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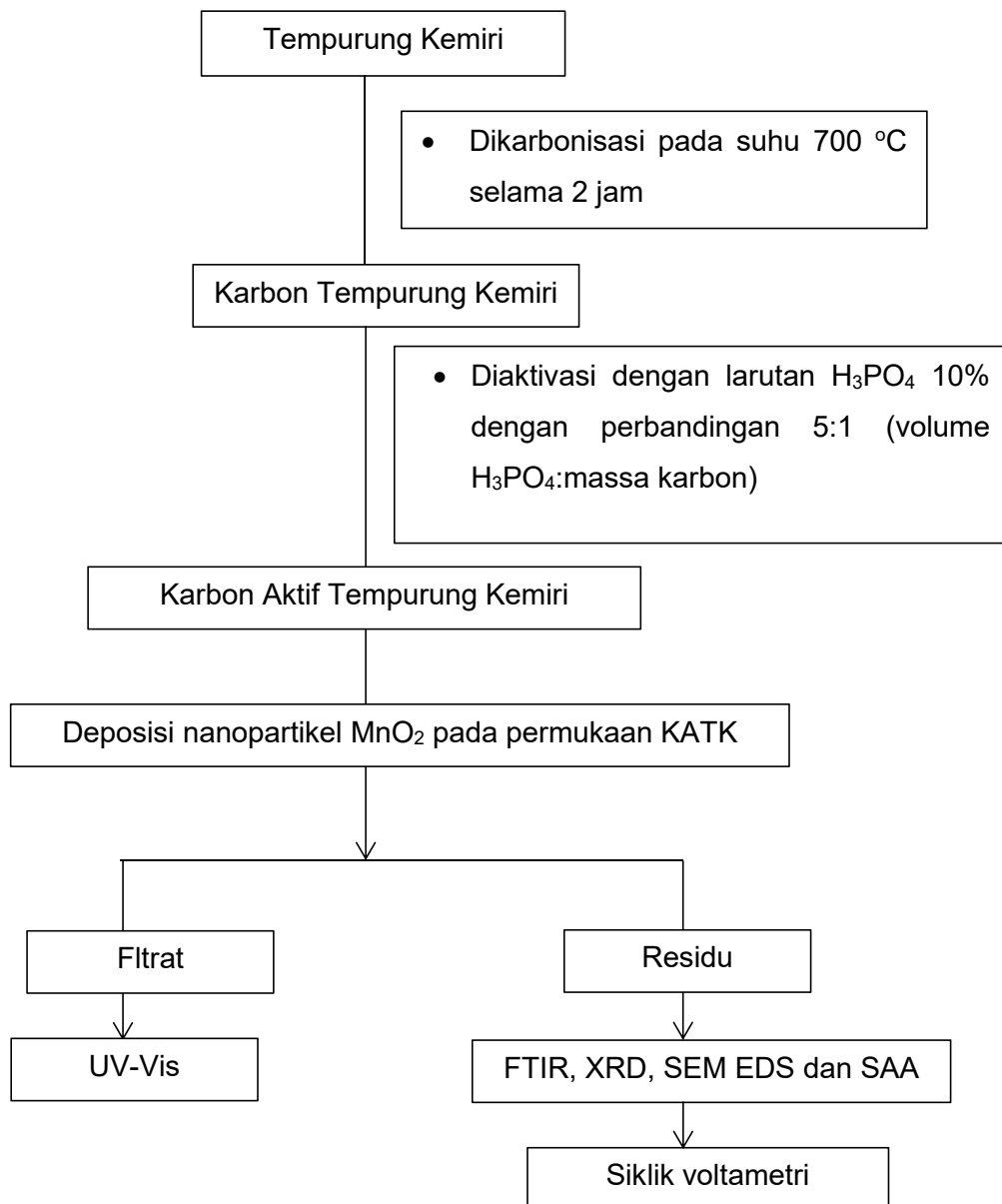
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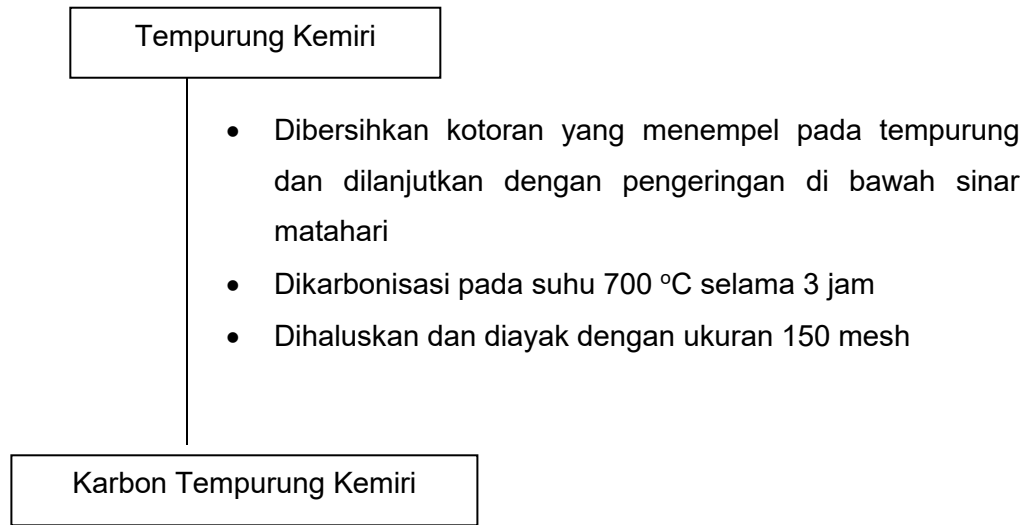
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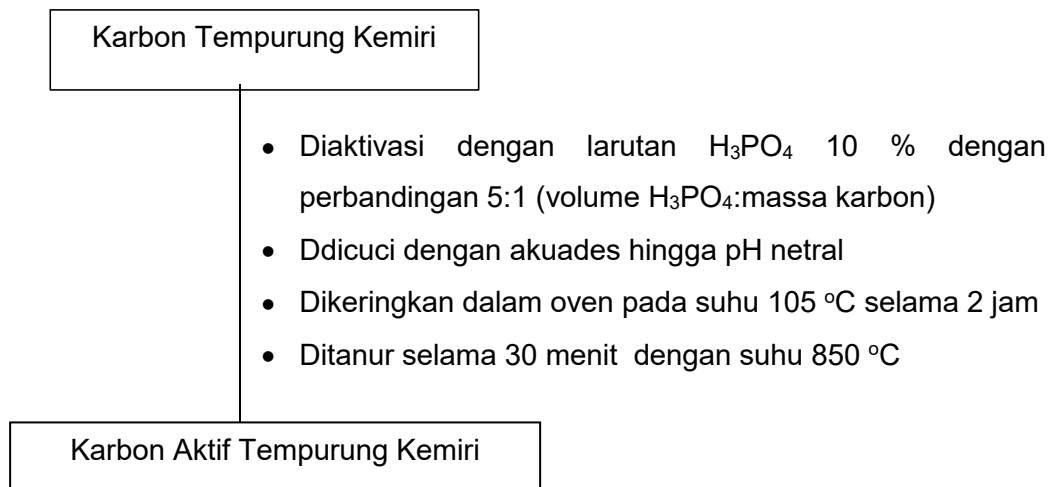
Lampiran 1. Skema Alur Penelitian



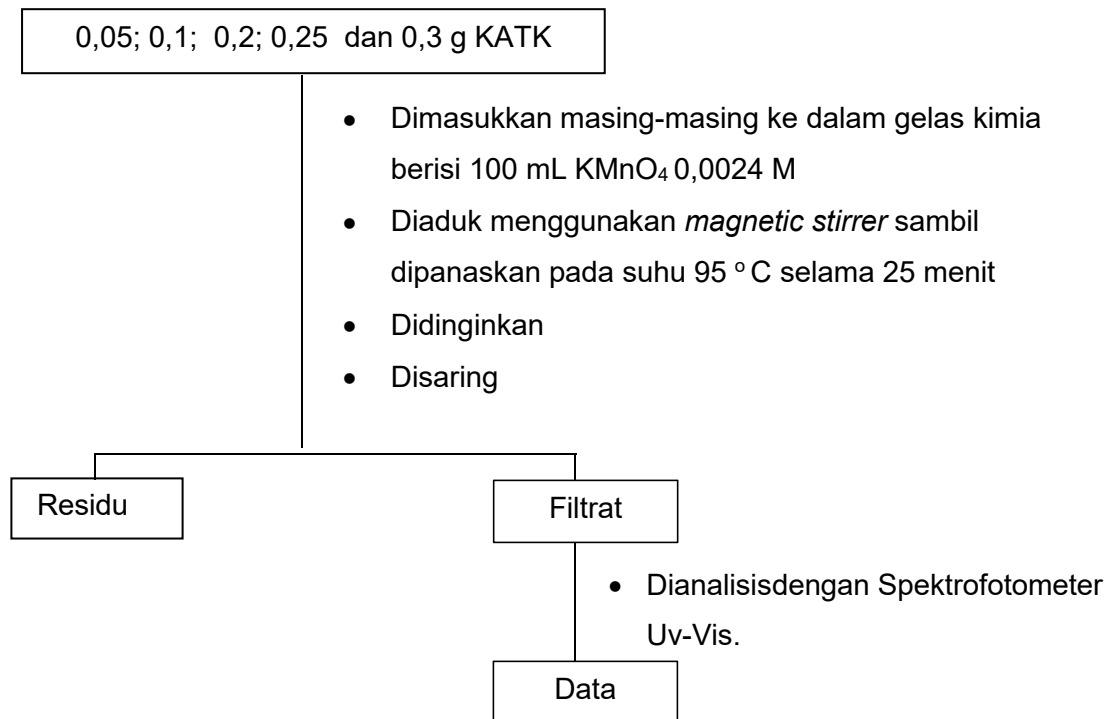
Lampiran 2. Skema Kerja Preparasi dan Karbonisasi Sampel



