Wrocław University of Science and Technology

LITHIUM AND COBALT RECOVERY BY ELECTROMEMBRANE SYSTEMS

DR. ANNA SIEKIERKA
WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

01

BATTERY RECOVERY PROBLEM

02

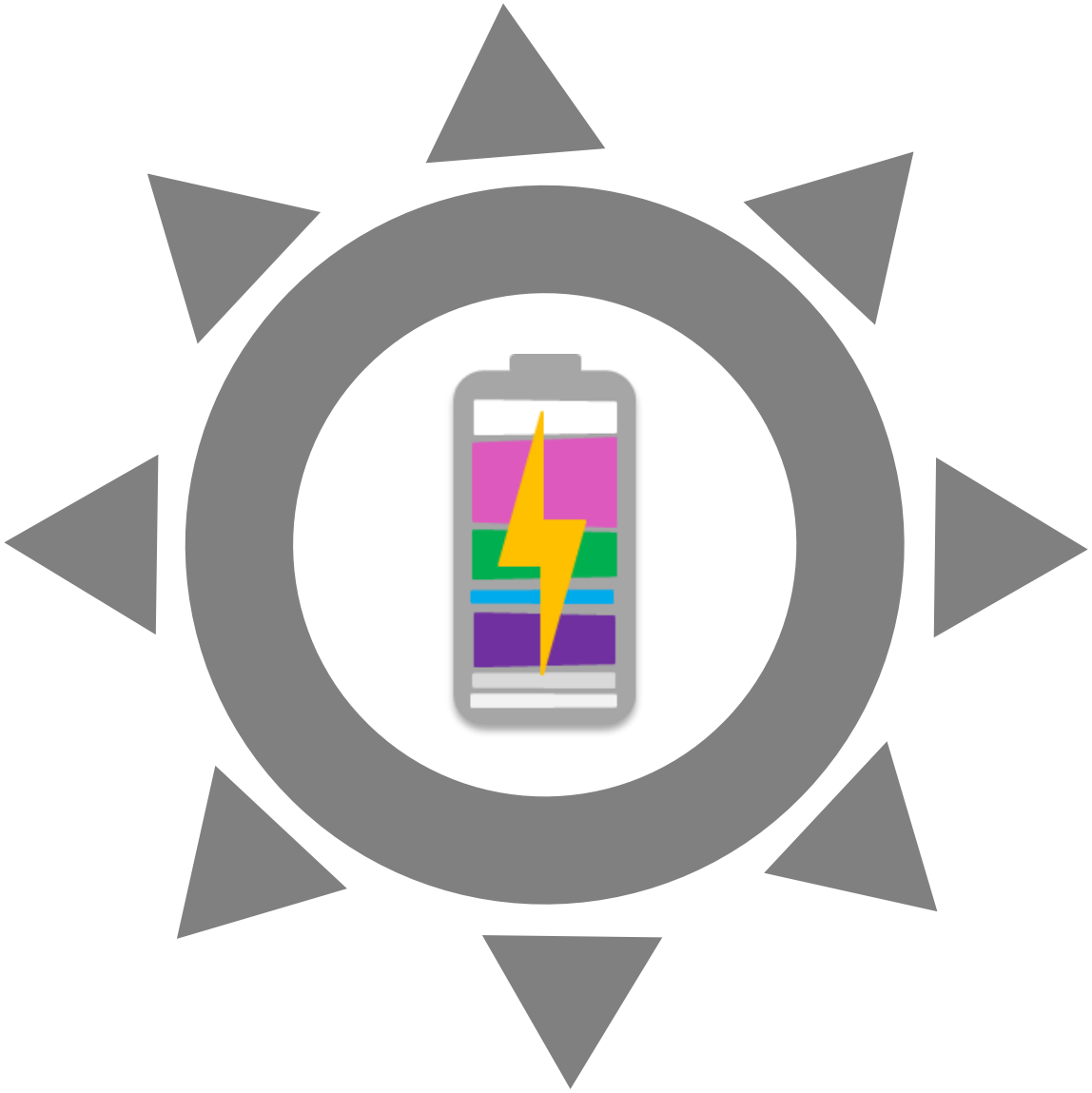
COF IN CDI

03

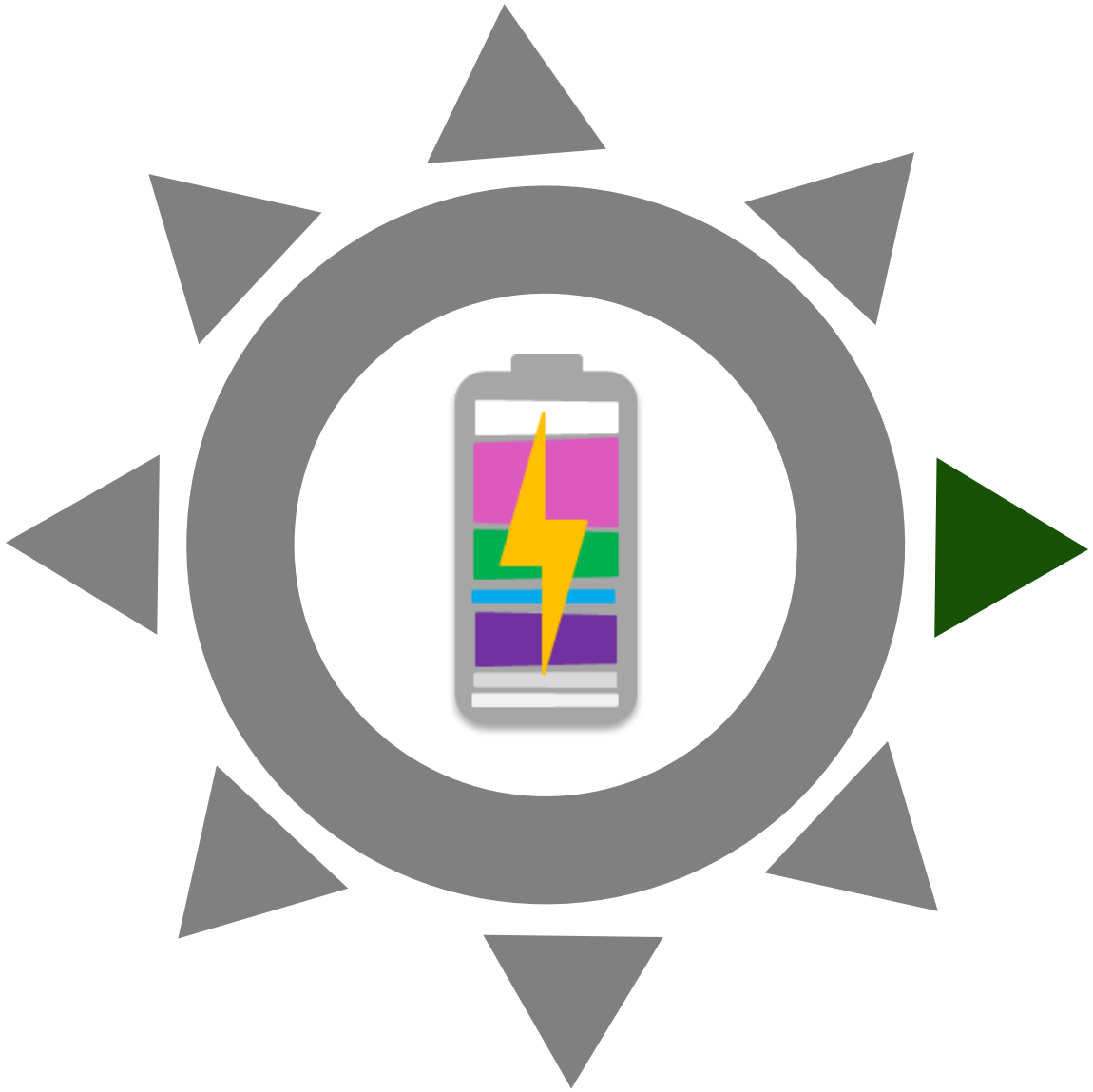
MEMBRANES IN ED

04

SUMMARY



BATTERY RECOVERY PROBLEM



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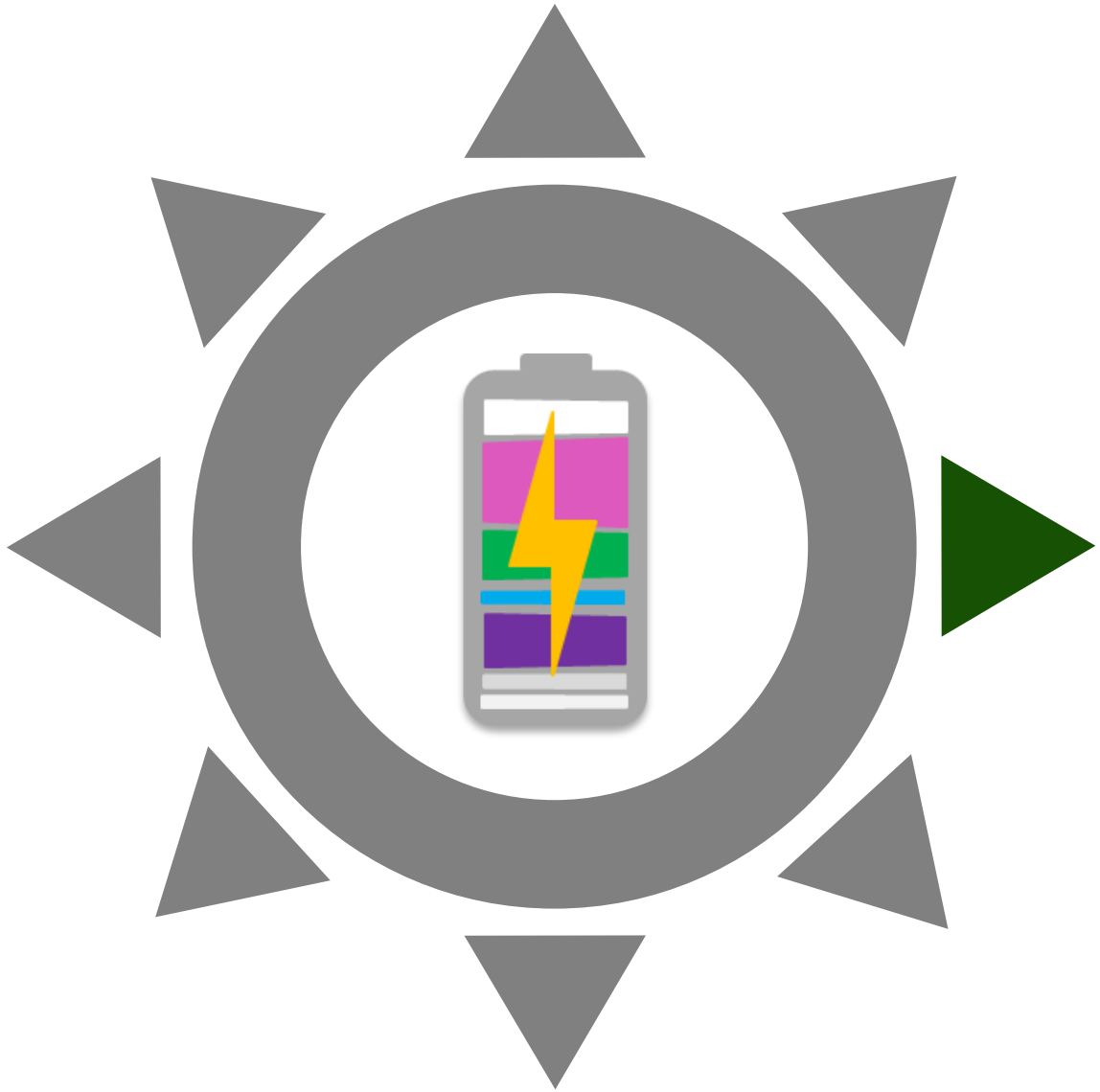

