Pengembangan Material Fungsional Ramah Lingkungan dalam Mendukung Ekonomi Melingkar

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Chemistry Department

Outline

- Green Chemistry
- Skema Riset
- Pengelolaan Air
- Material Fungsional
- Conclusion

12 Principles of Green Chemistry

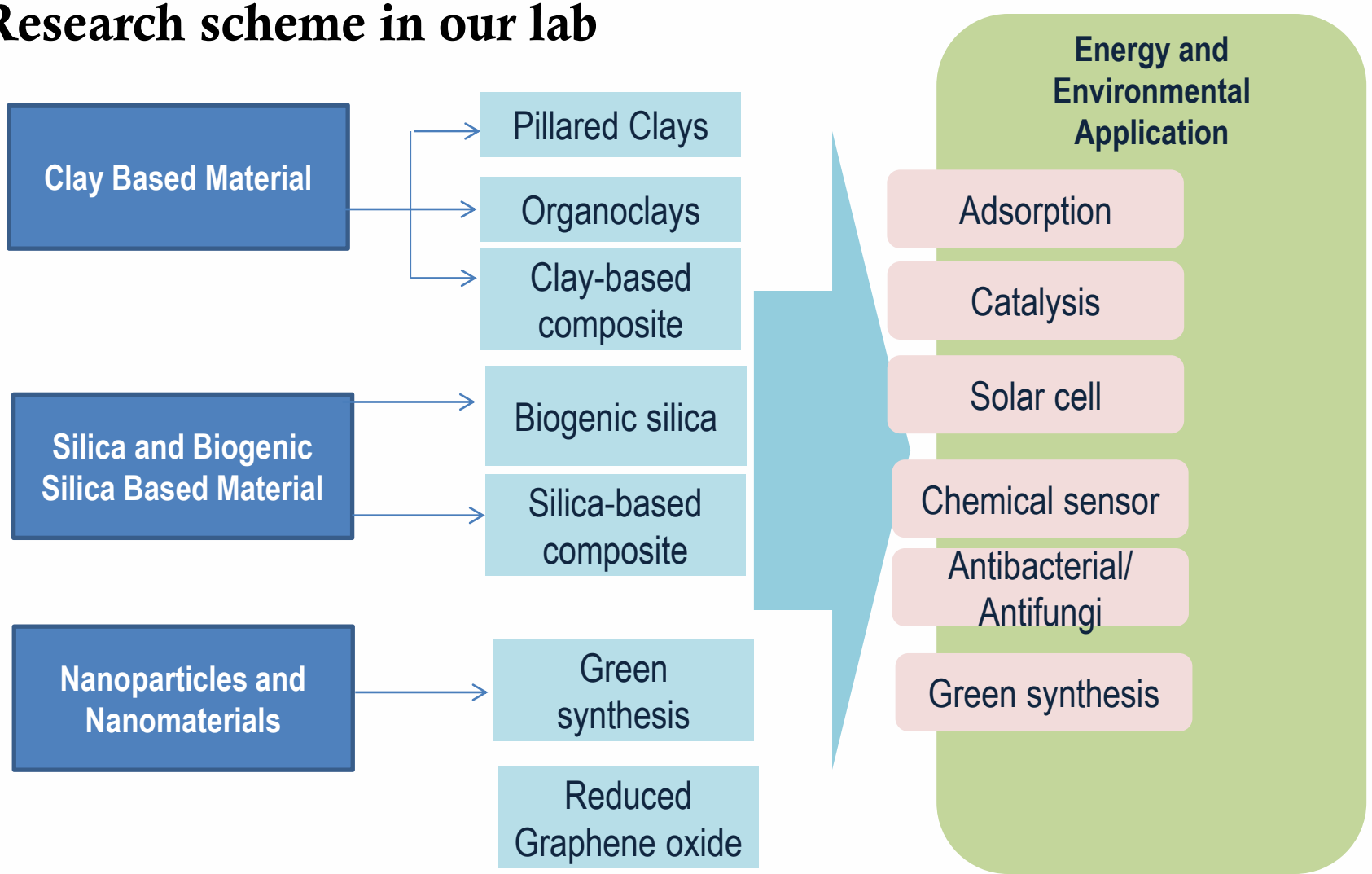
Benign Process for Water Treatment

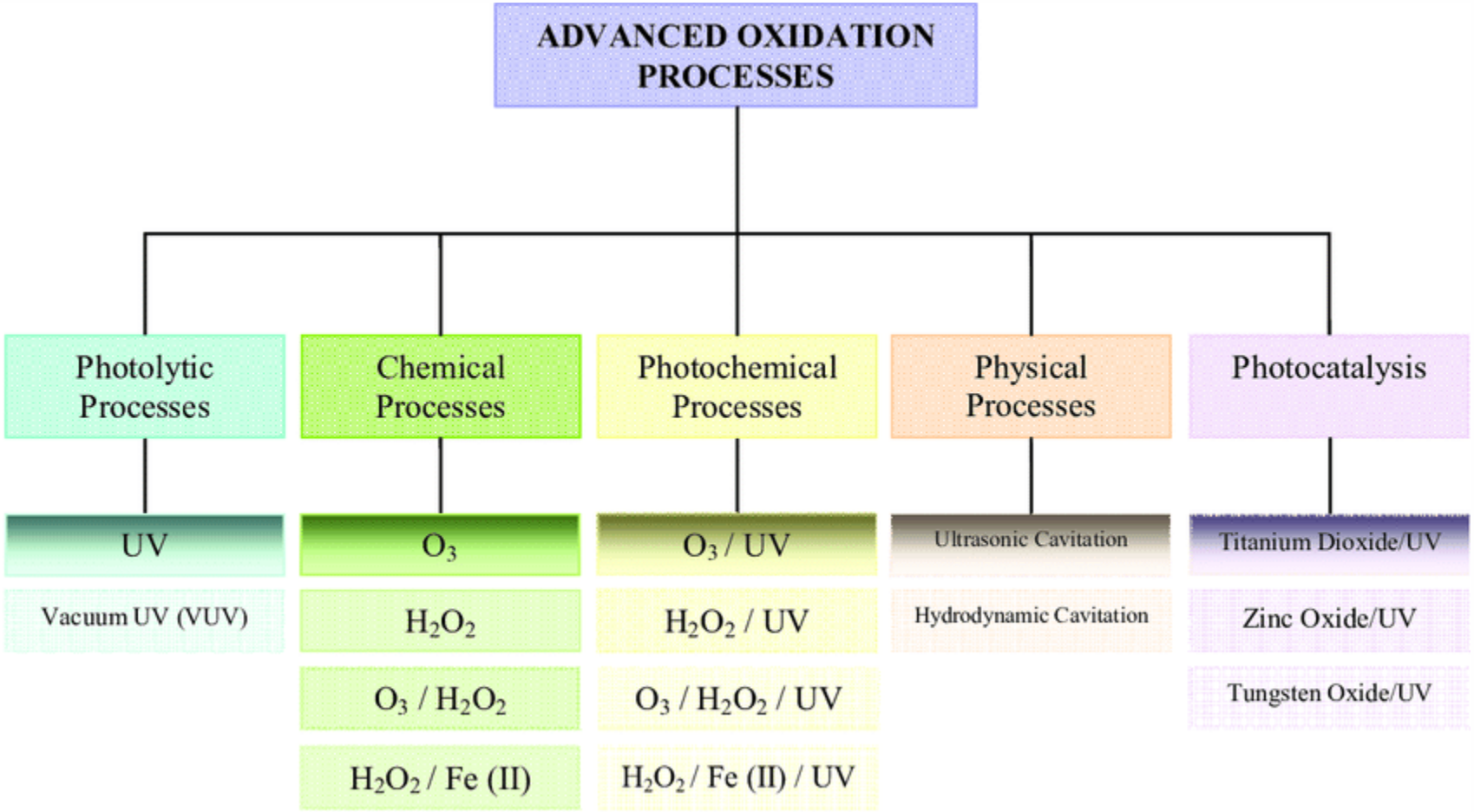
- Penggunaan Teknologi Berkelanjutan
- Material hemat (Low-Cost Material)
- Penggunaan Material terbarukan (The use of renewable resource)

- Advanced oxidation process
- Photocatalysis

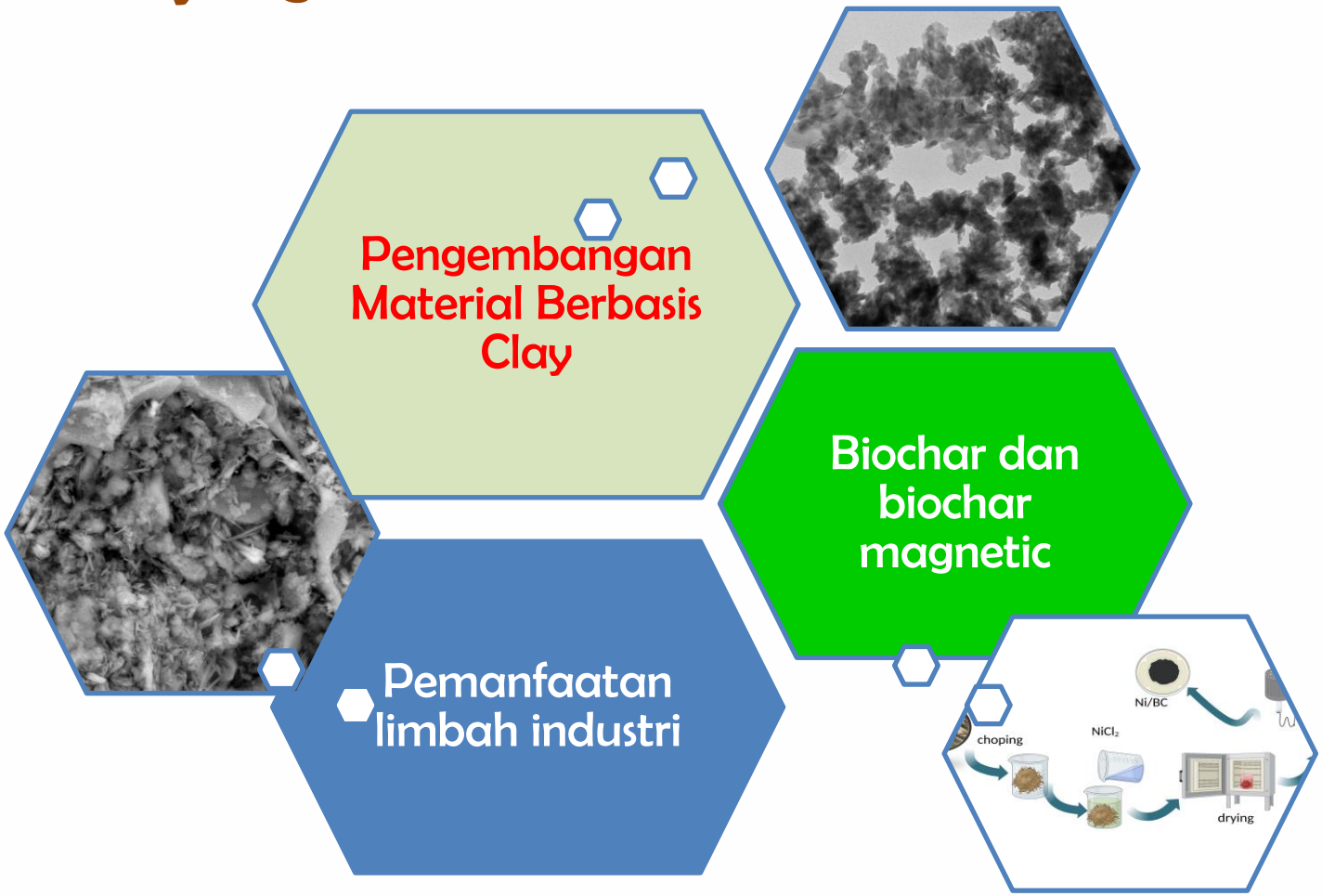
- Functional Materials

Research scheme in our lab

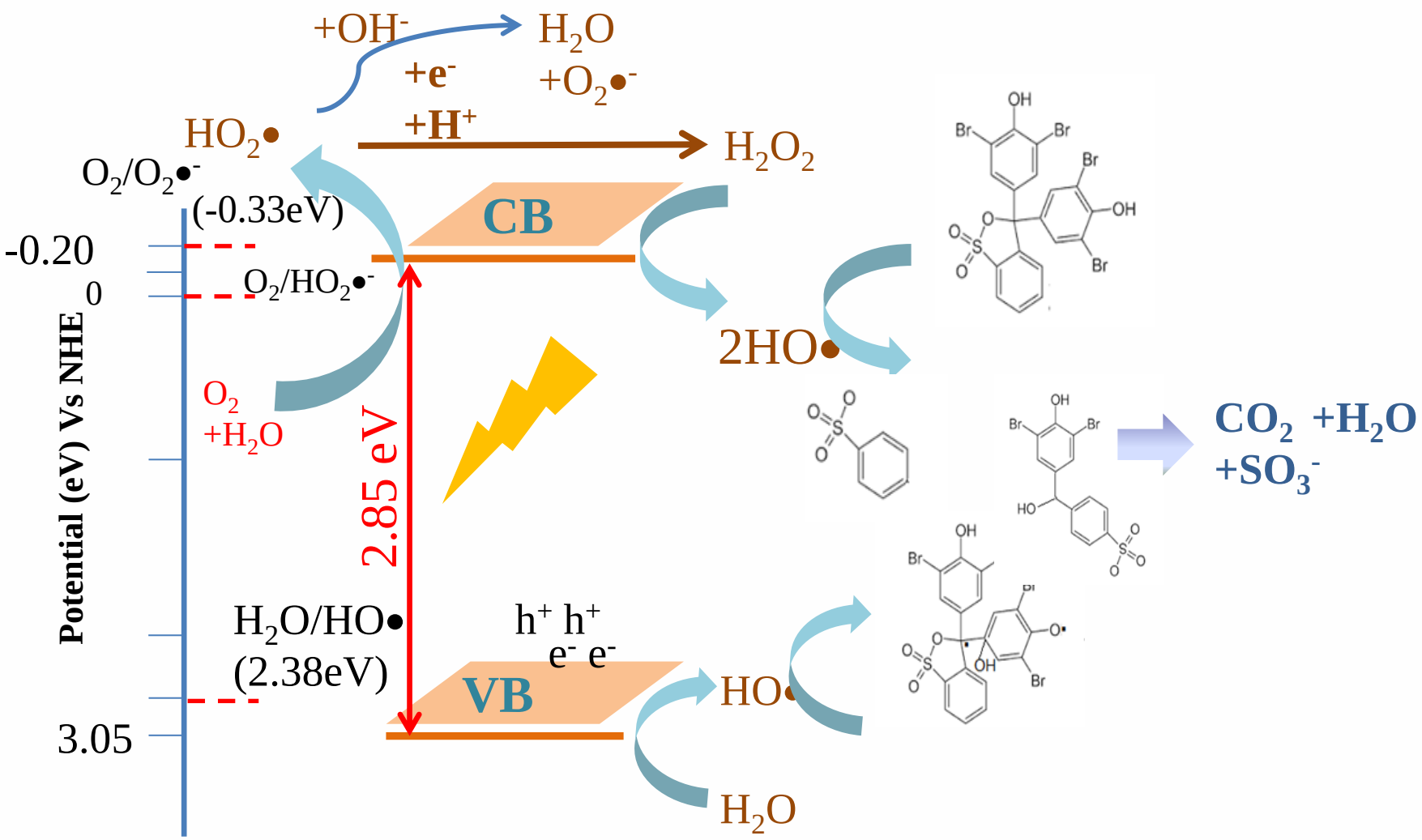



ADVANCED OXIDATION PROCESSES
Photolytic Processes
Chemical Processes
Photochemical Processes
Physical Processes
Photocatalysis
UV
Vacuum UV (VUV)
O_3
H_2O_2
O_3 / H_2O_2
H_2O_2 / Fe (II)
O_3 / UV
H_2O_2 / UV
O_3 / H_2O_2 / UV
H_2O_2 / Fe (II) / UV
Ultrasonic Cavitation
Hydrodynamic Cavitation
Titanium Dioxide/UV
Zinc Oxide/UV
Tungsten Oxide/UV