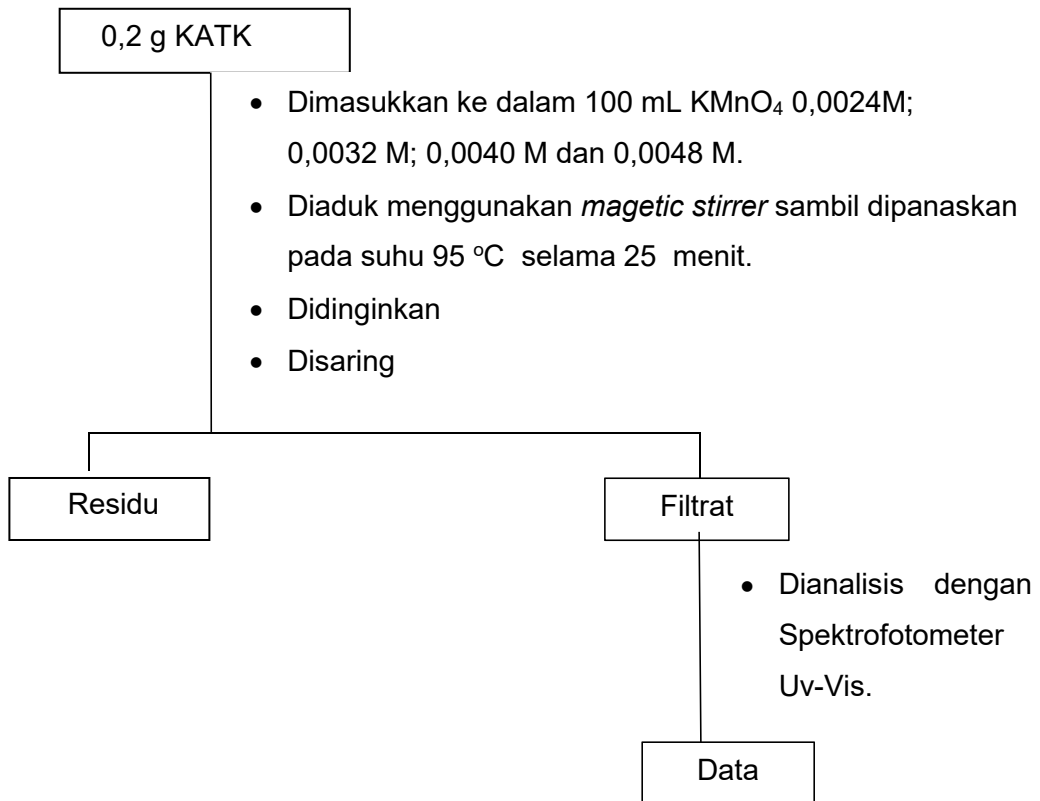
Lampiran 3. Skema Kerja Aktivasi Sampel



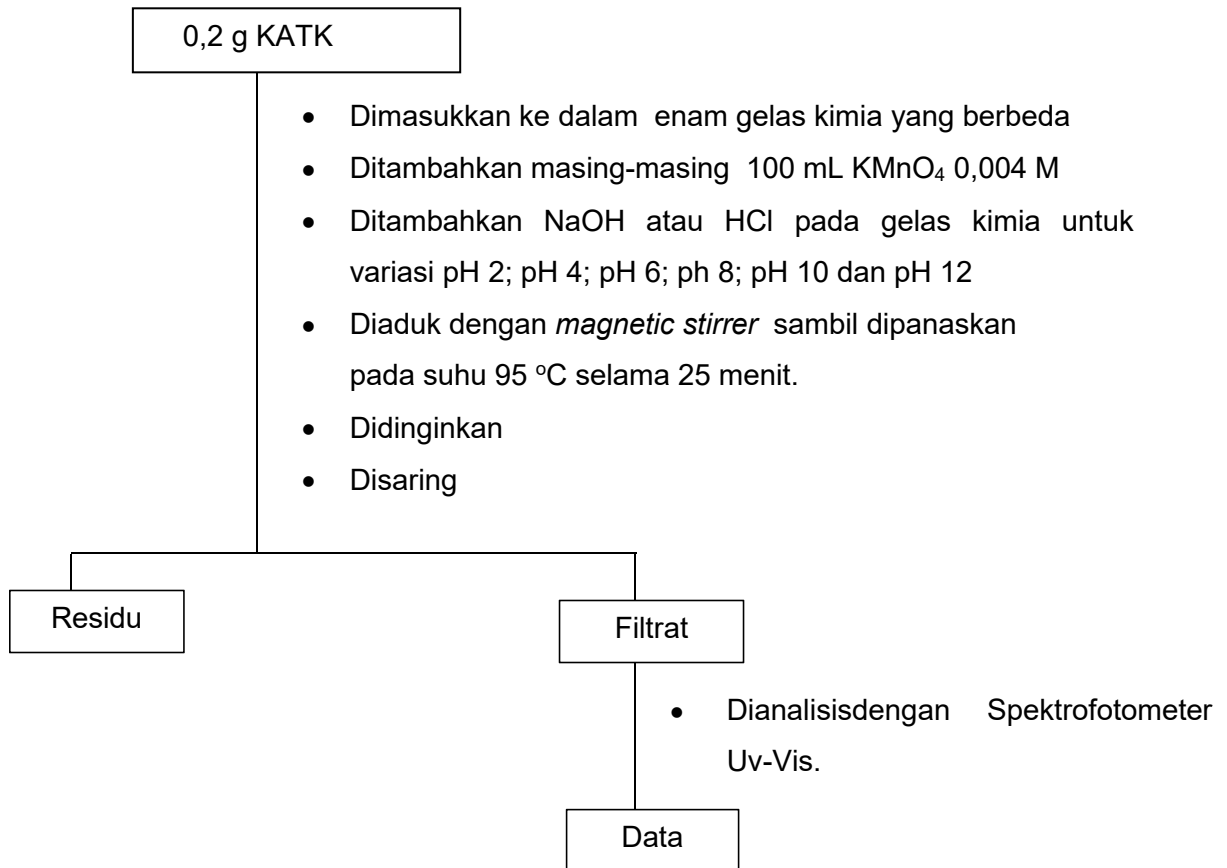
Lampiran 4. Skema pengaruh Massa KATK Terhadap pembentukan Nanopartikel MnO₂



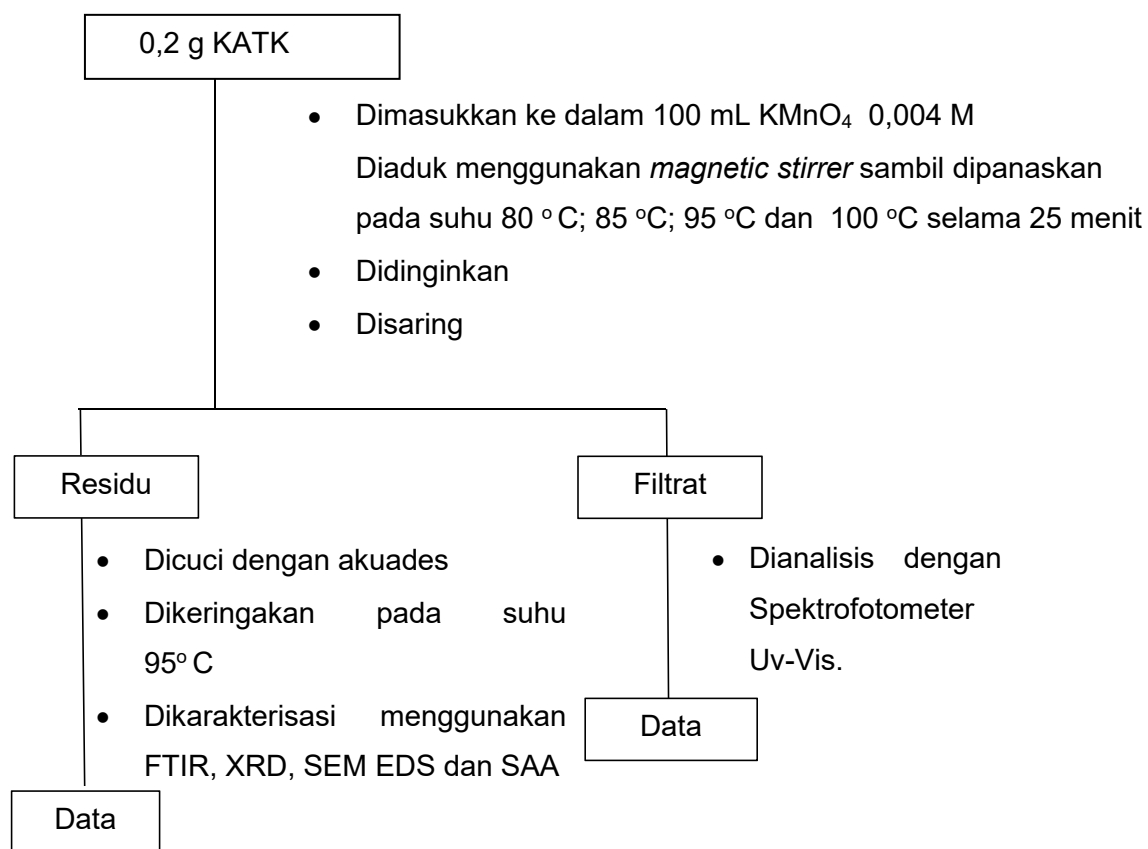
Lampiran 5. Skema Pengaruh Konsentrasi KMnO_4 Terhadap pembentukan Nanopartikel MnO_2



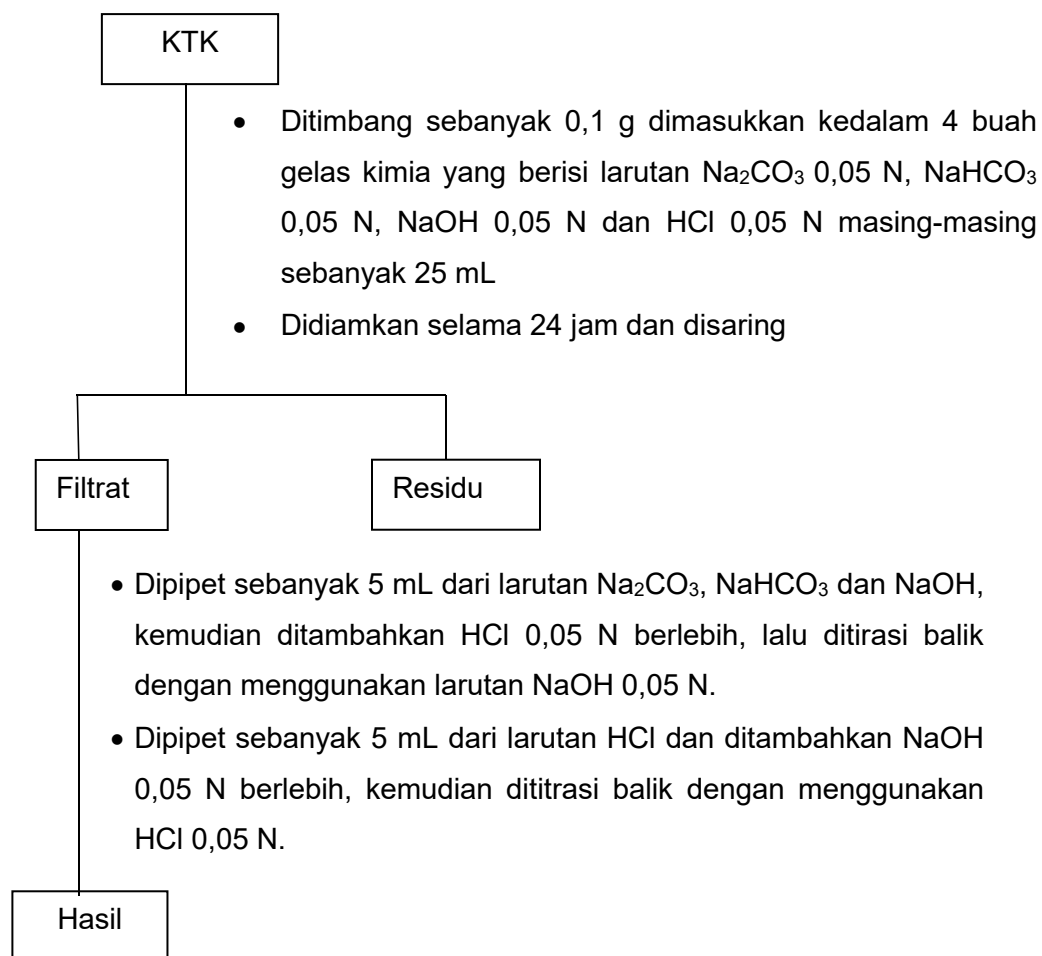
Lampiran 6. Skema Pengaruh pH Terhadap Pembentukan Nanopartikel MnO₂