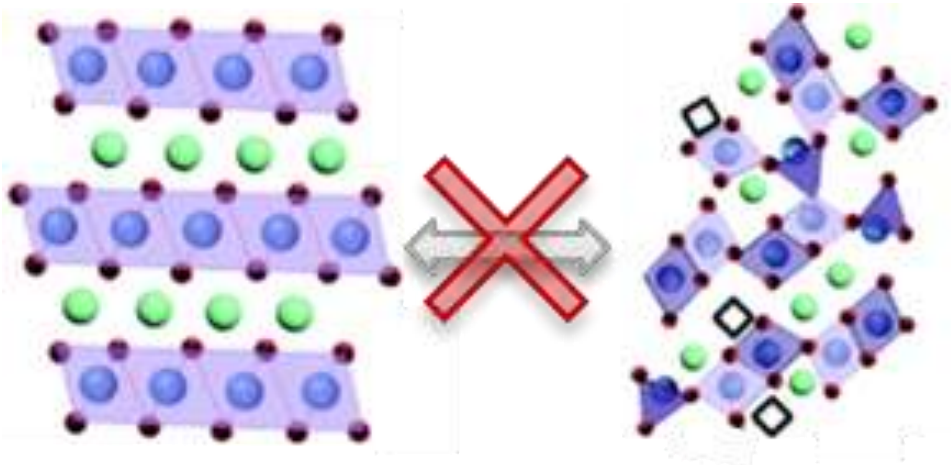

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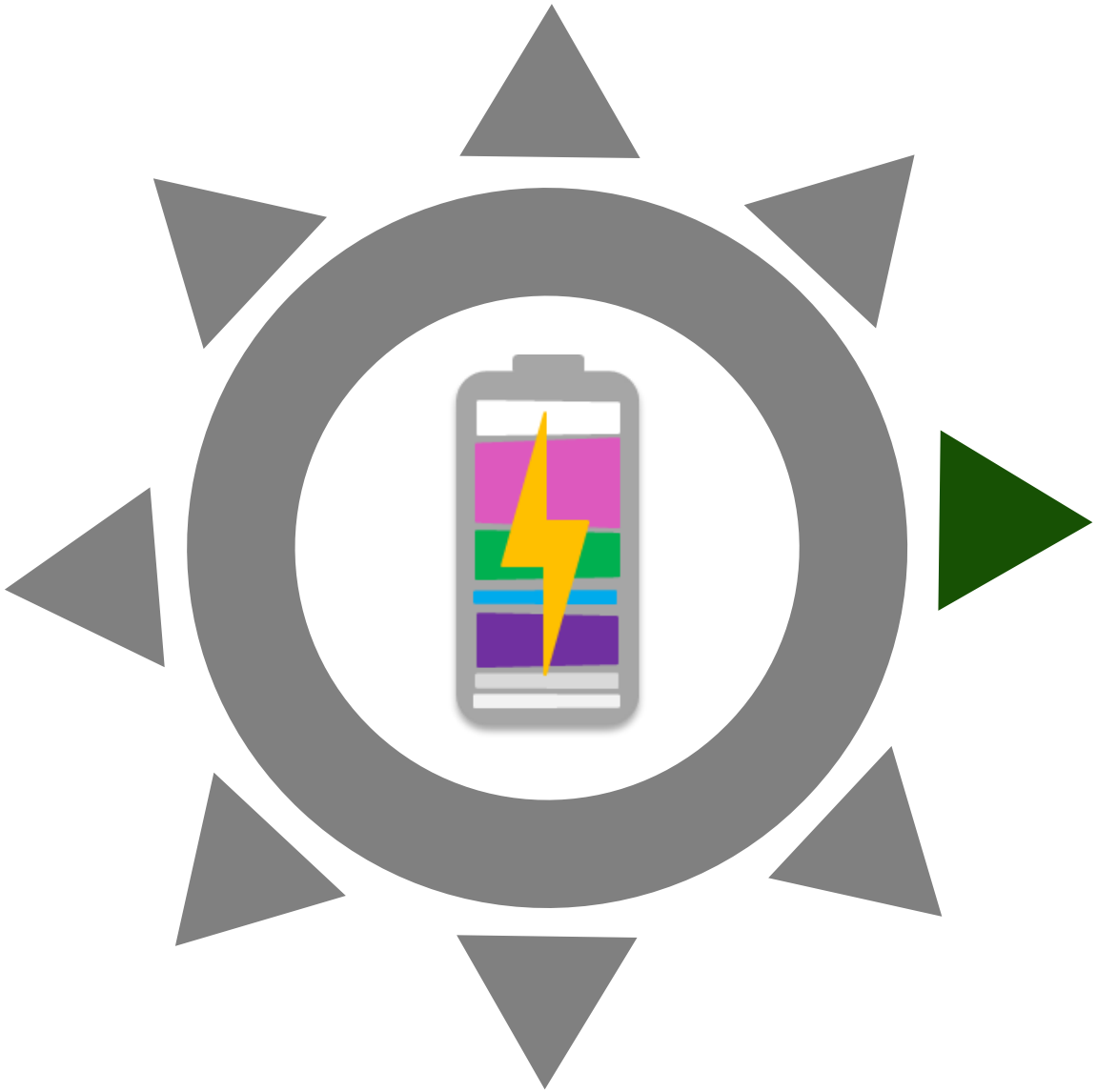

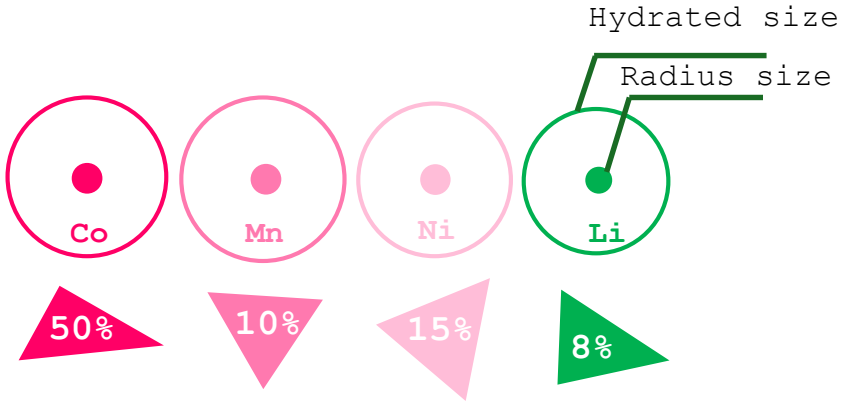

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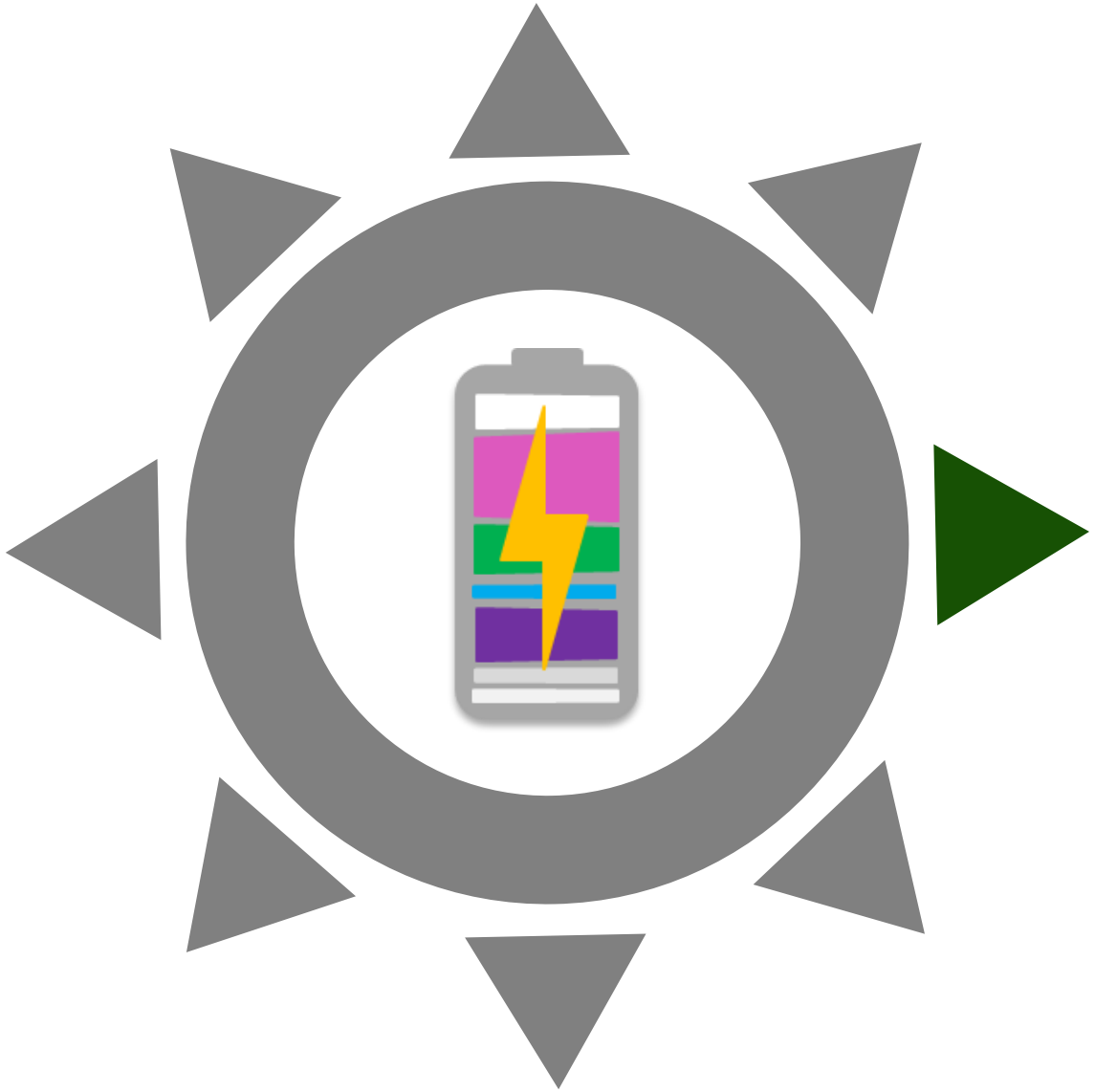