Pengembangan Material Fungsional yang dilakukan

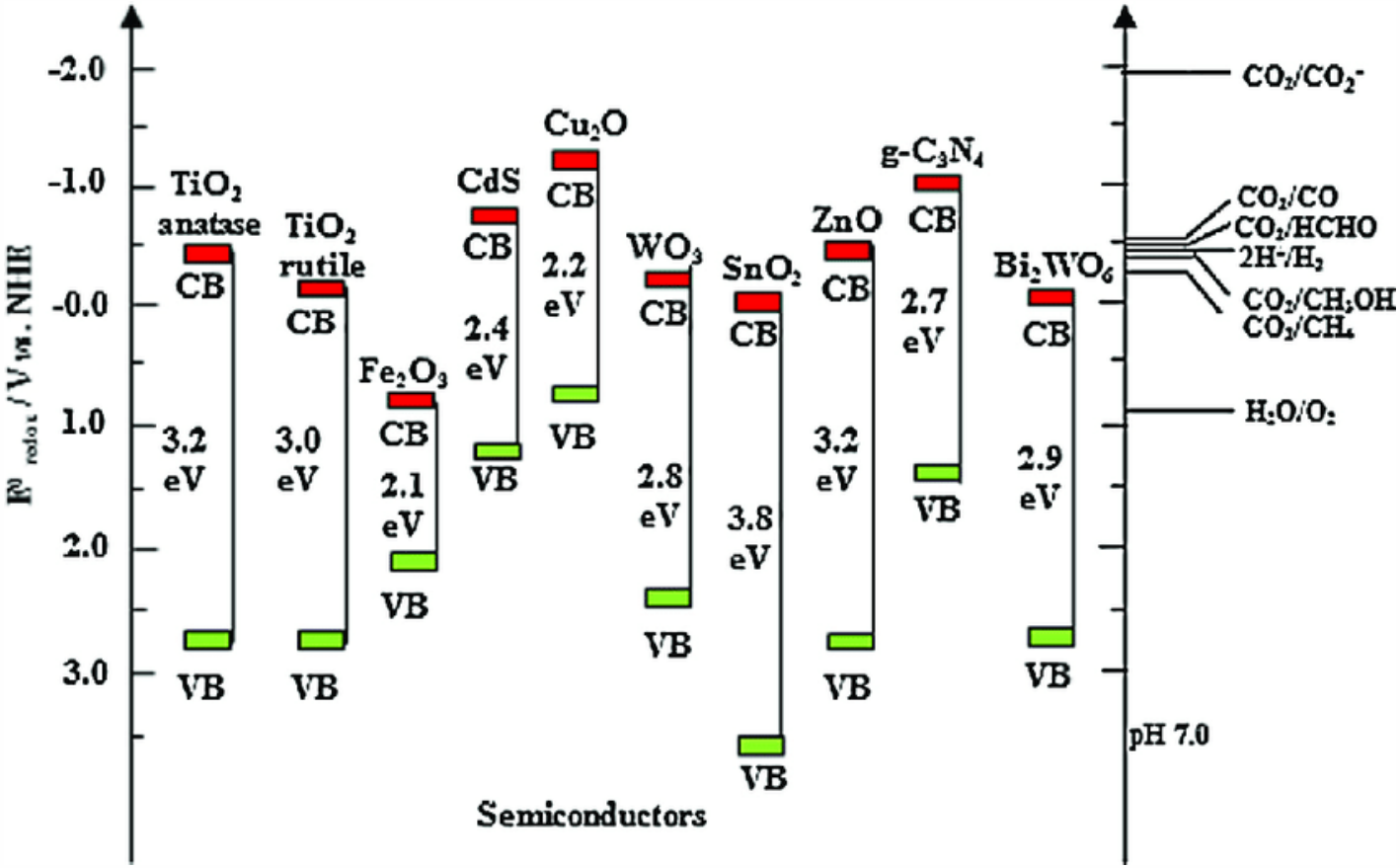


Mekanisme Fotokatalis



Band gap energy modification

- Creating certain phase
- Designing particle size

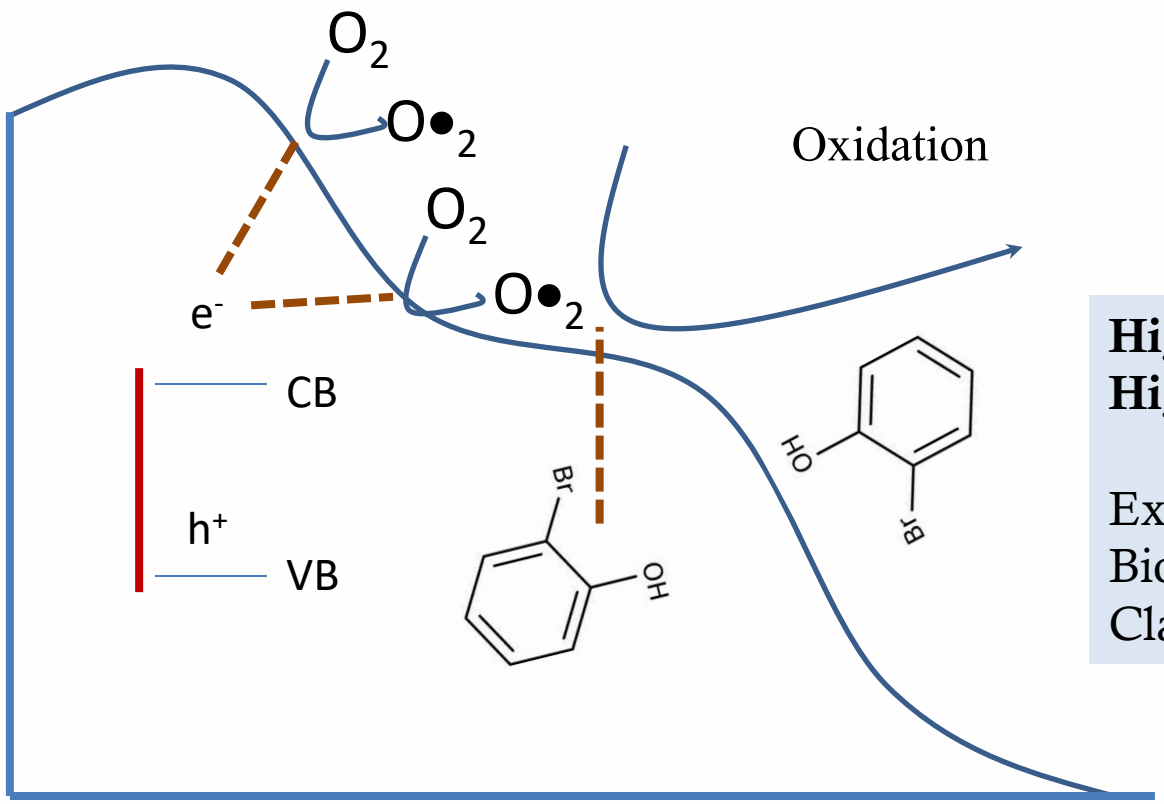


Functional materials: Modification for Enhancement

- Band gap energy modification
- Supporting metal oxide photocatalyst into solid support
- The use of supportive adsorbent

- Clay-based materials

Supporting metal oxide photocatalyst into solid support



High specific surface area
High pore distribution

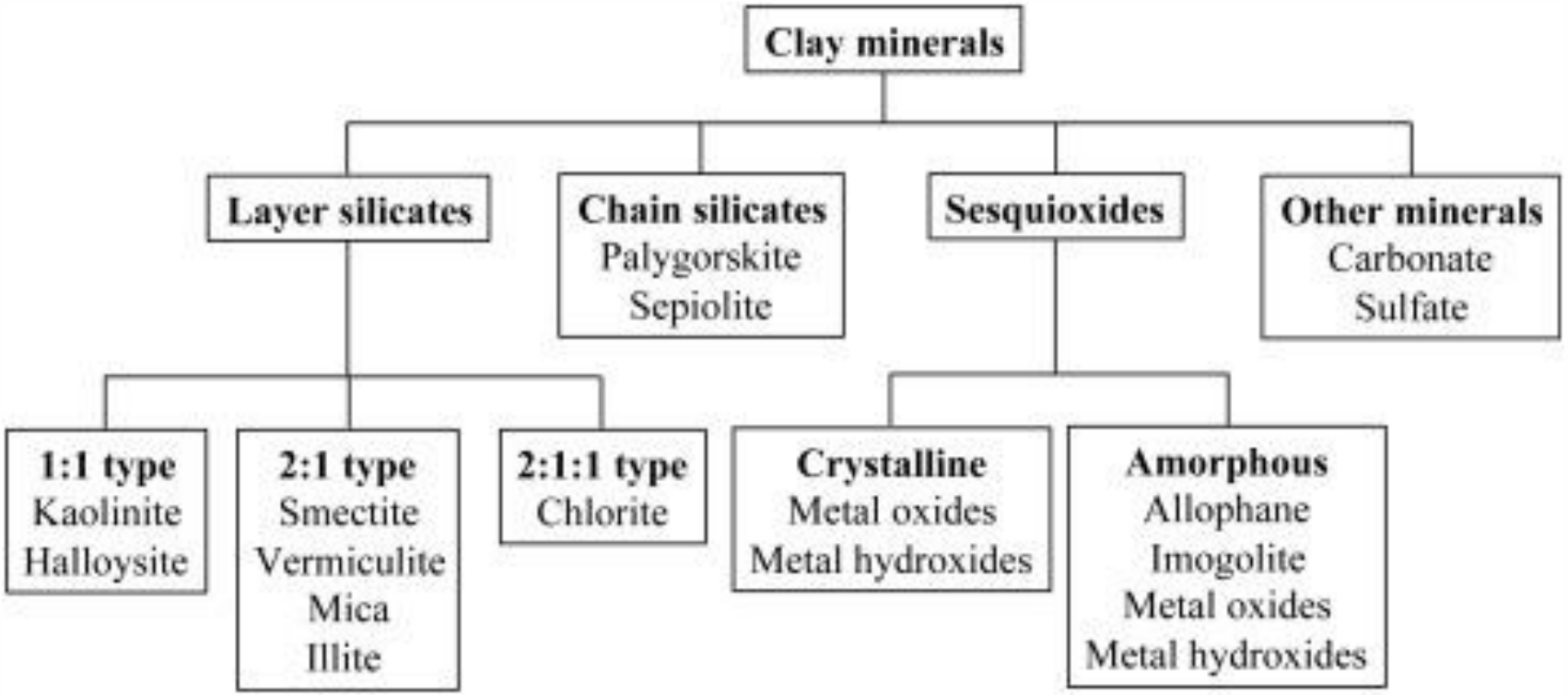
Example:
Biochar-based material
Clay-based material

Industry and research on clay minerals in Indonesia

Belitung

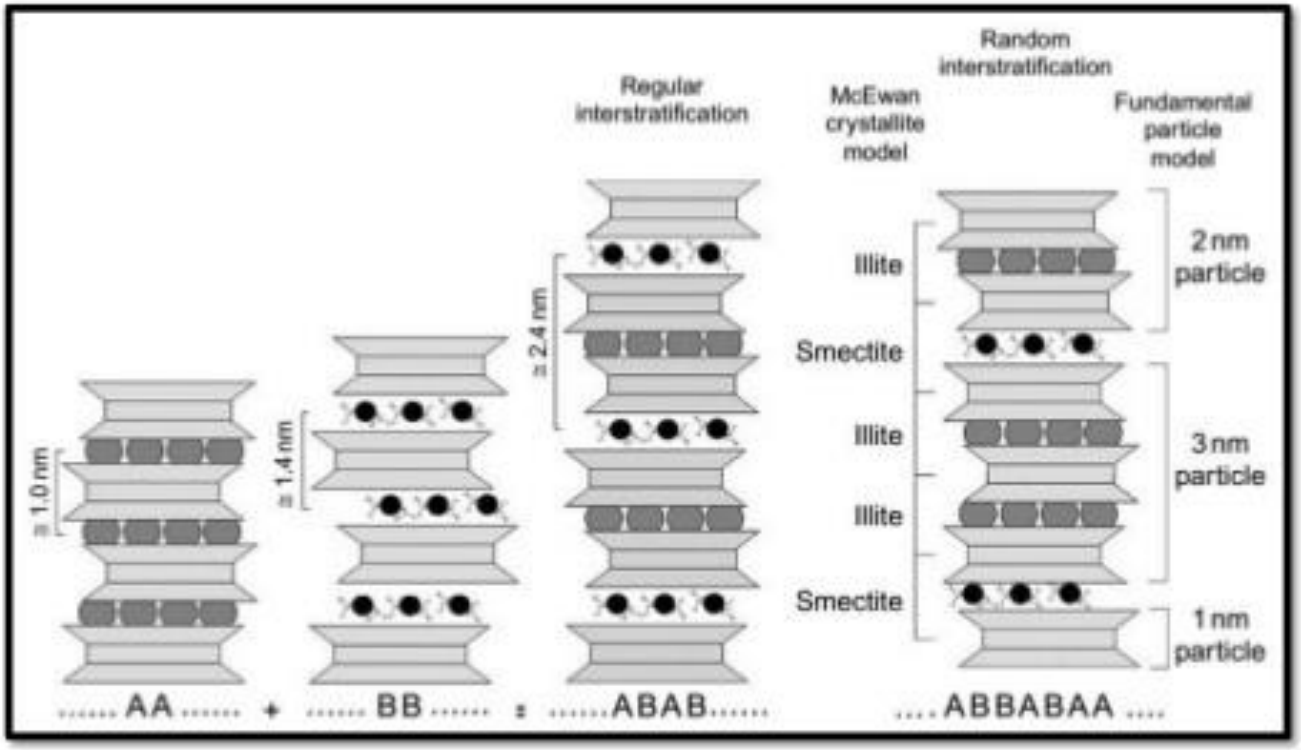
Pacitan

Tasik Malaya


Clay minerals
Layer silicates
Chain silicates
Palygorskite
Sepiolite
Sesquioxides
Other minerals
Carbonate
Sulfate
1:1 type
Kaolinite
Halloysite
2:1 type
Smectite
Vermiculite
Mica
Illite
2:1:1 type
Chlorite
Crystalline
Metal oxides
Metal hydroxides
Amorphous
Allophane
Imogolite
Metal oxides
Metal hydroxides