Lampiran 7. Skema Pengaruh Suhu Terhadap Pembentukan Nanopartikel MnO₂

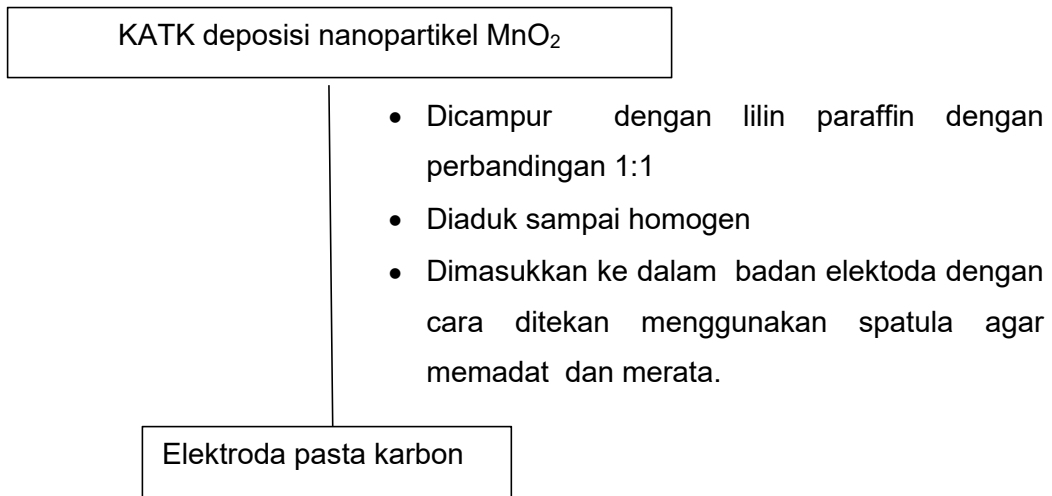


Lampiran 8. Skema Kerja Analisis Gugus Fungsi dengan Titration Boehm

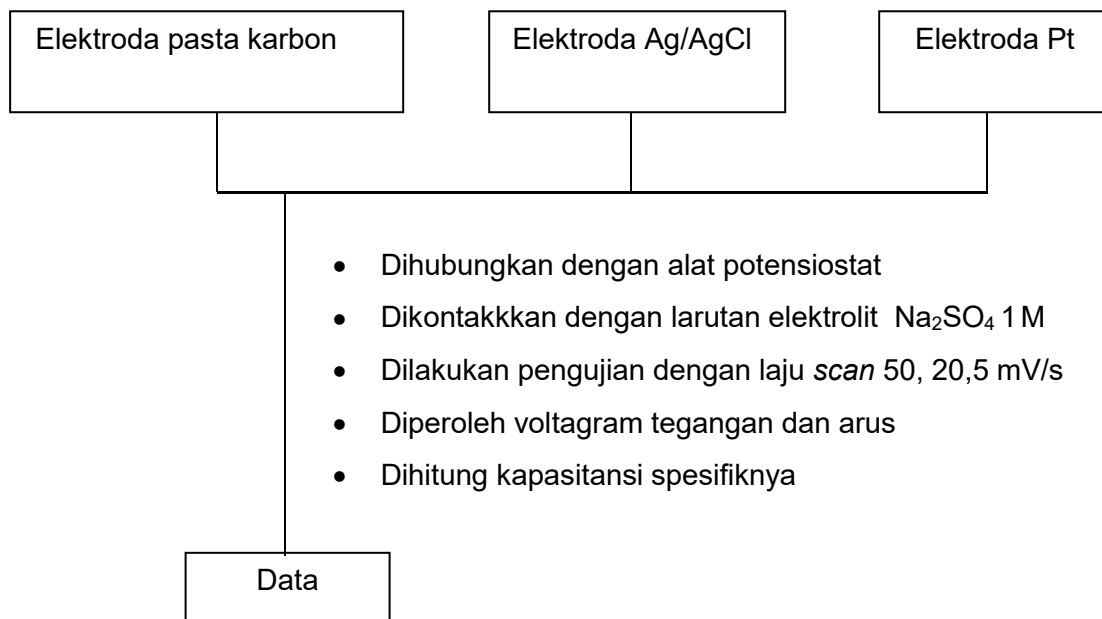


Catatan : diulangi pada sampel KATK dan KATAK + MnO_2

Lampiran 9. Skema Pembuatan Elektroda



Lampiran 10. Pengukuran Nilai Kapasitansi Spesik



Lampiran 11. Perhitungan Pembuatan Larutan Pereaksi

2.1..Pembuatan Larutan H₃PO₄ 10% dari H₃PO₄ 85%

$$\begin{aligned} V_1 \times M_1 &= V_2 \times M_2 \\ V_1 \times 85\% &= 250 \text{ mL} \times 10\% \\ V_1 &= 73.5 \text{ mL} \end{aligned}$$

2.2..Pembuatan Larutan Na₂CO₃ 0,05 N

$$\begin{aligned} \text{gram} &= L \times N \times \text{BE} \\ \text{gram} &= 0,25 \text{ L} \times 0,05 \text{ N} \times 106 \text{ g/eq} = 1,3250 \text{ gram} \end{aligned}$$

2.3..Pembuatan Larutan NaHCO₃ 0,05 N

$$\begin{aligned} \text{gram} &= L \times N \times \text{BE} \\ \text{gram} &= 0,25 \text{ L} \times 0,05 \text{ N} \times 84 \text{ g/eq} = 1,0500 \text{ gram} \end{aligned}$$

2.4..Pembuatan Larutan NaOH 0,05 N

$$\begin{aligned} \text{gram} &= L \times N \times \text{BE} \\ \text{gram} &= 0,25 \text{ L} \times 0,05 \text{ N} \times 40 \text{ g/eq} = 0,5000 \text{ gram} \end{aligned}$$

2.5..Pembuatan Larutan HCl 0,05 N

$$N = \frac{\% \times b_j \times 10}{\text{BE}}$$

$$N = \frac{37 \times 1,19 \text{ g/mL} \times 10}{36,5 \text{ g/eq}}$$

$$N = 12,06 \text{ N}$$

$$\begin{aligned} V_1 \times N_1 &= V_2 \times N_2 \\ V_1 \times 12,06 \text{ N} &= 250 \text{ mL} \times 0,05 \text{ N} \\ V_1 &= 1,03 \text{ mL} \end{aligned}$$

2.6..Pembuatan Larutan Na₂B₄O₇ 0,05 N

$$\begin{aligned} \text{gram} &= L \times N \times \text{BE} \\ \text{gram} &= 0,1 \text{ L} \times 0,05 \text{ N} \times 190,6 \text{ g/eq} = 0,9530 \text{ gram} \end{aligned}$$

2.7..Pembuatan Larutan H₂C₂O₄ 0,05 N

$$\begin{aligned} \text{gram} &= L \times N \times \text{BE} \\ \text{gram} &= 0,1 \text{ L} \times 0,05 \text{ N} \times 63 \text{ g/eq} = 0,3150 \text{ gram} \end{aligned}$$

2.8..Pembuatan Larutan Na₂SO₄ 1 M

$$\text{gram} = L \times M \times \text{BM}$$

$$\text{gram} = 0,05 \text{ L} \times 1 \text{ M} \times 142,04 \text{ g/mol}$$

$$\text{gram} = 7,1020 \text{ g}$$

Lampiran 12. Perhitungan kadar koloid nanopartikel MnO₂

A = a.b.c (g/liter) atau A = ε. b. c (mol/liter)

	MnO_4^-	→	MnO_2
Mula-mula	A		
Bereaksi	C		C
Sisa	B		C

Ket: A : konsentrasi awal KMnO₄.

B : sisa konsentasi KMnO₄ setelah bereaksi dengan karbon.

C : Konsentrasi koloid MnO₂ (C = A - B).

a. Pengaruh massa KATK

1. Massa KTAk 0,005 g

$$c = \frac{0,875 \times 1}{2,40 \times 10^3}$$

$$c = 3,64583 \times 10^{-4}$$

Kadar Koloid (%)

$$B = \frac{3,64583 \times 10^{-4}}{0,0024} \times 100$$

$$B = 0$$

2. Massa KATK 0,01 g

$$c = \frac{0,670 \times 1}{9,6 \times 10^3}$$

$$c = 6,67917 \times 10^{-5}$$

Kadar Koloid (%)

$$B = \frac{6,67917 \times 10^{-5}}{0,0024} \times 100$$

$$B = 2,91 \%$$

Absorbansi	Massa KATK (gram)	Konsentrasi (c) MnO ₂	Koloid nanopartikel MnO ₂ (%)
0,875	0,005	0	0
0,67	0,10	$6,97917 \times 10^{-5}$	2,91
0,683	0,15	$7,11458 \times 10^{-5}$	2,94
0,722	0,20	$7,52083 \times 10^{-5}$	3,13
0,716	0,25	$7,45833 \times 10^{-5}$	3,10
0	0,30	0	0

b. Pengaruh Konsentrasi KMnO₄

Absorbansi	Konsentrasi KMnO ₄ (M)	Konsentrasi (c) MnO ₂	Koloid nanopartikel MnO ₂ (%)
0,722	0,0024	$7,52083 \times 10^{-5}$	3,13
1,164	0,0032	$1,2125 \times 10^{-4}$	3,79
1,537	0,004	$1,60104 \times 10^{-4}$	4,00
1,22	0,0048	127083×10^{-4}	2,65

c. Pengaruh pH

Absorbansi	Ph	Konsentrasi (c) MnO ₂	Koloid nanopartikel MnO ₂ (%)
0,082	2	$8,54167 \times 10^{-6}$	0,21
0,142	4	$1,47917 \times 10^{-5}$	0,37
0,675	6	$7,03125 \times 10^{-5}$	1,76
1,197	8	$1,24688 \times 10^{-4}$	3,12
1,688	10	$1,75833 \times 10^{-4}$	4,40
3	12	0	0

d. Pengaruh suhu

Absorbansi	Suhu (°)	Konsentrasi (c) MnO₂	Koloid nanopartikel MnO₂ (%)
1,352	80	$1,41 \times 10^{-4}$	3,52
1,485	85	$1,55 \times 10^{-4}$	3,87
1,534	90	$1,60 \times 10^{-4}$	4
1,688	95	$1,76 \times 10^{-4}$	4,4
1,853	100	$1,93 \times 10^{-4}$	4,82

Lampiran 13. Perhitungan Kadar Gugus Fungsi dengan Titration Boehm

a. Karbon Tempurung Kemiri (KTK) - Penentuan Kadar Asam kaboksilat

No	V. Sampel (Vs) (mL)	V. Titran NaHCO ₃ (Vp) (mL)	N. NaHCO ₃	N. HCl	V. HCl (mL)	N. NaOH	V. NaOH (mL)	Massa Karbon (g)	n Carboxyl (meq/g)
1	25	5	0,05	0,0304	7	0,0558	1,2	0,1024	5,0894
2	25	5	0,05	0,0304	7	0,0558	1,3	0,1024	5,3618
3	25	5	0,05	0,0304	7	0,0558	1,1	0,1024	4,8169
Rata – rata									5,0894

$$n_{\text{carboxylic}} = \frac{[V_{\text{NaHCO}_3} N_{\text{NaHCO}_3} - (N_{\text{HCl}} V_{\text{HCl}} - N_{\text{NaOH}} V_{\text{NaOH}})] \frac{V_p}{V_s}}{w}$$

$$n_{\text{carboxylic}} = \frac{[5 \text{ mL} \times 0,05 \text{ N} - (0,03004 \text{ N} \times 7 \text{ mL} - 0,0558 \text{ N} \times 1,2 \text{ mL})] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,1024 \text{ gram}}$$

$$n_{\text{carboxylic}} = \frac{[0,25 \text{ meq} - 0,146 \text{ meq}] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,1024 \text{ gram}} = 5,0894 \frac{\text{meq}}{\text{gram}}$$

- Penentuan Kadar Lakton

No	V. Sampel (Vs) (mL)	V. Titran Na ₂ CO ₃ (Vp) (mL)	N. Na ₂ CO ₃	N. HCl	V. HCl (mL)	N. NaOH	V. NaOH (mL)	Massa Karbon (g)	n Lactone (meq/g)
1	25	5	0,05	0,0304	7	0,0558	1,1	0,1043	-0,3602
2	25	5	0,05	0,0304	7	0,0558	1,2	0,1043	-0,0927
3	25	5	0,05	0,0304	7	0,0558	1	0,1043	-0,6277
Rata- rata									-0,3602

$$n_{\text{lactonic}} = \frac{[V_{\text{Na}_2\text{CO}_3} N_{\text{Na}_2\text{CO}_3} - (N_{\text{HCl}} V_{\text{HCl}} - N_{\text{NaOH}} V_{\text{NaOH}})] \frac{V_p}{V_s}}{w} - n_{\text{carboxylic}}$$

$$n_{\text{lactonic}} = \frac{[5 \text{ mL} \times 0,05 \text{ N} - (0,0304 \text{ N} \times 7 \text{ mL} - 0,0558 \text{ N} \times 1,1 \text{ mL})] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,3178 \text{ gram}} - 5,0894 \frac{\text{meq}}{\text{gram}}$$

$$n_{\text{lactonic}} = \frac{[0,25 \text{ meq} - (0,151 \text{ meq})] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,1043 \text{ gram}} - 5,0894 \frac{\text{meq}}{\text{gram}}$$

$$n_{\text{lactonic}} = -0,3602 \frac{\text{meq}}{\text{gram}}$$

- Penentuan Kadar Fenol

No	V. Sampel (Vs) (mL)	V. Titran NaOH (Vp) (mL)	N. NaOH	N. HCl	V. HCl (mL)	N. NaOH	V. NaOH (mL)	Massa Karbon (g)	n Phenolic (meq/g)
1	25	5	0,0558	0,0304	7	0,0558	1	0,1012	1,3020
2	25	5	0,0558	0,0304	7	0,0558	1,1	0,1012	1,5777
3	25	5	0,0558	0,0304	7	0,0558	1	0,1012	1,3020
Rata –rata									1,3939

$$n_{\text{phenolic}} = \frac{[V_{\text{NaOH}}N_{\text{NaOH}} - (N_{\text{HCl}}V_{\text{HCl}} - N_{\text{NaOH}}V_{\text{NaOH}})] \frac{V_p}{V_s}}{w} - n_{\text{carboxylic}} - n_{\text{lactonic}}$$

$$n_{\text{phenolic}} = \frac{[5 \text{ mL} \times 0,0558 \text{ N} - (0,0304 \text{ N} \times 7 \text{ mL} - 0,0558 \text{ N} \times 1 \text{ mL})] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,1012 \text{ gram}} - 5,0894 \frac{\text{meq}}{\text{gram}} - (-0,3602 \frac{\text{meq}}{\text{gram}})$$

$$n_{\text{phenolic}} = \frac{[0,25 \text{ meq} - (0,2127 \text{ meq} - 0,0558 \text{ meq})] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,1012 \text{ gram}} - 5,0894 \frac{\text{meq}}{\text{gram}} - (-0,3602 \frac{\text{meq}}{\text{gram}})$$

$$n_{\text{phenolic}} = 1,3020 \frac{\text{meq}}{\text{gram}}$$

- Penentuan Kadar Basa Total

No	V. Sampel (Vs) (mL)	V. Titran HCl (Vp) (mL)	N. HCl	N. NaOH	V. NaOH (mL)	N. HCl	V. HCl (mL)	Massa Karbon (g)	n total base (meq/g)
1	25	5	0,0304	0,0558	7	0,0304	8	0,1011	0,2211
2	25	5	0,0304	0,0558	7	0,0304	8,1	0,1011	0,3714
3	25	5	0,0304	0,0558	7	0,0304	8,2	0,1011	0,5217
Rata – rata									0,3714

$$n_{\text{total base}} = \frac{[V_{\text{HCl}}N_{\text{HCl}} - (N_{\text{NaOH}}V_{\text{NaOH}} - N_{\text{HCl}}V_{\text{HCl}})] \frac{V_p}{V_s}}{w}$$

$$n_{\text{total base}} = \frac{[5 \text{ mL} \times 0,0304 \text{ N} - (0,0558 \text{ N} \times 7 \text{ mL} - 0,0304 \text{ N} \times 8 \text{ mL})] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,1011 \text{ gram}}$$

$$n_{\text{total base}} = \frac{[0,152 \text{ meq} - (0,3906 \text{ meq} - 0,24312 \text{ meq})] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,1011 \text{ gram}}$$

$$n_{\text{total base}} = \frac{[0,152 \text{ meq} - 0,14748 \text{ meq}] \frac{25 \text{ mL}}{5 \text{ mL}}}{0,1001 \text{ gram}} = 0,2211 \frac{\text{meq}}{\text{gram}}$$

b. Karbon Aktif Tempurung Kemiri (KATK)