Democratic Republic of Congo

80% of the worldwide production of Co in one country, DRC

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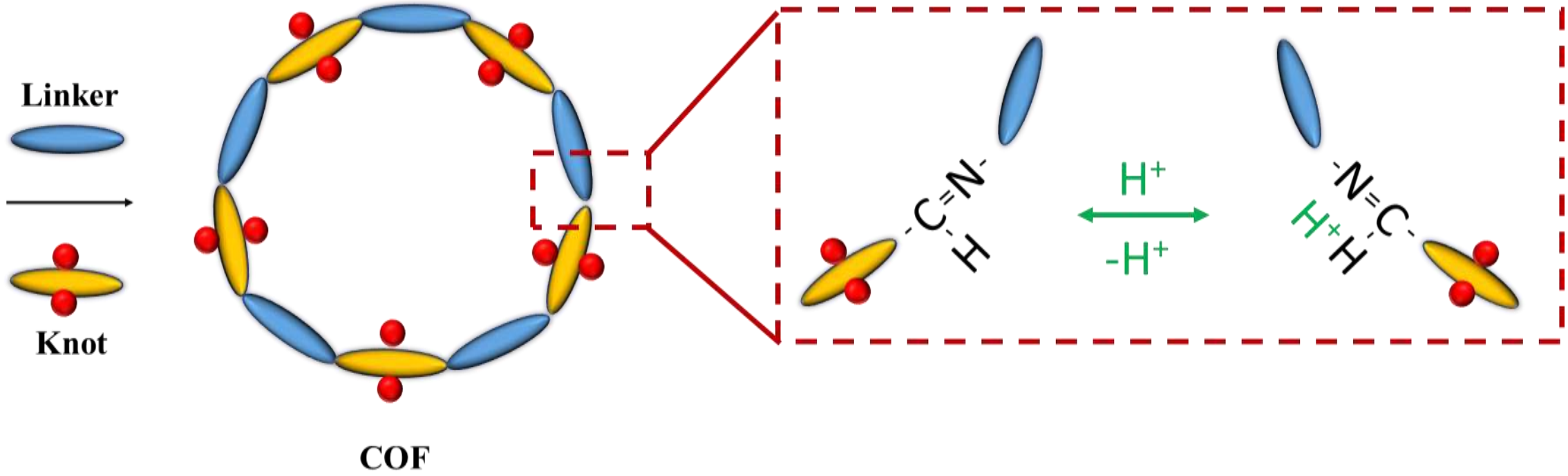
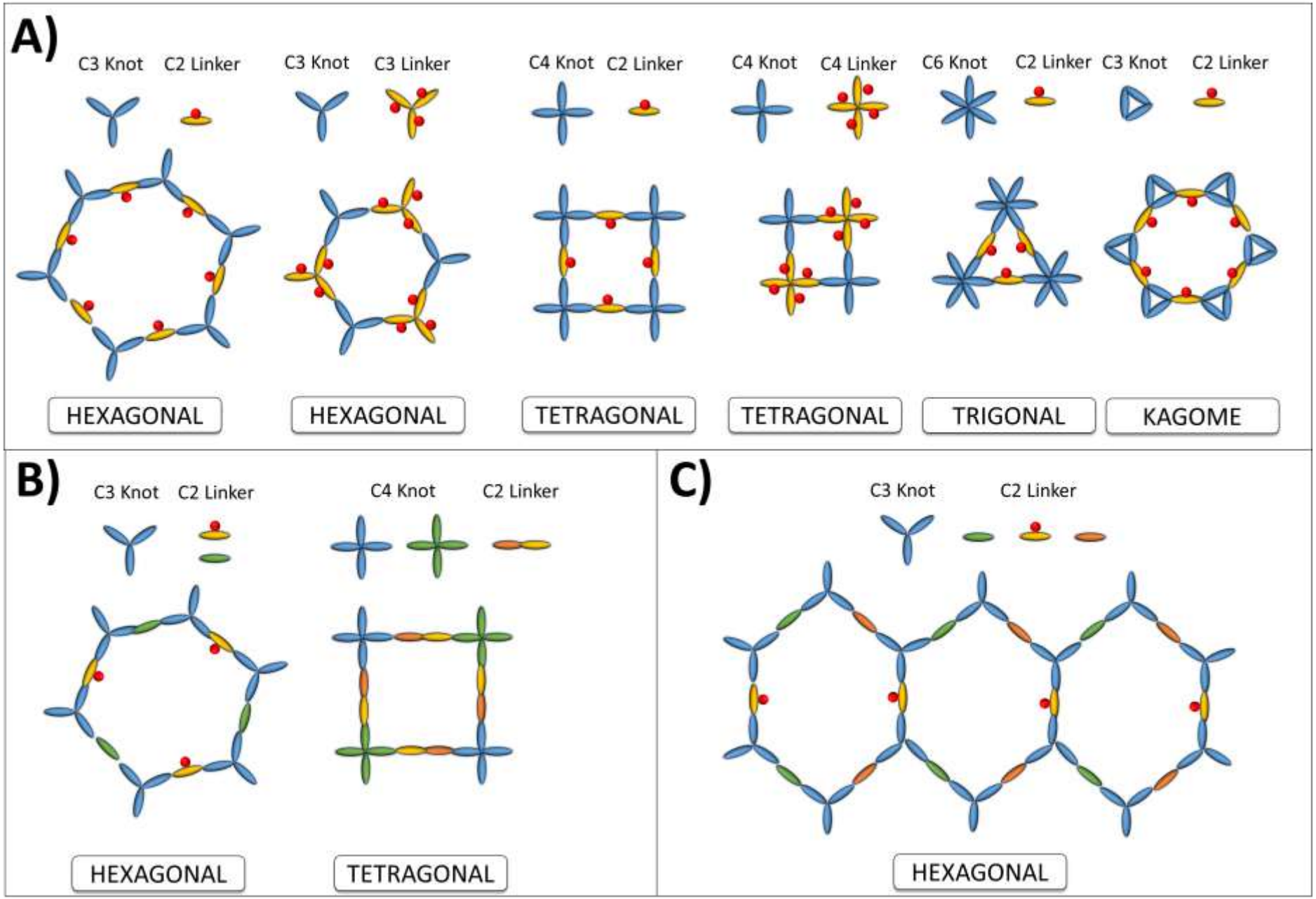
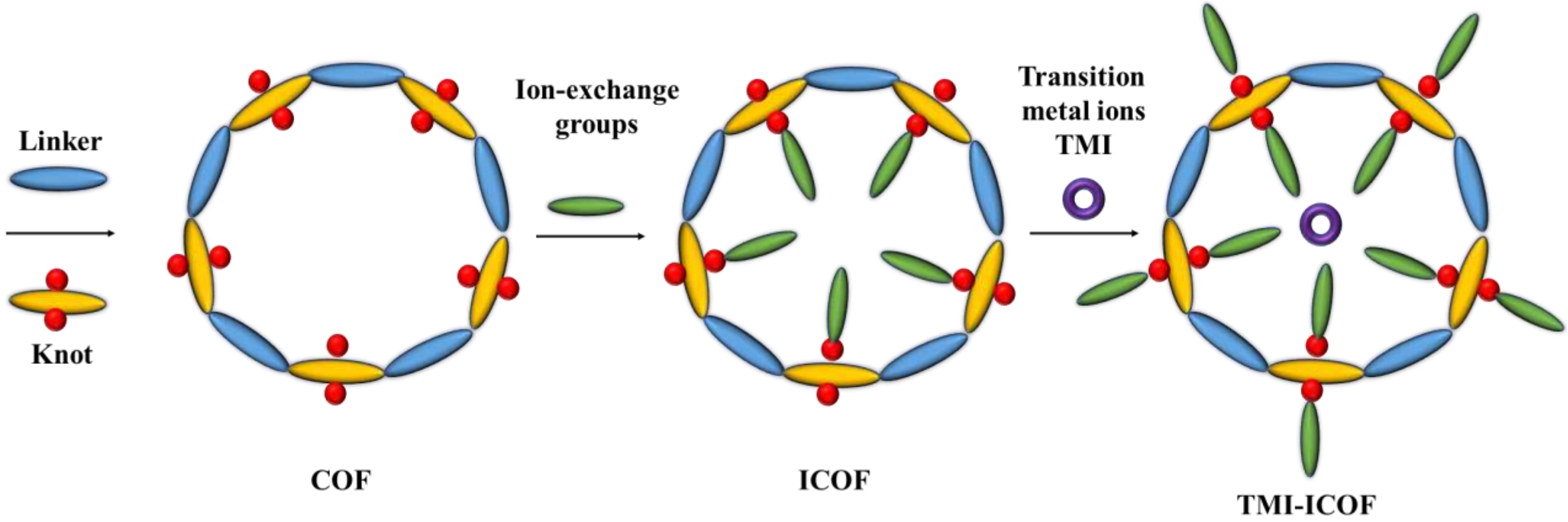
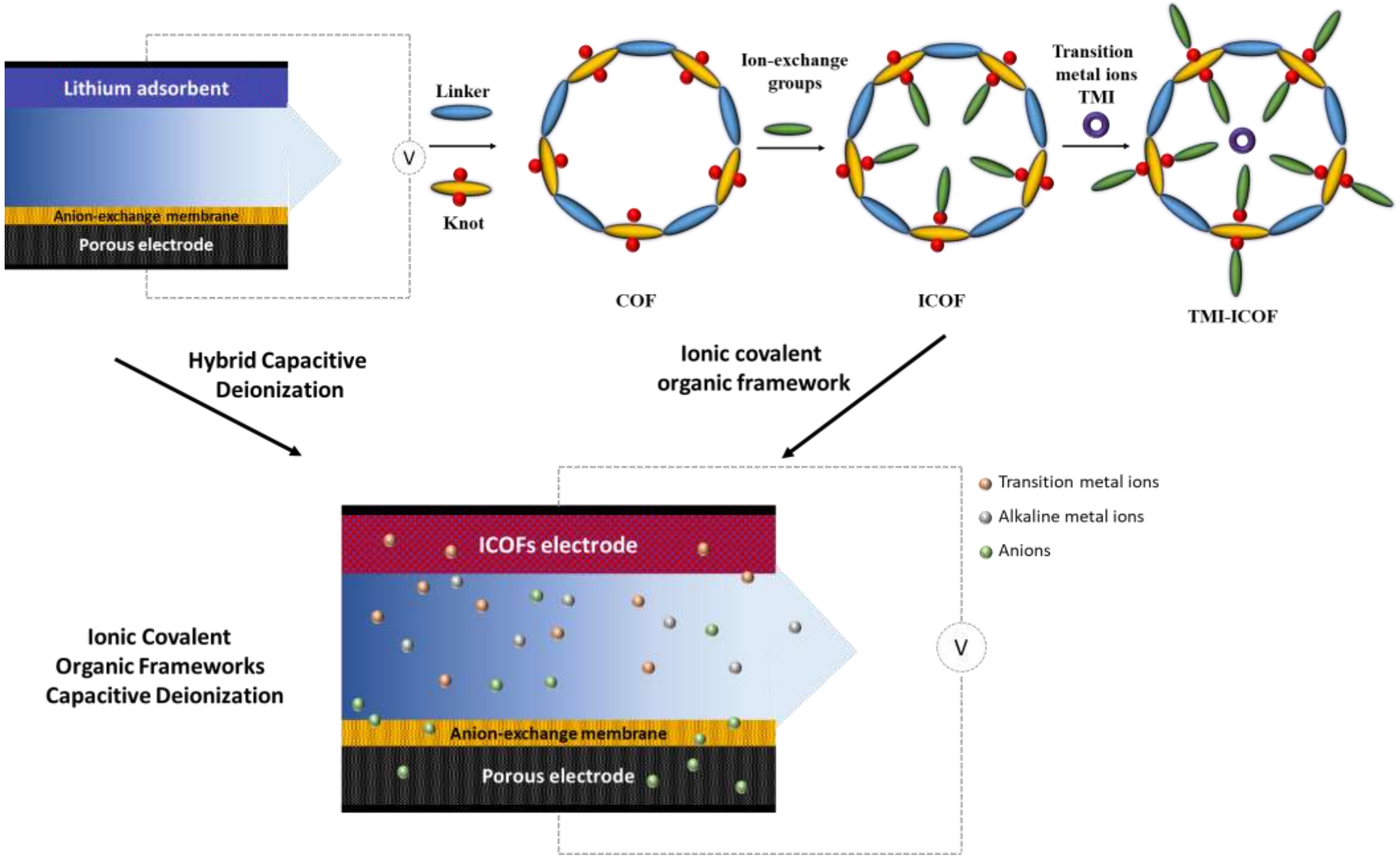
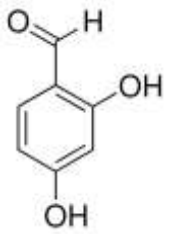

Linker
Knot
COF
H+
-H+


A)
C3 Knot
C2 Linker
C3 Knot
C3 Linker
C4 Knot
C2 Linker
C4 Knot
C4 Linker
C6 Knot
C2 Linker
C3 Knot
C2 Linker
HEXAGONAL
HEXAGONAL
TETRAGONAL
TETRAGONAL
TRIGONAL
KAGOME
B)
C3 Knot
C2 Linker
C4 Knot
C2 Linker
HEXAGONAL
TETRAGONAL
C)
C3 Knot
C2 Linker
HEXAGONAL


Linker
Knot
COF
Ion-exchange groups
ICOF
Transition metal ions TMI
TMI-ICOF

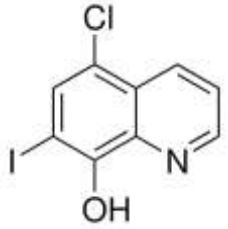

Lithium adsorbent
Anion-exchange membrane
Porous electrode
V
Linker
Knot
COF
Ion-exchange groups
ICOF
Transition metal ions TMI
TMI-ICOF
Hybrid Capacitive Deionization
Ionic covalent organic framework
Ionic Covalent Organic Frameworks Capacitive Deionization
ICOFs electrode
Anion-exchange membrane
Porous electrode
V
Transition metal ions
Alkaline metal ions
Anions