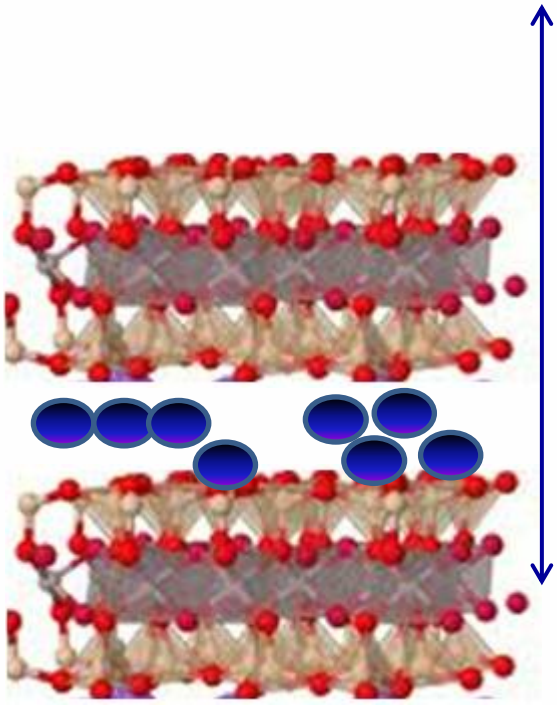
CLASSIFICATIONS

- Pure clay minerals
- Mixed-layer clay minerals



Brigatti et al., 2006

Structure of Smectite Clay



1.18 nm

Ion Exchanged Clay

Possible to exchange:
- Metal Polyoxocations
- Organic Compounds/surfactant
- Metal Ions

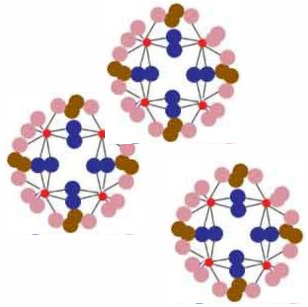
Metal Oxide Pillared Clay

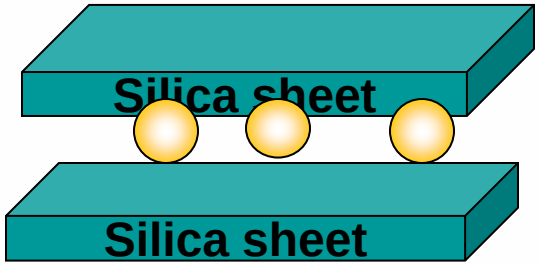
Mixed Metal/Metal Oxide Pillared Clay

Organoclay

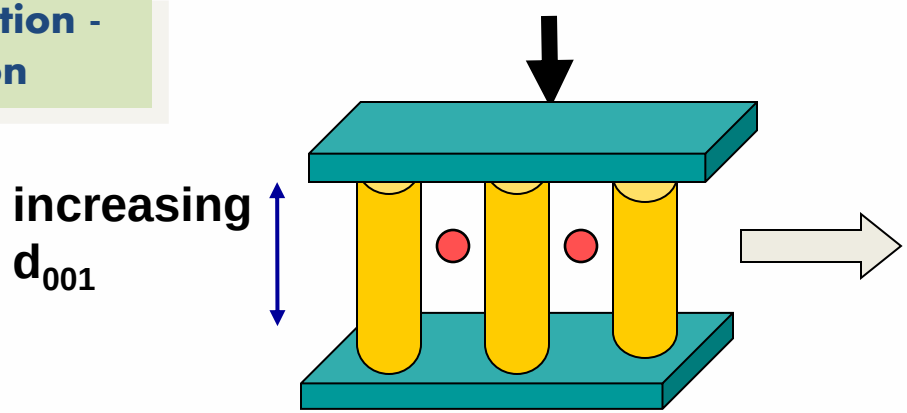
Modification- Metal Oxide Pilarization

Metal Polyoxocations Intercalation

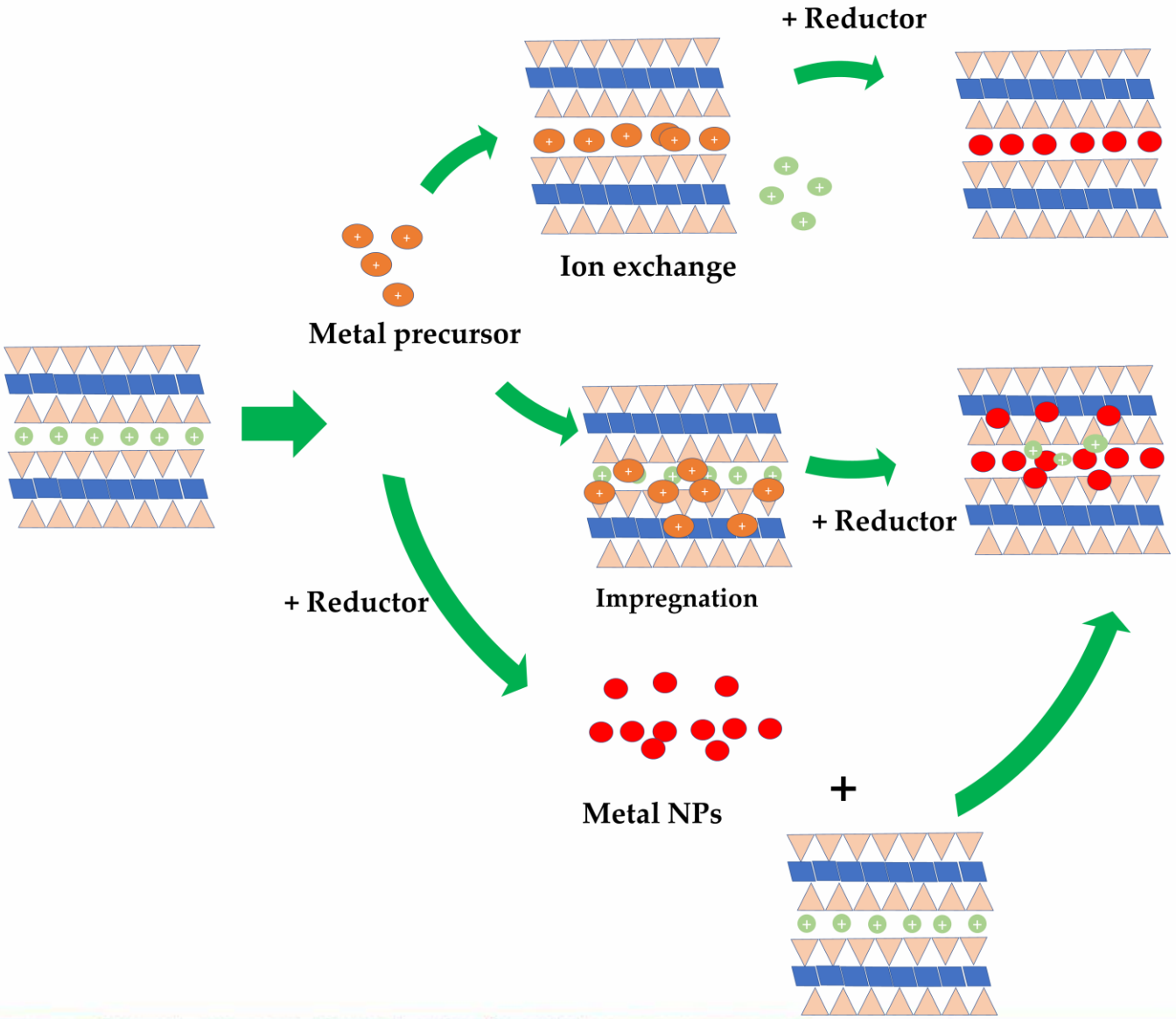




Dehydroxylation - Calcination



- **Homogeneous distribution with increased surfaced area**
- **Can be applied as support**

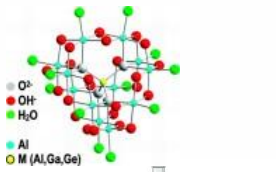

+ Reductor
Ion exchange
Metal precursor
Impregnation
+ Reductor
+ Reductor
Metal NPs
+