- Penentuan Kadar Asam kaboksilat

No	V. Sampel (Vs) (mL)	V. Titran NaHCO ₃ (Vp) (mL)	N. NaHCO ₃	N. HCl	V. HCl (mL)	N. NaOH	V. NaOH (mL)	Massa Karbon (g)	n Carboxyl (meq/g)
1	25	5	0,05	0,0370	8	0,0558	3,8	0,1013	8,1955
2	25	5	0,05	0,0370	8	0,0558	3,8	0,1013	8,1955
3	25	5	0,05	0,0370	8	0,0558	4,5	0,1013	10,1234
Rata – rata									8,8381

- Penentuan Kadar Lakton

No	V. Sampel (Vs) (mL)	V. Titran Na ₂ CO ₃ (Vp) (mL)	N. Na ₂ CO ₃	N. HCl	V. HCl (mL)	N. NaOH	V. NaOH (mL)	Massa Karbon (g)	n Lactone (meq/g)
1	25	5	0,05	0,0370	8	0,0558	4	0,1021	0,4823
2	25	5	0,05	0,0370	8	0,0558	4,1	0,1013	0,8263
3	25	5	0,05	0,0370	8	0,0558	4,1	0,1013	-1,1017
Rata – rata									0,0690

- Penentuan Kadar Fenol

	V. Sampel (Vs) (mL)	V. Titran NaOH (Vp) (mL)	N. NaOH	N. HCl	V. HCl (mL)	N. NaOH	V. NaOH (mL)	Massa Karbon (g)	n Phenolic (meq/g)
1	25	5	0,0558	0,0370	8	0,0558	5	0,1017	4,2033
2	25	5	0,0558	0,0370	8	0,0558	5,1	0,1017	4,1336
3	25	5	0,0558	0,0370	8	0,0558	5,1	0,1017	4,1336
Rata – rata									4,1568

- Penentuan Kadar Basa Total

No	V. Sampel (Vs) (mL)	V. Titran HCl (Vp) (mL)	N. HCl	N. NaOH	V. NaOH (mL)	N. HCl	V. HCl (mL)	Massa Karbon (g)	n total base (meq/g)
1	25	5	0,0370	0,0558	8	0,0304	2,3	0,1027	-9,3234
2	25	5	0,0370	0,0558	8	0,0304	2,3	0,1027	-9,3234
3	25	5	0,0370	0,0558	8	0,0304	2,3	0,1027	-9,3234
Rata – rata									-9,3234

Lampiran 14. Perhitungan Kapasitansi Spesifik

1. Perhitungan Kapasitansi Spesifik KTK

Scan rate 50 mV/s

$$C_s = \frac{(6,13 \times 10^{-4} - (-6,88 \times 10^{-7})) \text{ A}}{0,05 \text{ V/s} \times 0,0523 \text{ gram}} = \frac{(6,13 \times 10^{-3}) \text{ A}}{0,05 \text{ V/s} \times 0,0529 \text{ gram}} = 0,2188 \text{ F/g}$$

Scan rate 10 mV/s

$$C_s = \frac{(3,88 \times 10^{-4} - (-2,13 \times 10^{-4})) \text{ A}}{0,002 \text{ V/s} \times 0,0529 \text{ gram}} = \frac{(-2,13 \times 10^{-4}) \text{ A}}{0,002 \text{ V/s} \times 0,0529 \text{ gram}} = 0,5671 \text{ F/g}$$

Scan rate 5 mV/s

$$C_s = \frac{(9,38 \times 10^{-5} - (-6,88 \times 10^{-5})) \text{ A}}{0,005 \text{ V/s} \times 0,0529 \text{ gram}} = \frac{(7,39 \times 10^{-3}) \text{ A}}{0,005 \text{ V/s} \times 0,0529 \text{ gram}} = 0,6144 \text{ F/g}$$

2. Perhitungan Kapasitansi Spesifik KATK

Scan rate 50 mV/s

$$C_s = \frac{(1,29 \times 10^{-6} - (-1,23 \times 10^{-3})) \text{ A}}{0,05 \text{ V/s} \times 0,0505 \text{ gram}} = \frac{(-1,23 \times 10^{-3}) \text{ A}}{0,05 \text{ V/s} \times 0,0578 \text{ gram}} = 0,42605 \text{ F/g}$$

Scan rate 20 mV/s

$$C_s = \frac{(1,14 \times 10^{-6} - (-9,88 \times 10^{-4})) \text{ A}}{0,02 \text{ V/s} \times 0,0578 \text{ gram}} = \frac{(9,89 \times 10^{-4}) \text{ A}}{0,02 \text{ V/s} \times 0,0578 \text{ gram}} = 0,8552 \text{ F/g}$$

Scan rate 5 mV/s

$$C_s = \frac{(-3,18 \times 10^{-6} - (-3,02 \times 10^{-3})) \text{ A}}{0,005 \text{ V/s} \times 0,0505 \text{ gram}} = \frac{(3,02 \times 10^{-3}) \text{ A}}{0,005 \text{ V/s} \times 0,0578 \text{ gram}} = 10,4388 \text{ F/g}$$

3. Perhitungan Kapasitansi Spesifik KATK+MnO₂

Scan rate 50 mV/s

$$C_s = \frac{(2,34 \times 10^{-5} - (-1,73 \times 10^{-2})) \text{ A}}{0,05 \text{ V/s} \times 0,0677 \text{ gram}} = \frac{(1,73 \times 10^{-2}) \text{ A}}{0,005 \text{ V/s} \times 0,0587 \text{ gram}} = 5,6253 \text{ F/g}$$

Scan rate 20 mV/s

$$C_s = \frac{(2,76 \times 10^{-5} - (-1,93 \times 10^{-2})) \text{ A}}{0,005 \text{ V/s} \times 0,0677 \text{ gram}} = \frac{(1,93 \times 10^{-2}) \text{ A}}{0,005 \text{ V/s} \times 0,0677 \text{ gram}} = 14,2375 \text{ F/g}$$

Scan rate 5 mV/s

$$C_s = \frac{(3,19 \times 10^{-2} - (-3,15 \times 10^{-5})) \text{ A}}{0,005 \text{ V/s} \times 0,0677 \text{ gram}} = \frac{(-1,00044 \times 10^{-6}) \text{ A}}{0,005 \text{ V/s} \times 0,0677 \text{ gram}} = 94,1847 \text{ F/g}$$

a. Elektrolit Na₂SO₄ 1 M

Sampel	Scan rate (V/s)	I_c (A)	I_d (A)	Massa karbon (gram)	Kapasitansi spesifik (F/g)
KTK	0,05	$1,29 \times 10^{-6}$	$-6,88 \times 10^{-7}$	0,0529	0,2188
	0,02	$1,14 \times 10^{-6}$	$-9,88 \times 10^{-4}$	0,0529	0,5671
	0,005	$9,38 \times 10^{-5}$	$-6,88 \times 10^{-5}$	0,0529	0,6144
KTAK	0,05	$1,29 \times 10^{-6}$	$-1,23 \times 10^{-3}$	0,0578	0,4260
	0,02	$1,14 \times 10^{-6}$	$-9,88 \times 10^{-4}$	0,0578	0,8552
	0,005	$-3,18 \times 10^{-6}$	$-3,02 \times 10^{-3}$	0,0578	10,4388
KTAK + MnO ₂	0,05	$2,34 \times 10^{-5}$	$-1,73 \times 10^{-2}$	0,0512	5,6253
	0,02	$2,76 \times 10^{-5}$	$-1,93 \times 10^{-2}$	0,0677	14,2375
	0,005	$3,19 \times 10^{-2}$	$-3,15 \times 10^{-5}$	0,0677	94,1847

Lampiran 15. Dokumentasi

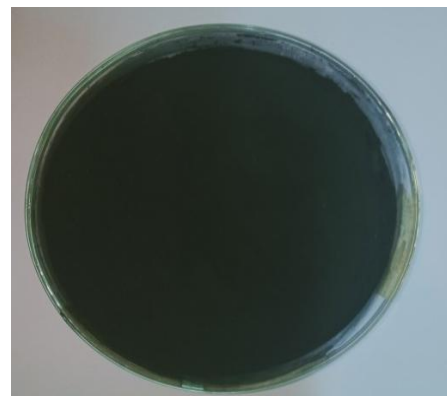
Tempurung kemiri



Tempurung kemiri dikarbonisasi

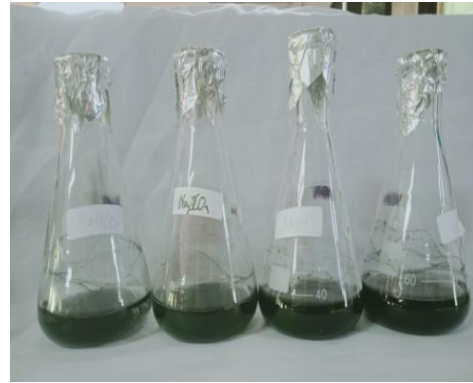


Karbon tempurung kemiri

Karbon tempurung kemiri
150 meshAktivasi karbon tempurung
kemiri dengan H_3PO_4 Penetralan karbon aktif
tempurung kemiri