Linker



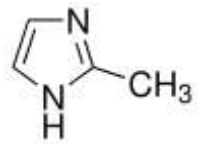
DHBA

Knot



5C7I8HQ

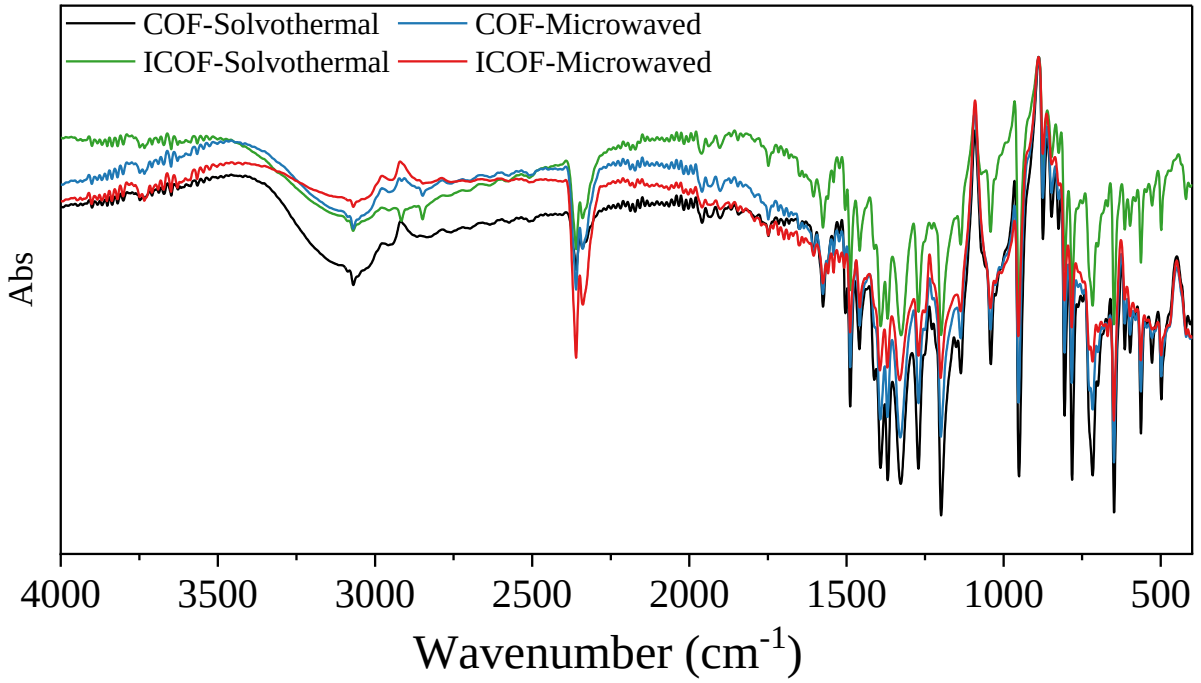
Ion-exchanger

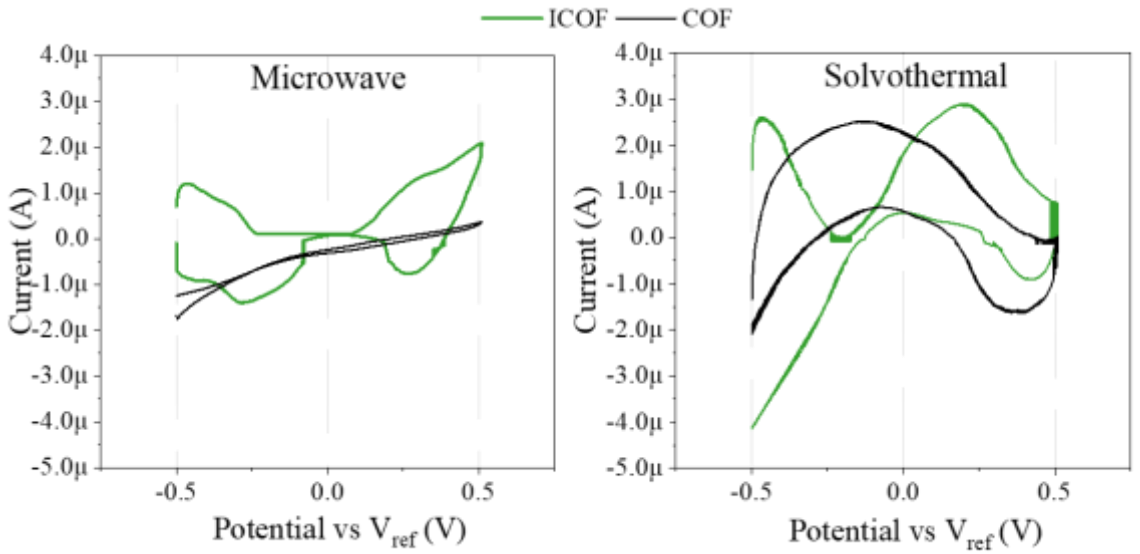


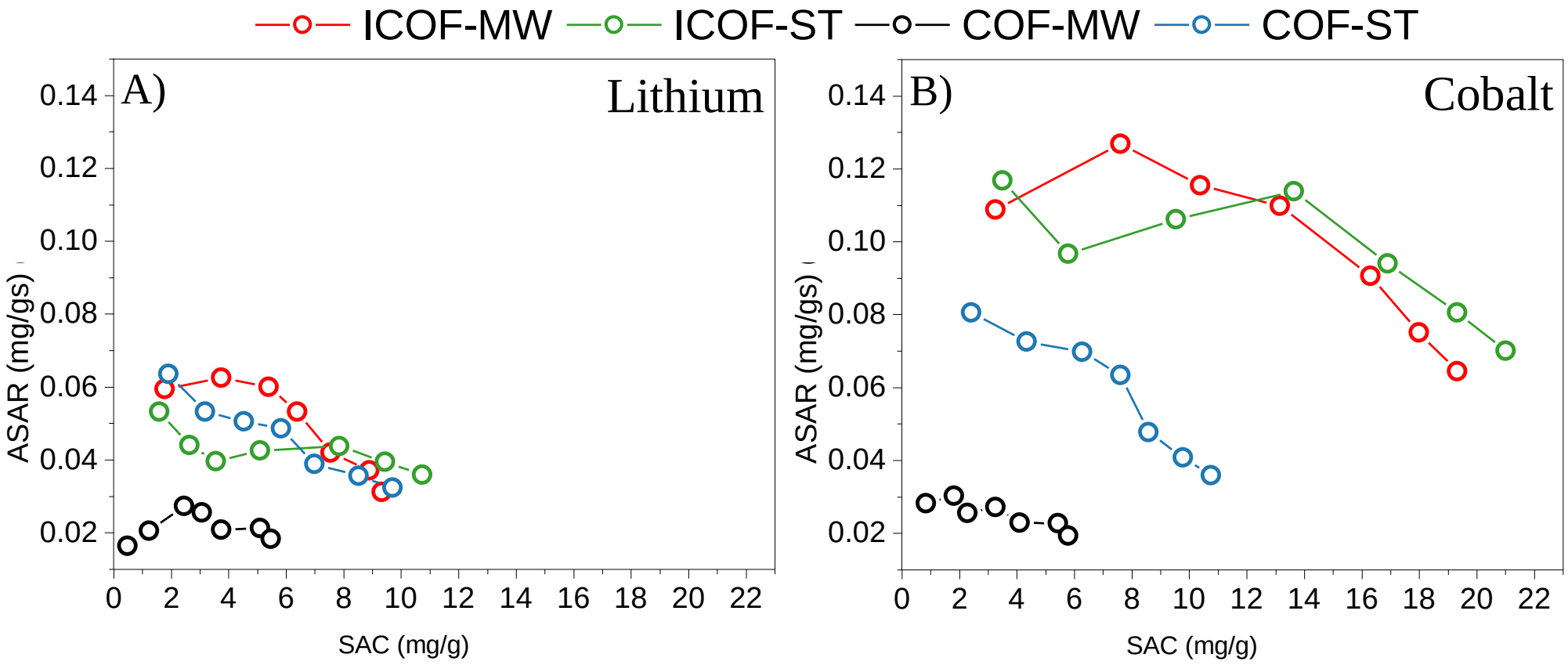
2MIM

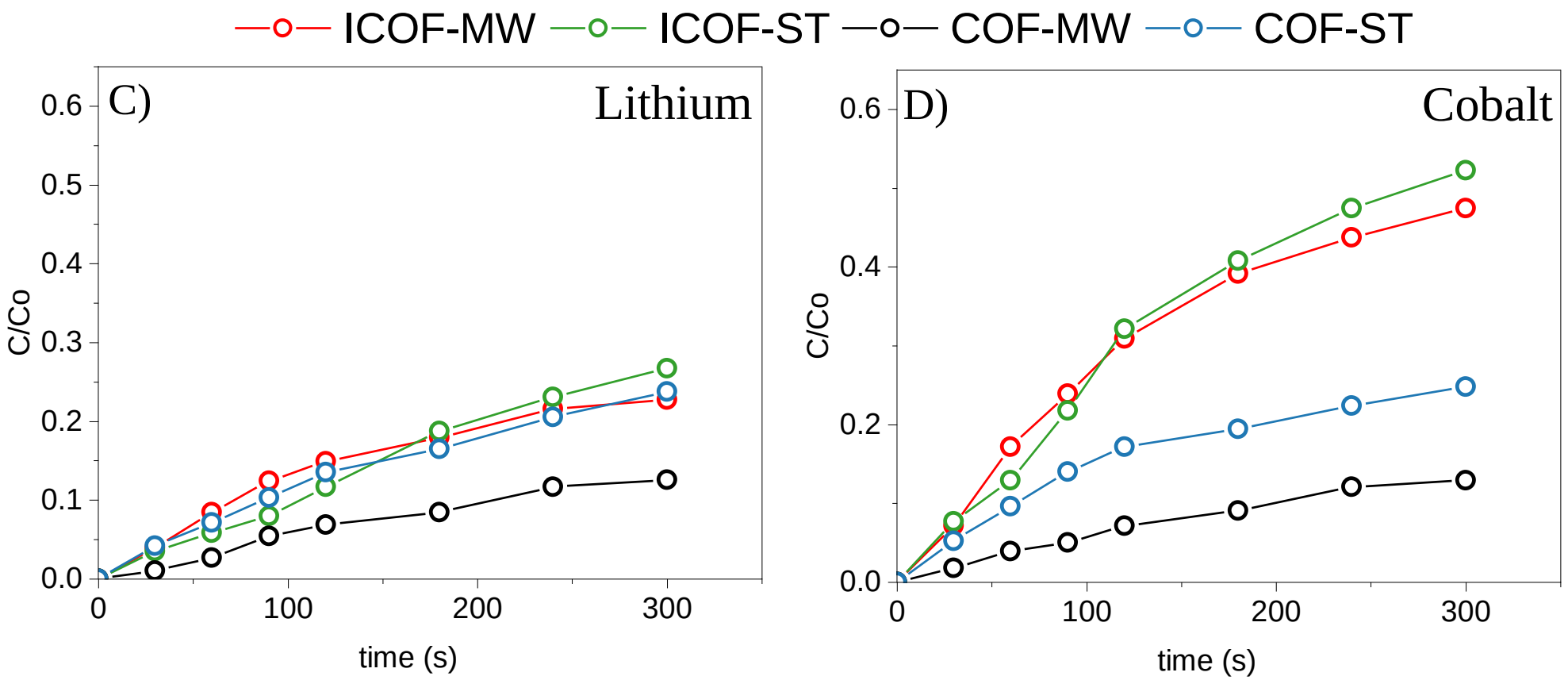
Solvothermal reaction	120°C	3 days
Microwaved reaction	30W	2 min

	COF MW	ICOF MW	COF ST	ICOF ST
Resistance [Ω.cm2]	83	58	67	42
Co-IEC [mmol/g]	0.74	0.87	0.76	1.24
Li-IEC [mmol/g]	0.47	0.53	0.37	0.42
Contact angle [°]	73	52	61	38
Energy Activation [kcal/mol]	8.97	7.02	6.14	4.62



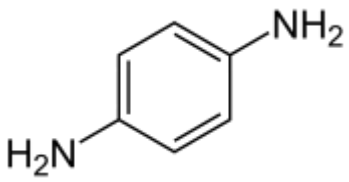


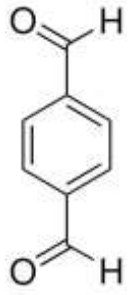

ICOF-MW
ICOF-ST
COF-MW
COF-ST
A)
Lithium
B)
Cobalt
ASAR (mg/gs)
SAC (mg/g)
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0
2
4
6
8
10
12
14
16
18
20
22


ICOF-MW
ICOF-ST
COF-MW
COF-ST
C)
Lithium
C/Co
time (s)
D)
Cobalt
C/Co
time (s)