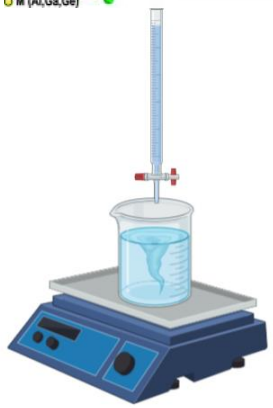
Preparation of metal oxide precursor

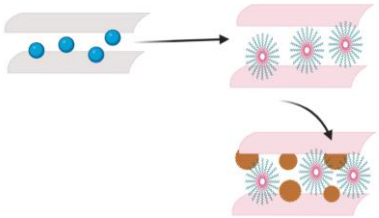
Intensification on intercalation

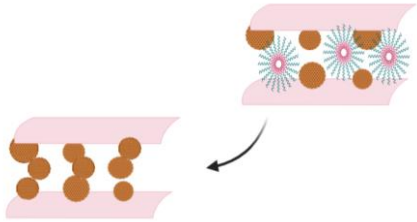
Intensification on intercalation

Metal oxide formation-dihydroxylation

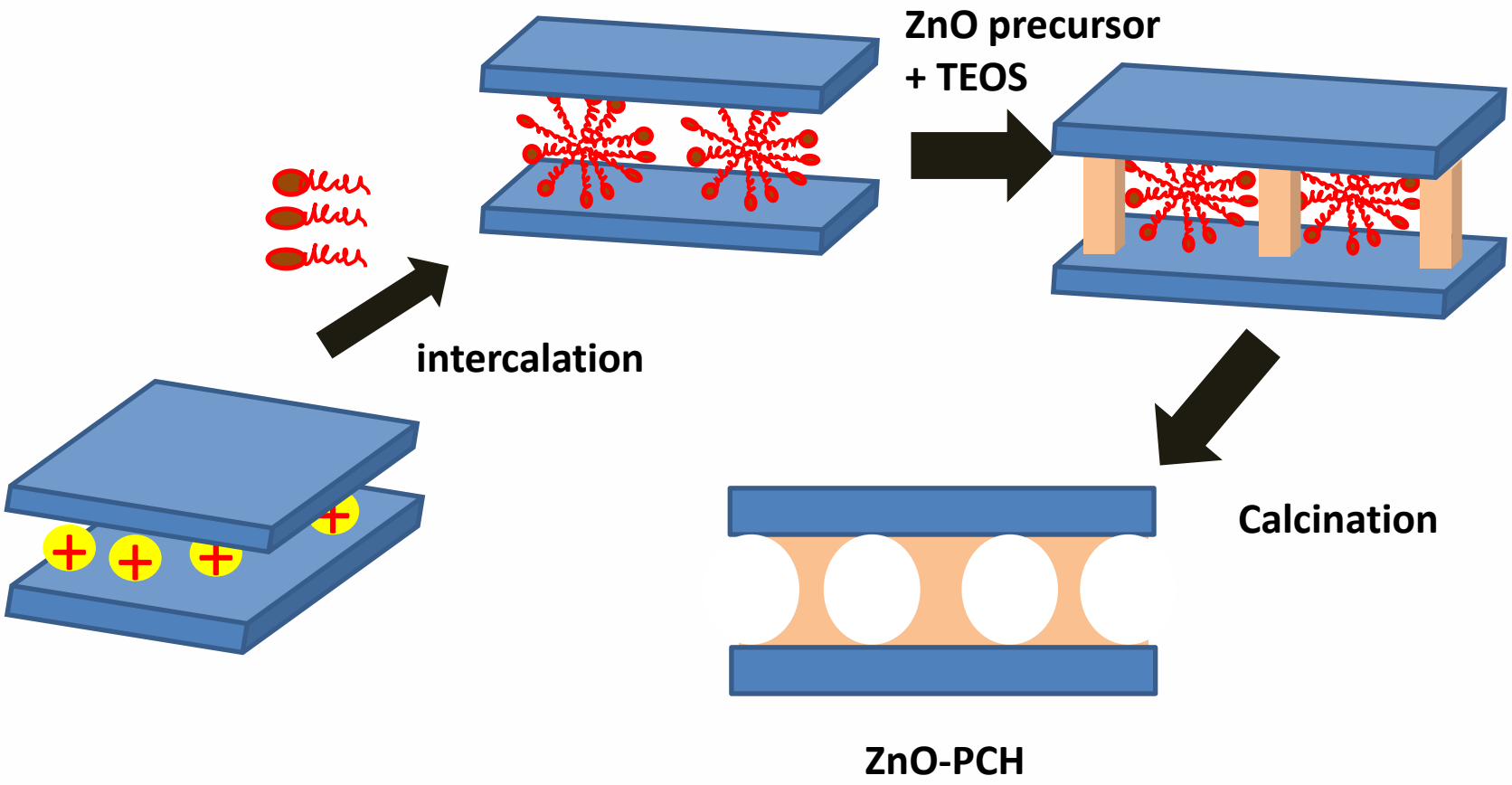






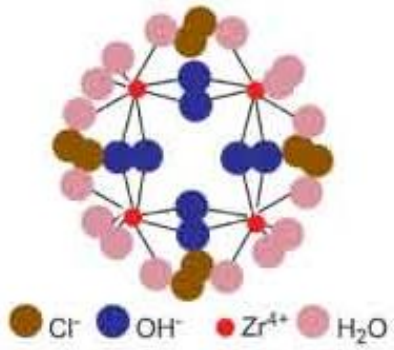


Physico-Chemical Characterization
XRD, SEM, FTIR, XRF

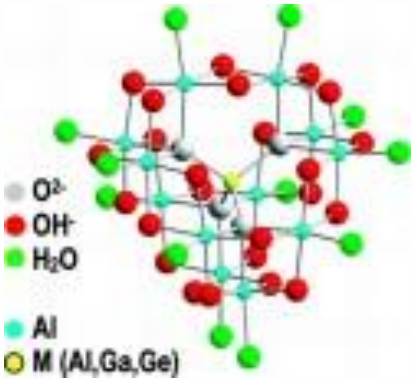

ZnO precursor
+ TEOS
intercalation
Calcination
ZnO-PCH

Polioksokation-Kondisi sintesis **Bentuk**

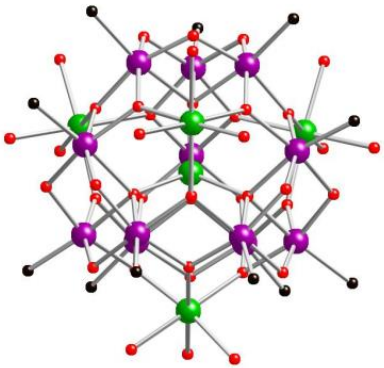
- **Zr_4 --- Zr/Ba = 20**



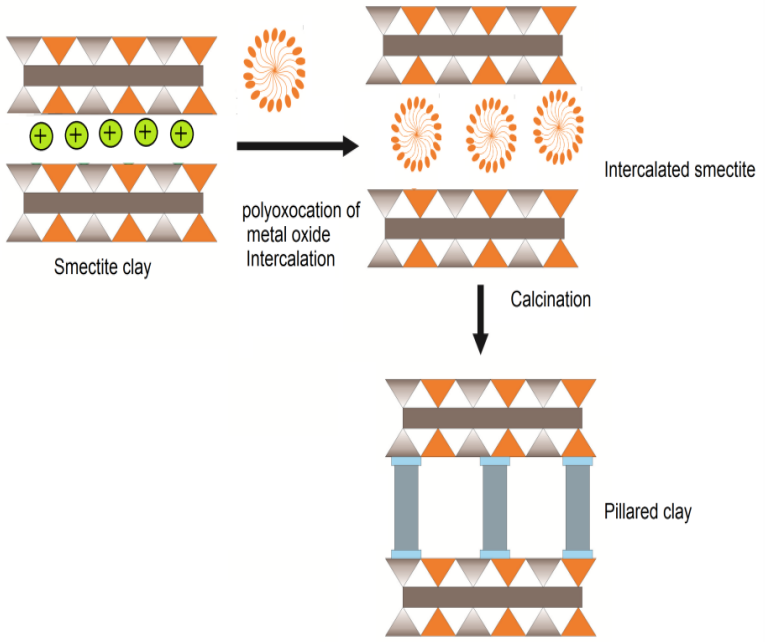
- **Al_{13} --- Al^{3+} /$^{-}$OH = 2**

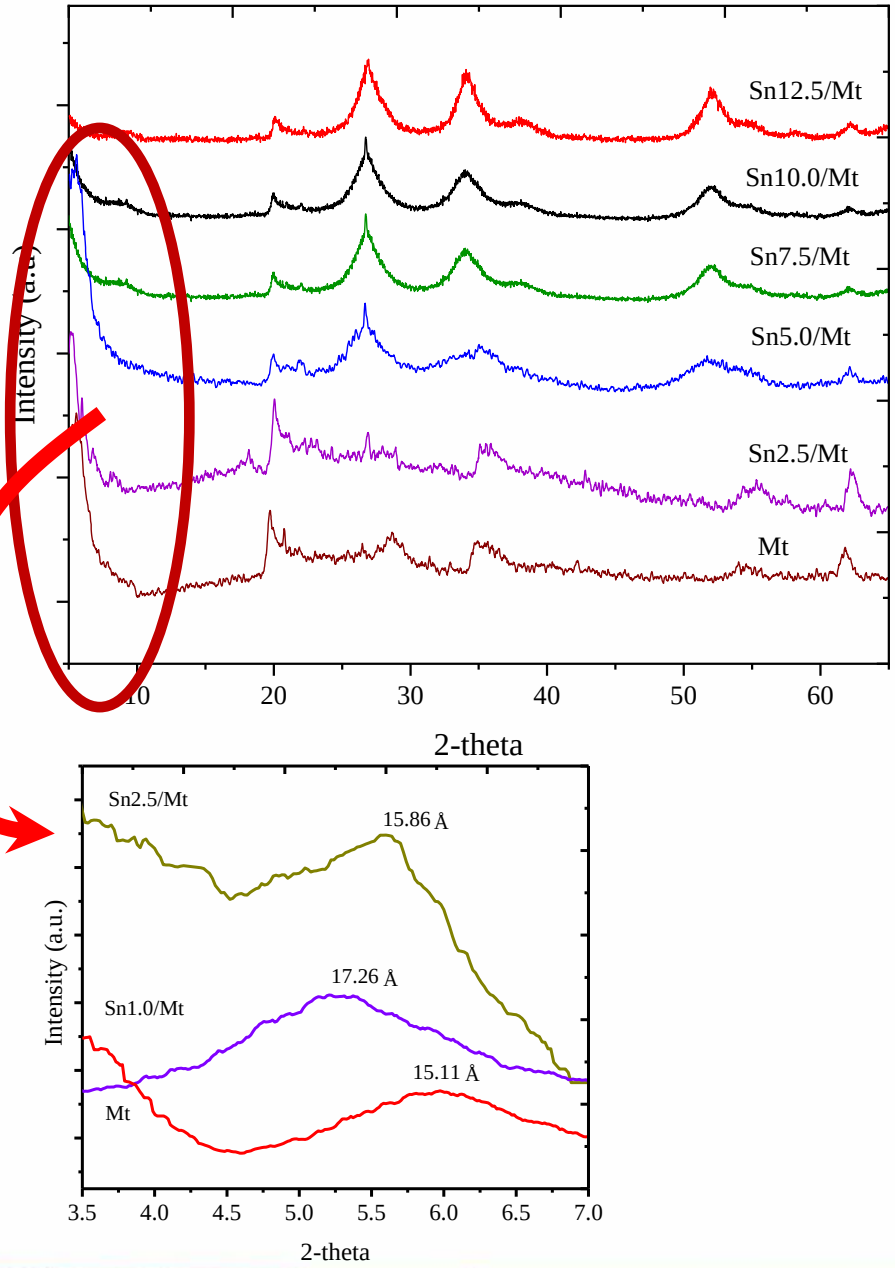


- **Zn --- Zn^{2+}/$^{-}$OH=2**

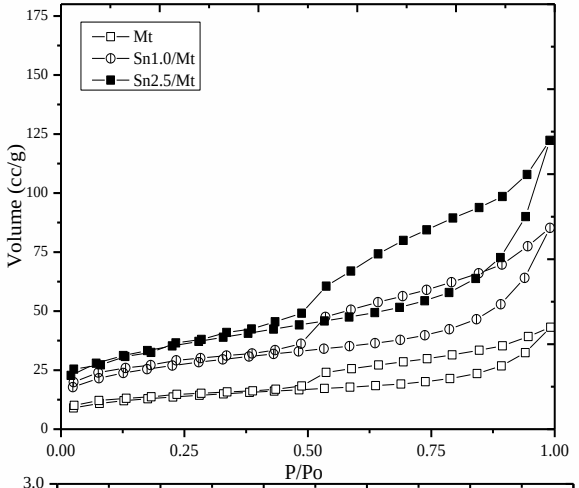


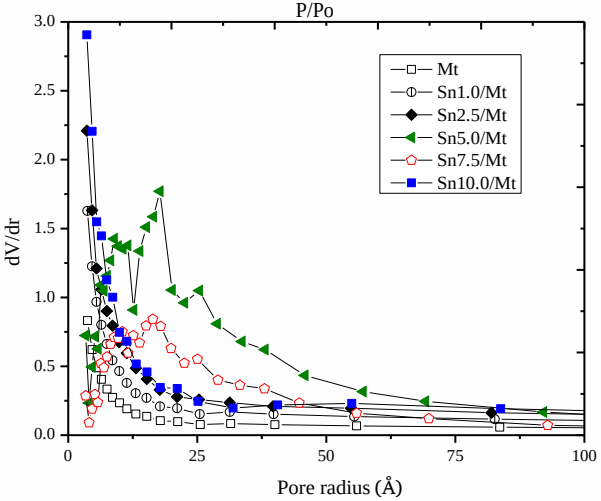
XRD characterization SnO_2/Mt

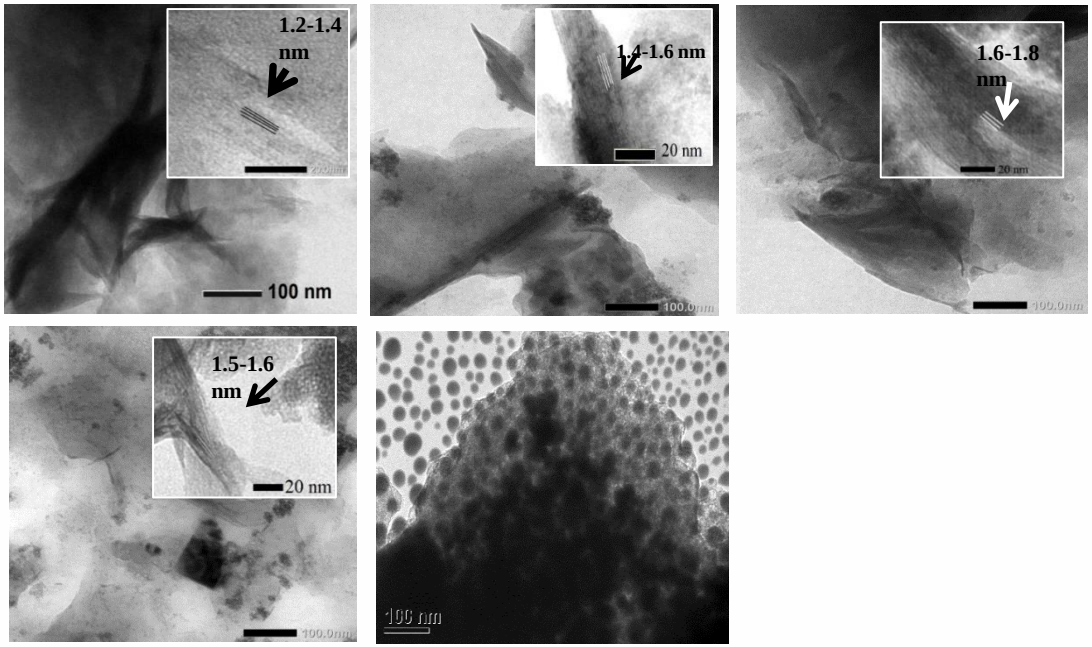




Scanning Electron Microscope



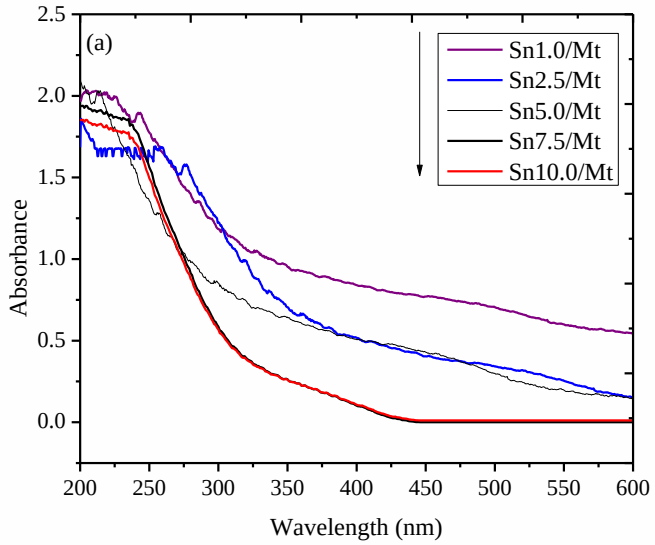


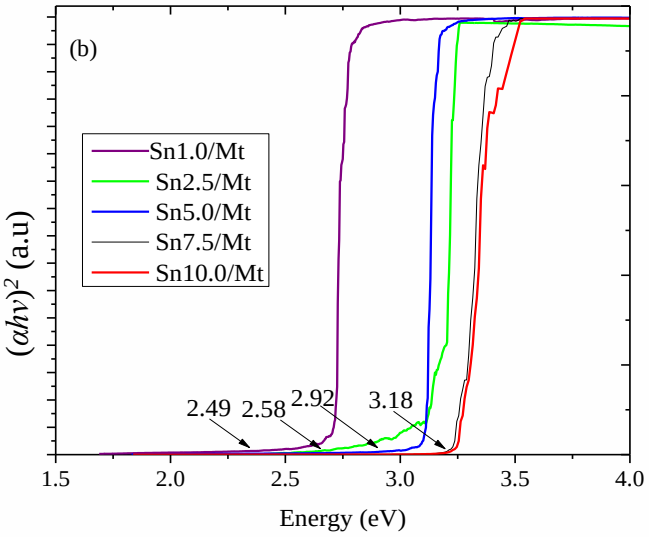


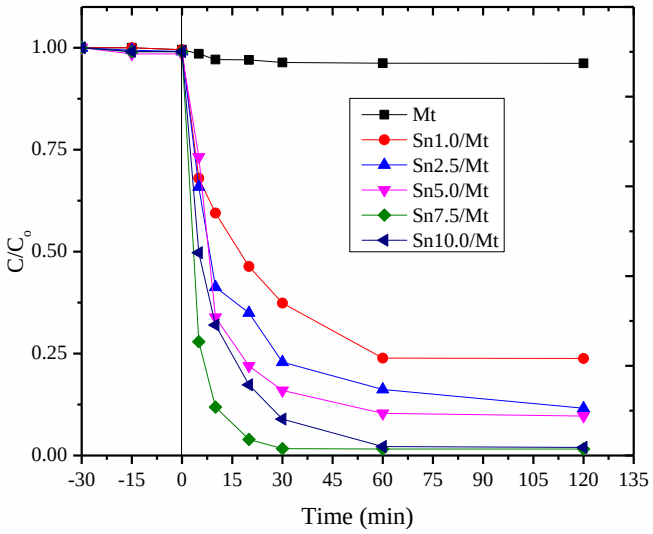
(a).Mt (b) Sn1.0/Mt (c) Sn2.5/Mt (d). Sn5.0/Mt (e). Sn7.5/Mt