Karbon aktif tempurung
Kemiri



Perendaman sampel untuk
titrasi Boehm



Hasil titrasi Boehm



Deposisi nanopartikel MnO_2



Filtrat sebelum dan sesudah
deposisi MnO_2



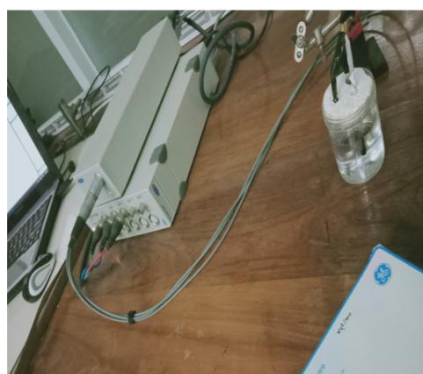
Penyaringan filtrat hasil deposisi

KATK + MnO₂

Pembuatan pasta karbon



Pembutan Elektroda

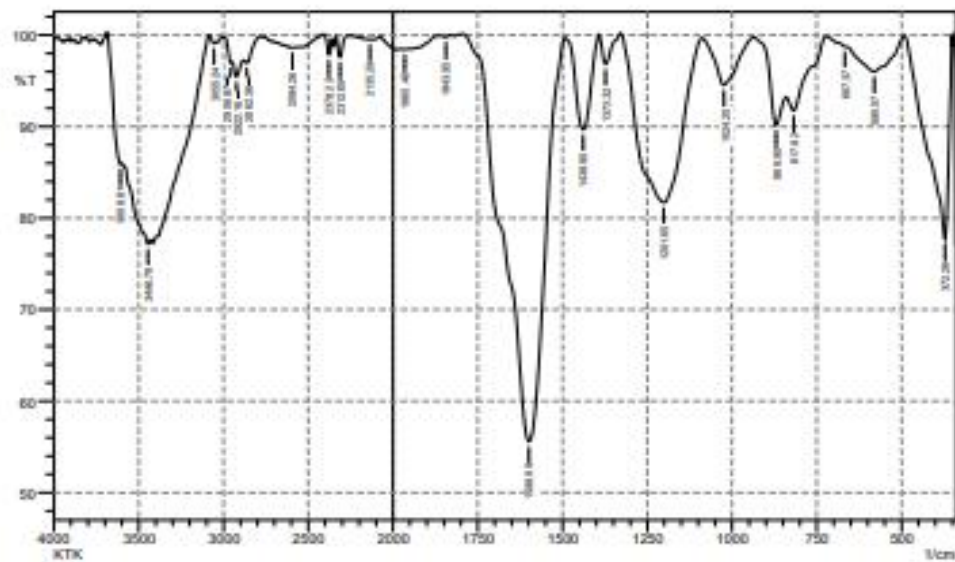


Pengukuran Kapasitansi

Lampiran 16. DATA FTIR

1. KTK

SHIMADZU



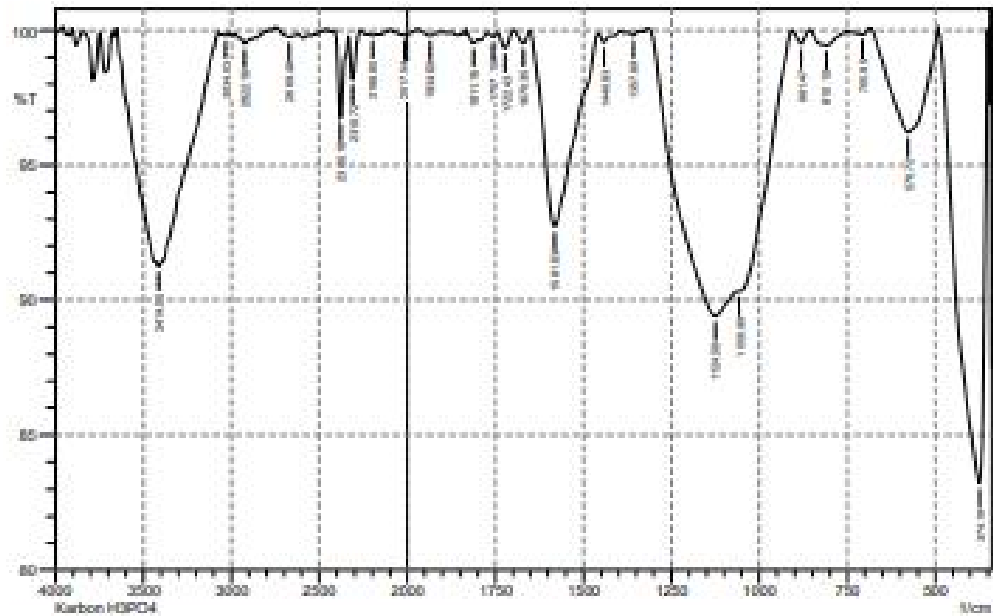
No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	372.26	77.773	21.068	491.85	352.97	7.287	0.845
2	580.57	96.018	3.201	663.51	493.78	1.975	1.47
3	667.37	98.742	0.04	723.31	665.44	0.177	0.002
4	817.82	91.759	2.643	839.03	723.31	2.373	0.597
5	869.9	90.153	5.042	935.48	840.90	2.001	0.608
6	1024.2	94.537	5.17	1087.85	937.4	1.811	1.622
7	1201.65	81.696	18.218	1327.03	1089.78	12.083	12.039
8	1373.32	96.848	3.214	1392.61	1328.95	0.389	0.417
9	1438.9	89.688	10.097	1490.97	1394.53	2.275	2.182
10	1598.99	55.583	44.261	1795.73	1492.9	30.125	30
11	1843.95	99.794	0.189	1857.45	1828.52	0.014	0.011
12	1985.46	98.429	0.076	1977.04	1951.96	0.168	0.004
13	2135.2	99.525	0.057	2245.14	2121.7	0.165	0.028
14	2312.65	97.599	2.309	2335.8	2284.43	0.321	0.295
15	2378.23	97.839	1.896	2411.02	2360.67	0.195	0.155
16	2594.26	98.031	0.3	2785.21	2546.04	0.941	0.178
17	2862.36	96.973	0.777	2881.65	2785.21	0.716	0.093
18	2922.16	95.463	1.652	2949.16	2881.65	1.085	0.234
19	2956.87	96.983	0.514	2995.45	2949.16	0.341	0.017
20	3055.24	99.083	0.444	3086.11	3037.89	0.127	0.049
21	3446.79	77.173	1.15	3581.81	3433.29	14.125	0.804
22	3698.81	85.921	1.345	3687.9	3601.1	3.369	0.558

Comment:
KTK

Date/Time: 7/22/2021 4:12:08 PM
No. of Scans:
Resolution:
Apodization:

2. KATK

SHIMADZU



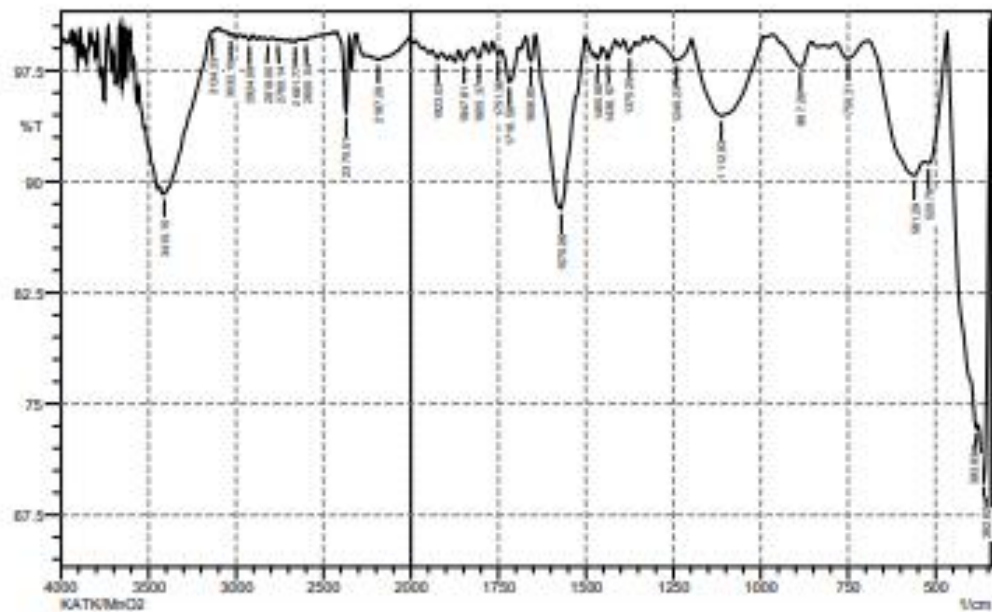
No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	374.19	99.231	99.697	491.85	351.04	6.545	6.526
2	576.72	99.268	3.815	684.73	493.78	1.845	1.868
3	705.95	99.852	0.185	748.38	684.73	0.022	0.026
4	870.1	99.435	0.551	858.32	752.24	0.152	0.144
5	881.47	99.499	0.5	906.54	858.32	0.056	0.055
6	1059.99	99.325	0.124	1058.92	958.47	3.716	0.441
7	1124.5	99.4	3.43	1313.52	1058.92	8.573	2.942
8	1357.89	99.811	0.137	1375.25	1349.53	0.017	0.009
9	1440.83	99.541	0.293	1458.18	1421.54	0.049	0.022
10	1581.83	99.722	7.213	1621.07	1458.18	3.165	3.1
11	1670.25	99.511	0.477	1697.36	1653	0.05	0.049
12	1723.43	99.332	0.624	1743.65	1697.36	0.069	0.061
13	1757.15	99.74	0.171	1772.98	1743.65	0.021	0.01
14	1811.16	99.511	0.268	1834.3	1757.15	0.059	0.025
15	1934.8	99.794	0.162	1989.32	1897.95	0.032	0.027
16	2017.54	99.823	0.207	2098.58	1989.32	0.051	0.067
17	2198.85	99.805	0.061	2229.07	2198.85	0.036	0.006
18	2319.72	98.177	1.681	2333.87	2289.36	0.25	0.219
19	2380.16	98.768	3.137	2414.88	2333.87	0.463	0.424
20	2669.48	99.74	0.166	2746.83	2634.76	0.069	0.05
21	2822.16	99.494	0.229	2847.23	2804.29	0.136	0.038
22	3034.03	99.804	0.065	3049.49	3014.74	0.024	0.005
23	3414	91.236	0.944	3653.18	3392.79	6.333	1.294

Comment:
Karbon H3PO4

Date/Time: 6/28/2021 12:16:45 PM
No. of Scans:
Resolution:
Apodization:

3.KATK+MnO₂

SHIMADZU



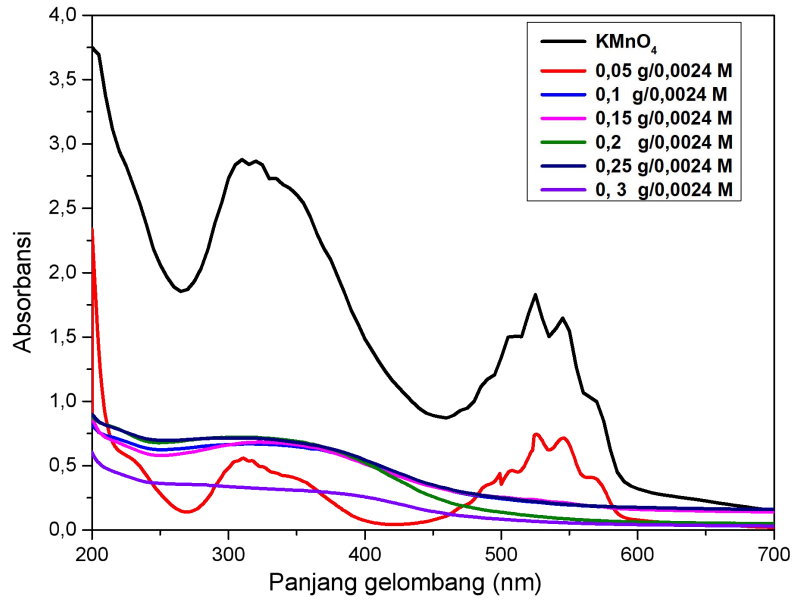
No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	362.62	89.75	13.931	375.12	343.33	3.696	1.499
2	353.83	73.363	1.891	466.77	378.05	7.773	1.742
3	520.76	91.234	1.432	530.42	468.7	1.627	0.427
4	561.29	90.415	2.425	690.52	532.35	4.625	1.332
5	750.31	98.321	1.103	785.03	692.44	0.453	0.229
6	887.26	97.738	1.684	945.12	854.47	0.568	0.337
7	1112.93	94.447	5.22	1197.79	991.41	3.329	3.048
8	1240.23	98.206	1.457	1309.67	1197.79	0.551	0.4
9	1375.25	98.687	0.8	1392.61	1357.89	0.138	0.06
10	1436.97	98.265	1.008	1454.33	1415.75	0.196	0.078
11	1465.9	98.31	0.357	1499.76	1454.33	0.099	0.017
12	1570.06	88.169	0.742	1573.91	1504.48	1.986	0.107
13	1656.85	98.149	1.698	1672.28	1645.28	0.129	0.11
14	1718.58	96.732	2.217	1739.79	1691.57	0.475	0.256
15	1751.36	98.538	0.568	1766.8	1739.79	0.134	0.033
16	1805.37	98.333	0.891	1822.73	1789.94	0.177	0.065
17	1847.81	98.166	0.764	1863.24	1822.73	0.247	0.062
18	1923.03	98.315	0.442	1940.39	1913.39	0.171	0.027
19	2187.28	98.227	0.152	2206.57	2156.42	0.373	0.018
20	2370.51	94.673	5.126	2420.66	2353.16	0.579	0.544
21	2600.04	99.581	0.109	2619.33	2576.9	0.067	0.01
22	2661.77	99.449	0.087	2671.41	2642.48	0.061	0.006
23	2760.14	99.553	0.098	2794.85	2744.71	0.083	0.011
24	2818	99.572	0.144	2835.36	2794.85	0.063	0.013
25	2924.09	99.539	0.316	2945.3	2904.8	0.053	0.027
26	3032.1	99.849	0.177	3049.46	3016.67	0.008	0.012
27	3134.33	100.133	0.036	3138.18	3111.18	-0.026	0.005
28	3410.15	89.178	0.278	3415.93	3143.97	7.34	0.741

