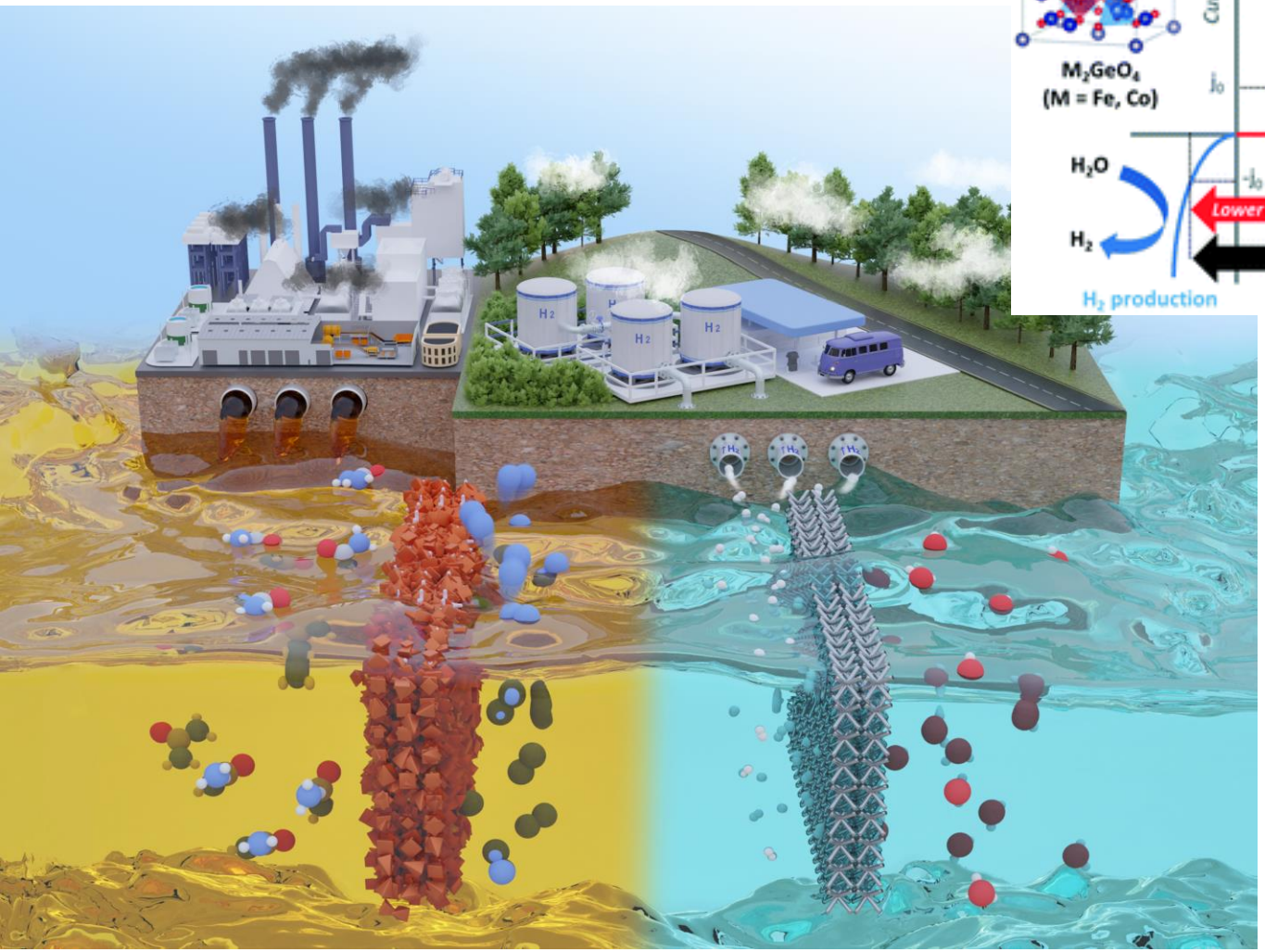


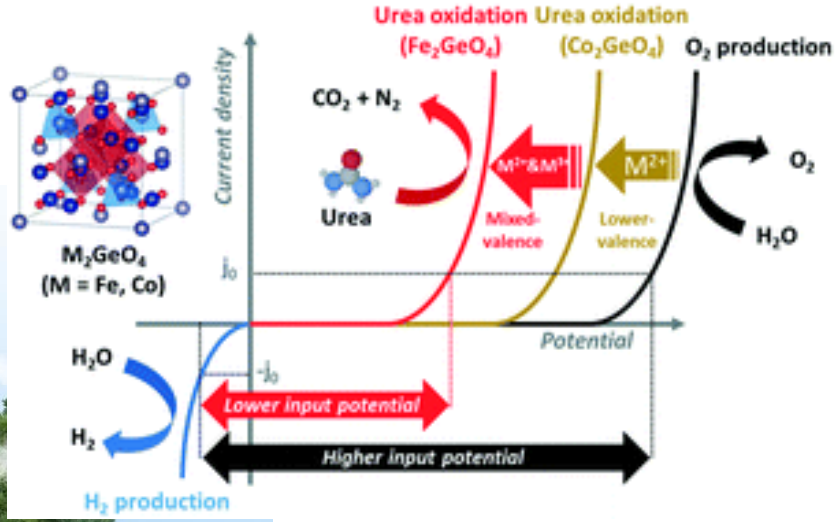


고성능 슈퍼커패시터 구현한 국제 공동연구진...상용화 기대
친환경차 장거리도 씽씽? 에너지저장장치 성능 'up' 성공
대용량 그래핀 불소도핑 성공..고성능 슈퍼커패시터 상용화 '탄력'
韓 연구진 "고성능 슈퍼커패시터 상용화 난제 해결
그래핀 대용량 불소도핑 성공...고성능 슈퍼커패시터 구현 기반 마련
불소 도핑으로 '고출력 에너지 저장장치' 성능 높여

Uk Sim et al., Chemical Engineering Journal 2022, 428, 132086*

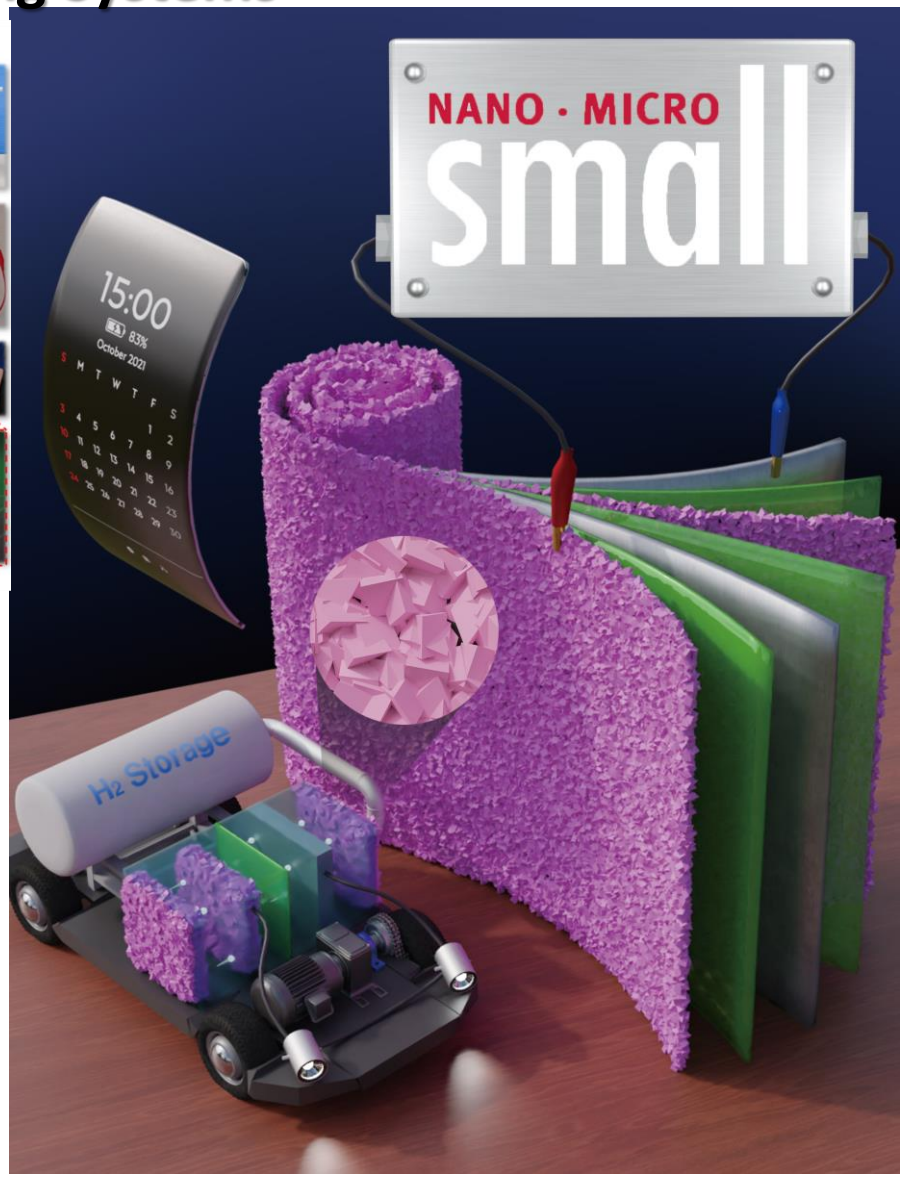
Boosting eco-friendly hydrogen generation by urea-assisted water electrolysis using M_2GeO_4 (M = Fe, Co) as an active electrocatalyst





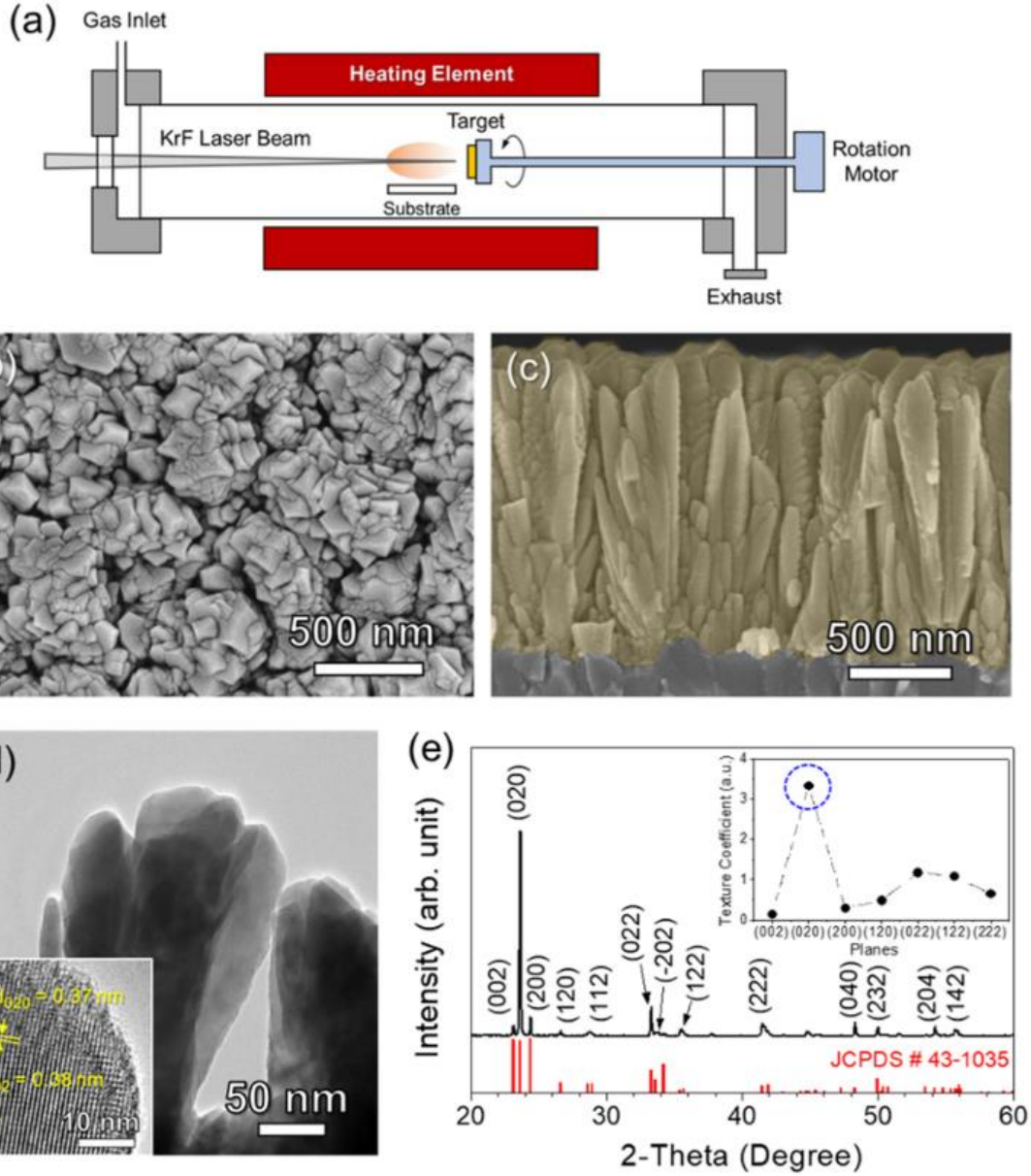
Uk Sim et al., Environmental Science: Nano 2021, Accepted*

In situ Grown $CoMn_2O_4$ 3D-tetragons on Carbon Cloth: Flexible Electrodes for efficient Rechargeable Zinc-Air Battery Powered Water Splitting Systems



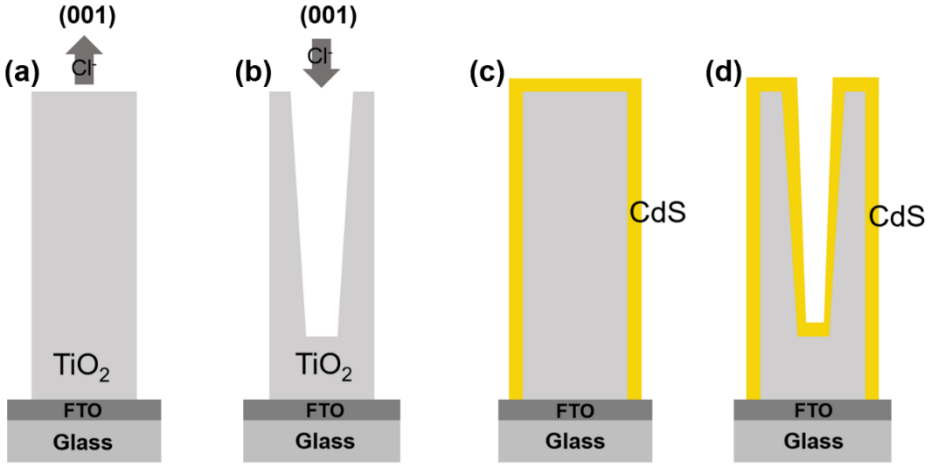
Uk Sim et al., Small 2021, Accepted*

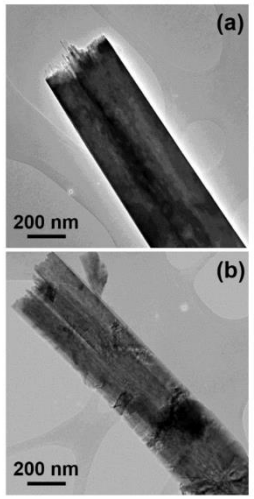
WO_3 via Texture and Nanostructure Control