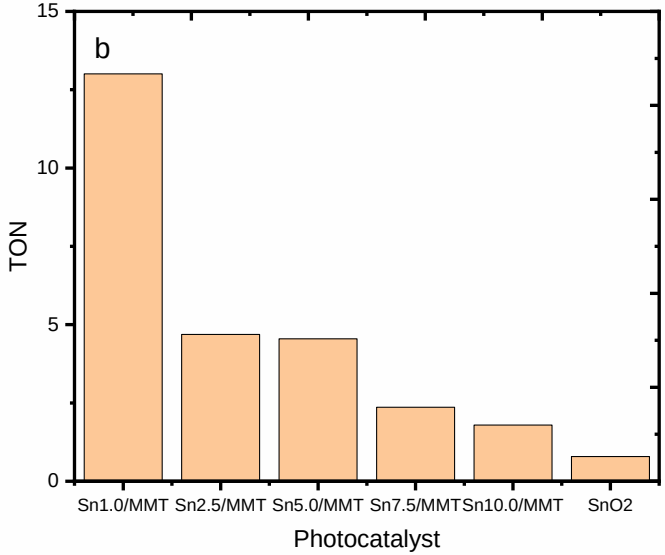
a. Adsorption-desorption isotherm of SnO_2/Mt at varied Sn/molar ratio
b. Pore distribution of SnO_2/Mt at varied Sn/molar ratio

DRUV-Vis

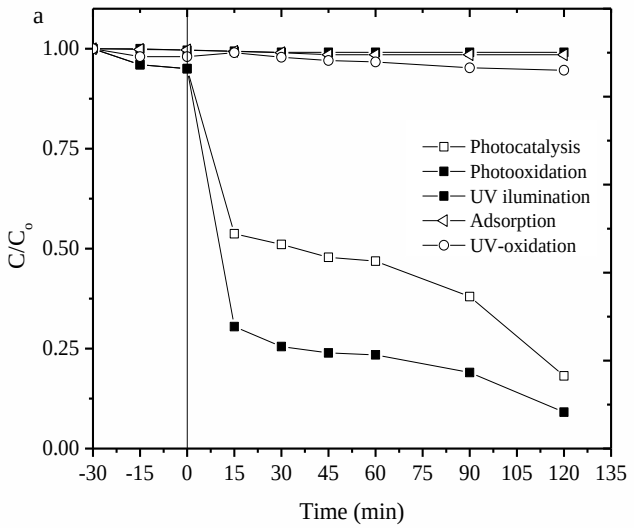

(a)
Sn1.0/Mt
Sn2.5/Mt
Sn5.0/Mt
Sn7.5/Mt
Sn10.0/Mt
Absorbance
Wavelength (nm)

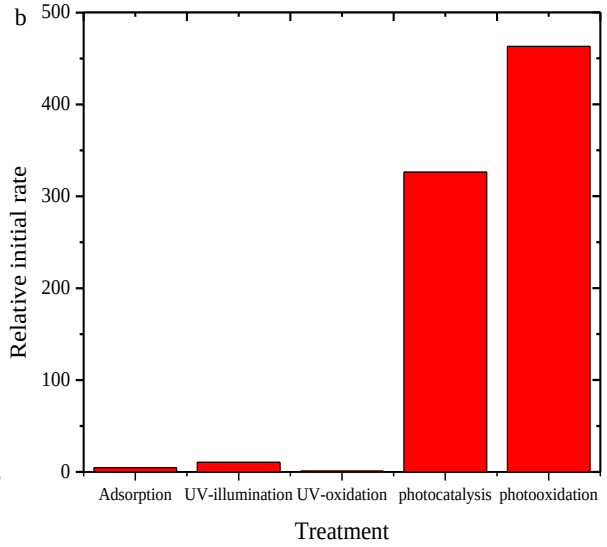

(b)
Sn1.0/Mt
Sn2.5/Mt
Sn5.0/Mt
Sn7.5/Mt
Sn10.0/Mt
2.49
2.58
2.92
3.18
(αhν)² (a.u)
Energy (eV)

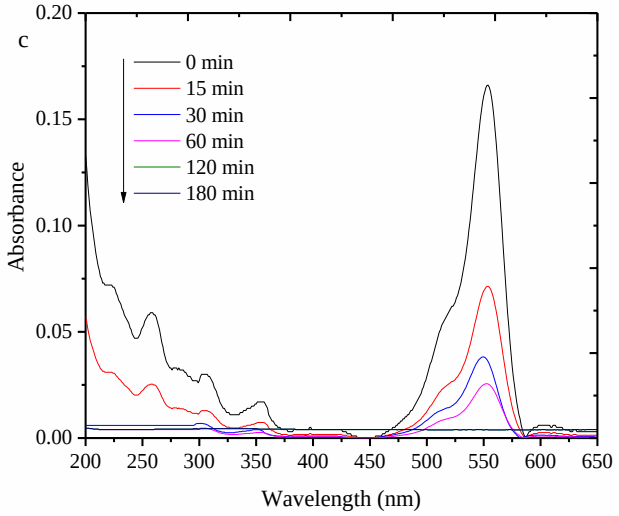

Mt
Sn1.0/Mt
Sn2.5/Mt
Sn5.0/Mt
Sn7.5/Mt
Sn10.0/Mt
C/C°
Time (min)