Comment:
KATK/MnO₂

Date/Time: 11/8/2021 3:54:43 PM
No. of Scans:
Resolution:
Apodization:

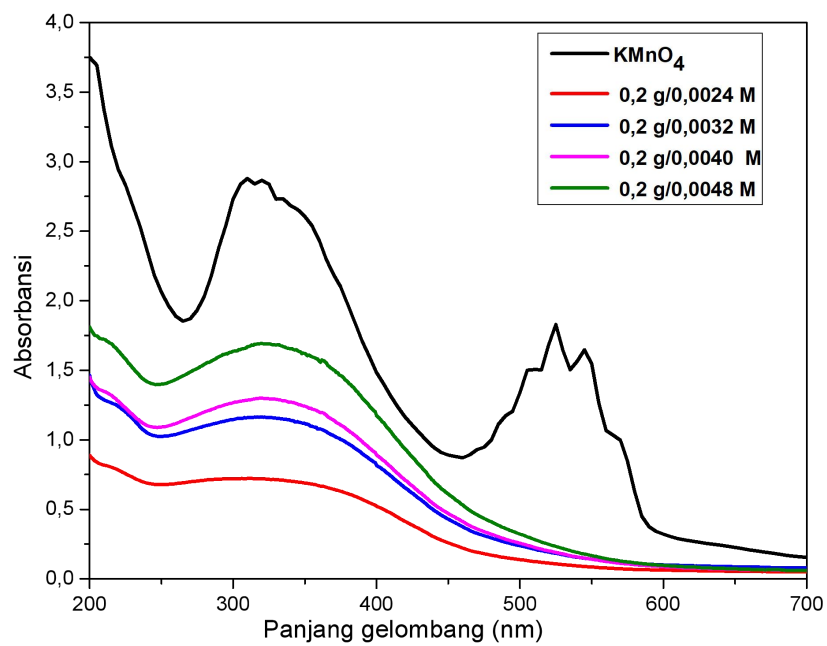
Lampiran 17. DATA UV-Vis

1. Data Pengaruh Massa KATK Terhadap Pembentukan Nanopartikel MnO₂



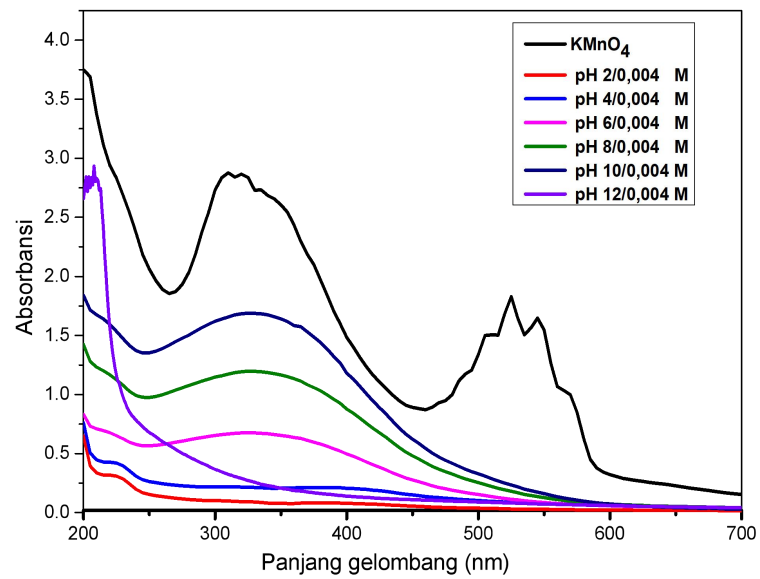
Massa karbon	Absorbansi	Panjang gelombang (nm)	Koloid MnO ₂ (%)
0,05	0,826; 0,875; 0,719; 1,094 dan 1,104	545, 525, 508, 317 dan 311	0
0,1	0,67	320	2,91
0,15	0,683	325	2,95
0,2	0,722	313	3,13
0,25	0,716	310	3,11
0,3	-	-	-

2. Data Pengaruh Konsentrasi KMnO_4 Terhadap Pembentukan Nanopartikel MnO_2



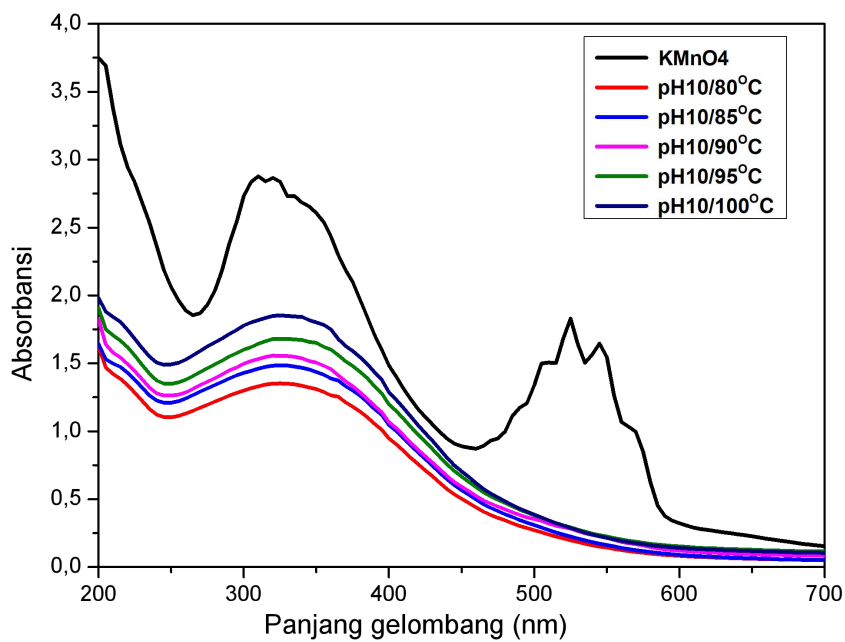
Konsentrasi	Absorbansi	Panjang gelombang (nm)	Koloid MnO_2 (%)
0,0024	0,722	313	3,13
0,0032	1,164	315	3,79
0,004	1,666	326	4
0,0048	1,22	320	2,65

3. Data Pengaruh pH Terhadap Pembentukan Nanopartikel MnO₂



pH	Absorbansi	Panjang gelombang (nm)	Koloid MnO ₂ (%)
2	0	0	0
4	0,142	365	0,37
6	0,675	325	1,75
8	1,197	325	3,12
10	1,688	325	4,40
12	2,933 dan 2,844	208 dan 202	0

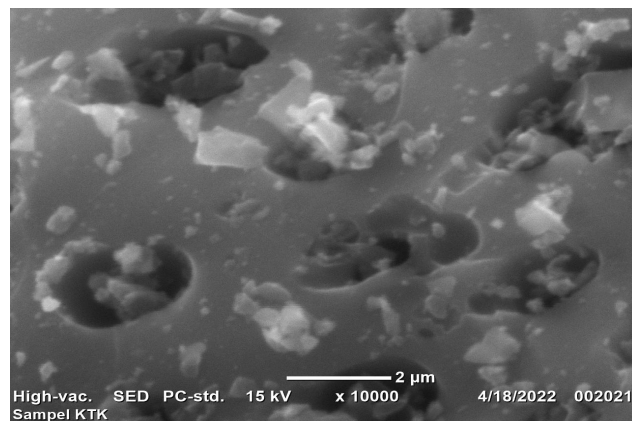
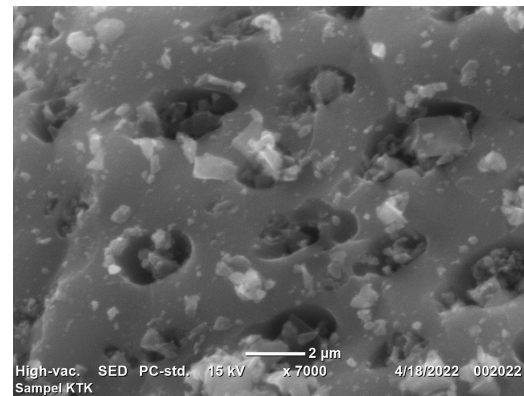
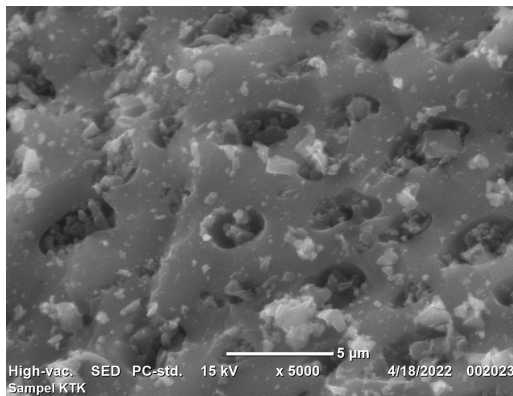
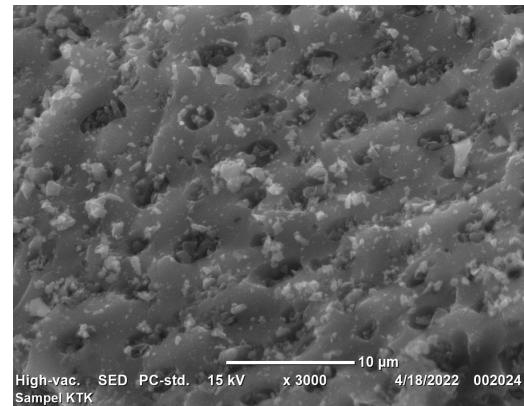
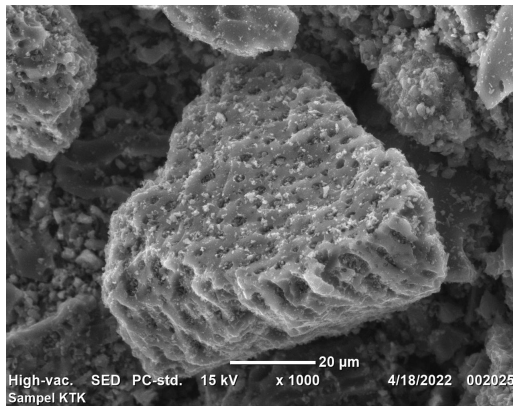
4. Data Pengaruh Suhu Terhadap Pembentukan Nanopartikel MnO₂

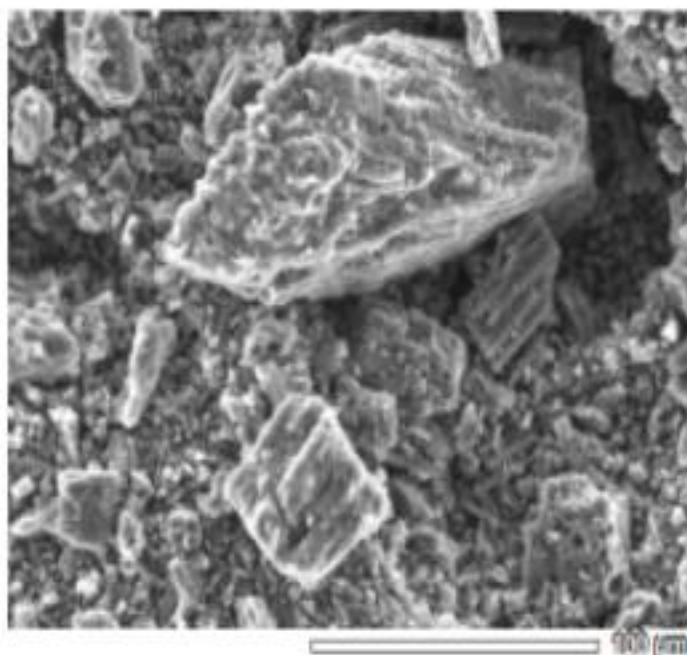


Suhu	Absorbansi	Panjang gelombang (nm)	Koloid MnO ₂ (%)
80	1,352	325	3,52
85	1,485	325	3,86
90	1,534	325	4
95	1,688	325	4,4
100	1,853	322	4,83

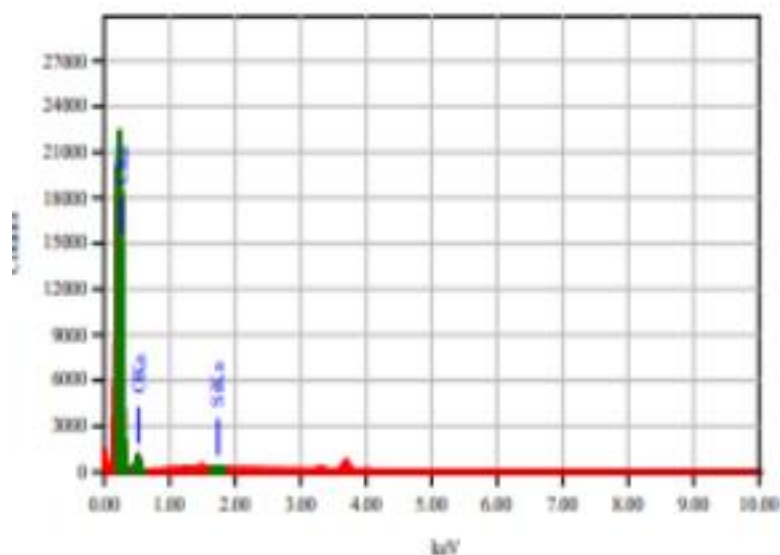
Lampiran 18. Hasil Karakterisasi SEM EDS