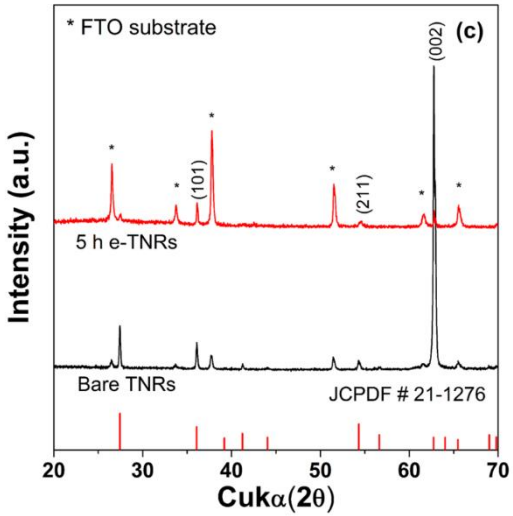


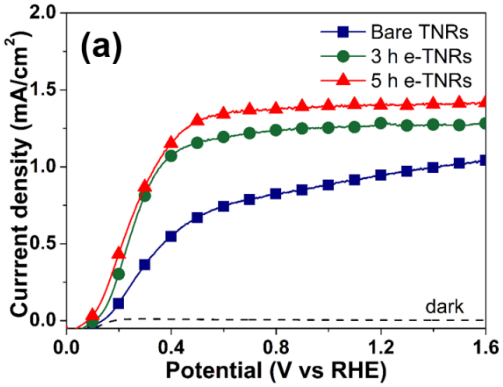
UK Sim et al., Journal of Catalysis 2020, 389, 328-336*

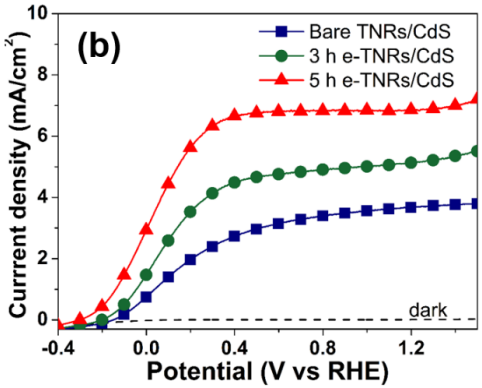
Morphology Control of TiO_2 Nanorods Photoanode

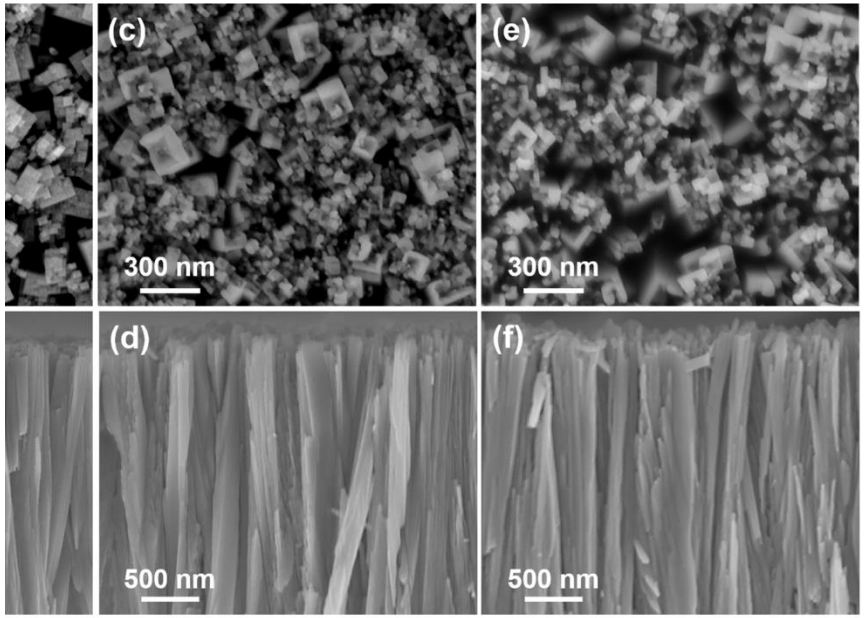


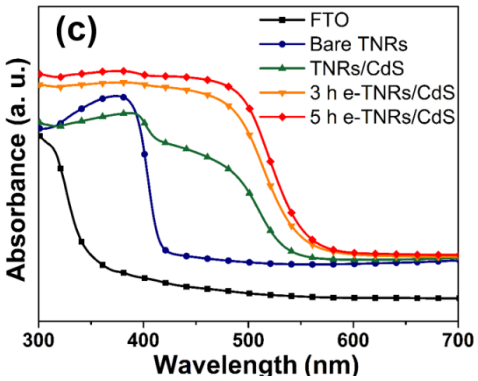


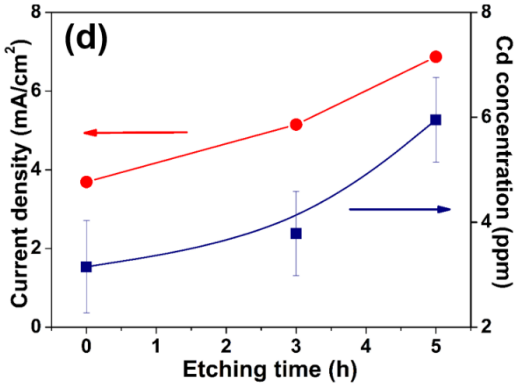








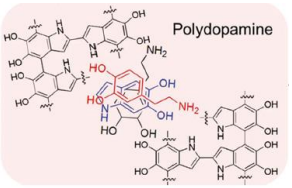


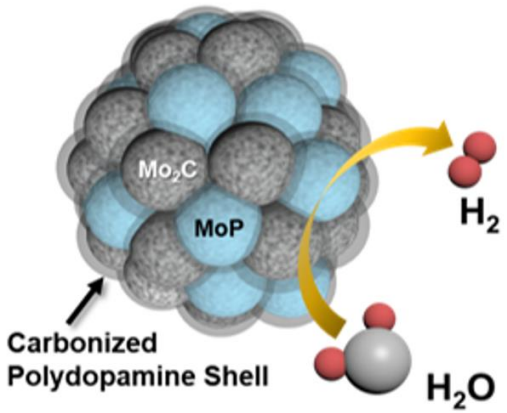


Uk Sim* et al., Ceramics International 2021, 47 (3), 3972-3977

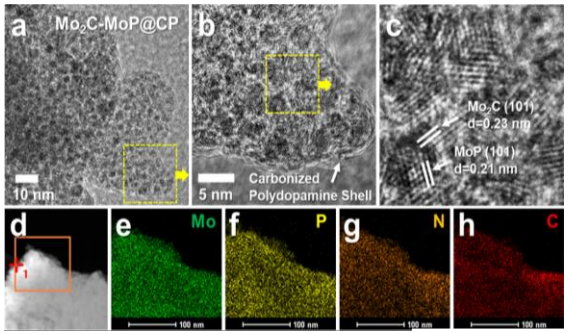
Mo2C-MoP @ Carbonized Polydopamine

Concept

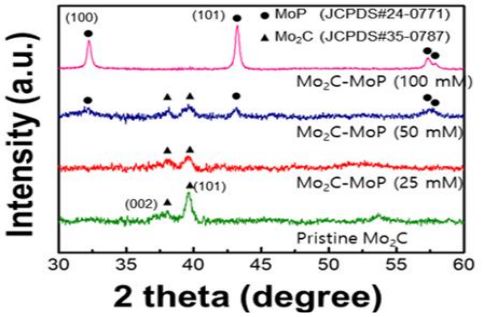




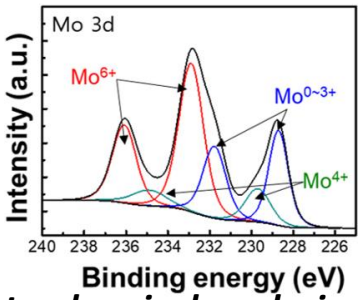
TEM and elemental mapping

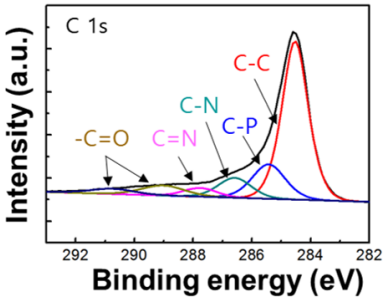


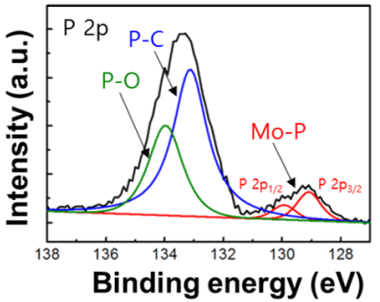
XRD analysis



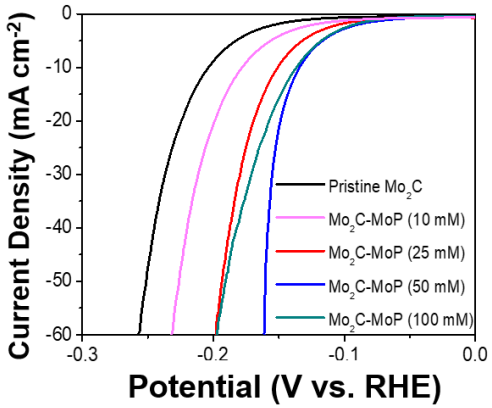
XPS analysis

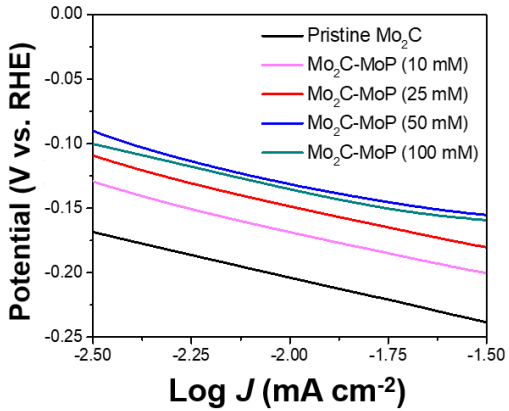


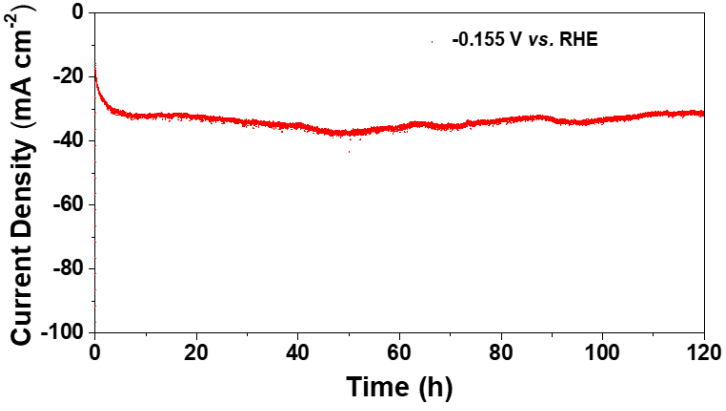




Electrochemical analysis



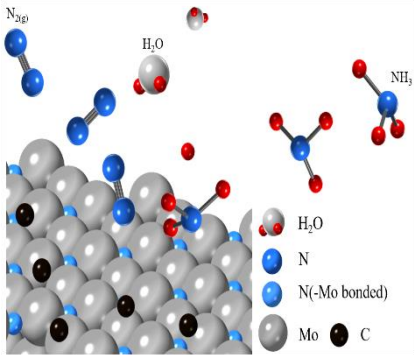




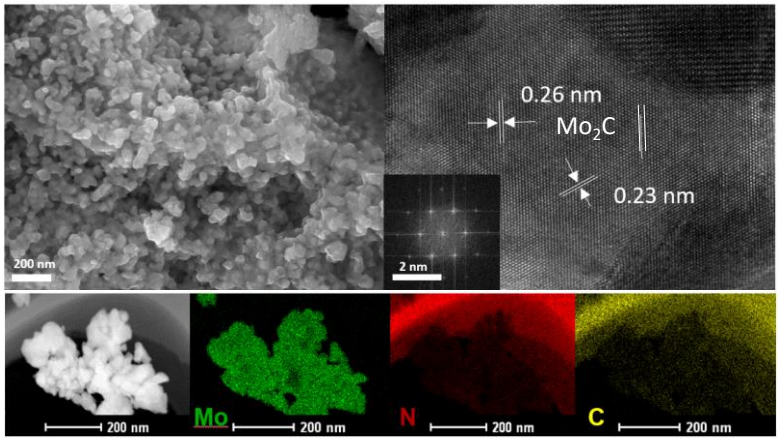
Uk Sim et al., Composites Part B-Engineering, 2019, 175 (15), 107071-107077*