Linker

Knot

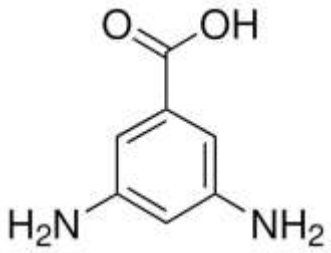


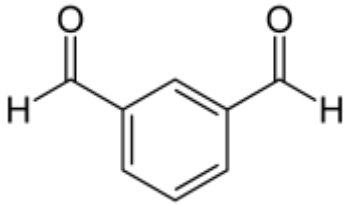


COF (2) ST

PDA

TPA



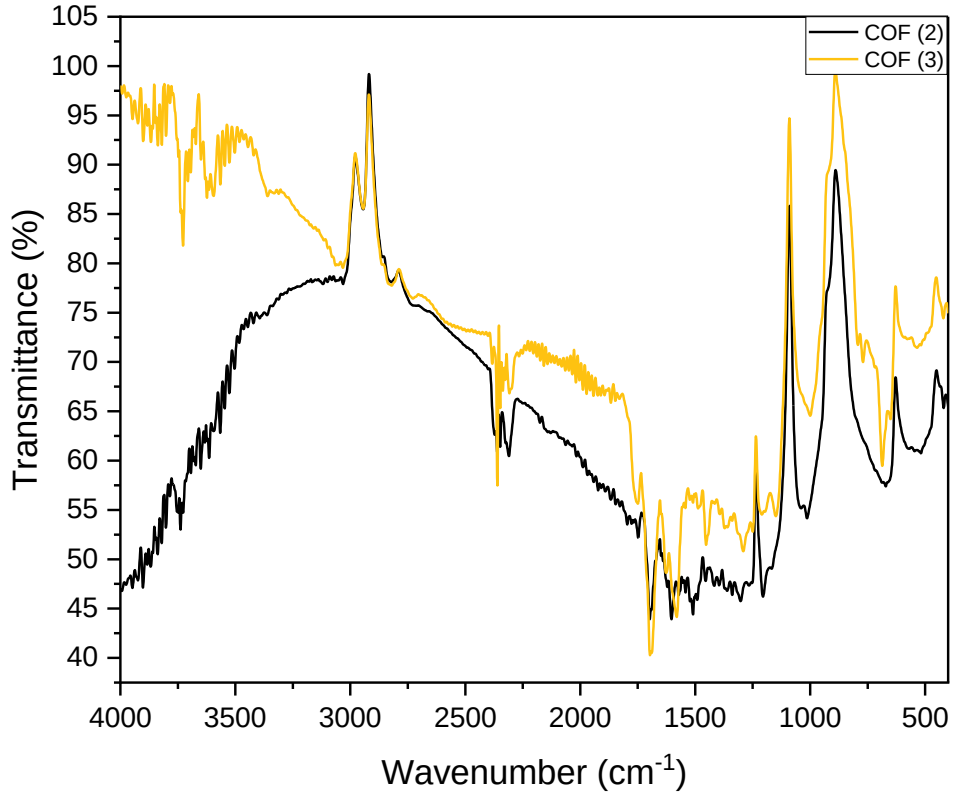


COF (3) ST

DABA

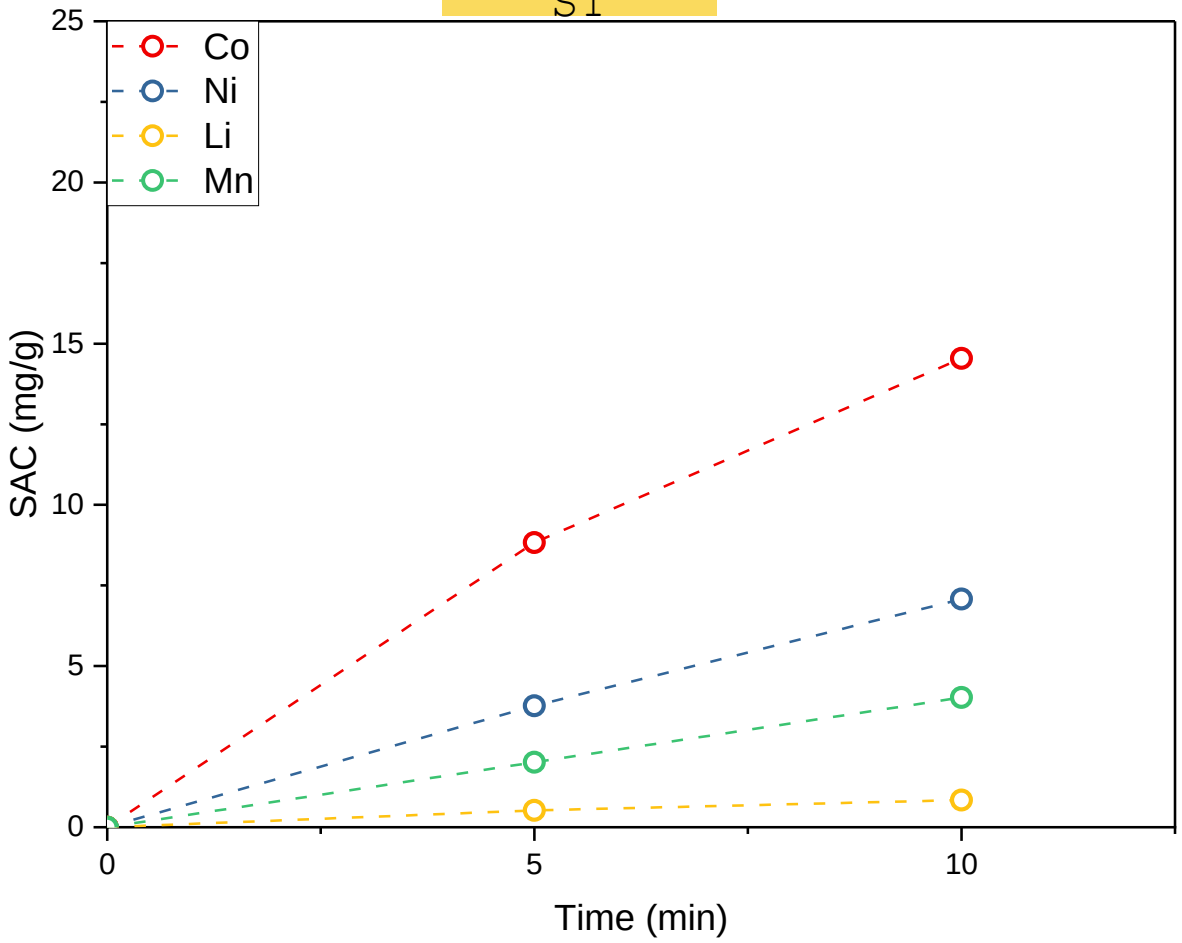
TPA

Solvothermal reaction	70°C	4 hours



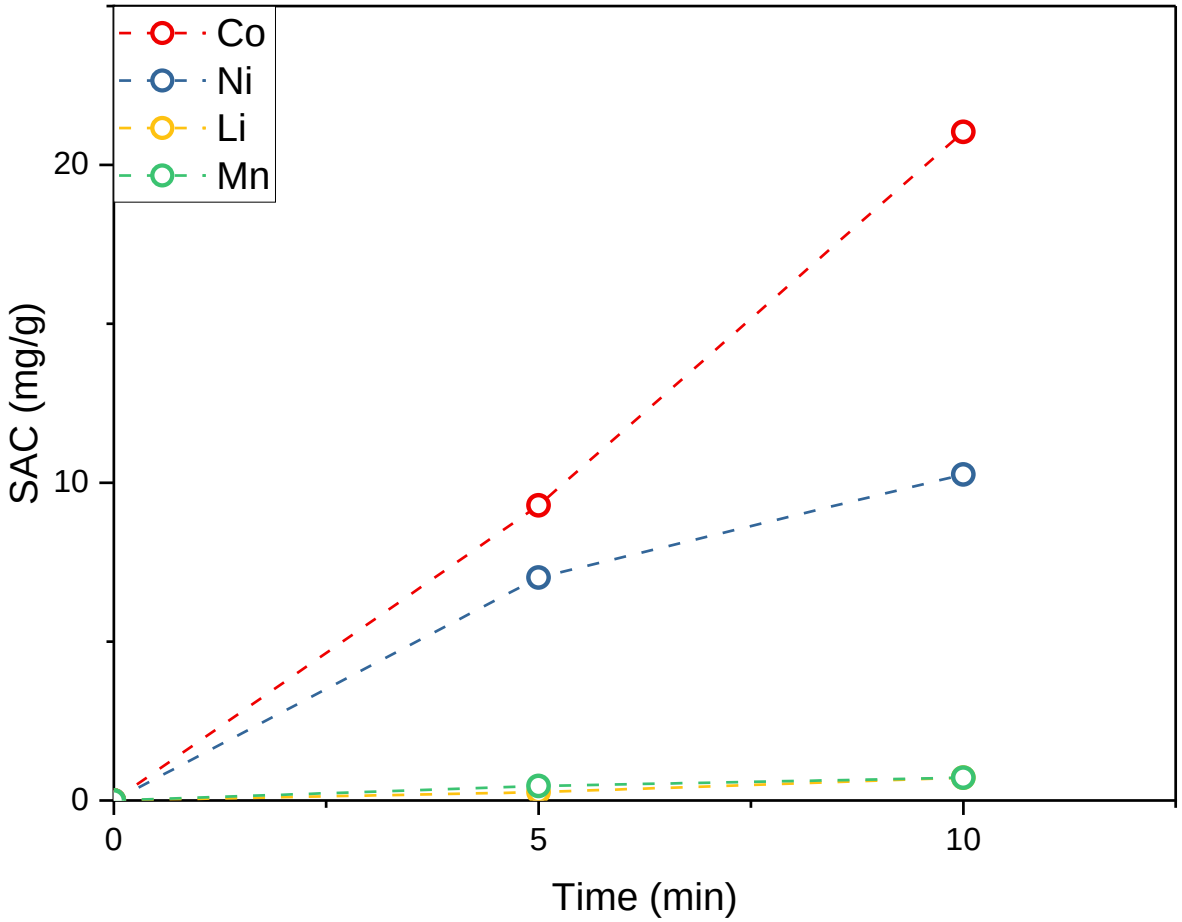
	COF (2) ST	COF (3) ST
Resistance [Ω.cm2]	83	73
Co-IEC [mmol/g]	0.64	0.72
Li-IEC [mmol/g]	0.28	0.41
Contact angle [°]	78	73
Energy Activation [kcal/mol]	10.3	8.9

COF (2)
ST



β Co/Li	β Co/Ni	β Co/Mn
17.2	2.1	3.6

COF (3)
ST



β Co/Li	β Co/Ni	β Co/Mn
29.5	2.2	29.1

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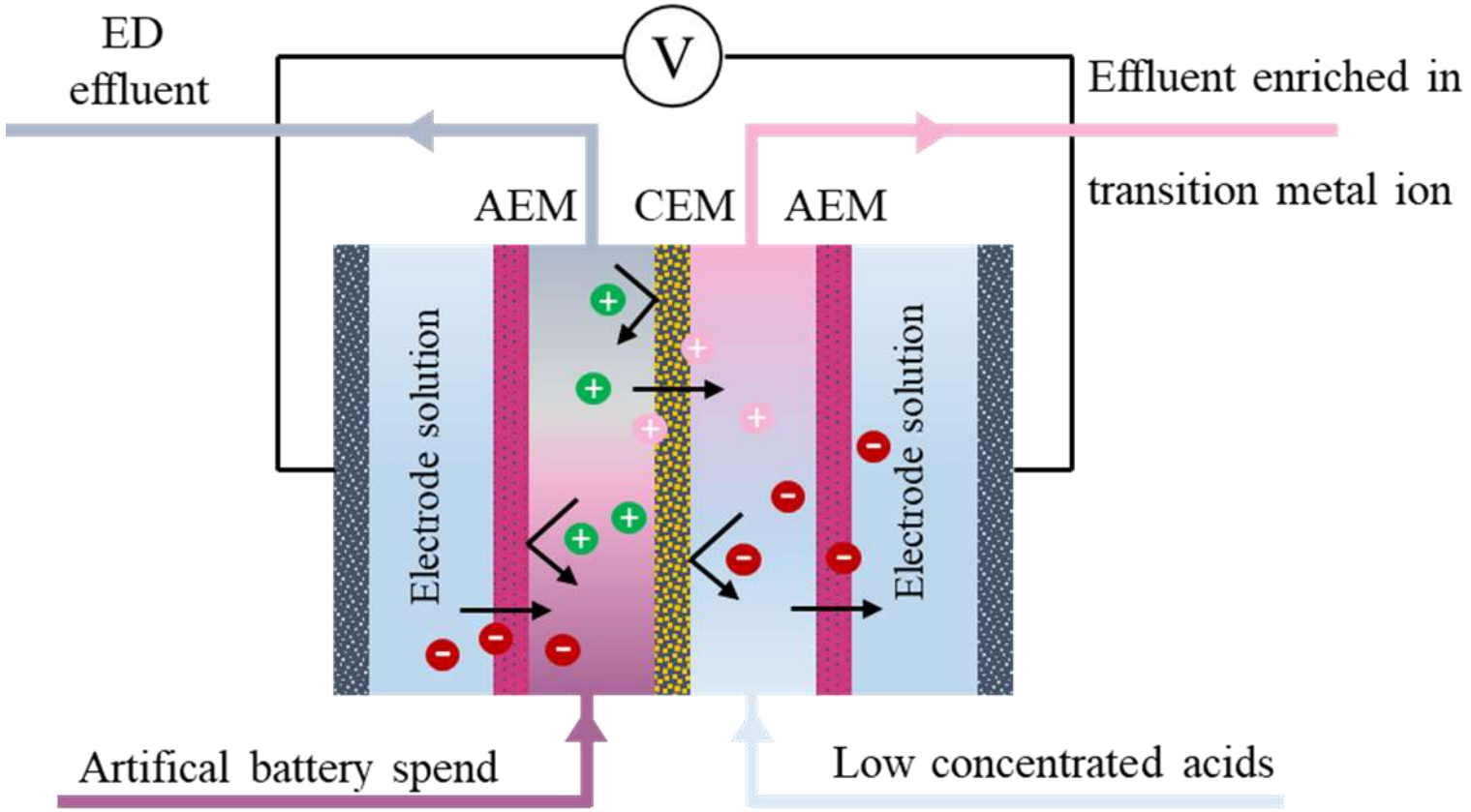
ENERGY HARVESTING FROM BATTERIES WASTE