b
TON
Sn1.0/MMT
Sn2.5/MMT
Sn5.0/MMT
Sn7.5/MMT
Sn10.0/MMT
SnO2
Photocatalyst

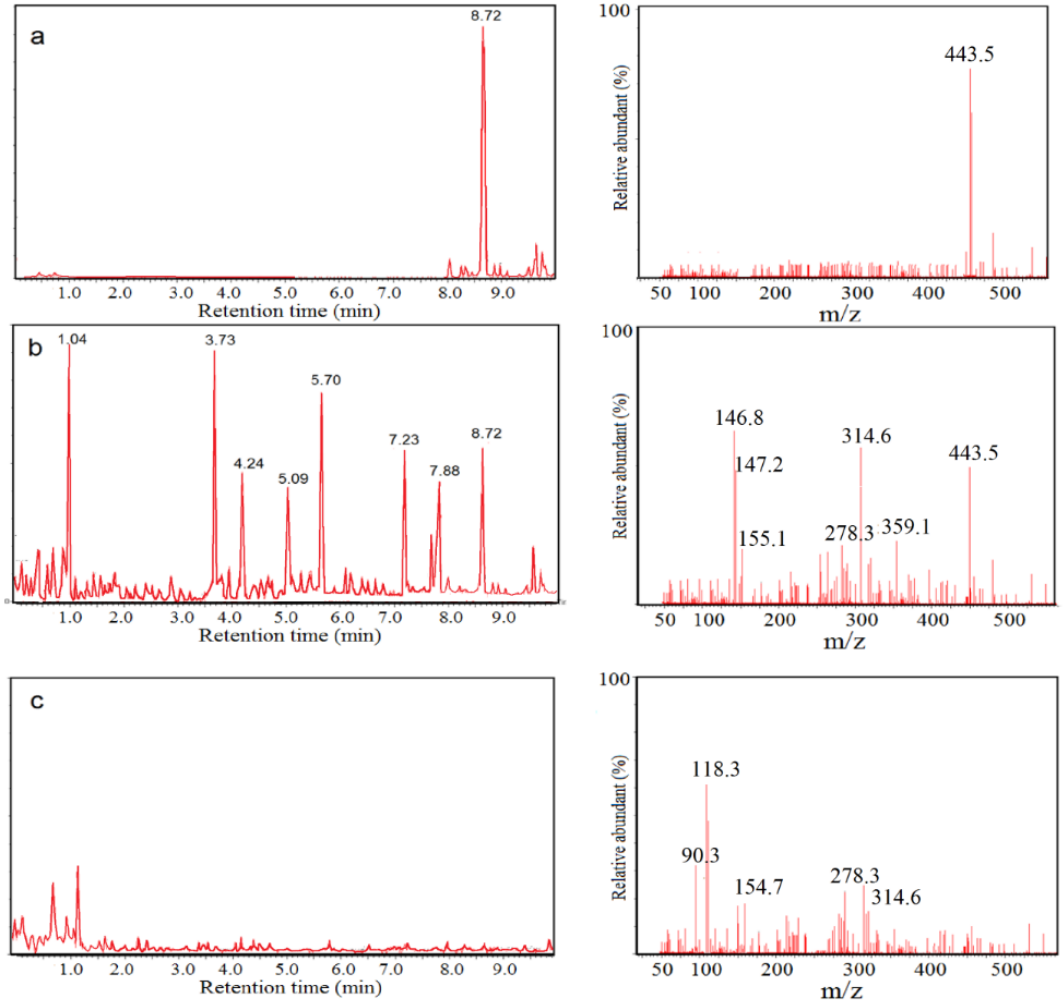
Aktivitas Fotokatalitik

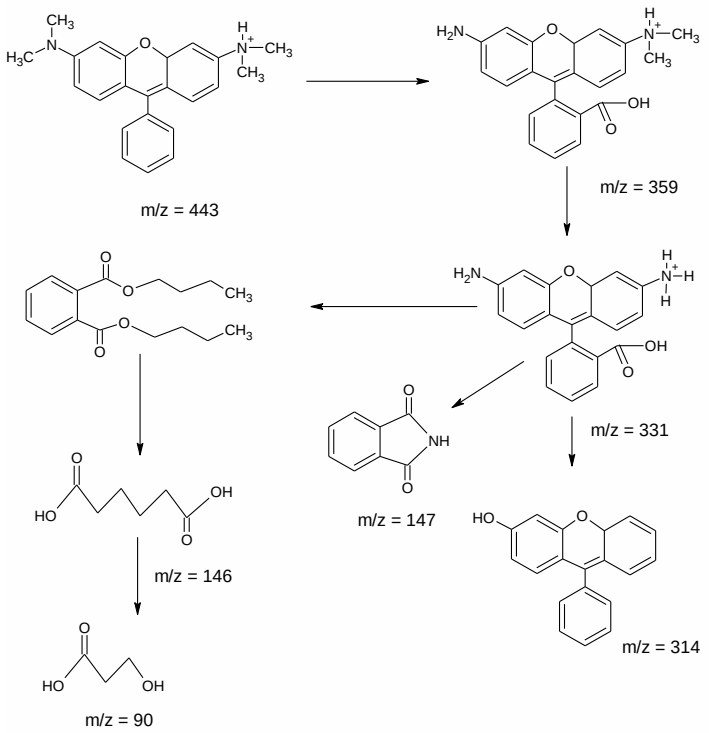




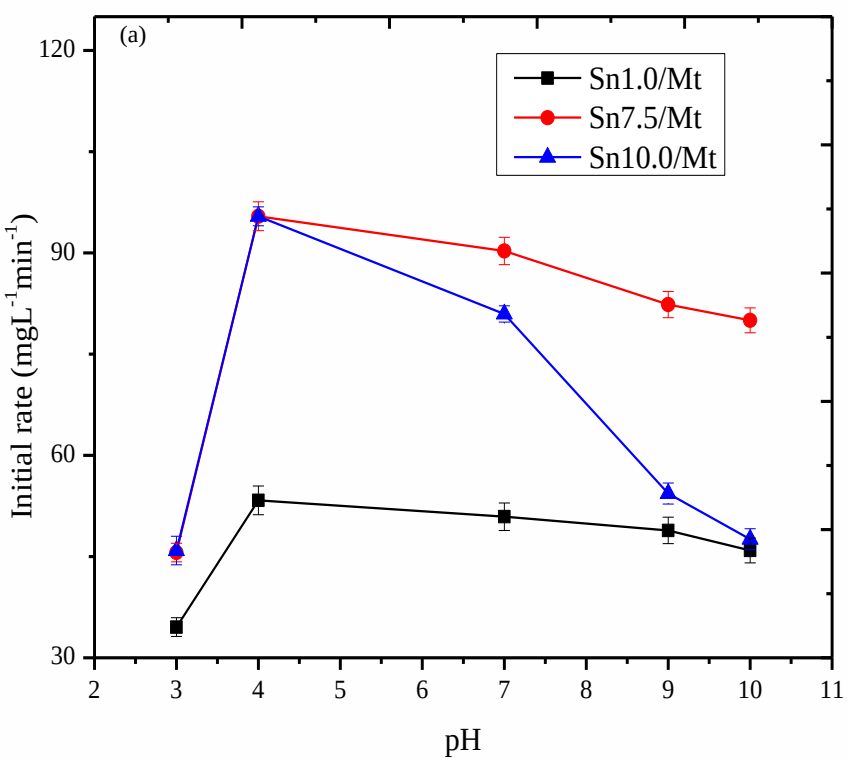


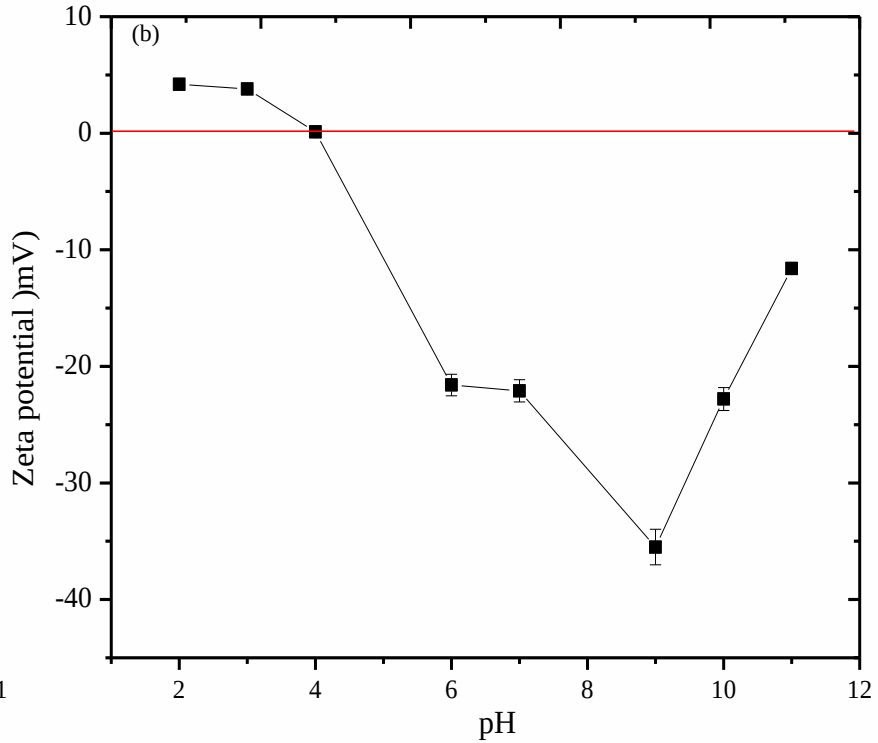
Photocatalytic degradation



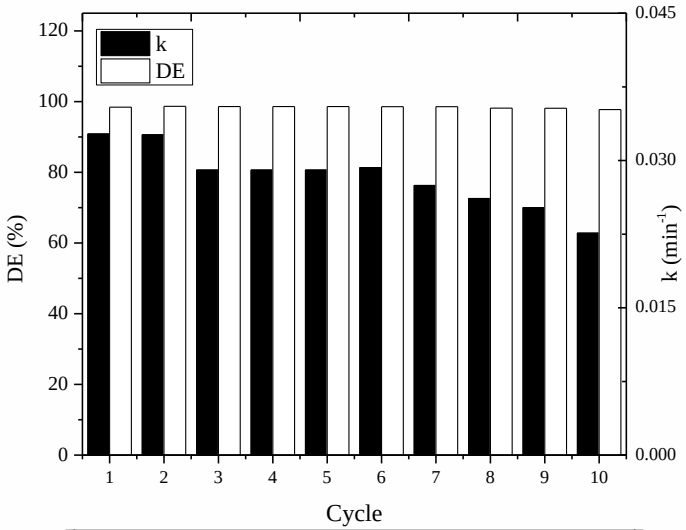


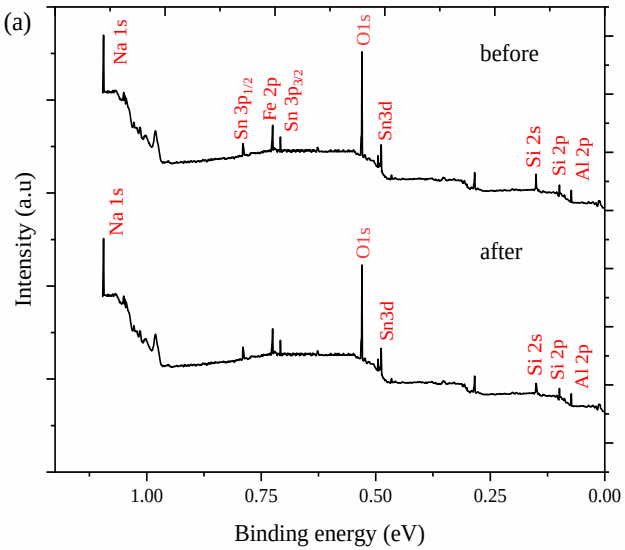
Photocatalytic degradation

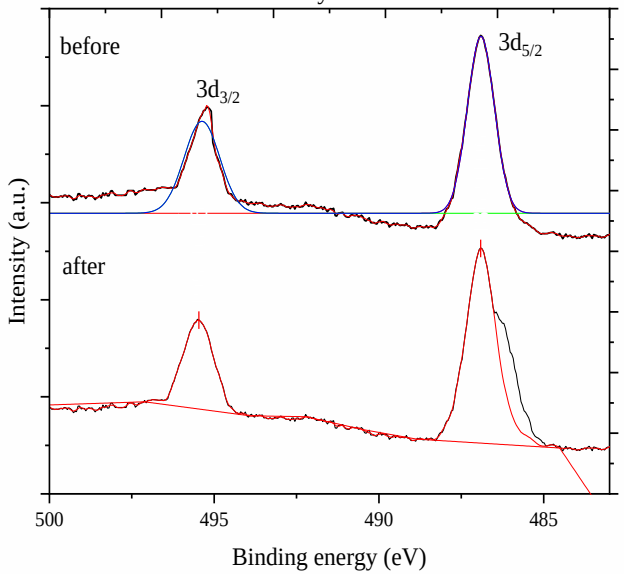


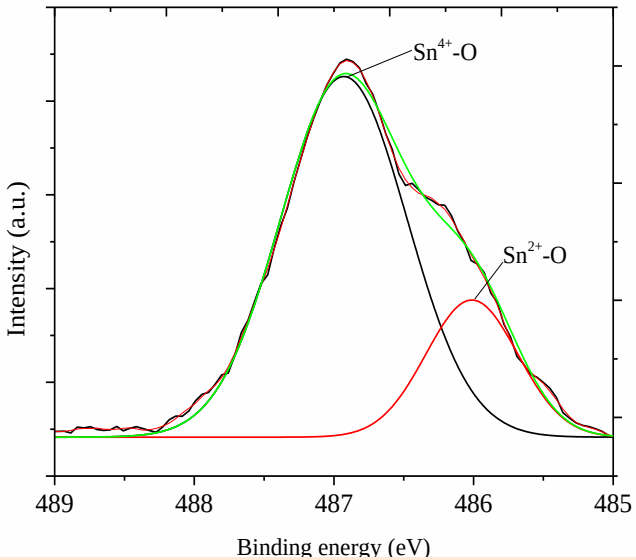


Reusability



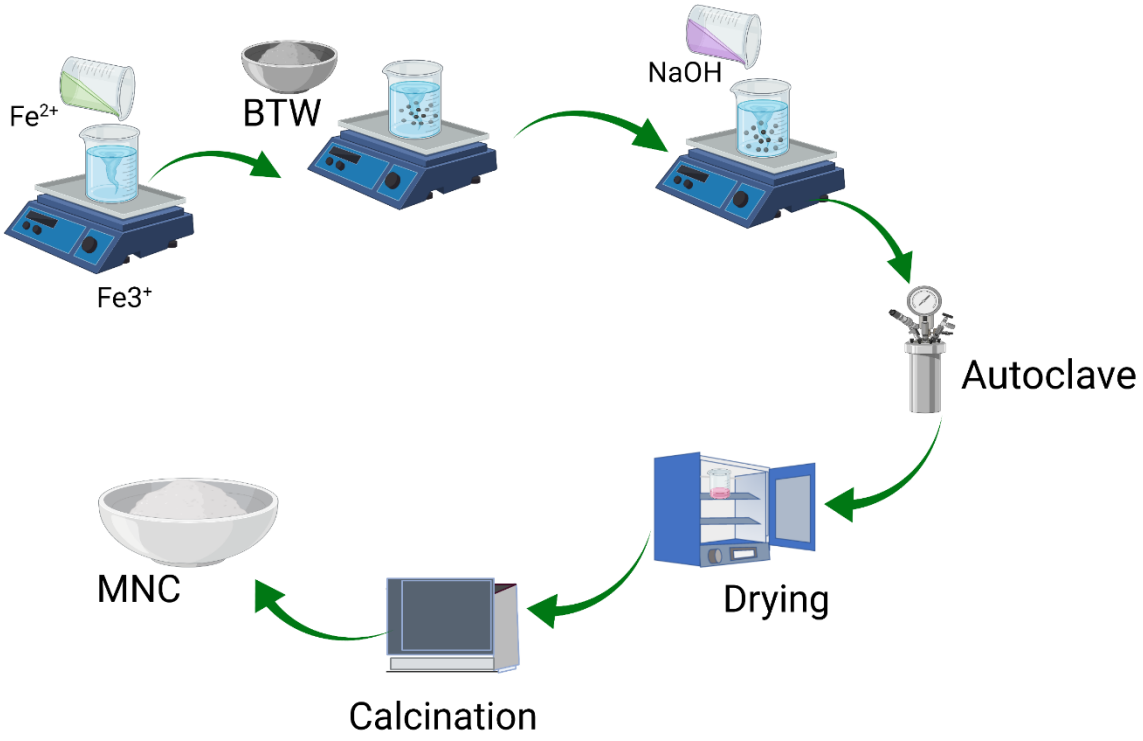


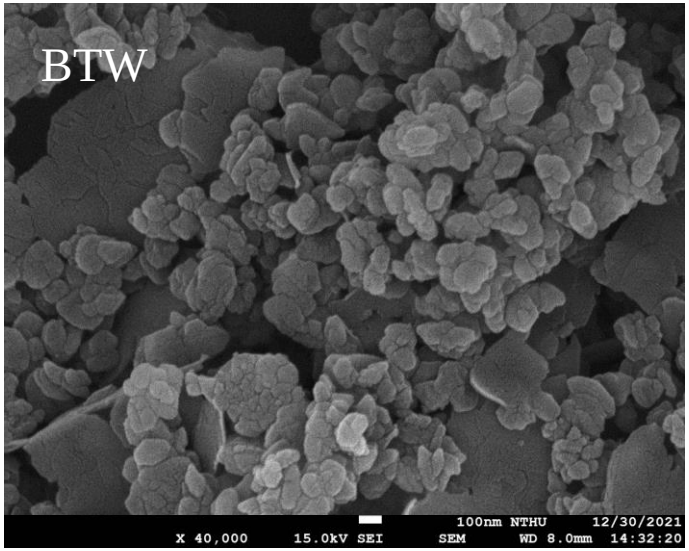


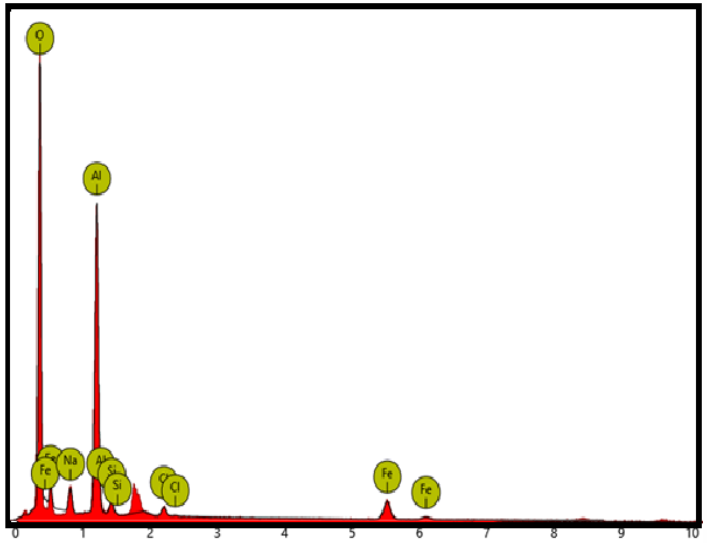


a. Kinetics constant and degradation efficiency at reusability b. Survey scan of sample at fresh and recycled
c. 3d spectra before and after usage d. Deconvolution of Sn 3d after usage

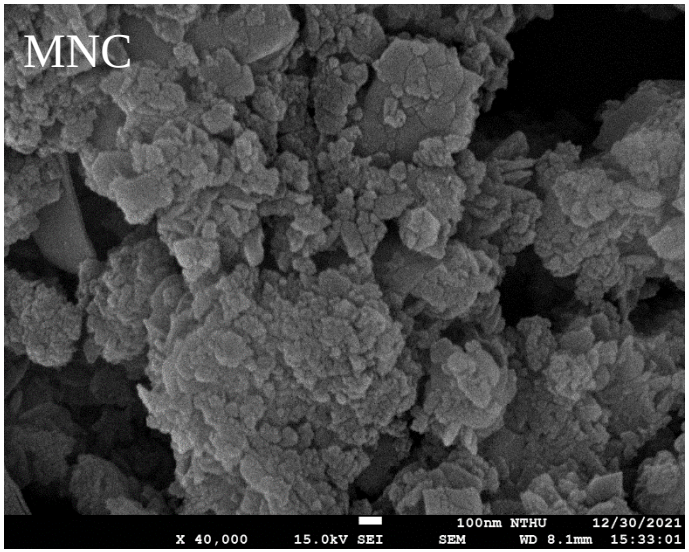
Pemanfaatan Limbah Tailing Bauxit sebagai Katalis AOP