Mo_2C-Mo_2N

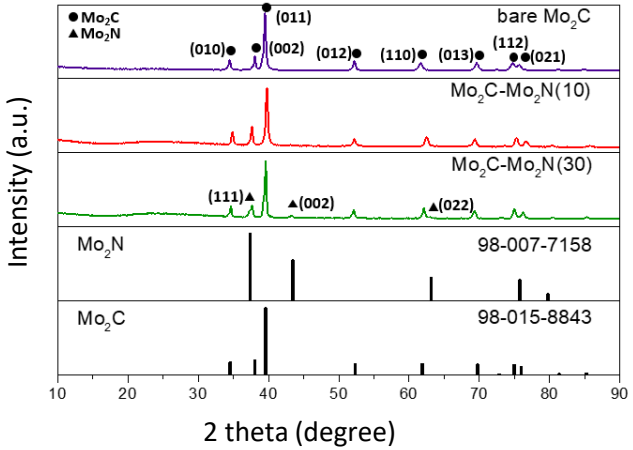
Concept



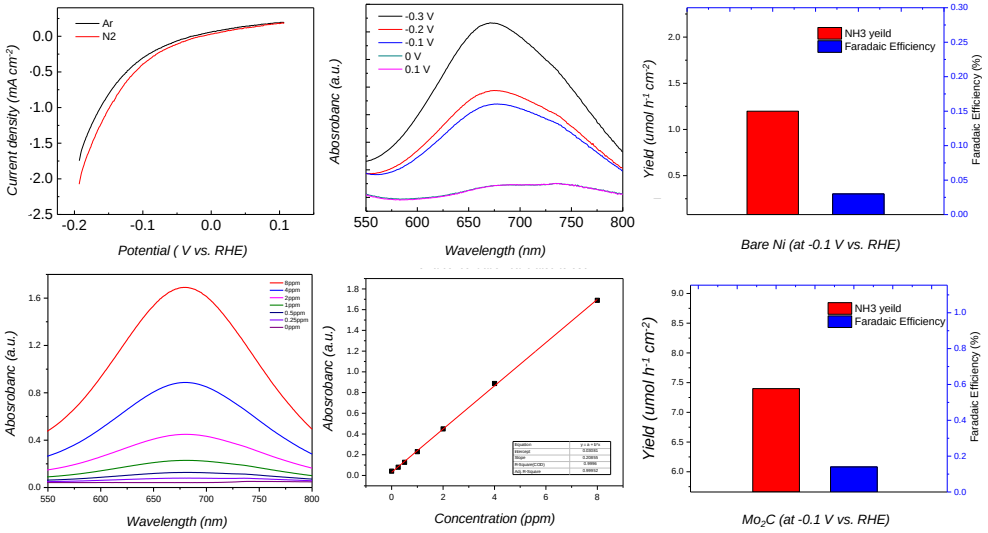
SEM, TEM, DP and elemental mapping



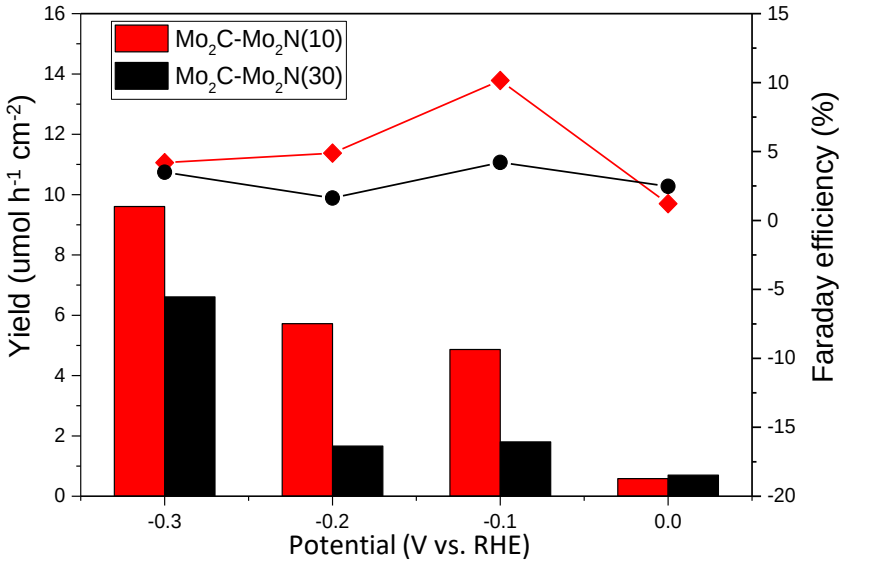
XRD analysis



Electrochemical reaction for NRR



Ammonia yield and faradaic efficiency



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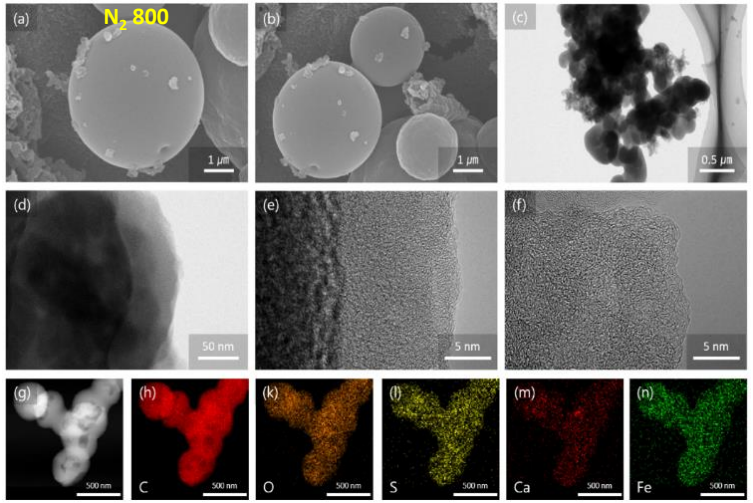
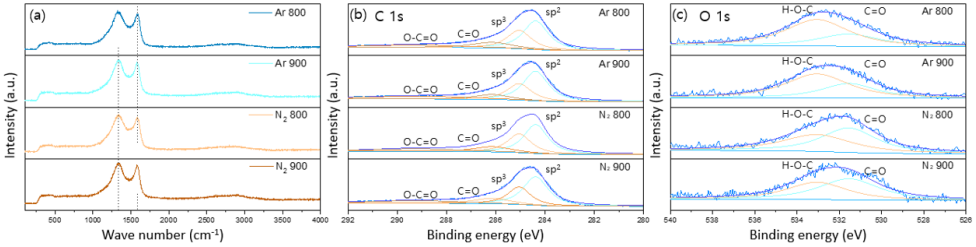
Camellia Japonica

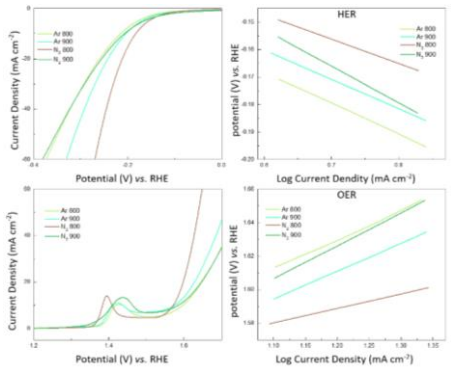
SEM, TEM, elemental mapping



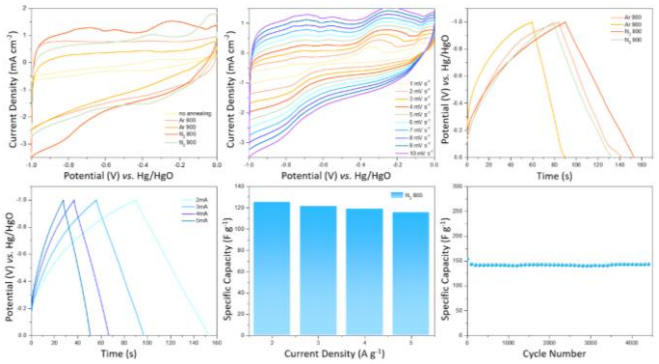
XPS analysis



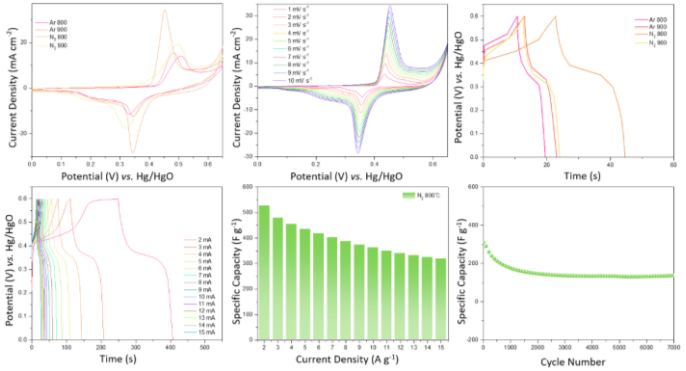
hydrogen and oxygen production measurement [3-electrode]



supercapacitance measurement @ negative potential range [3-electrode]



supercapacitance measurement @ positive potential range [3-electrode]



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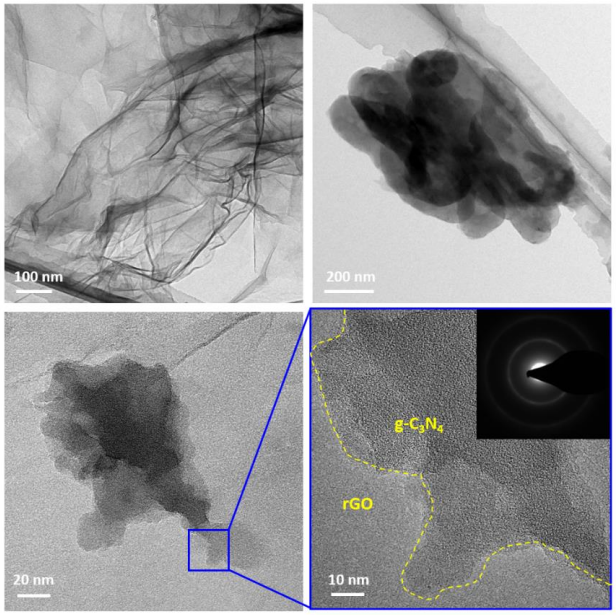
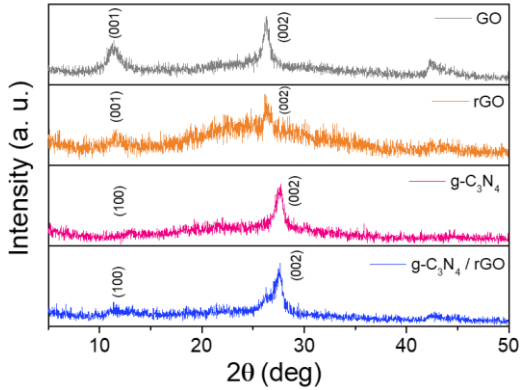
Graphitic-carbon Nitride($g\text{-}C_3N_4$) decorated rGO

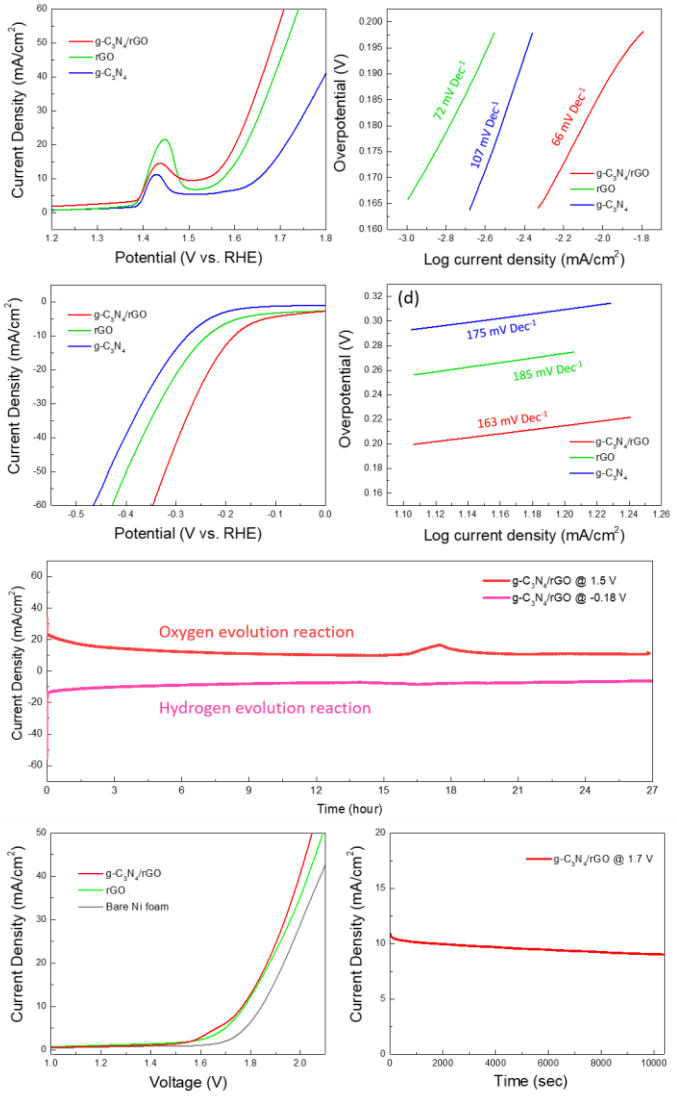
TEM image



XRD analysis



Electrochemical analysis



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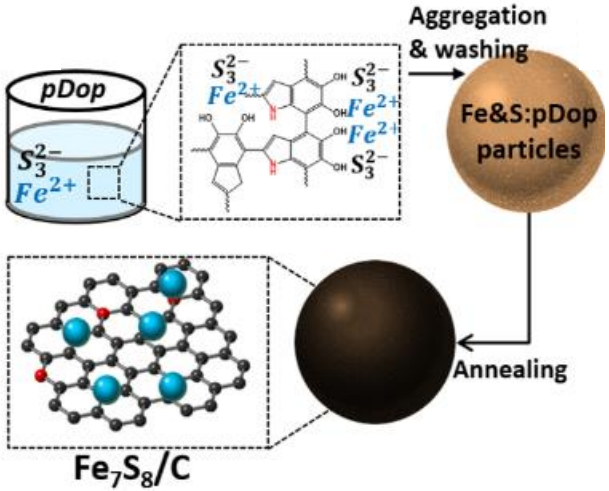
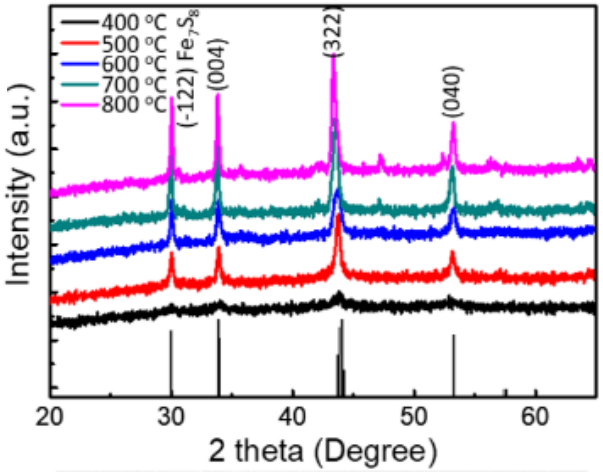
Iron Sulfide

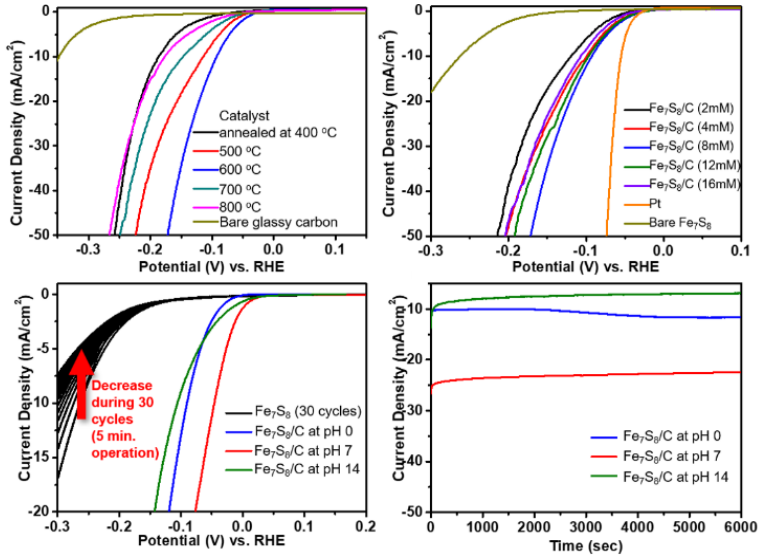
Schematic of monoclinic pyrrhotite of Fe_7S_8



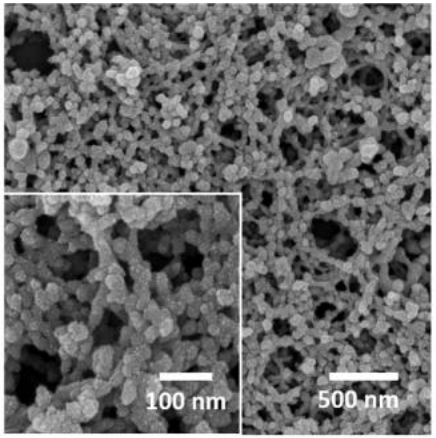
XRD analysis

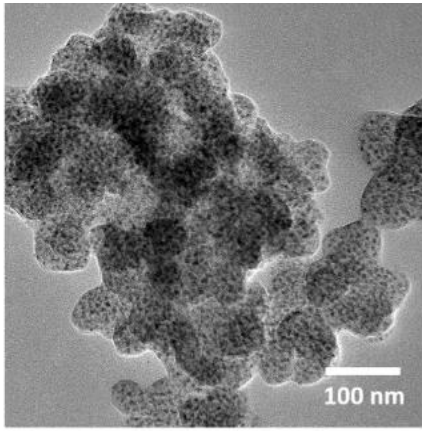


Electrochemical reaction for HER



SEM and TEM image





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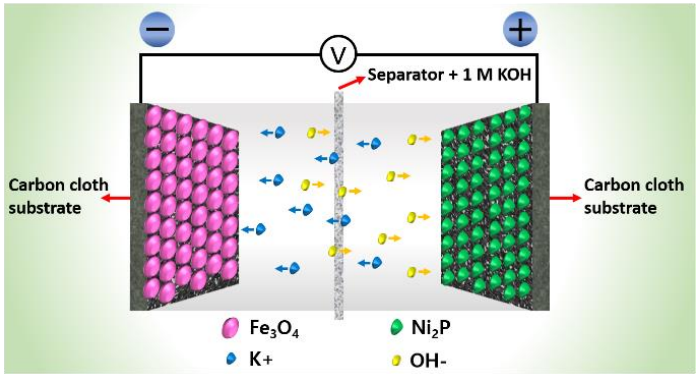
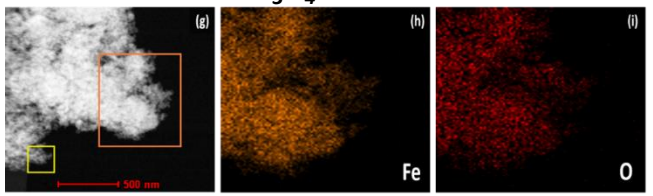
Anodic Iron Oxide and Cathodic Nickel Phosphide for Ingenious Metallic Asymmetric Supercapacitor