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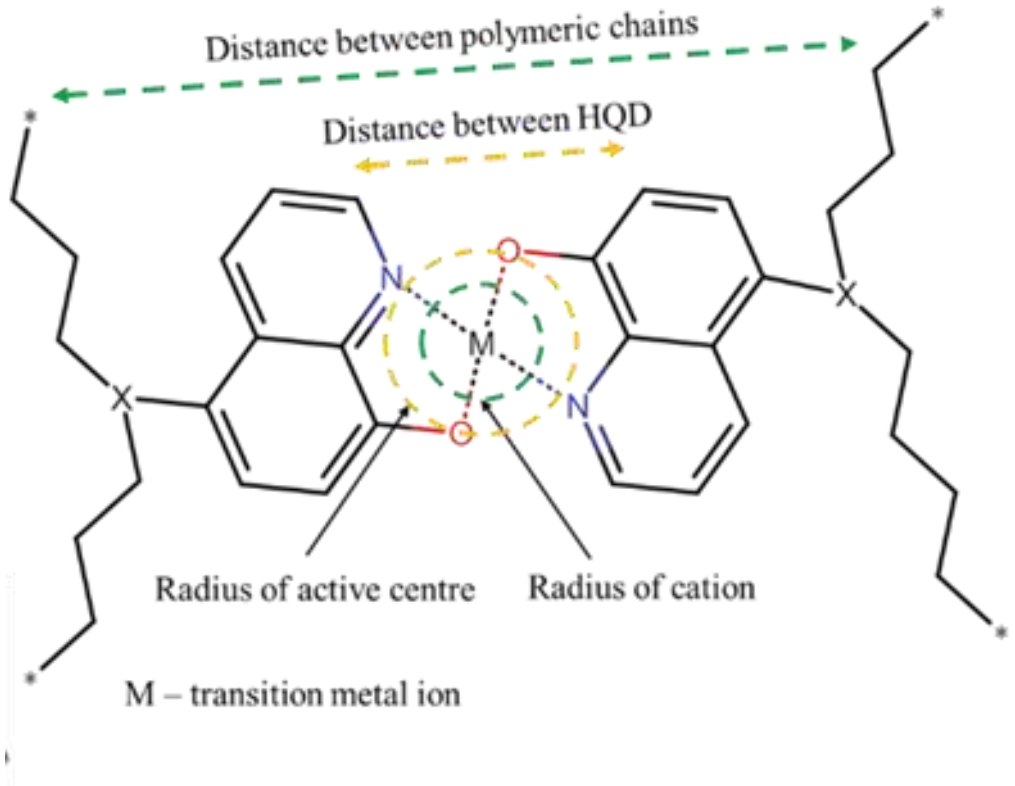
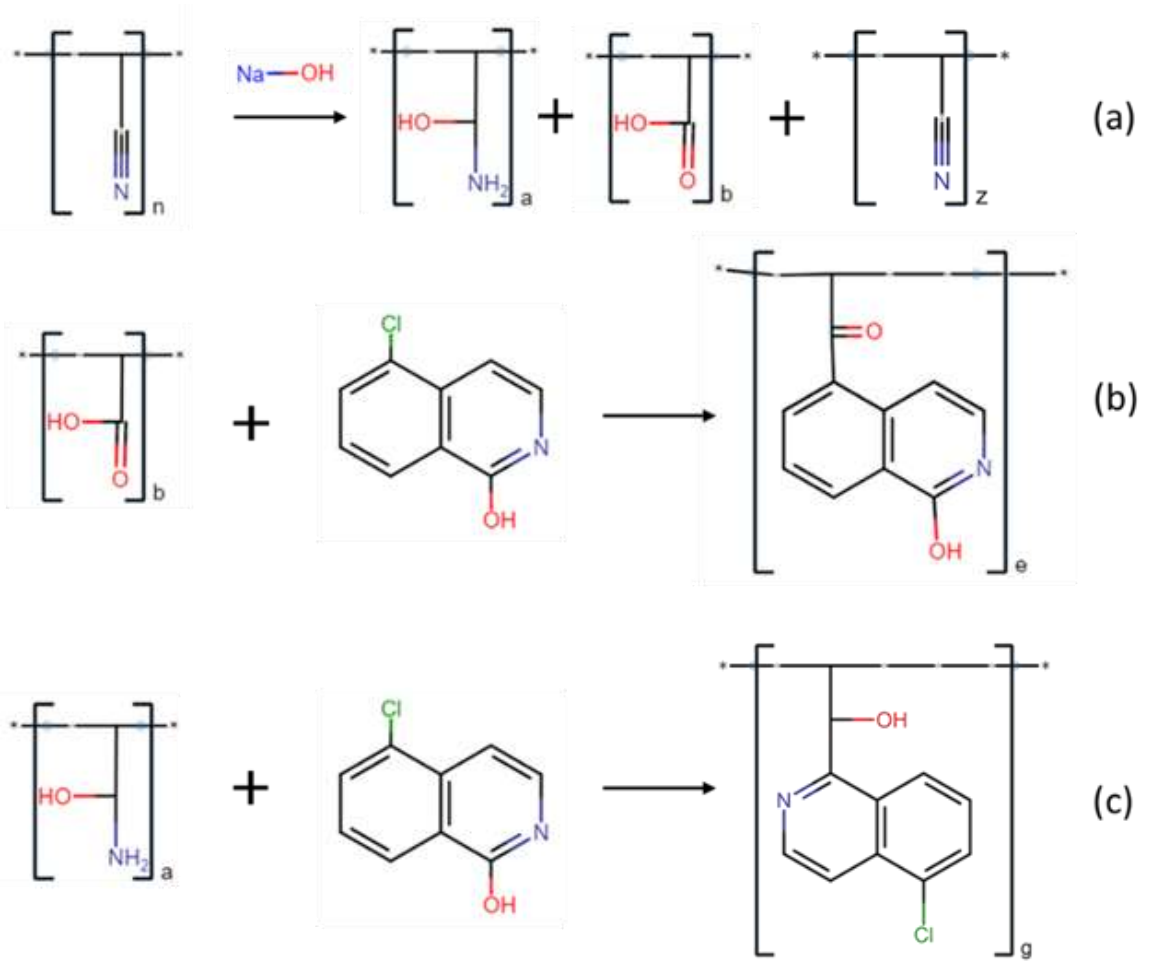
Novel chemistry of cation exchange membranes





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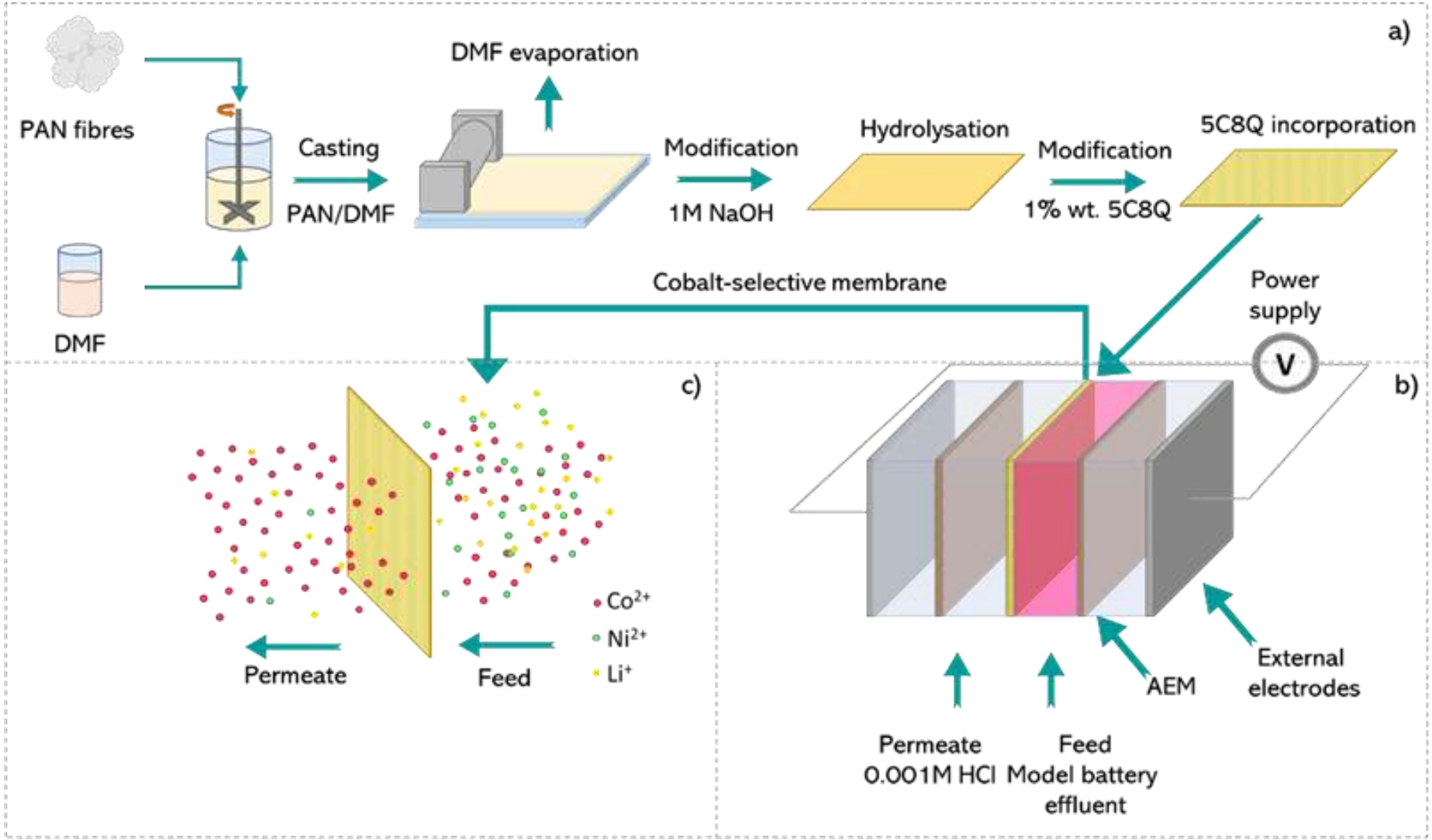

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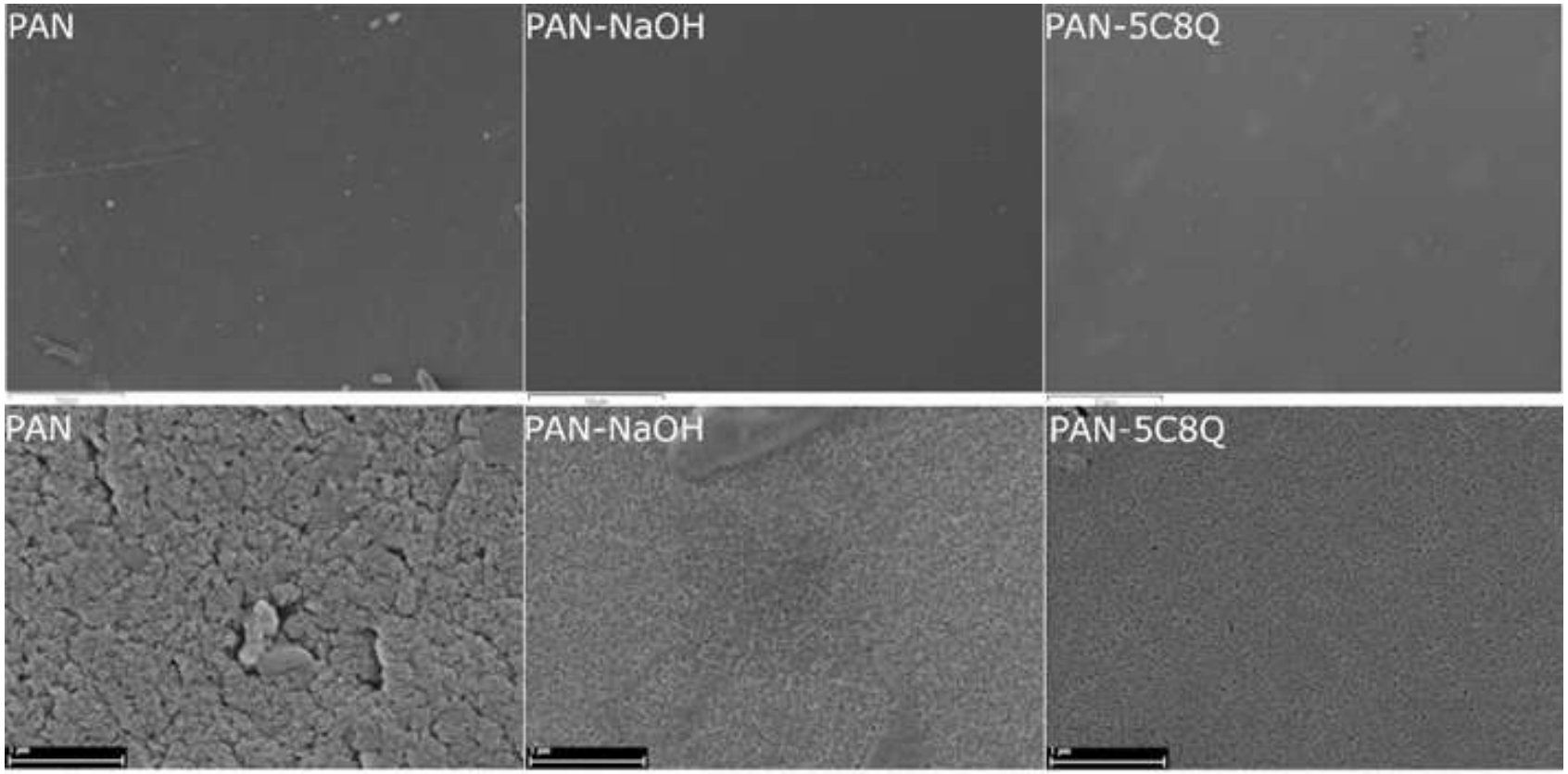