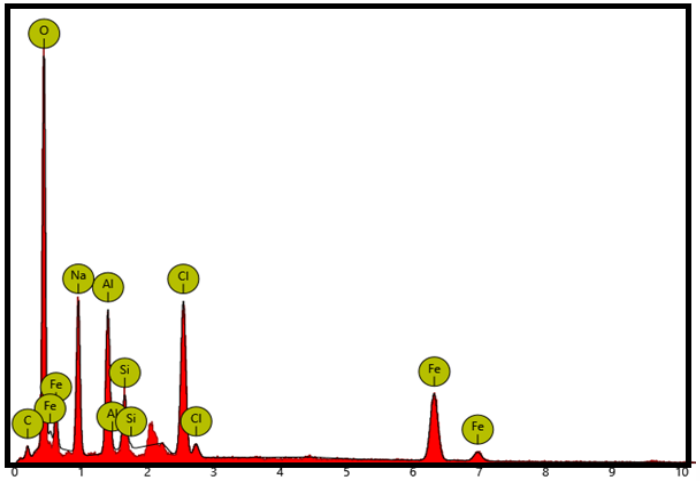

Fe2+
Fe3+
BTW
NaOH
Autoclave
Drying
Calcination
MNC



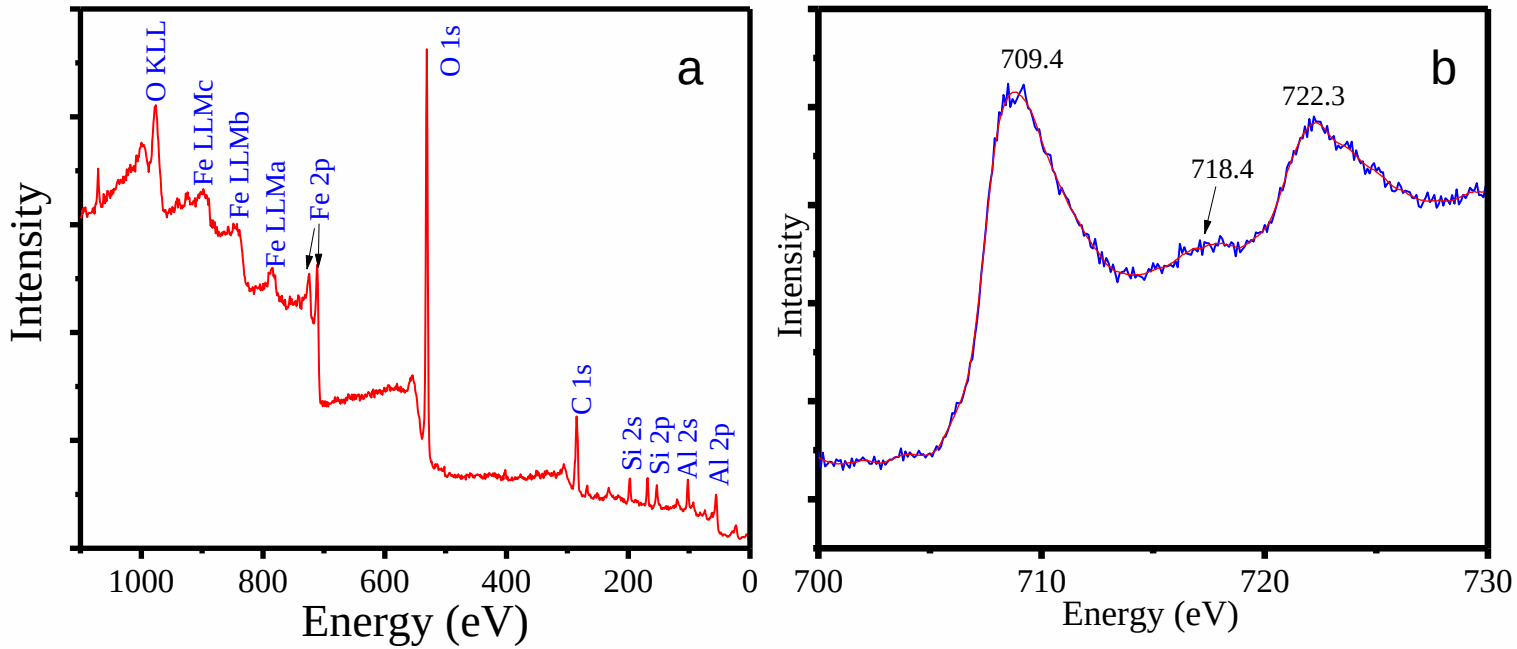


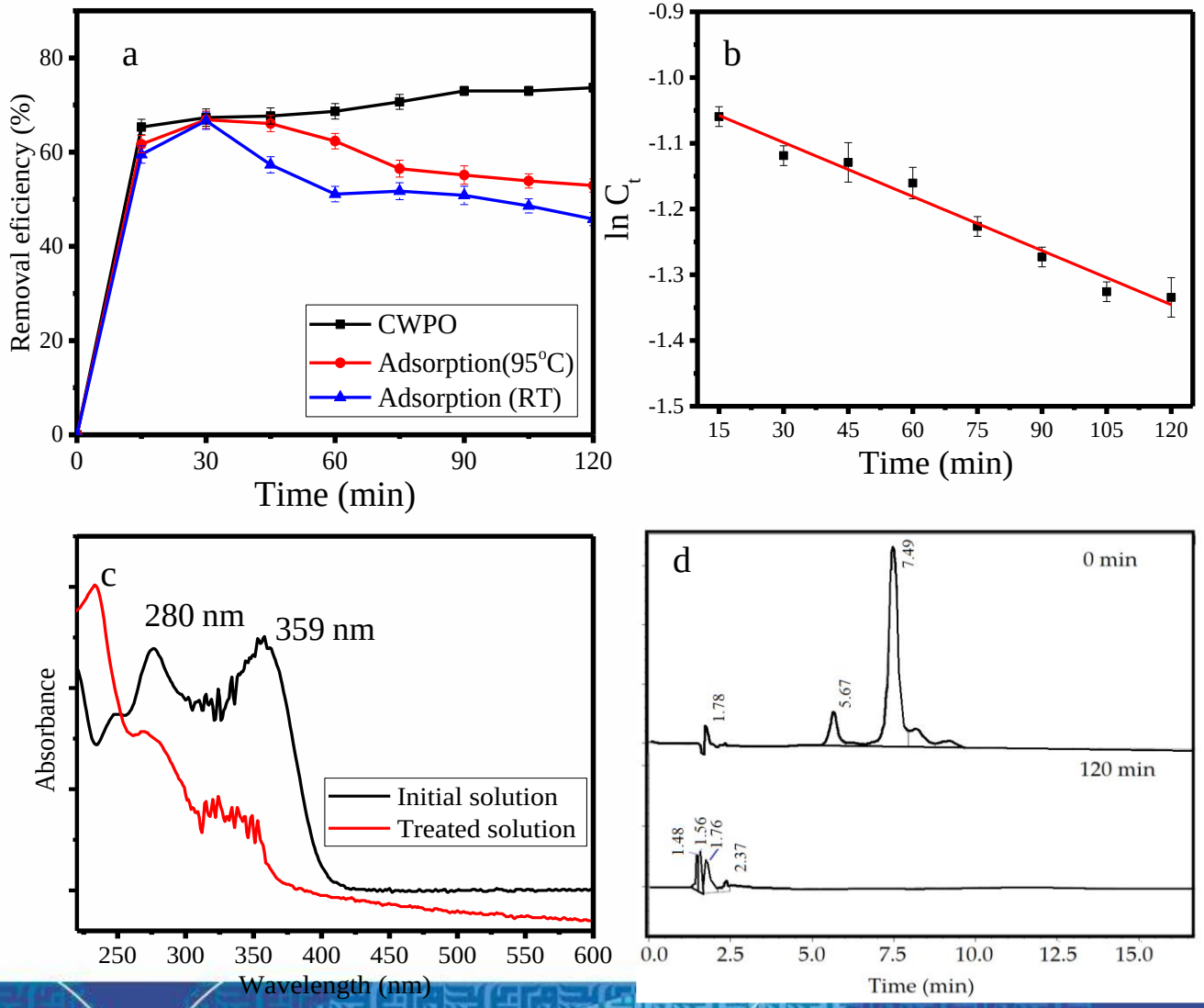
Energy (keV)

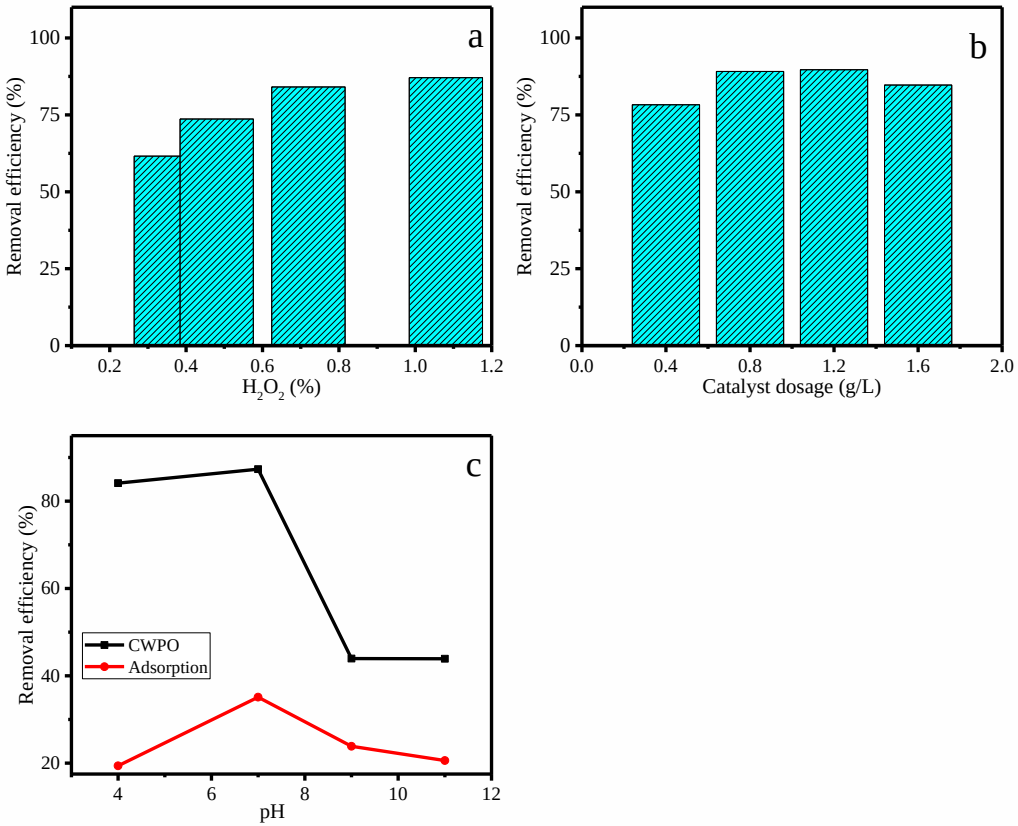


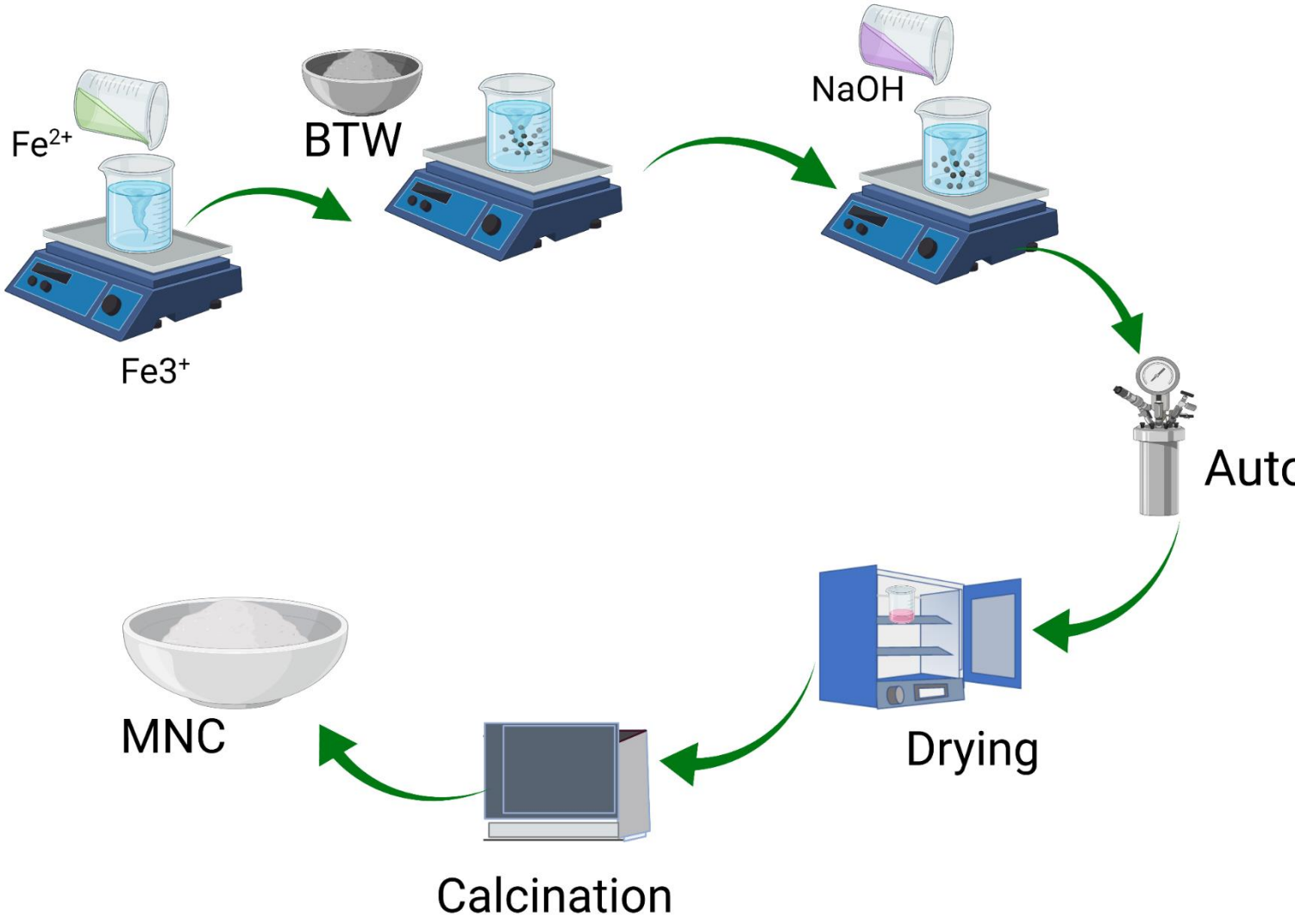


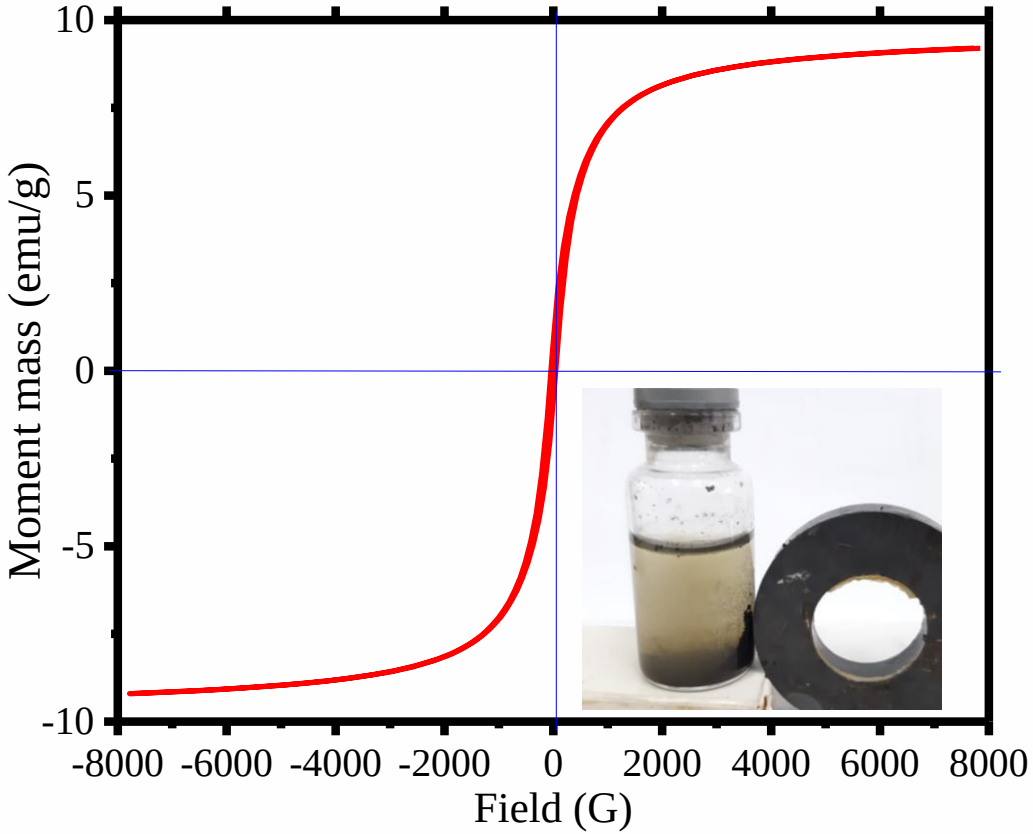
Energy (keV)