Schematic of Asymmetric Supercapacitor

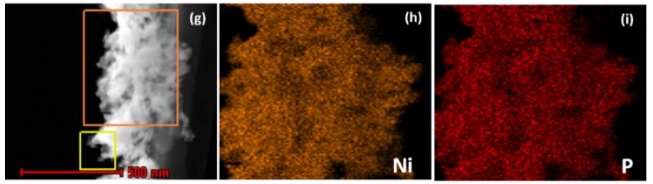


Elemental mapping

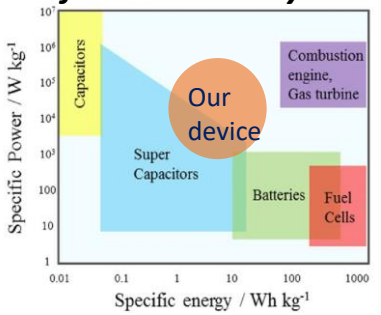
Fe_3O_4 - Anode



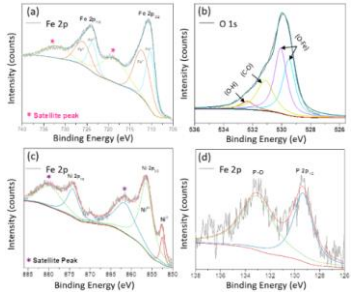
Ni_2P - Cathode



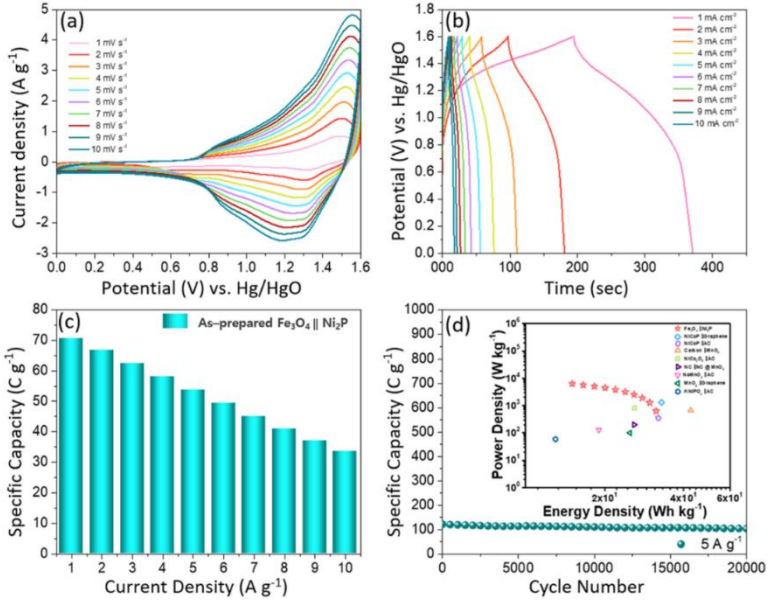
Performance analysis index



XPS analysis

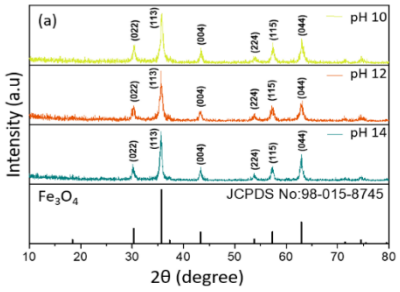


Electrical test for asymmetric cell

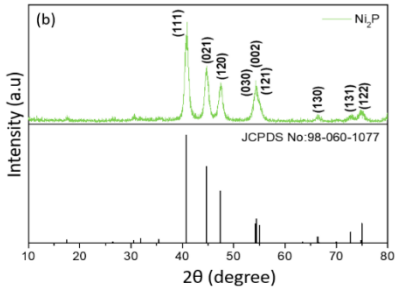


XRD analysis

Fe_3O_4 – Anode



Ni_2P - Cathode



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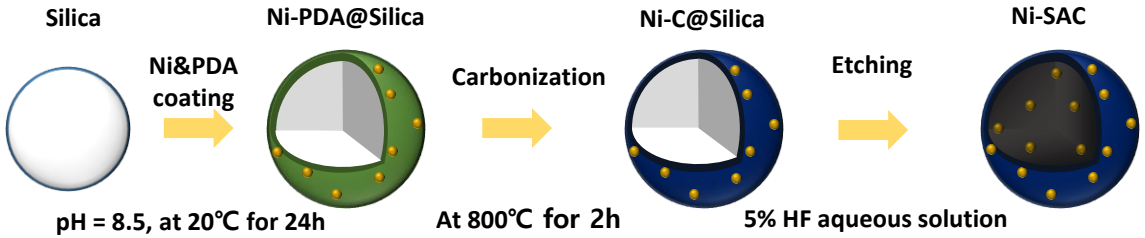
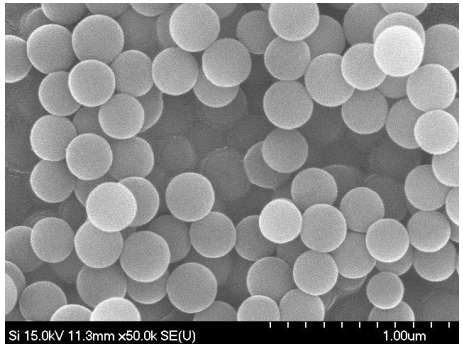
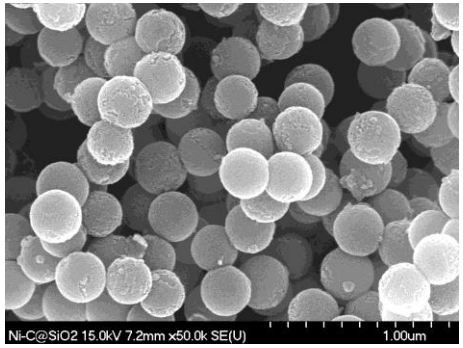
Ni and N doped Carbon sphere

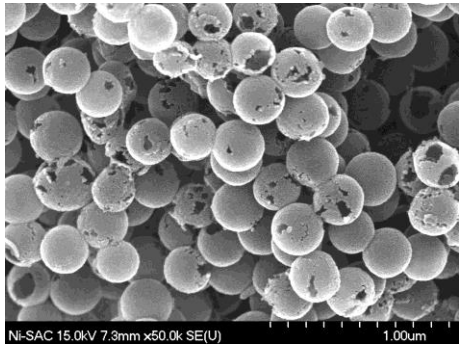
SEM images

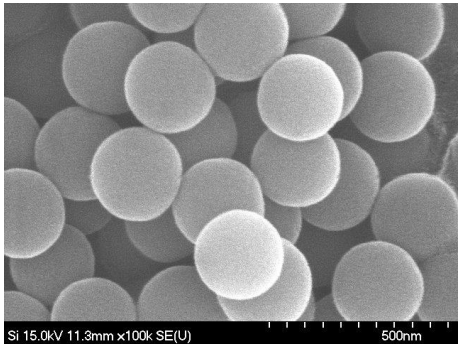


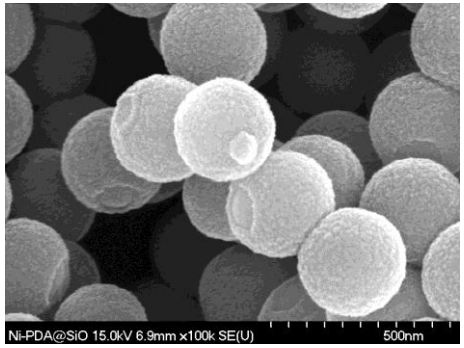
Silica nanoparticles(SiO2) ***Ni and Polydopamine@SiO2*** ***Ni and N doped C@SiO2*** ***Ni and N doped Hollow Carbon sphere***

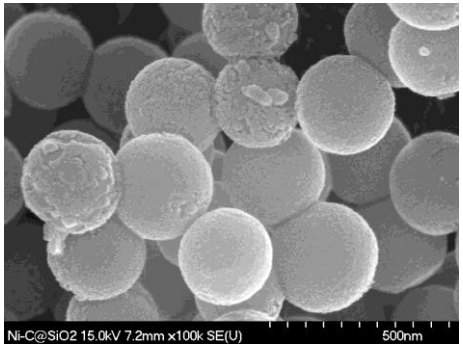


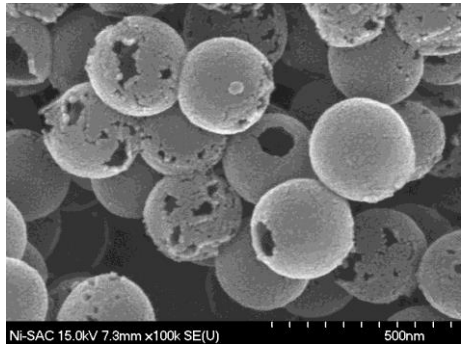










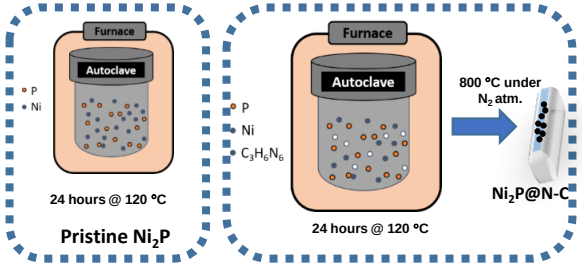


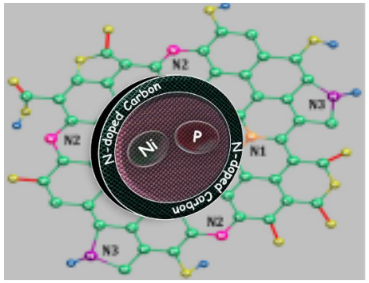
Average size of particles of SiO2 ≒253.10nm

Average of particle size ≒278.2nm

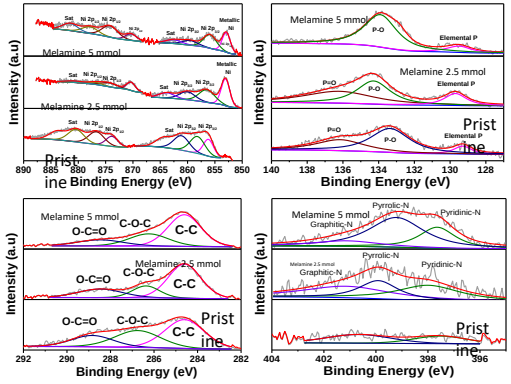
Ni_2P@N-C by Hydrothermal Method

Schematic of Ni2P@N-C by Hydrothermal Method

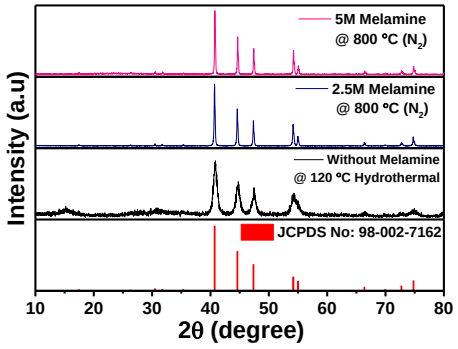




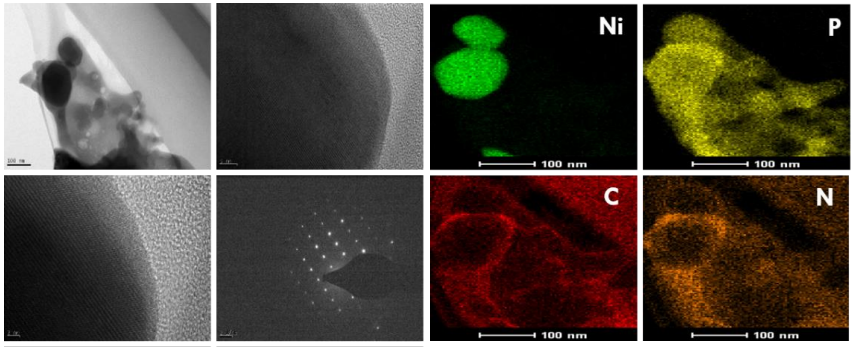
XPS analysis



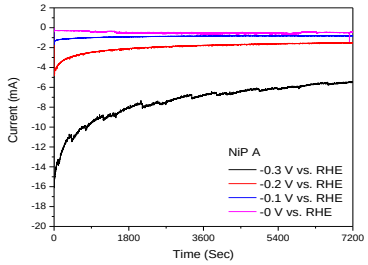
XRD analysis

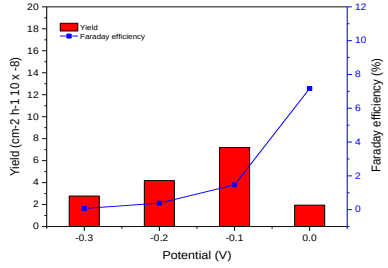


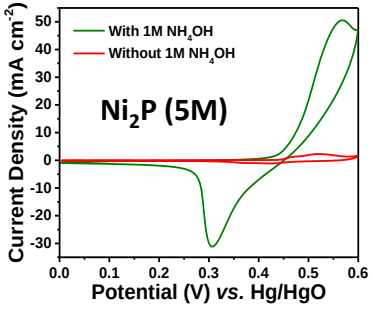
TEM, DP and elemental mapping

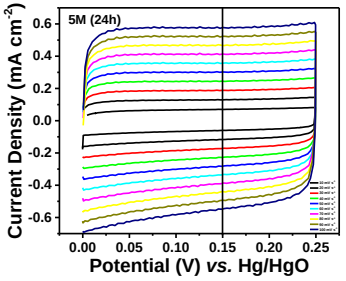


Electrocatalytic Reactions for NRR and AOR









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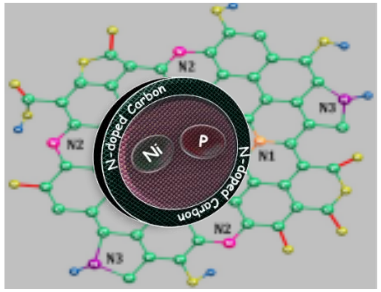
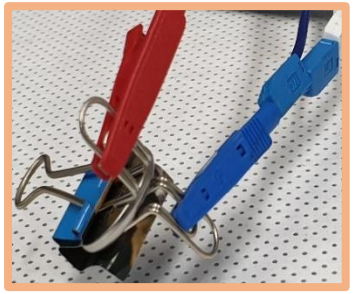
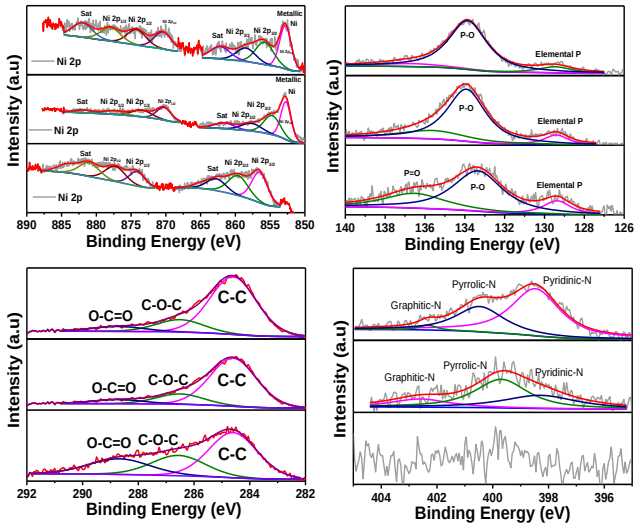
N-doped carbon rich $Ni_{12}P_5$ by Hydrothermal Method