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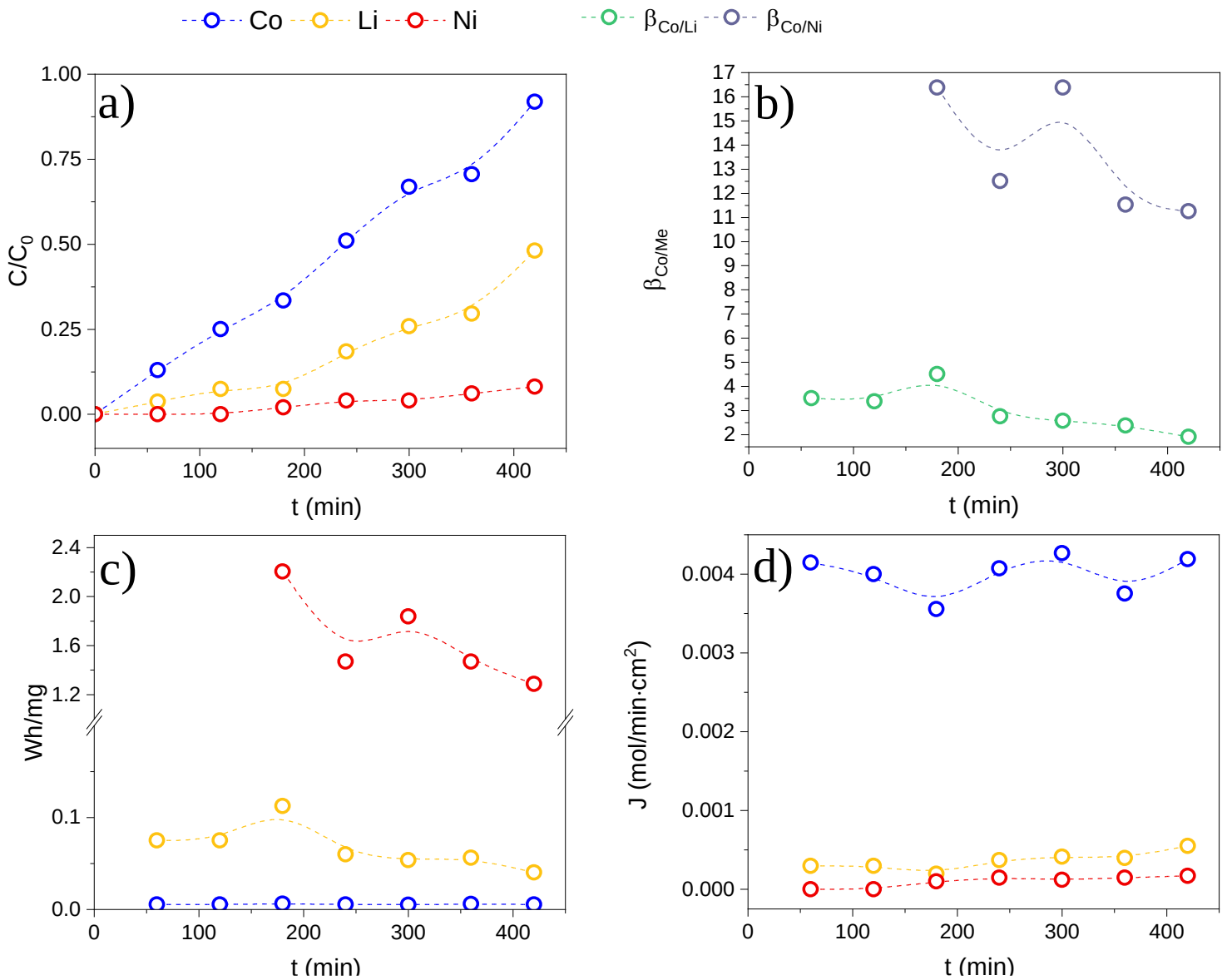

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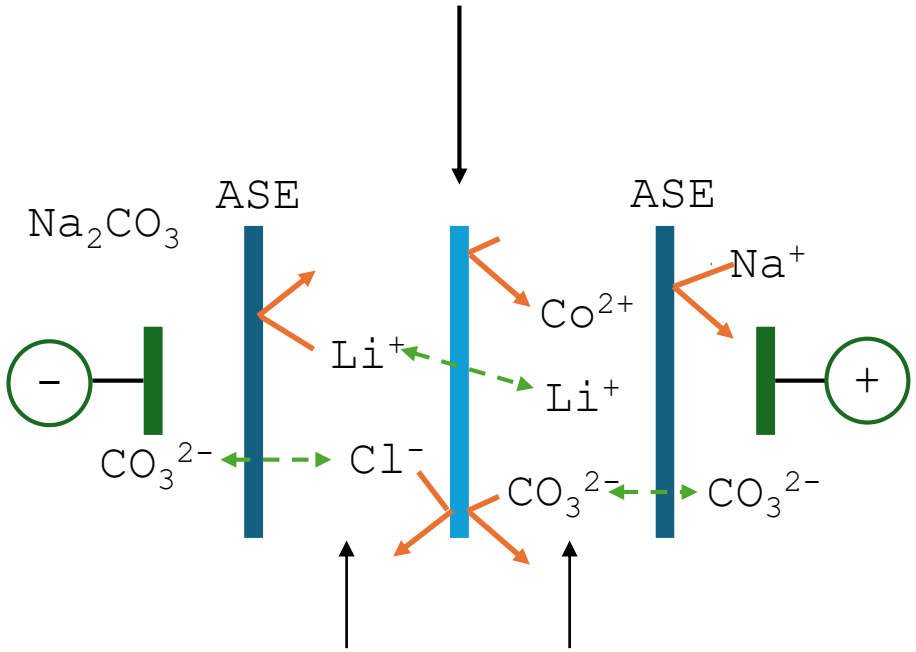
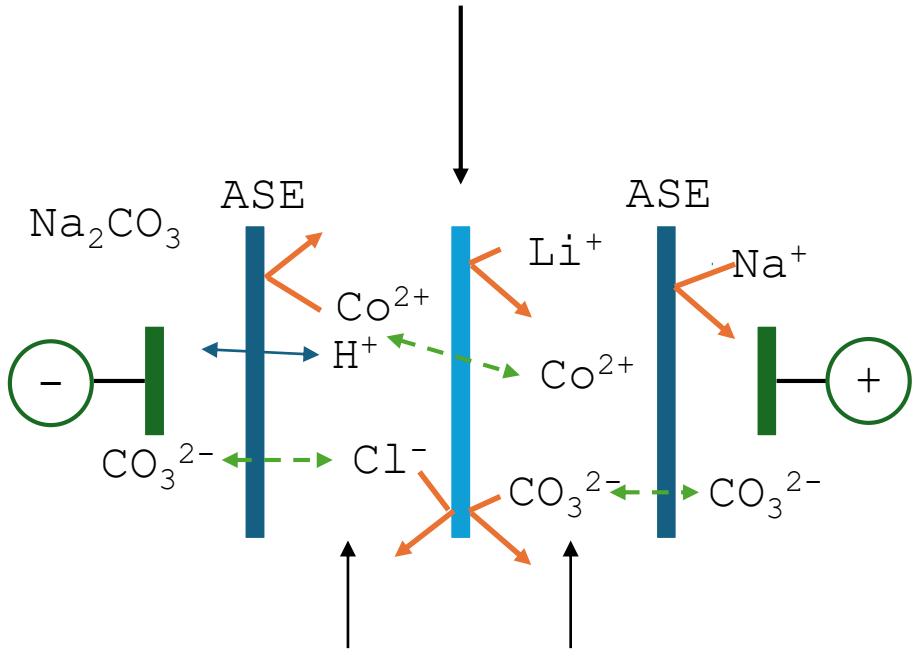
Commercial – CIMS Neosepta



➢ Lithium – selective system

Cobalt-selective CEM



➢ Cobalt – selective system

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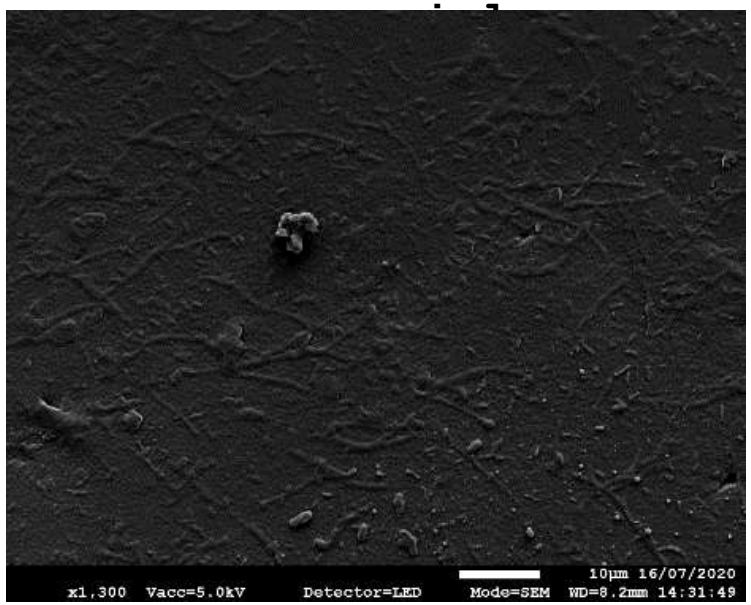
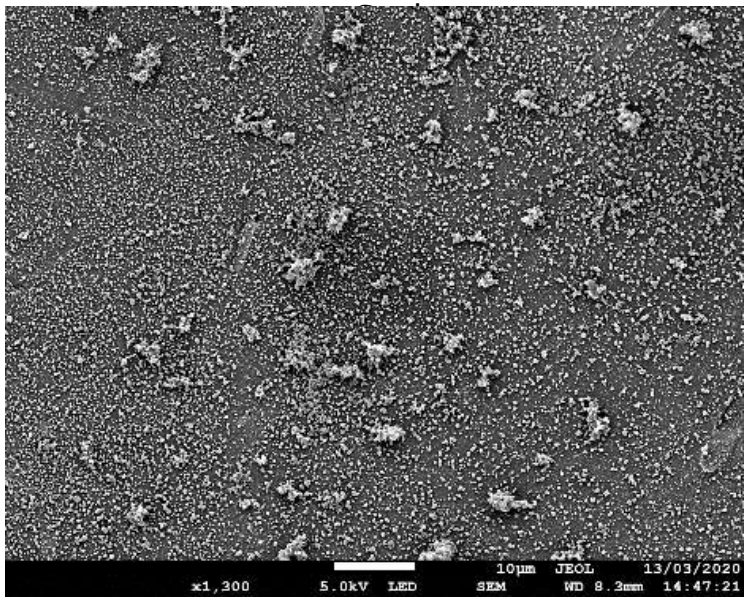
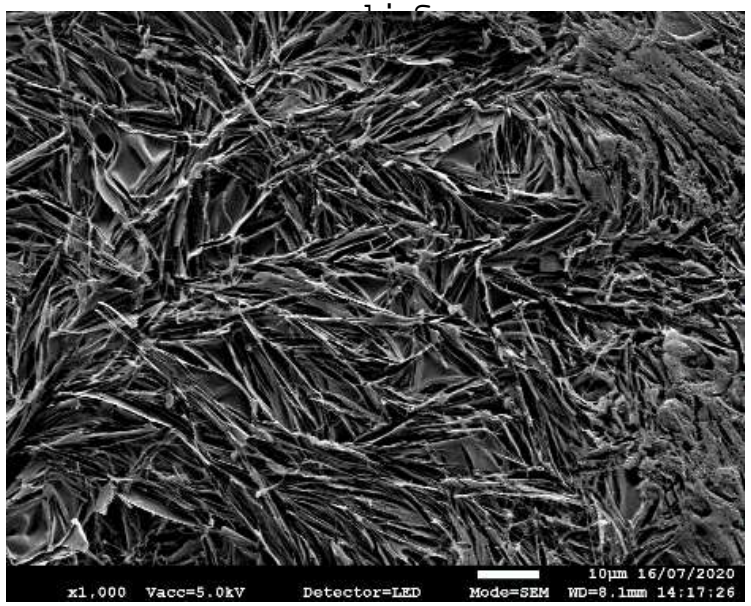
Monovalent selective CEM