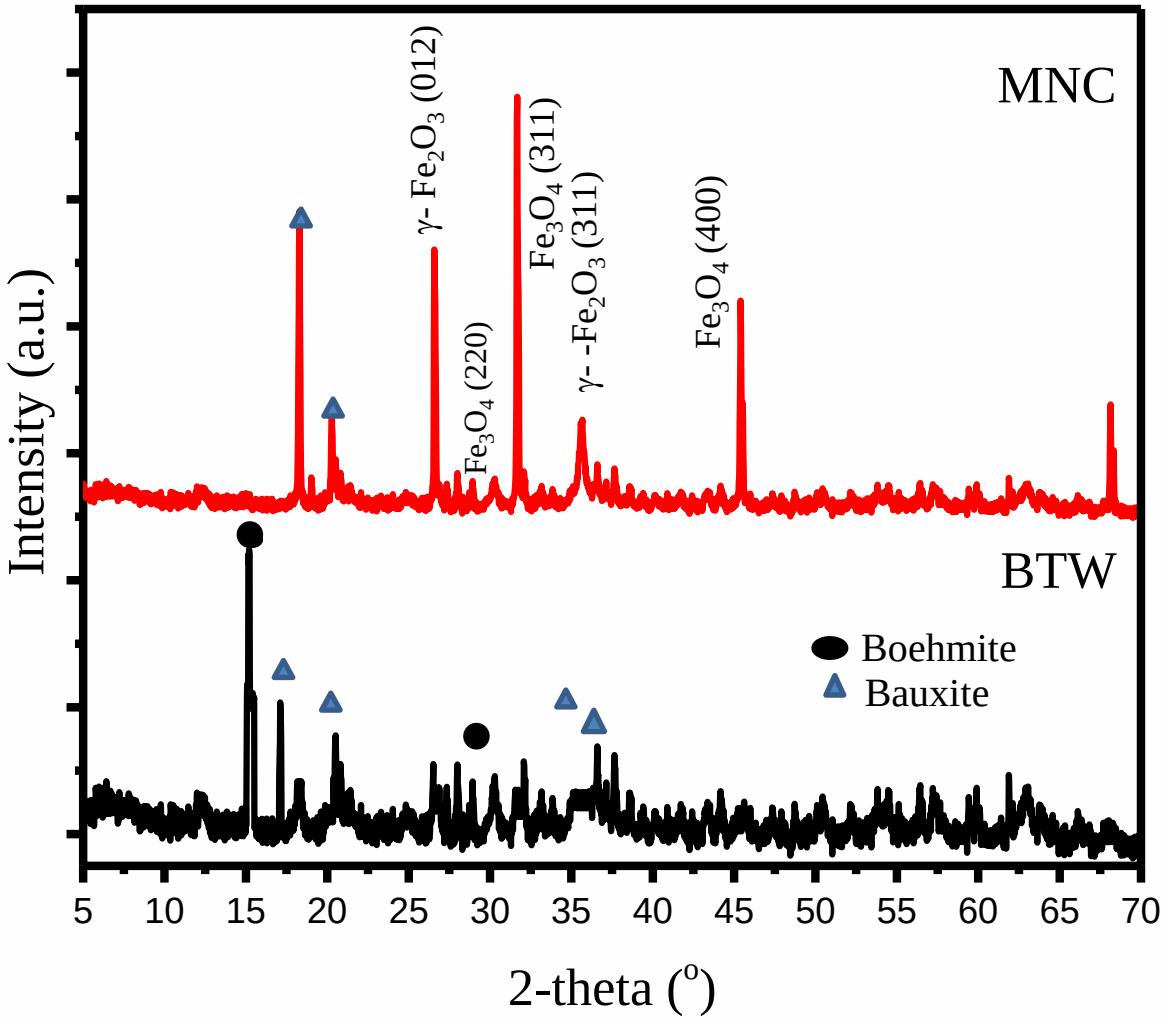

a
Intensity
O KLL
Fe LLMc
Fe LLMb
Fe LLMa
Fe 2p
O 1s
C 1s
Si 2s
Si 2p
Al 2s
Al 2p
1000
800
600
400
200
0
Energy (eV)
b
Intensity
709.4
718.4
722.3
700
710
720
730
Energy (eV)

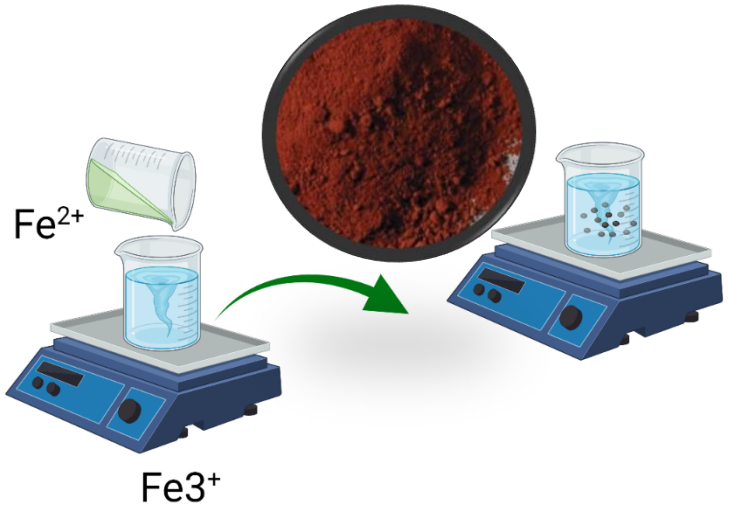

a
Removal eficiency (%)
Time (min)
CWPO
Adsorption(95°C)
Adsorption (RT)
b
ln C_t
Time (min)
c
280 nm
359 nm
Absorbance
Wavelength (nm)
Initial solution
Treated solution
d
0 min
120 min
7.49
5.67
1.78
1.48
1.56
1.76
2.37
Time (min)


a
Removal efficiency (%)
100
75
50
25
0
0.2
0.4
0.6
0.8
1.0
1.2
H2O2 (%)
b
Removal efficiency (%)
100
75
50
25
0
0.0
0.4
0.8
1.2
1.6
2.0
Catalyst dosage (g/L)
c
Removal efficiency (%)
80
60
40
20
CWPO
Adsorption
4
6
8
10
12
pH


Fe2+
Fe3+
BTW
NaOH
Auto
Drying
Calcination
MNC

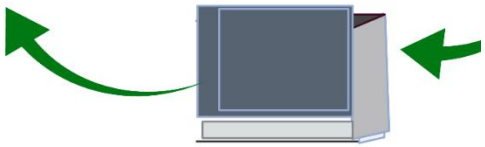

10
5
0
-5
-10
Moment mass (emu/g)
-8000
-6000
-4000
-2000
0
2000
4000
6000
8000
Field (G)


MNC
BTW
γ- Fe2O3 (012)
Fe3O4 (220)
Fe3O4 (311)
γ- -Fe2O3 (311)
Fe3O4 (400)
Boehmite
Bauxite
Intensity (a.u.)
2-theta (o)
5
10
15
20
25
30
35
40
45
50
55
60
65
70

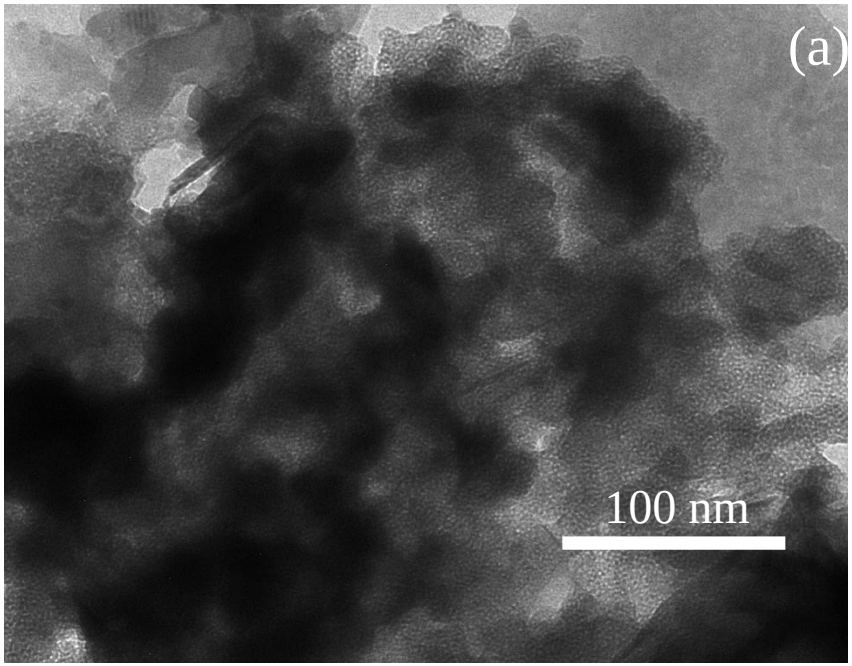


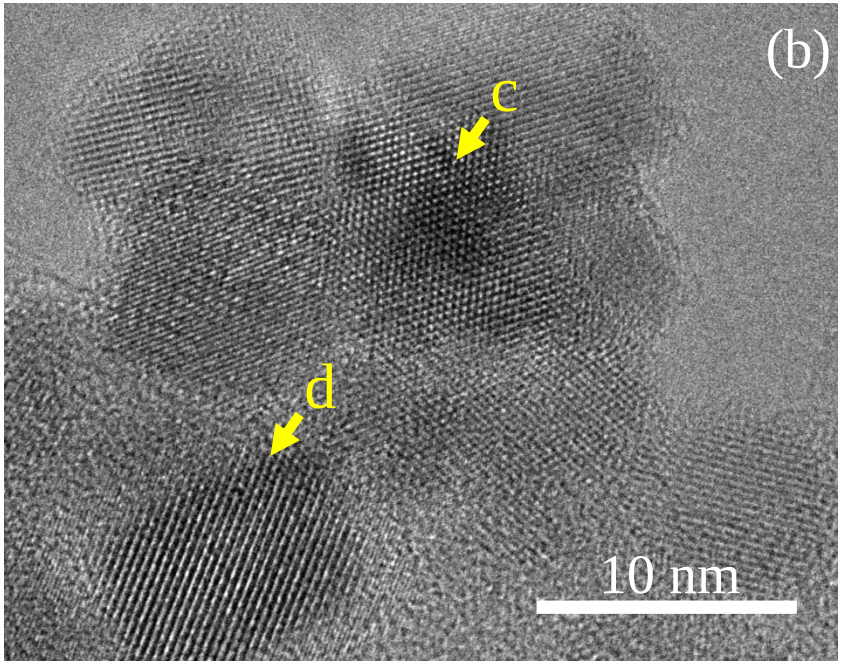
Autoclave

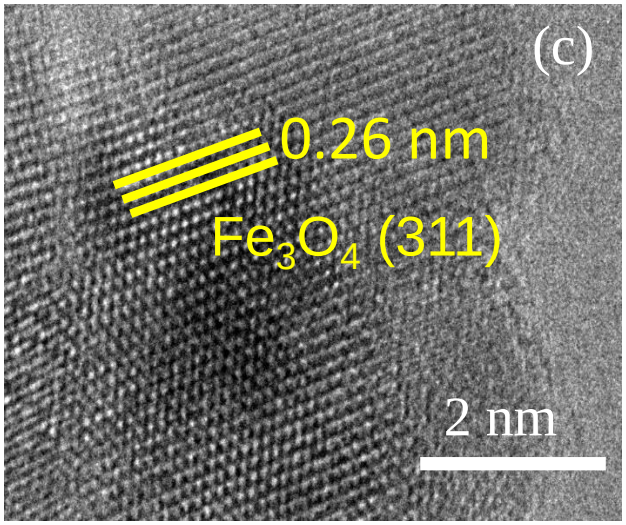
MNC

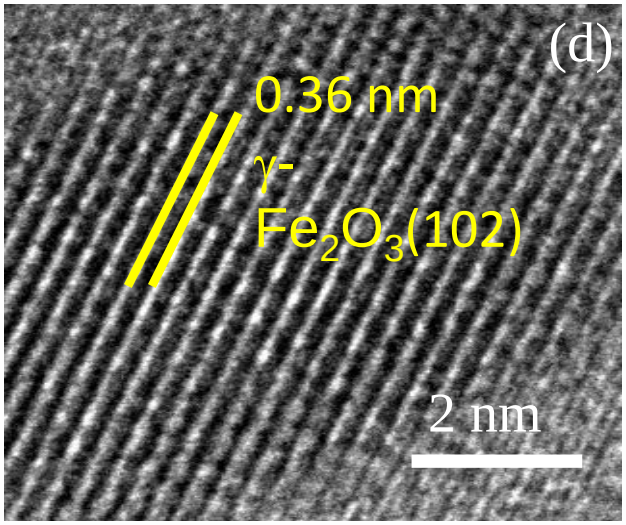


Calcination


(a)
100 nm


(b)
c
d
10 nm


(c)
0.26 nm
Fe3O4 (311)
2 nm


(d)
0.36 nm
γ-
Fe2O3(102)
2 nm

Acknowledgement

- World Class Research 2020
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