Schematic of N-doped carbon rich Ni12P5 and picture of Cell

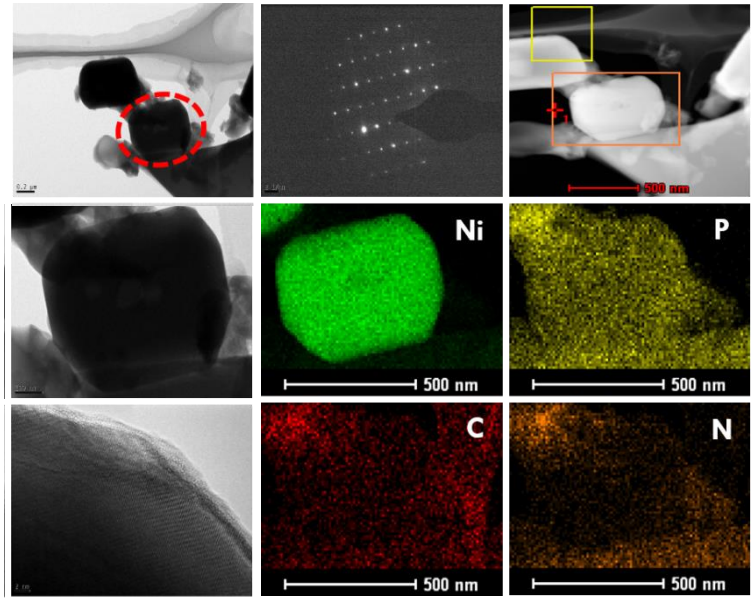




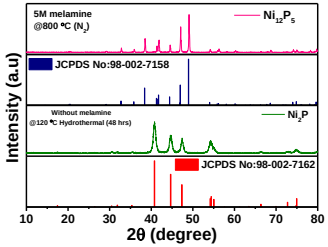
XPS analysis



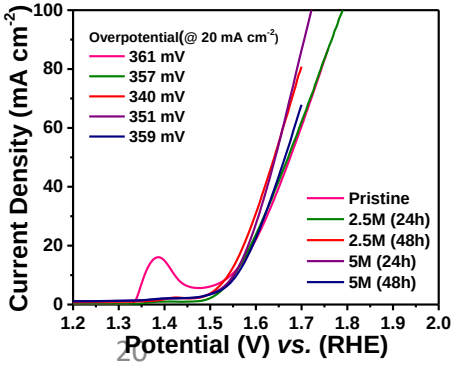
TEM, DP and elemental mapping



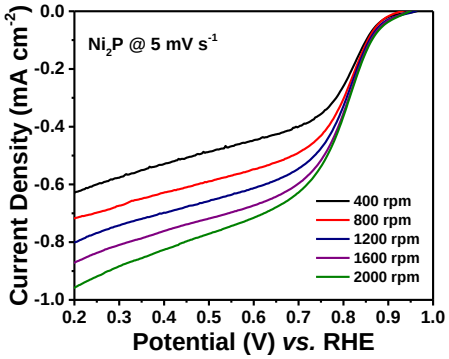
XRD analysis



Electrocatalytic Reactions for OER

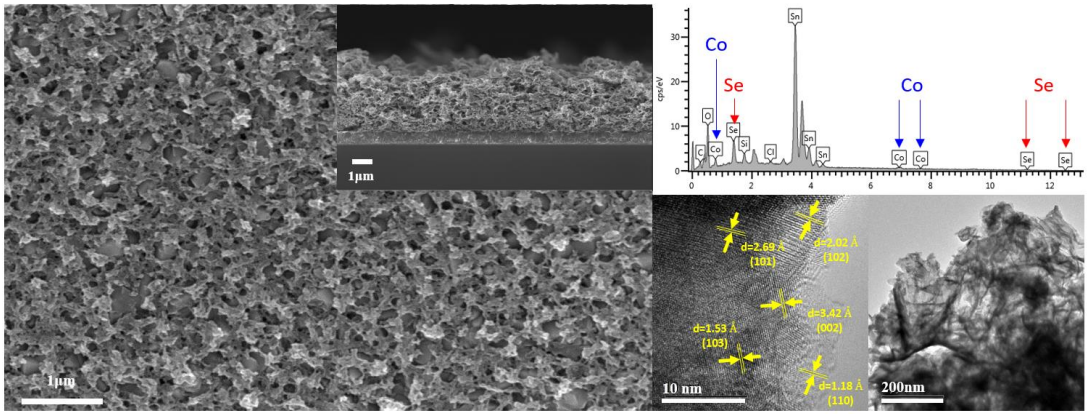


Electrocatalytic Reactions for ORR

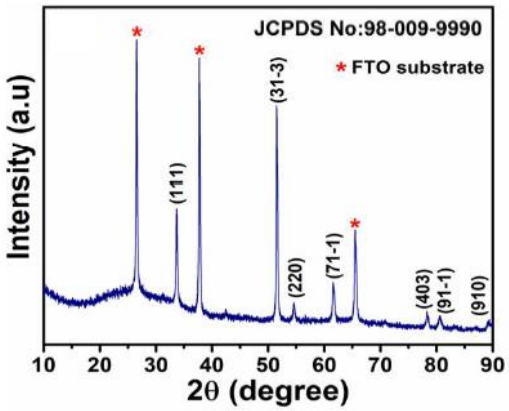


Cobalt Selenide

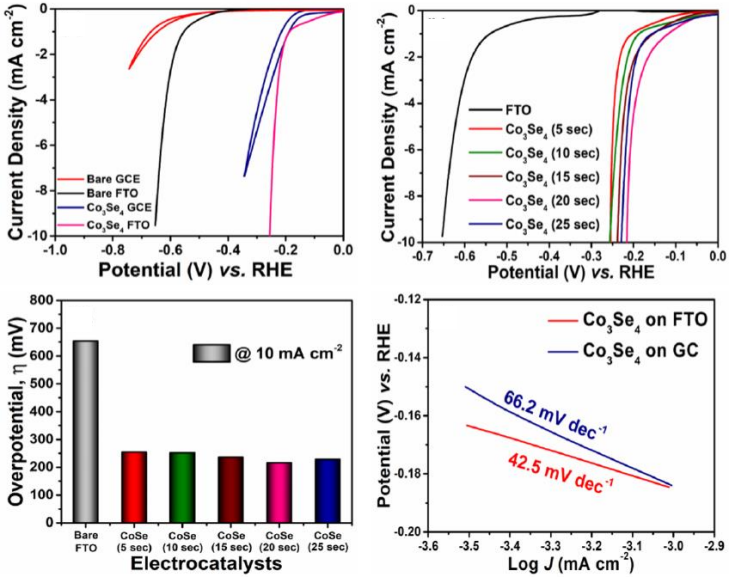
SEM, EDX and TEM analysis



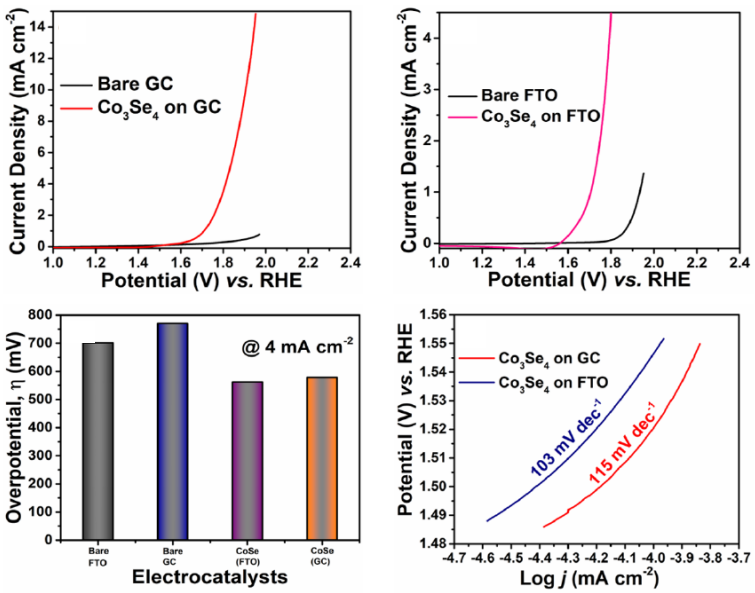
XRD analysis



Electrocatalytic Reactions for HER



Electrocatalytic Reactions for OER



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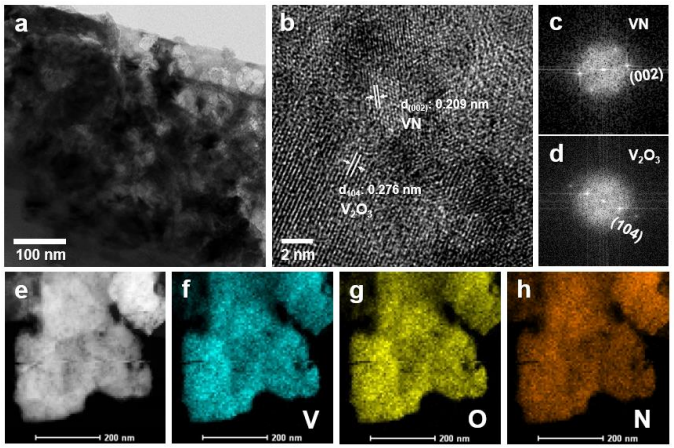
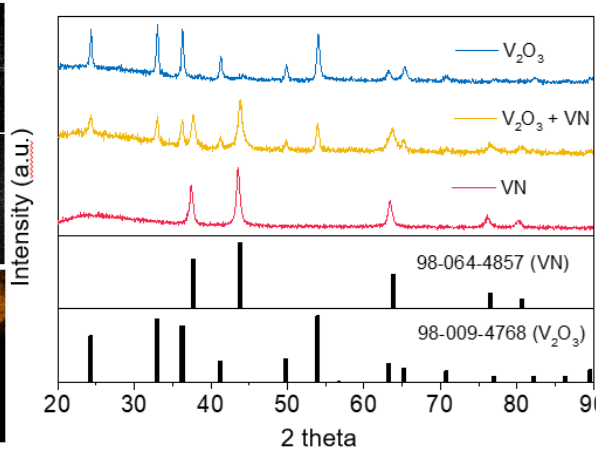
Vanadium Nitride and Oxide

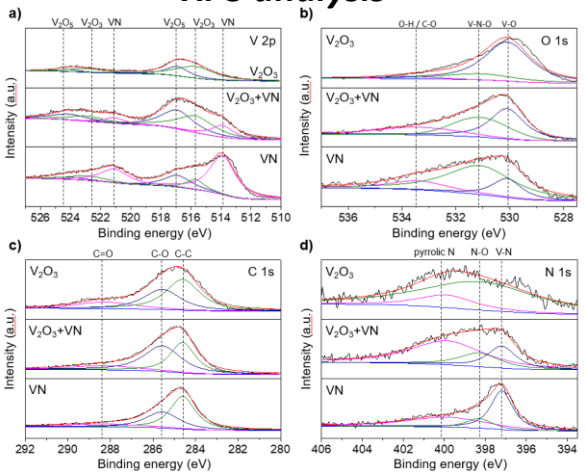
TEM, DP and elemental mapping



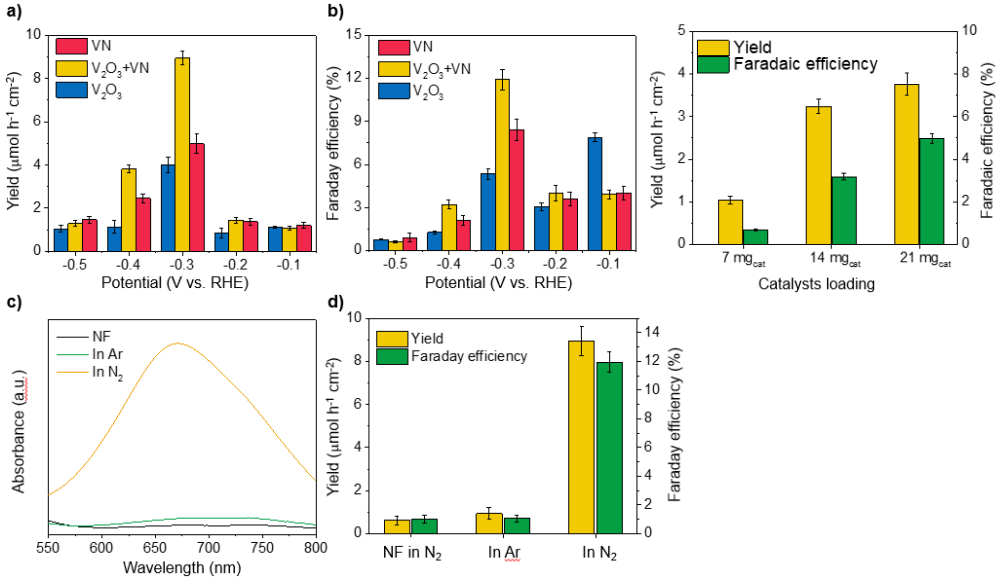
XRD analysis



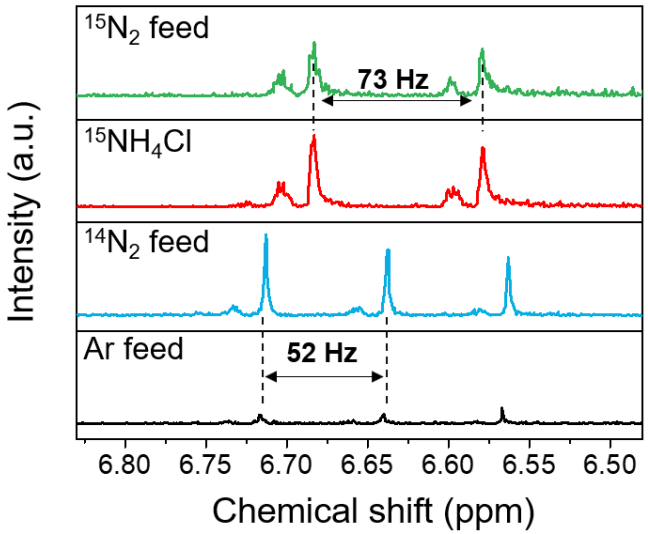
XPS analysis



Electrochemical test for NRR



NMR Verification



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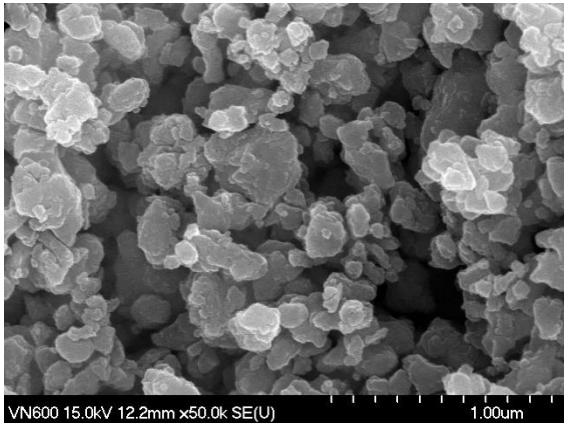
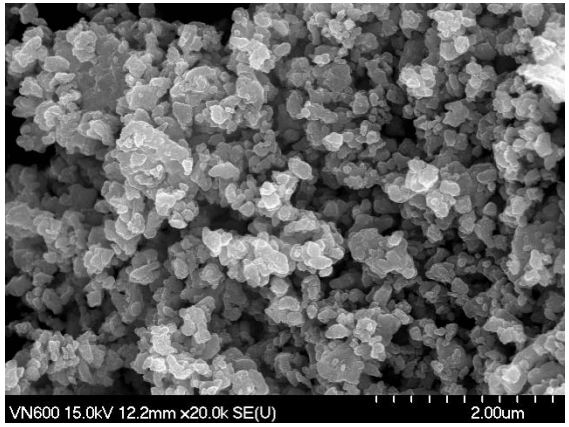
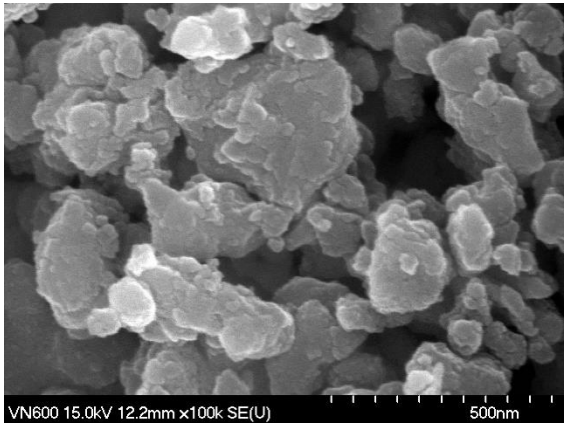
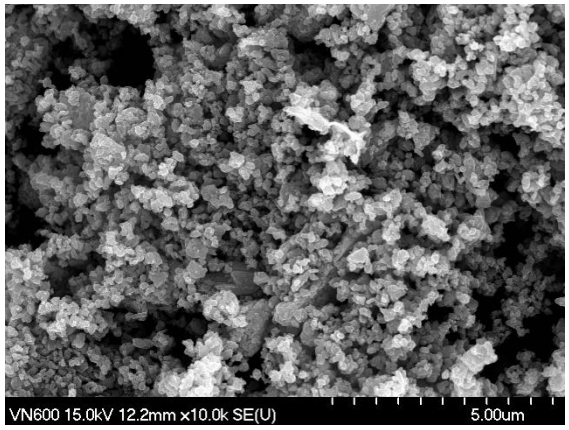
Vanadium Oxide (V_2O_3)