Cobalt selective CEM -

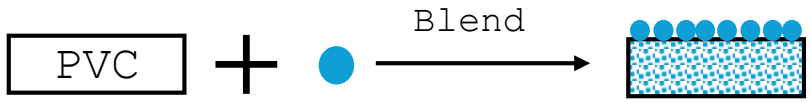


Cobalt selective CEM- bulk



Mechanism based on ion hydrated diameter exclusion

5-Chloro-8-hydroxyquinoline



5-Chloro-8-hydroxyquinoline

Mechanism based on selective carrier chelating

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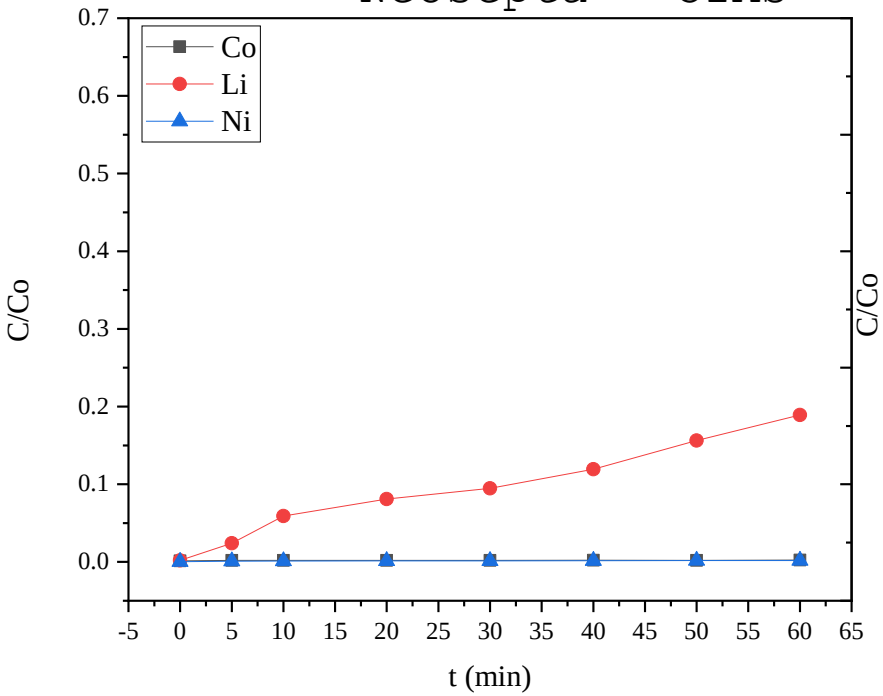
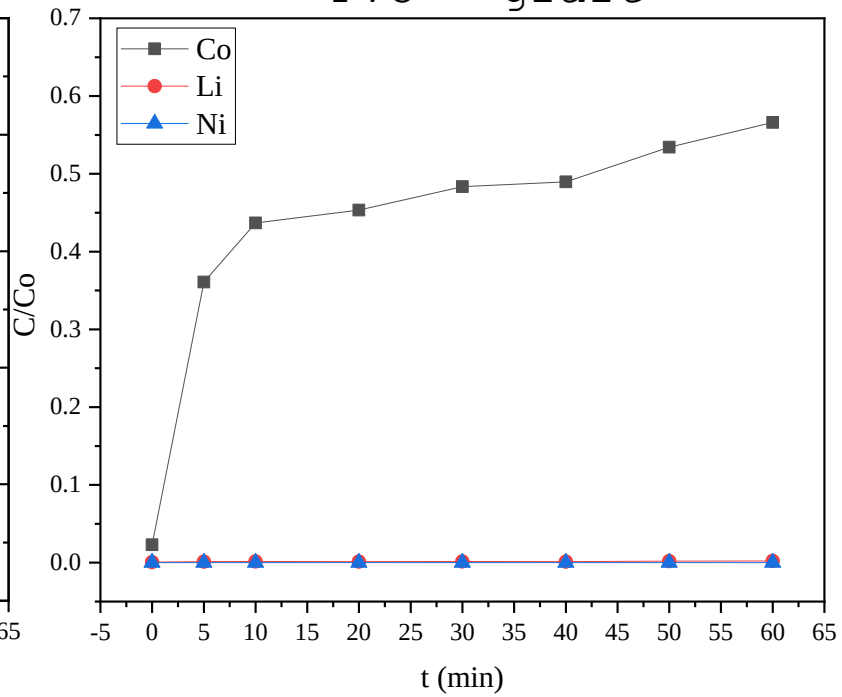
Neosepta - CIMS



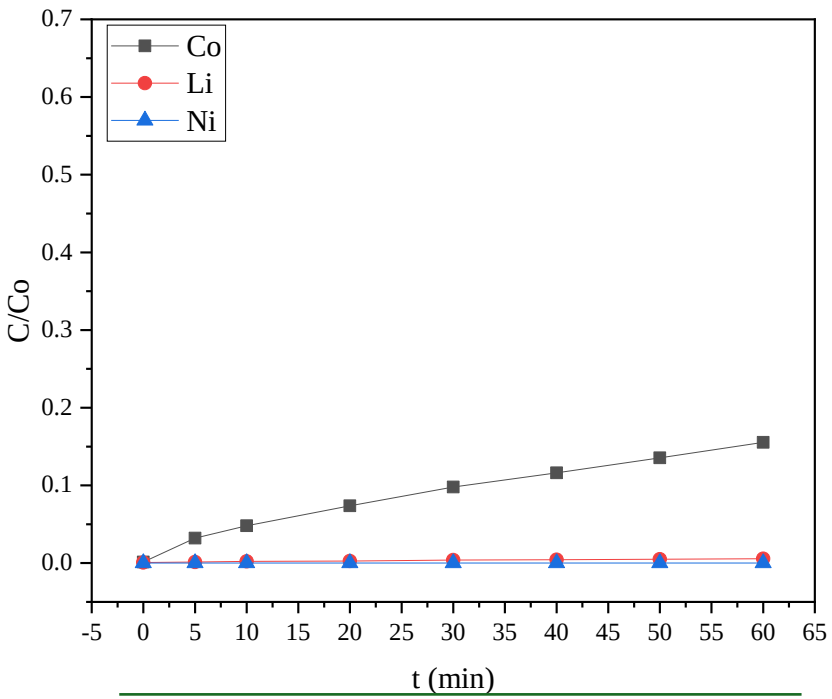
Factors	CIMS
Permselectivity Li/Co	77
Permselectivity Co/Li	0.01
Flux Li [g/cm²min]	1.03
Flux Co [g/cm²min]	0.007

PVC - graft



Factors	PVC-graft
Permselectivity Li/Co	0,004
Permselectivity Co/Li	258
Flux Li [g/cm²min]	0.01
Flux Co [g/cm²min]	1.36

PVC - bulk



Factors	PVC-bulk
Permselectivity Li/Co	0.04
Permselectivity Co/Li	26.8
Flux Li [g/cm²min]	0.03
Flux Co [g/cm²min]	0.37

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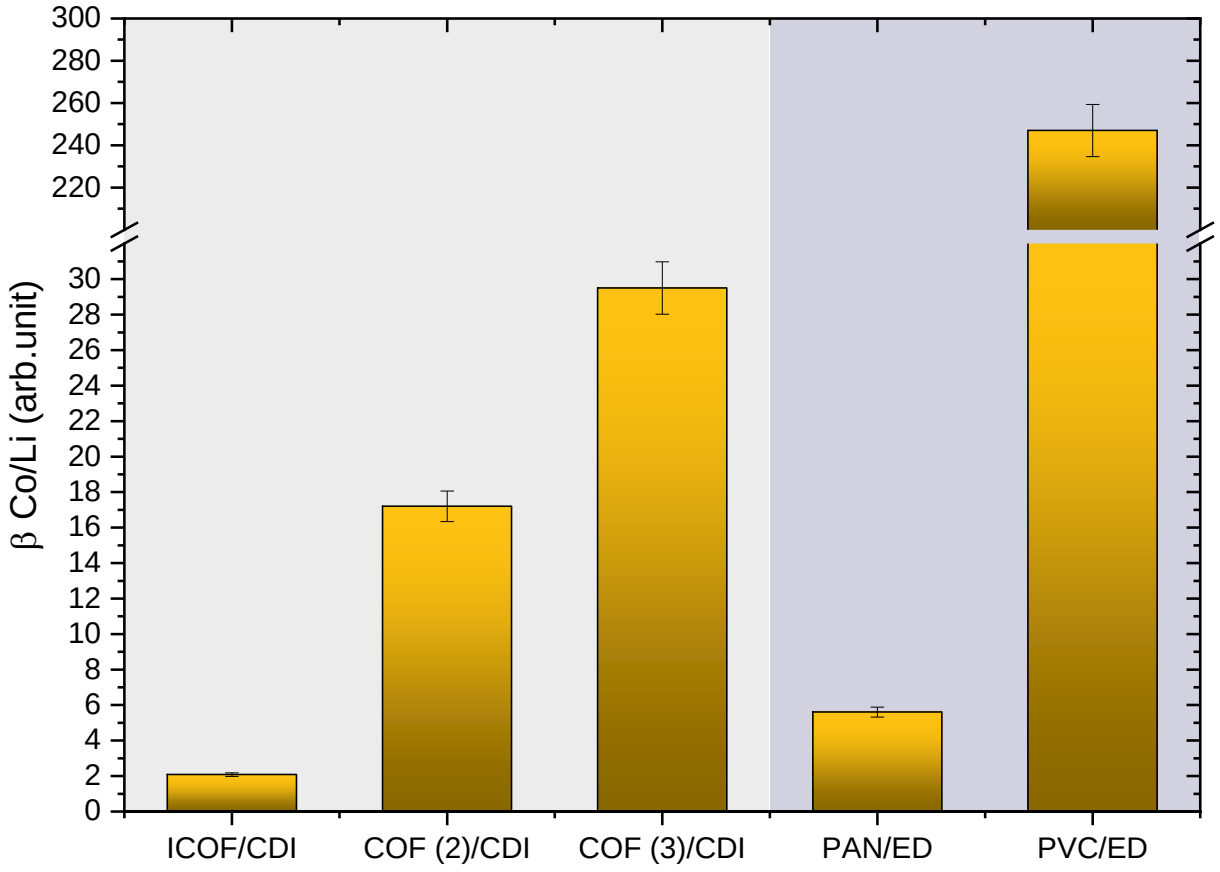
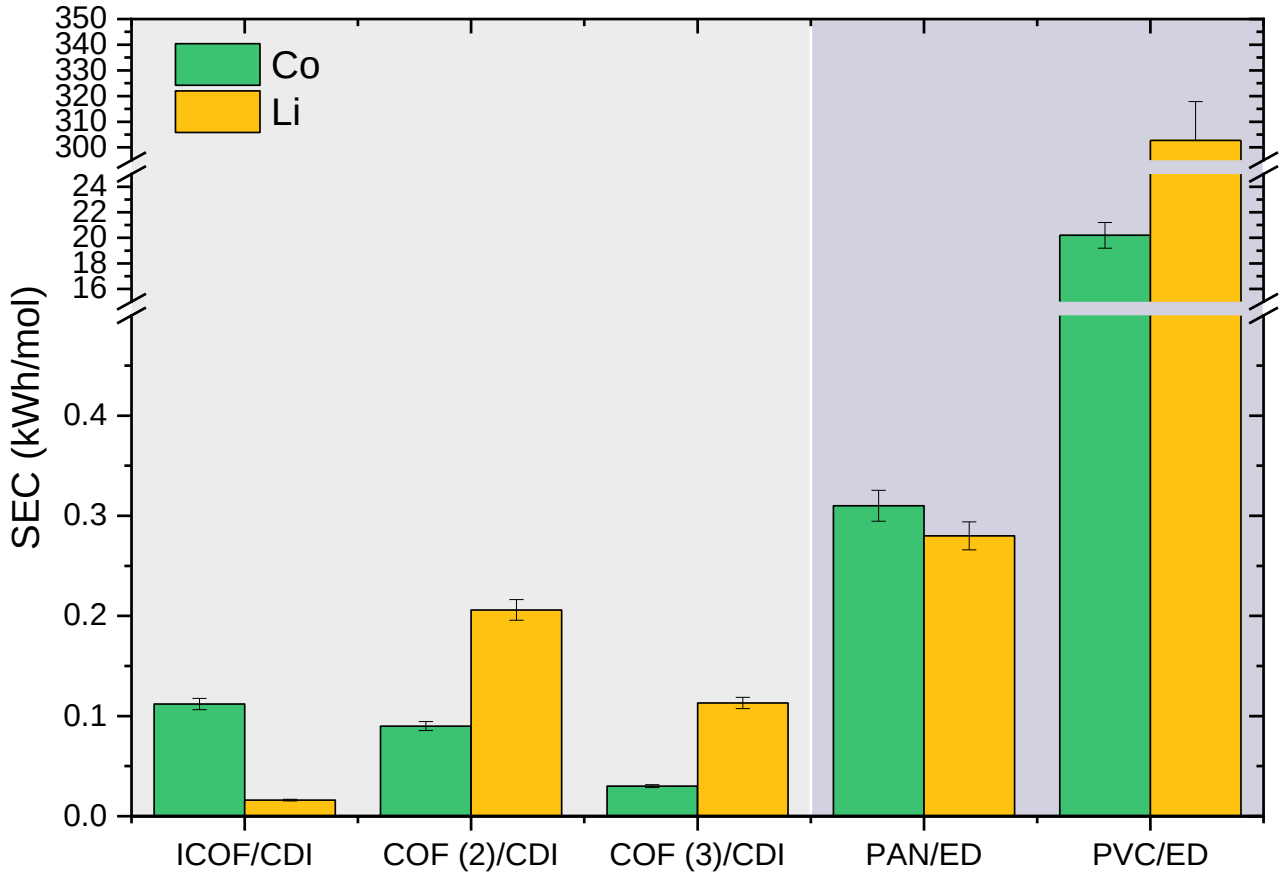
MEMBRANES IN ED

COF IN CDI and SELECTIVE MEMBRANES IN ED





SELECTIVITY AND ENERGY CONSUMPTION COMPARISON

SUMMARY

Wrocław University of Science and Technology

NATIONAL SCIENCE CENTRE POLAND

PTMemC Polish Membrane Society

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This research was funded by the National Science Centre, Poland, Sonata 2022/47/D/ST5/00298.

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