1. Hasil uji SEM KTK





Title	: DM1
Instrument	: JSM-6010PLUS
Volt	: 15.00 kV
Mag.	: x 500
Date	: 2023/04/10
Pixel	: 512 x 384

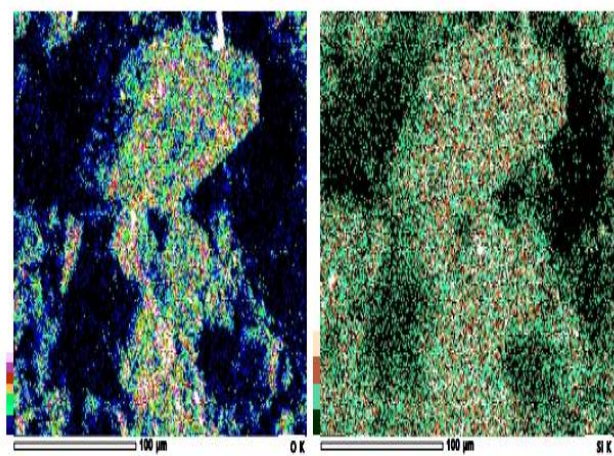
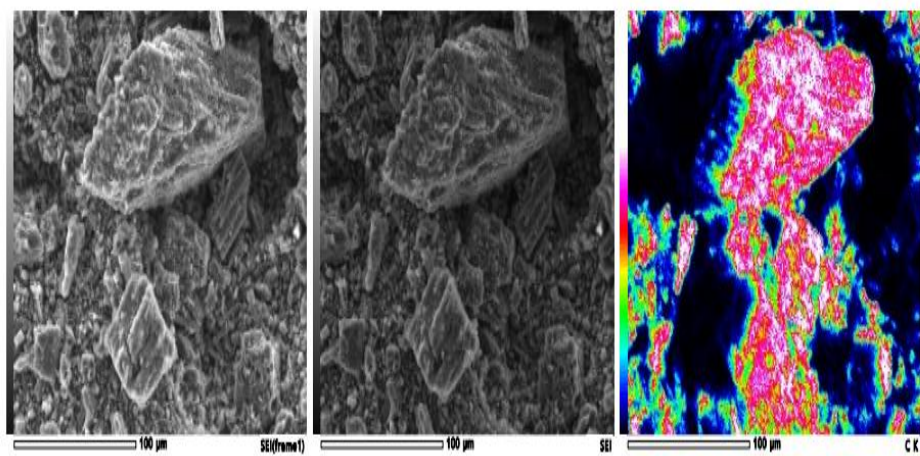


Acquisition Parameter	
Instrument	: JSM-6010PLUS
Acc. Voltage	: 15.0 kV
Probe Current	: 1.0000 nA
PSA mode	: ET
Real Time	: 51.78 sec
Live Time	: 50.80 sec
Dead Time	: 3 s
Coating Rate	: 800 cps
Energy Range	: 0 - 20 keV

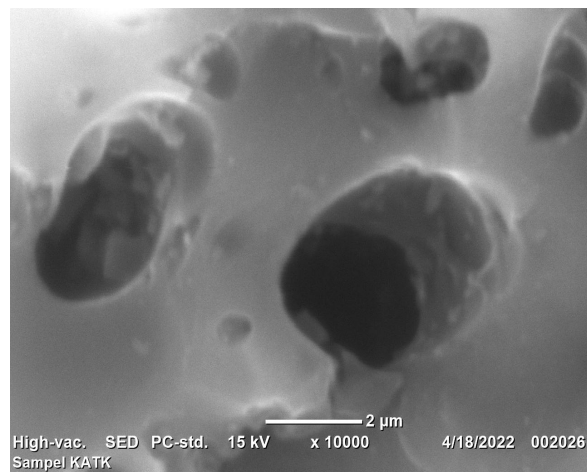
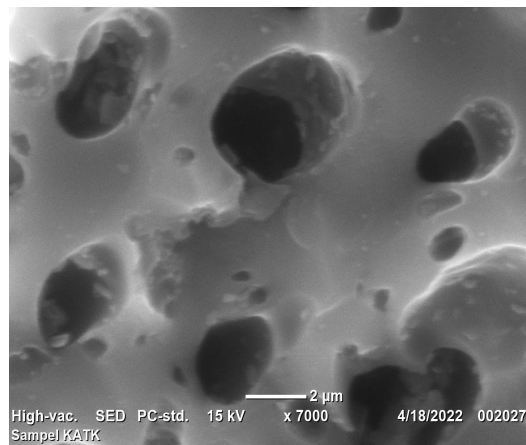
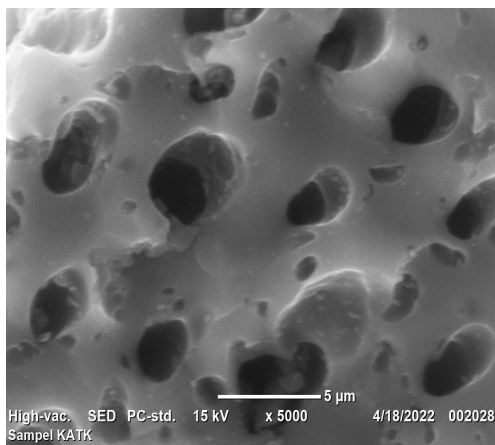
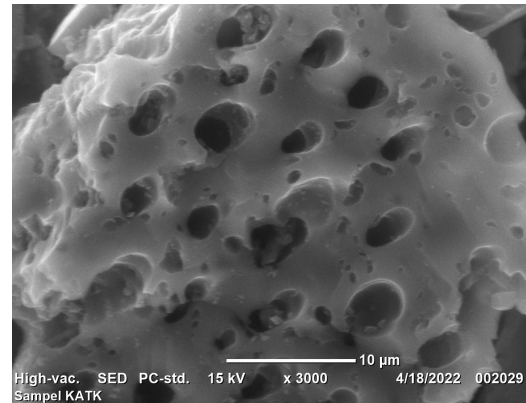
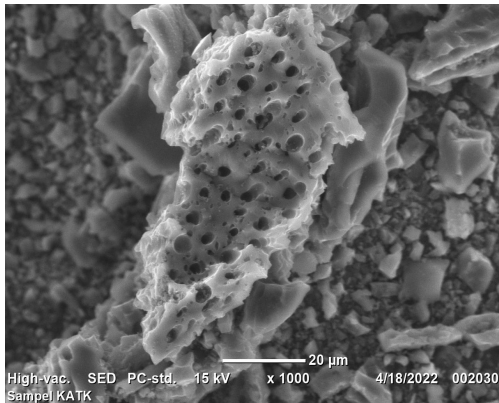
bin file standardless standardless quantitative Analysis

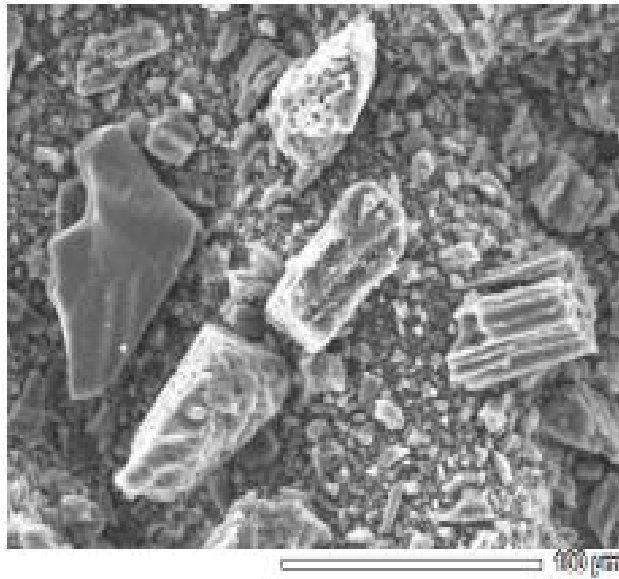
Fitting Coefficient : 0.8551

Element	(keV)	Mass%	Counts	Sigma	Atom%	Compound	Mass Ratio	Z
C K (Ref.)	0.277	92.51	21412.23	0.33	95.15		1.0000	
O K	0.525	4.17	5368.24	0.10	4.71		0.3869	
I K	1.710	0.32	343.19	0.04	0.14		0.0144	
Total		100.00			100.00			

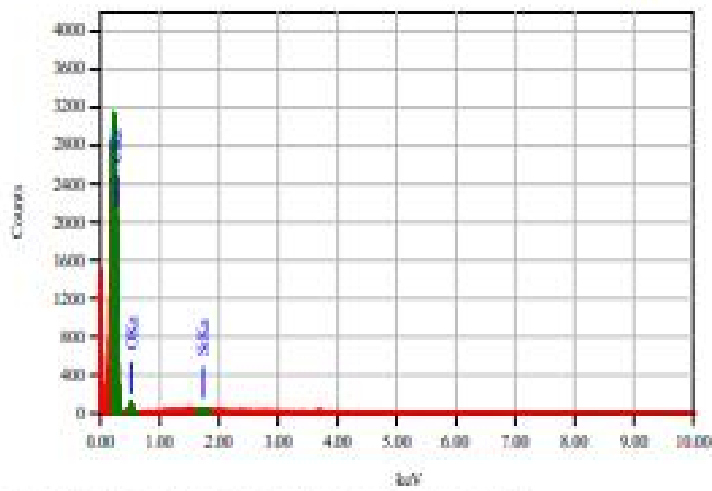


2. Hasil uji SEM KATK





Title	: 2002
Instrument	: JCM-6000PLUS
volt	: 15.00 kV
Mag.	: x 500
Date	: 2002/04/18
File	: 212 x 204

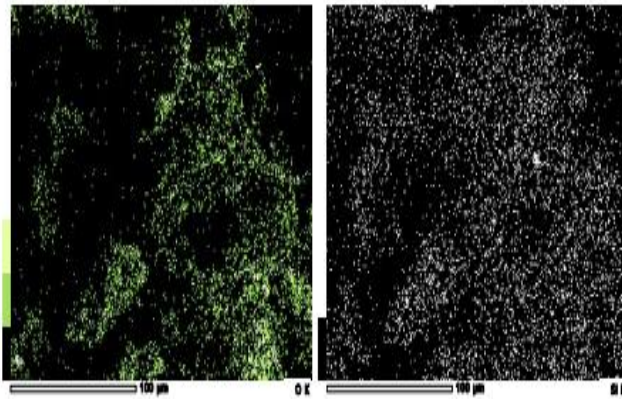
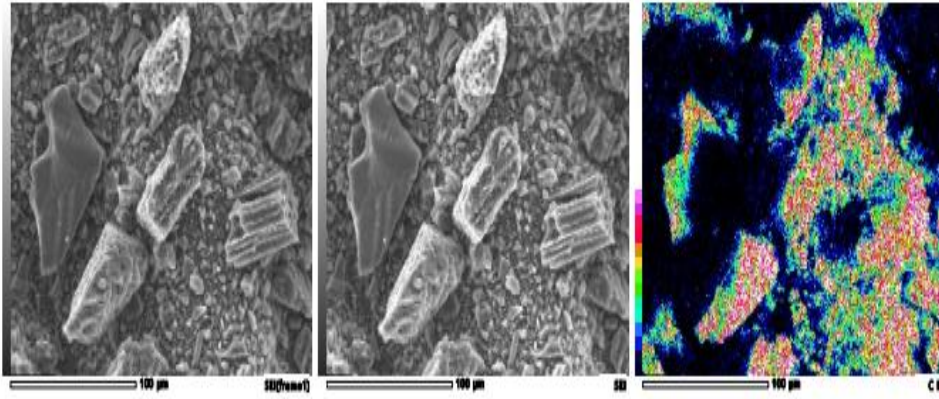