SEM images

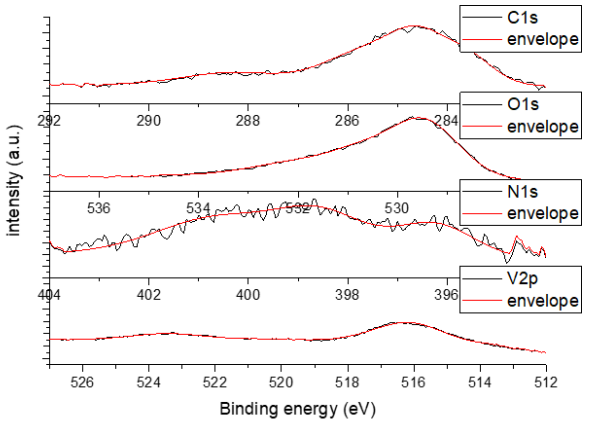


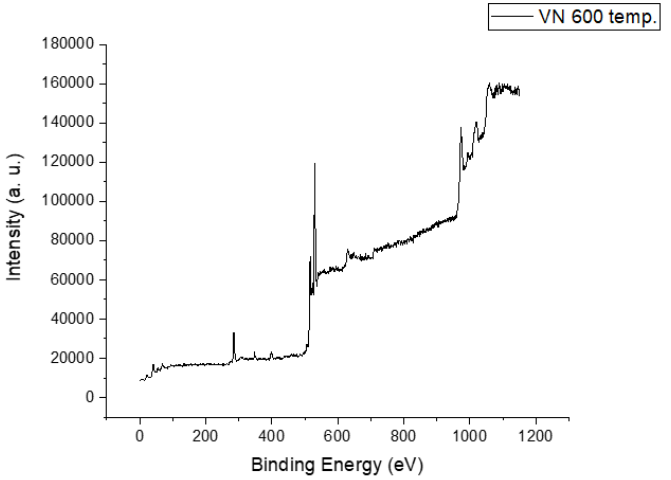






XPS analysis

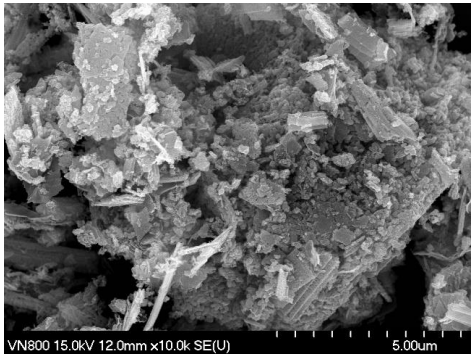




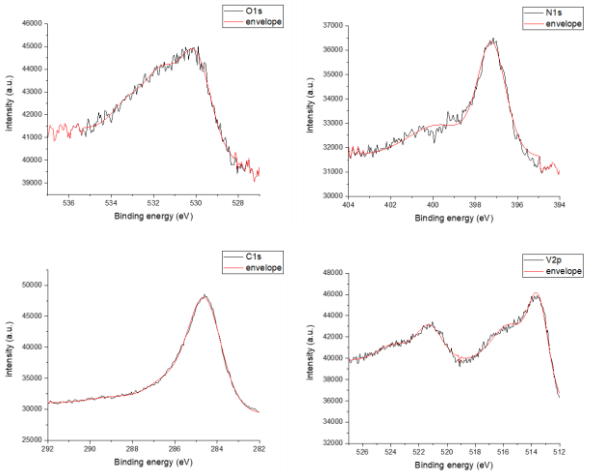
Vanadium Oxynitride

Vanadium Nitride(VN 800)

SEM images

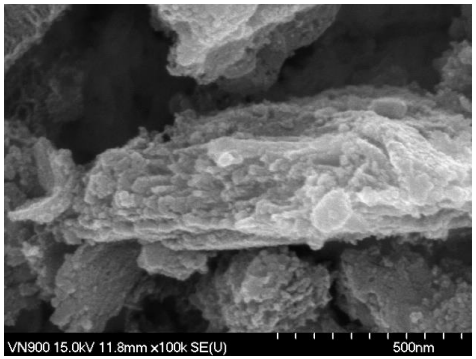


XPS analysis

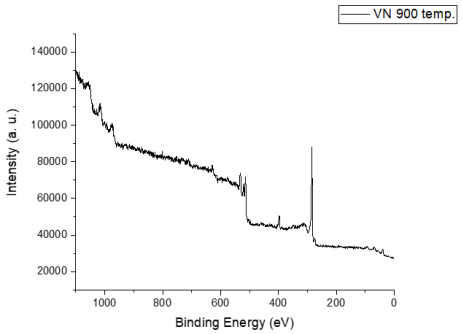


Vanadium Nitride(VN 900)

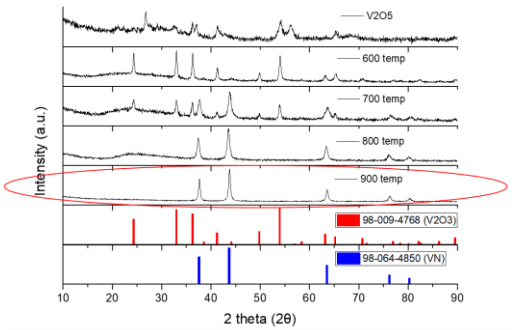
SEM images

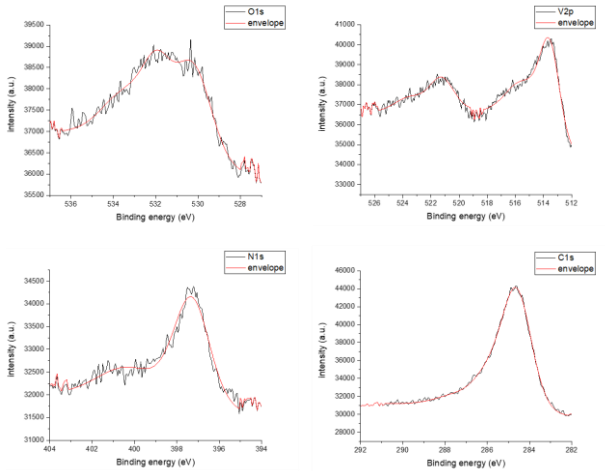


XPS analysis



XRD analysis

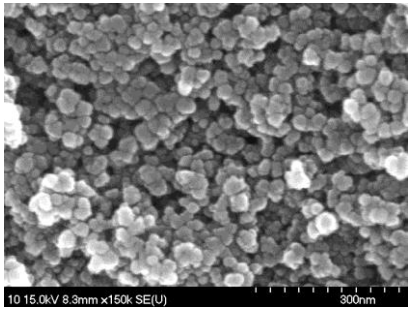




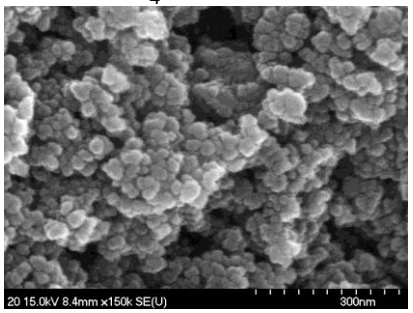
Iron Oxide

SEM images

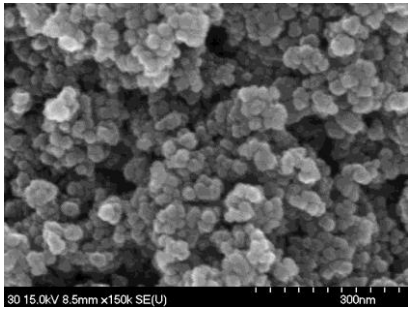
Ethyl Alcohol



NH_4OH 10ml

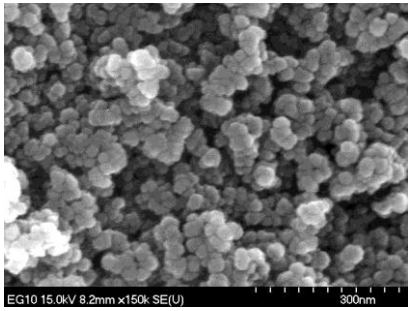


NH_4OH 20ml

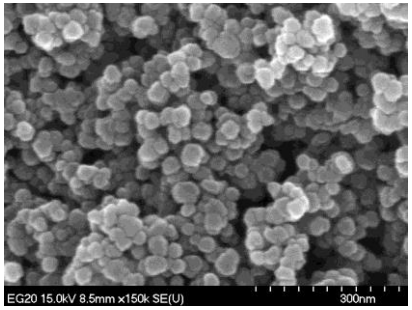


NH_4OH 30ml

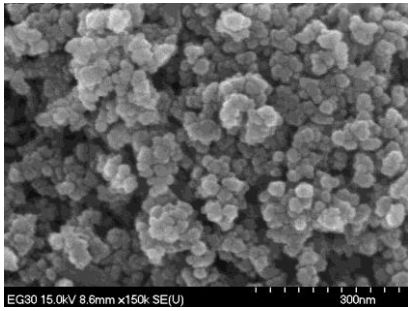
Ethylene Glycol



NH_4OH 10ml

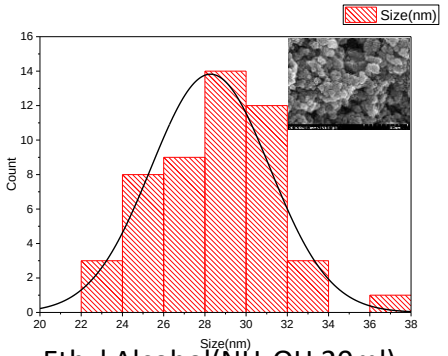


NH_4OH 20ml

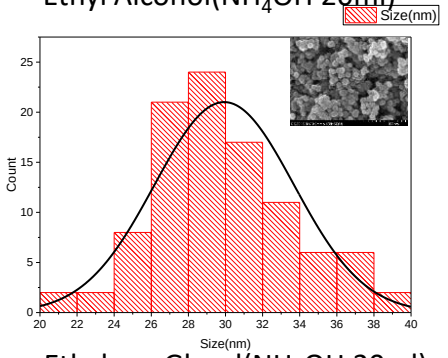


NH_4OH 30ml

Particle size

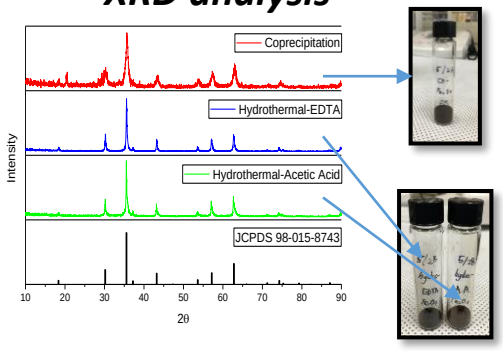


Ethyl Alcohol(NH_4OH 20ml)



Ethylene Glycol(NH_4OH 20ml)

XRD analysis



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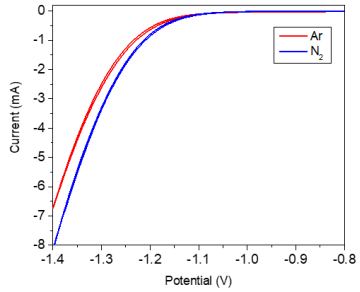
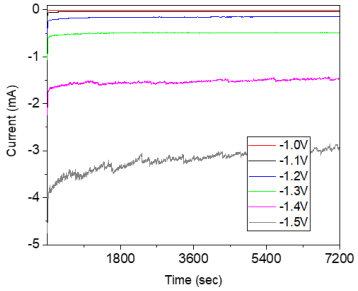
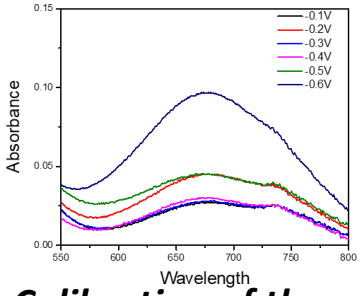
WC-10Co

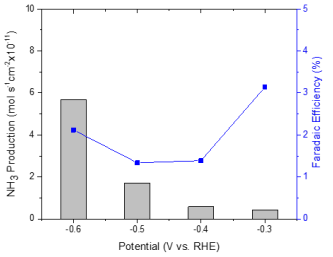
Synthesis of WC-10Co

Electrochemical test for ammonia

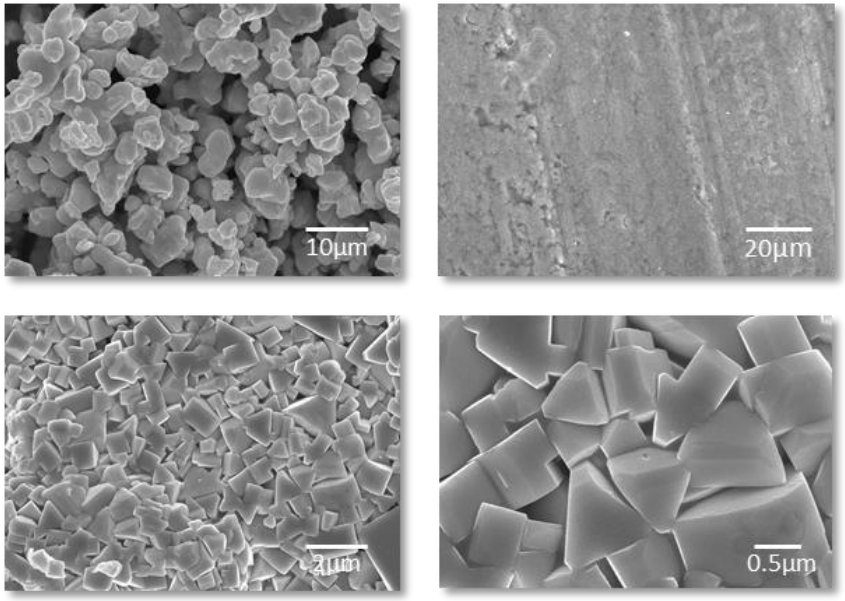




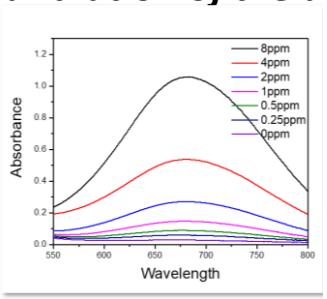


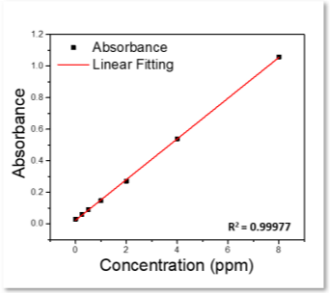


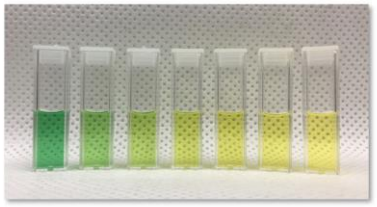
SEM images



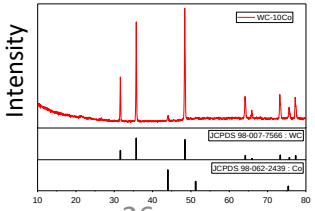
Calibration of the ammonia concentration







XRD analysis



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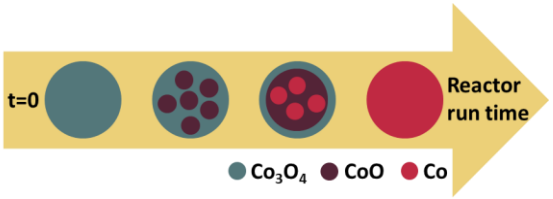
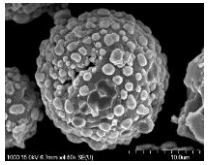
Co-MnO@C

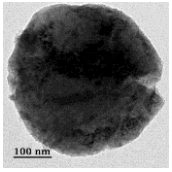
Reduction of Cobalt oxide



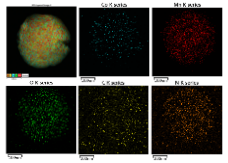
SEM



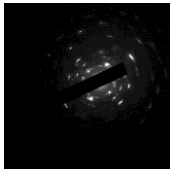
TEM



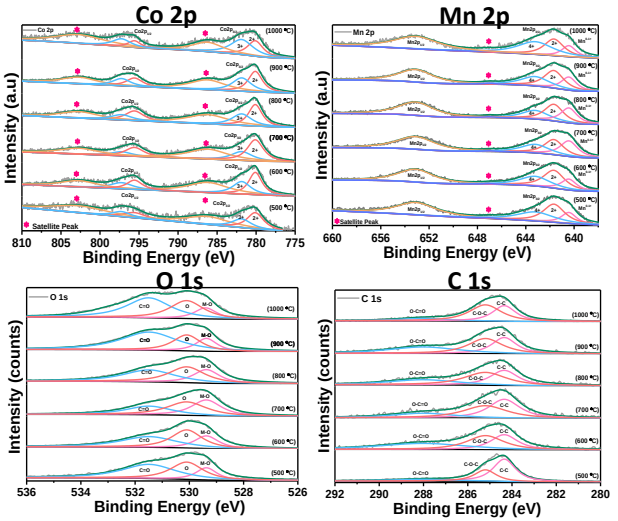
Elemental mapping



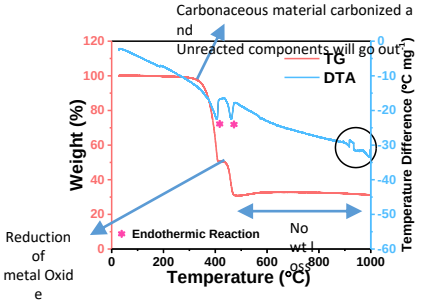
DP

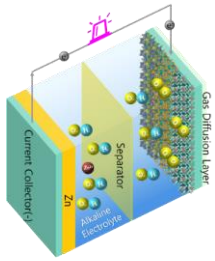


X-ray Photoelectron Spectroscopy

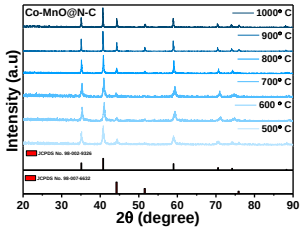


Thermogravimetry/Differential thermal analysis

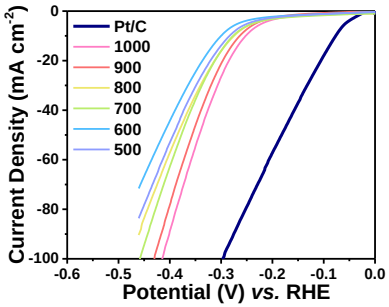




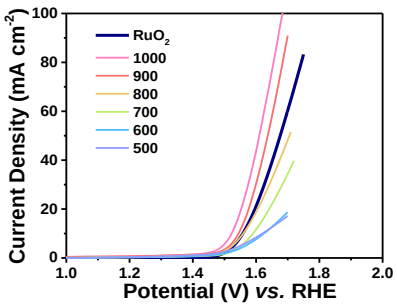
X-Ray Diffraction



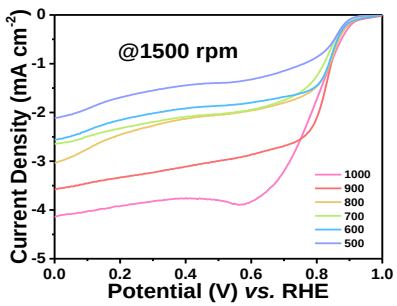
Electrocatalytic Reactions for Oxygen Evolution Reaction



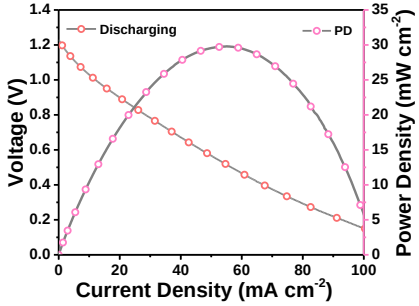
Electrocatalytic Reactions for Oxygen Evolution Reaction



Linear Sweep Voltammetry @ 5 mV s^{-1} from 500 to 1000 °C



Electrocatalytic Reactions for Zinc-air battery



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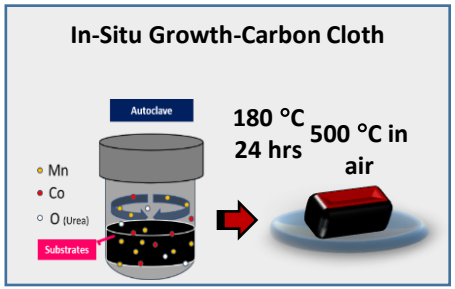
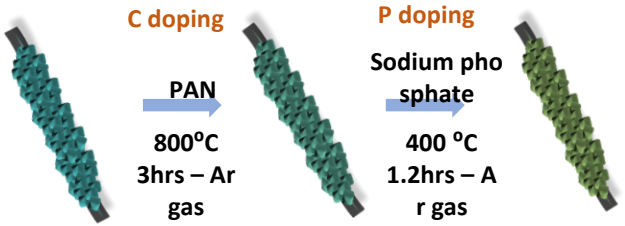
CoMn2O4 Spinels

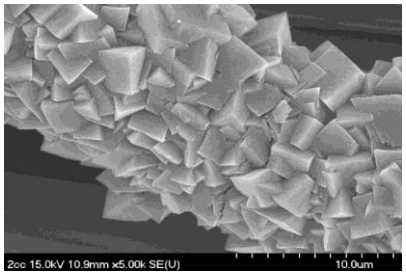
Schematic of CoMn2O4 Spinels

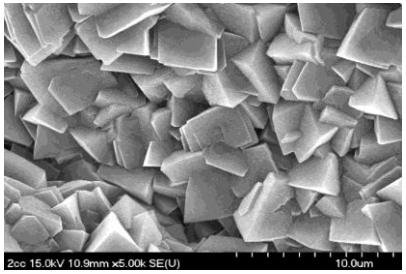


$CoMn_2O_4$ → $CoMn_2O_4$@C/CC → P-$CoMn_2O_4$@C/CC

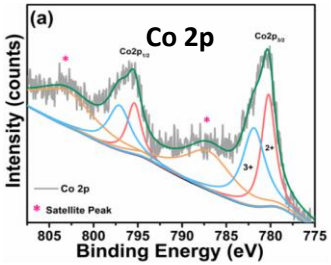


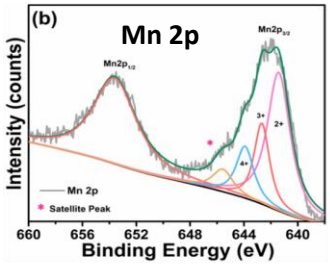
SEM images

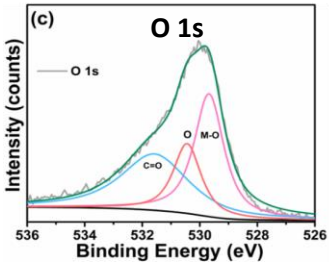


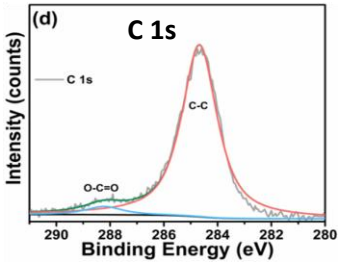


XPS analysis

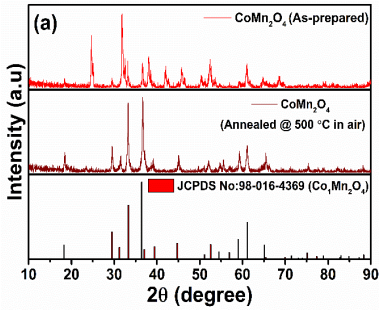




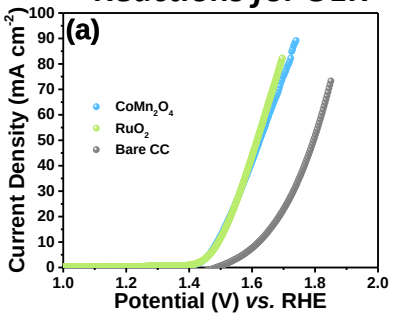




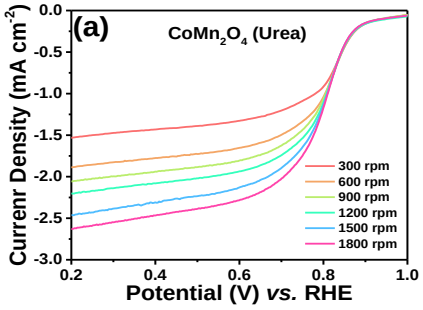
XRD analysis



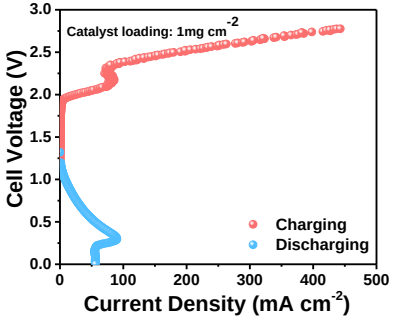
Electrocatalytic Reactions for OER



Electrocatalytic Reactions for ORR



Charge and discharge polarization curves



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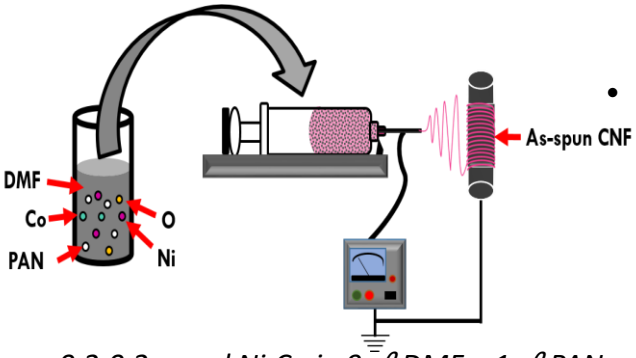
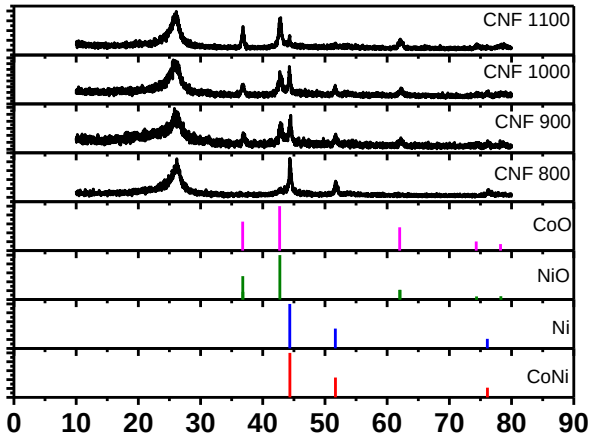
Ni • CoO-CNF

Schematic of Ni • CoO-CNF



- *0.2:0.2 mmol Ni:Co in 9㎖ DMF + 1㎖ PAN*
- *Stabilized @ 80℃ → 200℃ 1H*
- *Carbonized under N_2 Atm for 3H @ X℃*

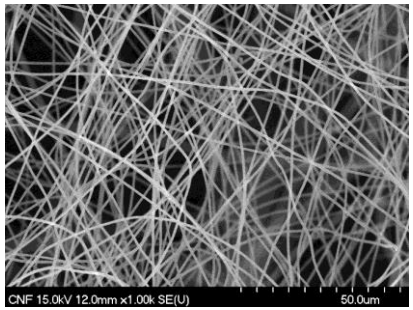
XRD analysis

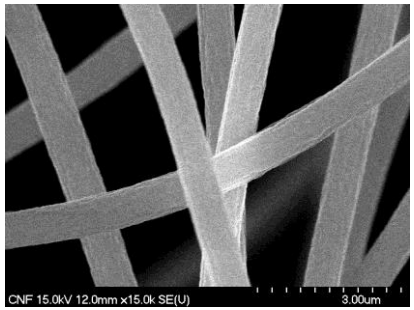


SEM images

- *Before carbonization*

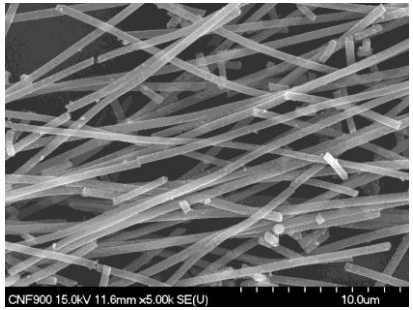
Clean fiber
Size ~ 700nm

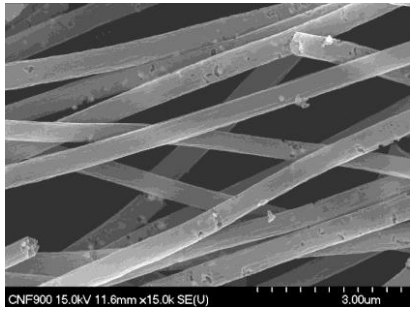




- *CNF 900 (Carbonized @ 900℃)*

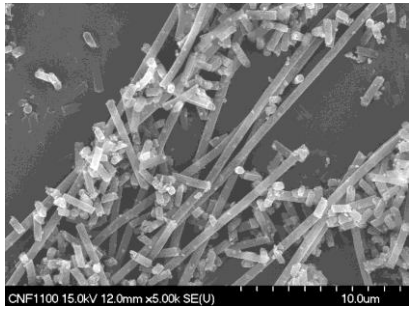
Size ~500nm

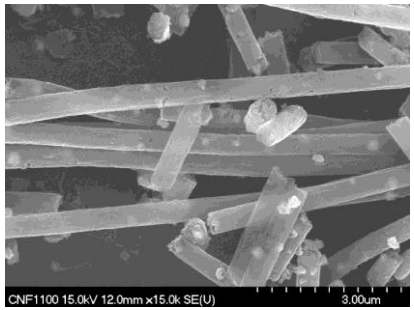




- *CNF 1100 (Carbonized @ 1100℃)*

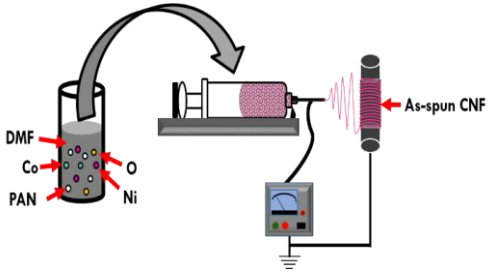
Size ~500nm



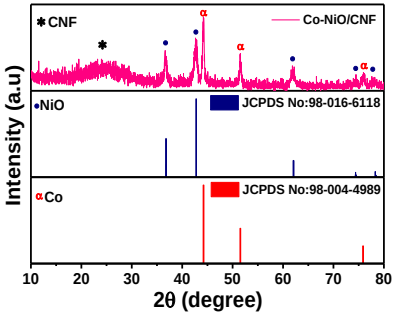


S-doped Porous Co-NiO/N-CNF by Electrospinning Method

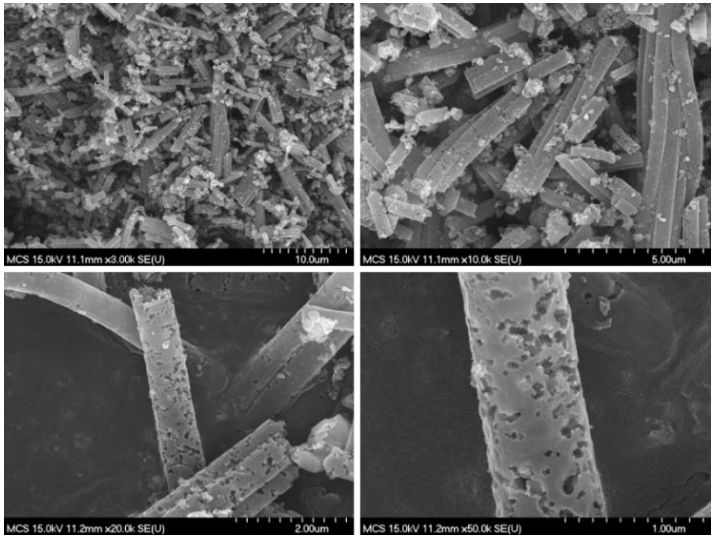
Schematic of Ni • CoO-CNF



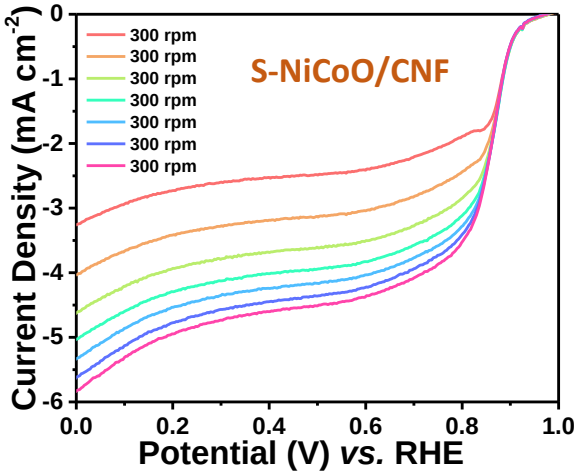
XPS analysis



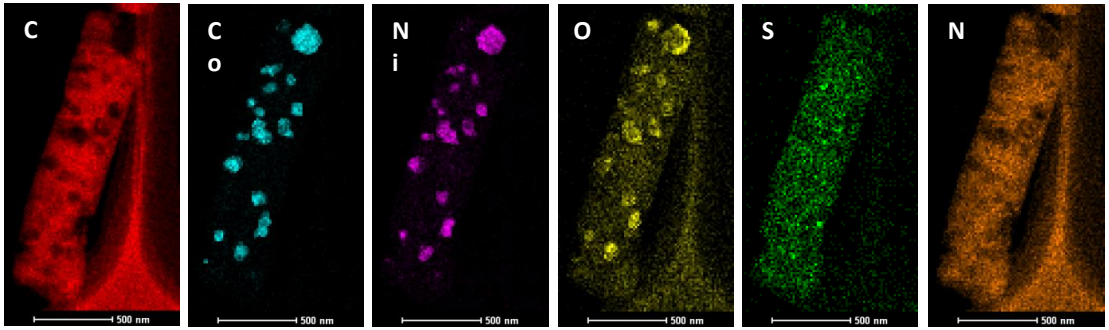
TEM images

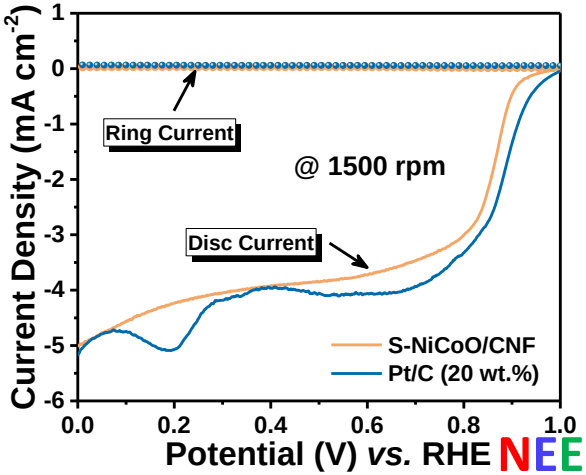


Electrocatalytic Reactions for ORR



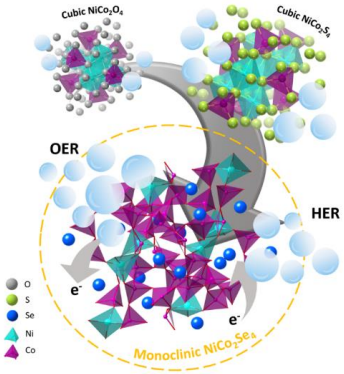
Elemental mapping



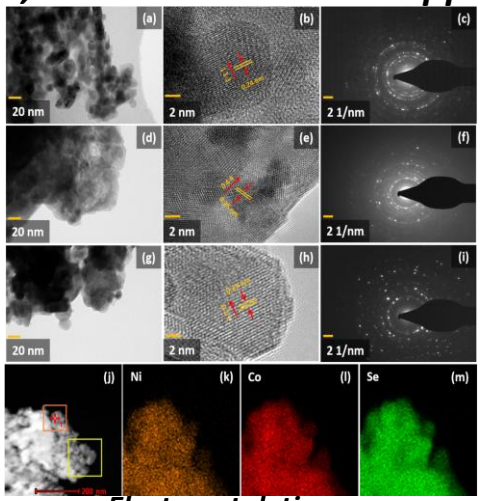


Spinel-type Bimetallic Oxides, Sulphides, and Selenides

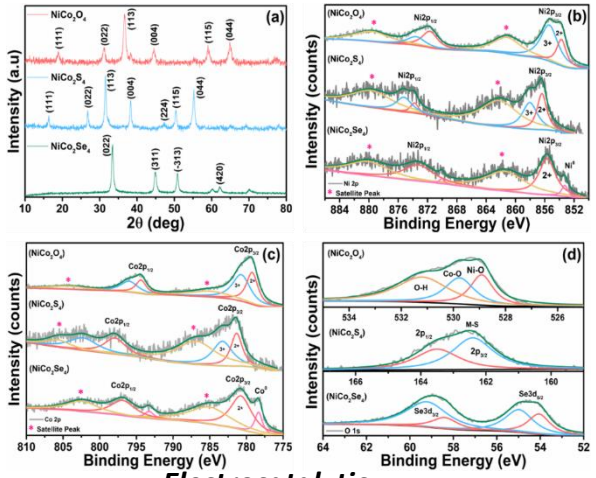
Schematic of Spinel-type Bimetallic Oxides, Sulphides, and Selenides



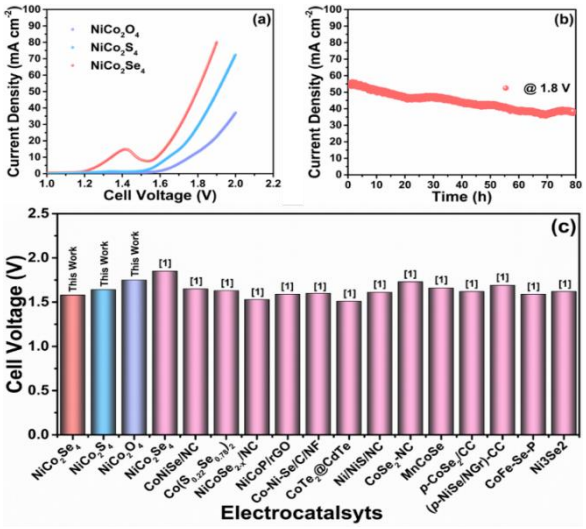
TEM, DP and elemental mapping



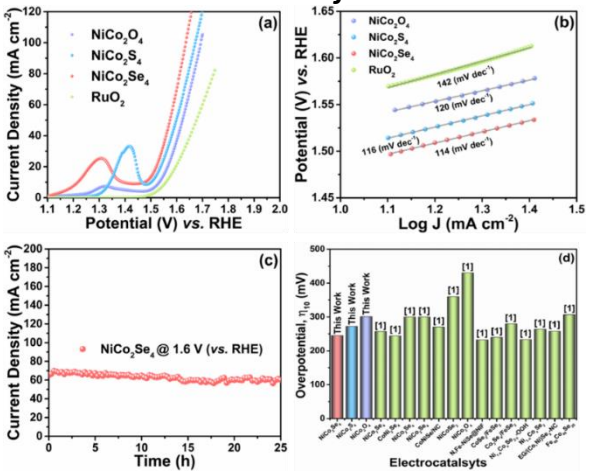
XRD and XPS analysis



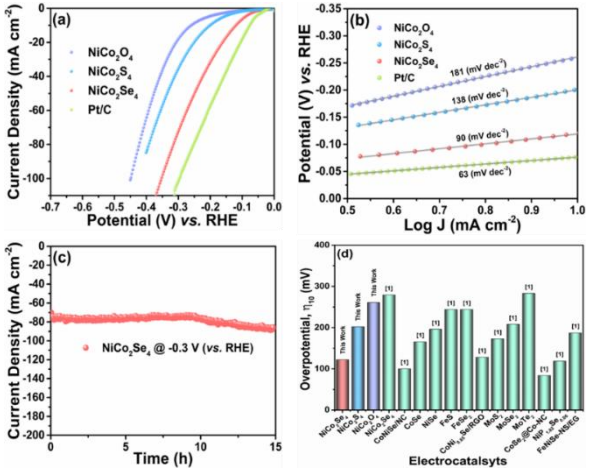
Electrocatalytic Reactions for Full Cell



Electrocatalytic Reactions for OER

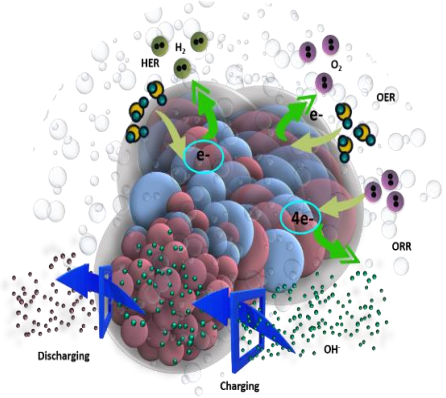


Electrocatalytic Reactions for HER

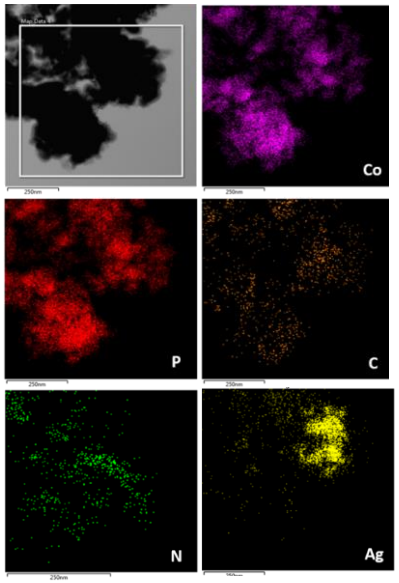


N-doped Carbon Enriched Hybrid CoP/Ag Nanocomposites

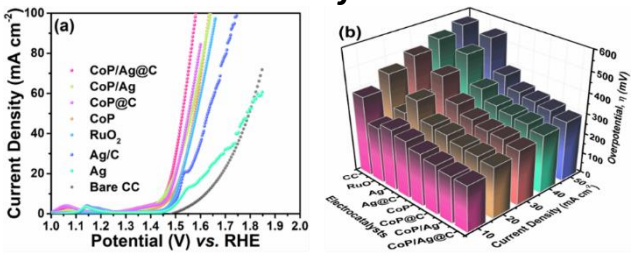
Schematic of N-doped Carbon Enriched Hybrid CoP/Ag Nanocomposites



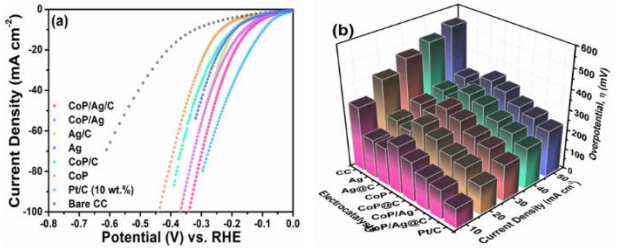
TEM and elemental mapping



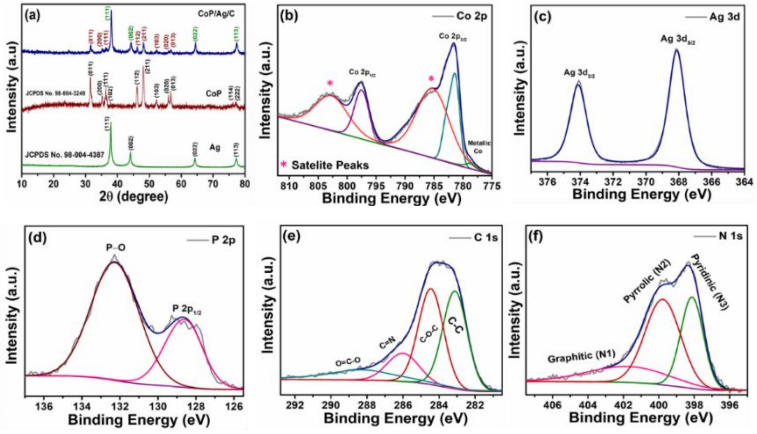
Electrocatalytic Reactions for HER



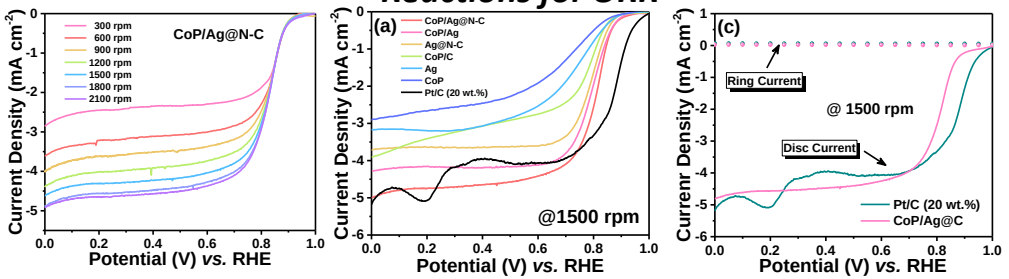
Electrocatalytic Reactions for OER



XRD and XPS analysis



Electrocatalytic Reactions for ORR



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