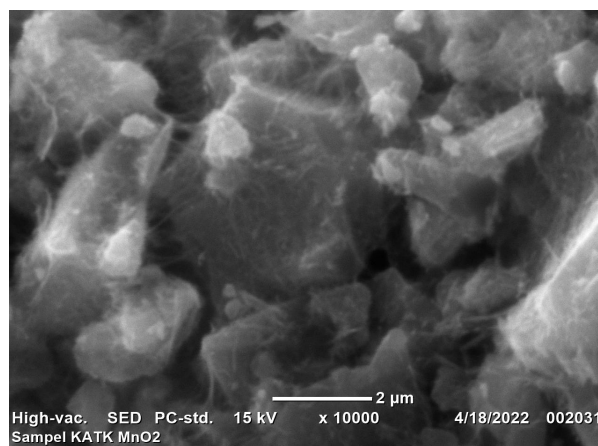
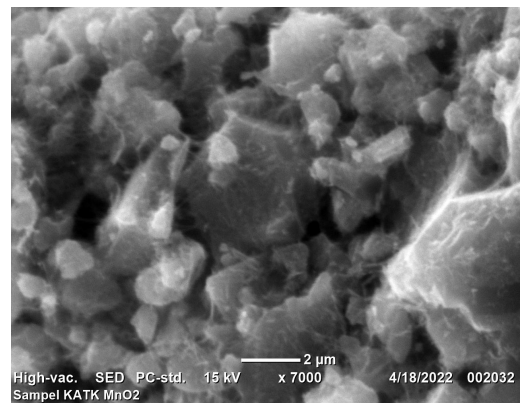
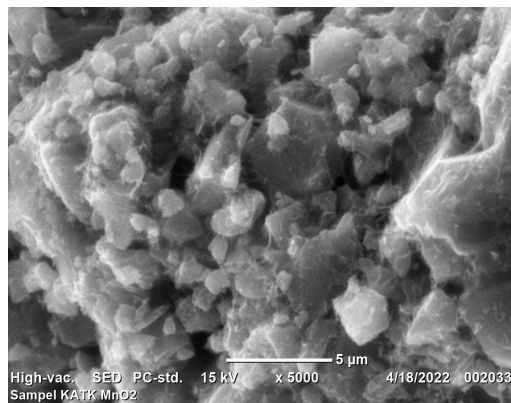
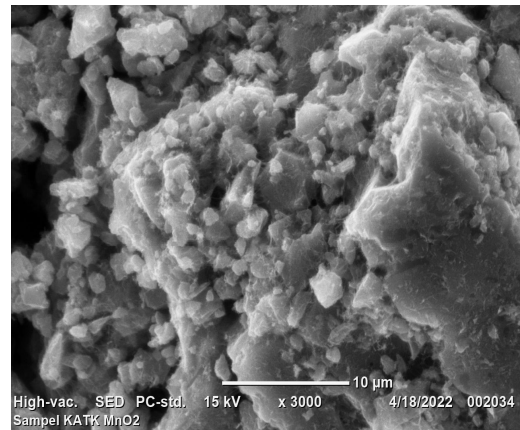
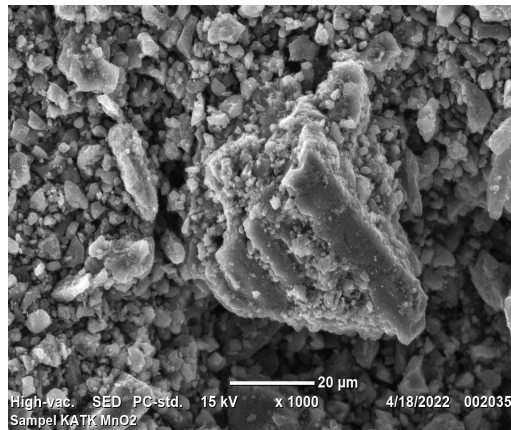
Acquisition Parameter
 Instrument : JCM-6000PLUS
 Acc. Voltage : 15.0 kV
 Probe Current : 1.00000 nA
 PMA mode : 73
 Real Time : 10.00 sec
 Live Time : 10.00 sec
 Dead Time : 1 s
 Counting Rate : 1193 cps
 Energy Range : 0 - 20 keV

Thin Film standardless, Standardless quantitative analysis
 Fitting coefficient : 0.87654

Element	(ref.)	(wt)	Mass	Counts	Sigma	Atom	Compound	Mass Ratio	Z
C K	(ref.)	0.277	81.32	8209.27	0.82	84.60		1.0000	
N K		0.825	4.18	477.14	0.22	3.18		0.0369	
Si K		1.738	8.48	69.28	0.17	0.21		0.0148	
Total			100.00			100.00			

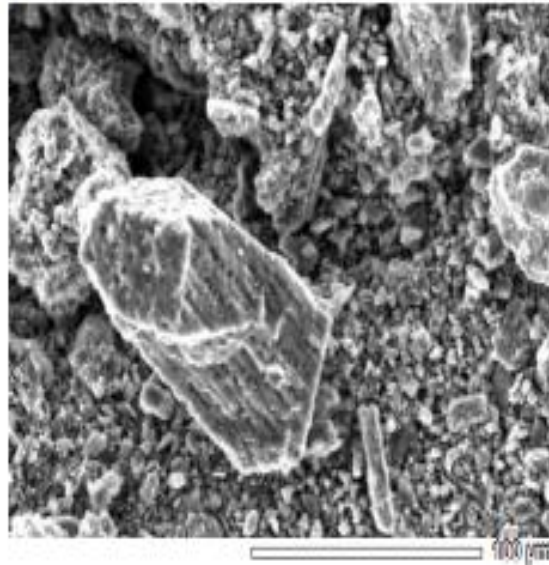
View002



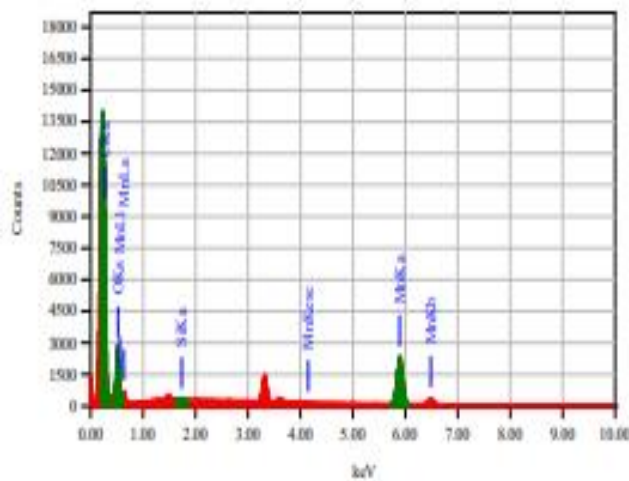
3. Hasil uji SEM KATK+MnO₂

View003

page 1/1



Title	DM1
Instrument	JSM-6010PLUS
Volt	15.00 kV
Mag.	x 500
Date	2022/04/18
Pixel	512 x 384



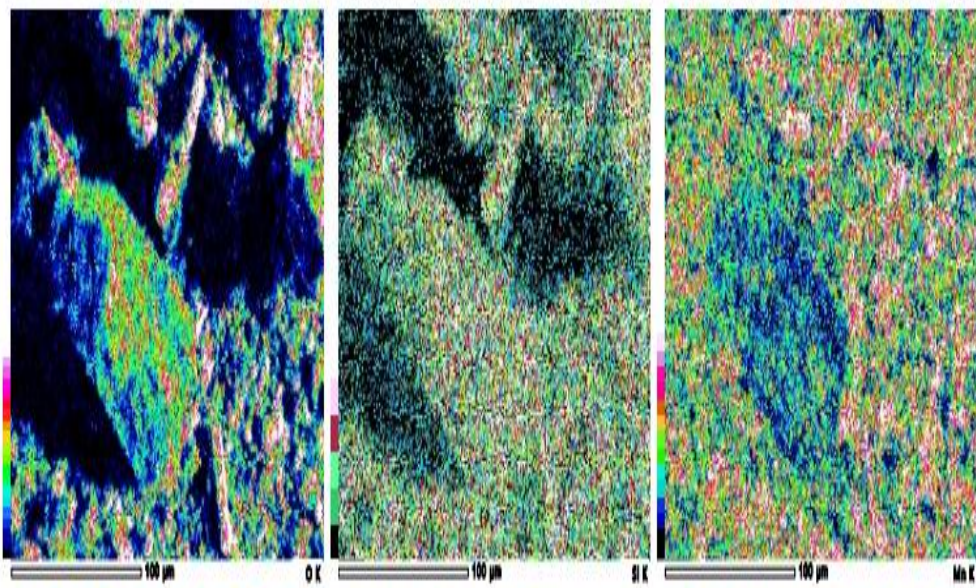
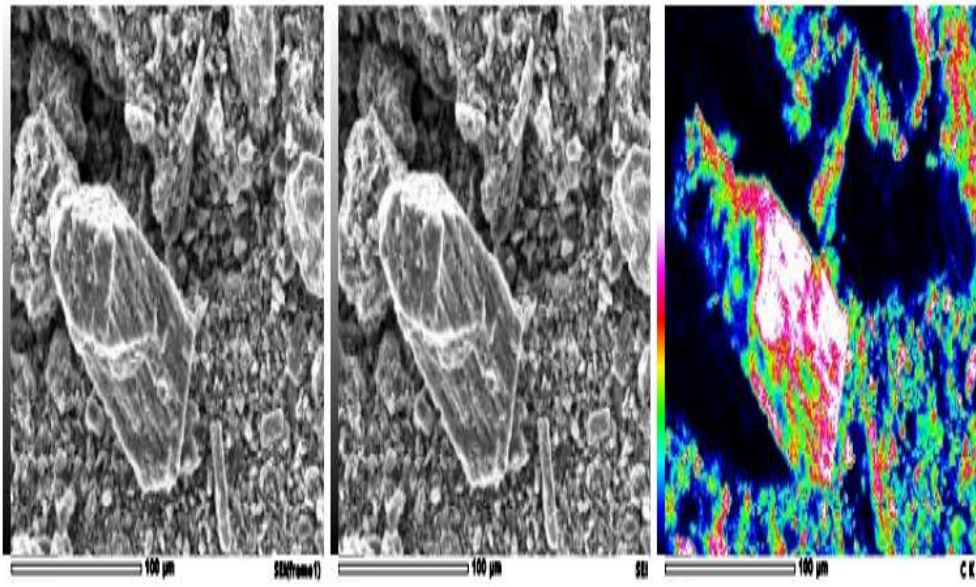
Acquisition Parameter

Instrument	JSM-6010PLUS
Acc. Voltage	15.0 kV
Probe Current	1.00000 nA
FWA Mode	TS
Real Time	51.81 sec
Live Time	10.00 sec
Dead Time	1 %
Counting Rate	8108 cps
Energy Range	0 - 20 keV

Thin film standardless standardless quantitative Analysis

Fitting coefficient : 0.5632

Element	(keV)	Mass	Counts	Sigma	Atom	Compound	Mass	Totals	Z
C K	0.277	33.08	17838.69	0.16	42.67				0.9475
O K	0.525	8.16	12935.46	0.09	15.07				0.2664
Si K	1.739	0.47	199.73	0.04	0.14				0.2879
Mn K ^{ref.}	5.894	57.58	29576.91	0.48	23.92				1.0000
Total		100.00			100.00				



Lampiran 19. Hasil Karakterisasi SAA

1. KTK



TriStar II 3020 2.00 TriStar II 3020 Version 2.00 Unit Serial #: 1108 Page 1
1 Port 1

Sample: KTK
Operator: Sarah
Submitter: 37897
File: C:\TriStar II 3020\data\SAMPEL\2022\Mel\Sample ID...KTK.SMP

Started: 5/10/2022 6:39:58 AM	Analysis Adsorptive: N2
Completed: 5/10/2022 12:03:41 PM	Analysis Bath Temp.: -195.850 °C
Report Time: 5/12/2022 1:00:40 PM	Thermal Correction: No
Sample Mass: 0.6066 g	Warm Free Space: 10.8393 cm ³ Measured
Cold Free Space: 32.1203 cm ³	Equilibration Interval: 5 s
Low Pressure Dose: None	Sample Density: 1.000 g/cm ³
Automatic Degas: No	

Summary Report

Surface Area

Single point surface area at P/Po = 0.312478818: 351.3653 m²/g

BET Surface Area: 351.0143 m²/g

t-Plot Micropore Area: 266.7521 m²/g

t-Plot External Surface Area: 84.2622 m²/g

BJH Adsorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 77.700 m²/g

BJH Desorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 76.3209 m²/g

D-H Adsorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 62.281 m²/g

D-H Desorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 69.0026 m²/g

Pore Volume

Single point adsorption total pore volume of pores
less than 317.6681 nm diameter at P/Po = 0.993943706: 0.221366 cm³/g

t-Plot micropore volume: 0.138871 cm³/g

BJH Adsorption cumulative volume of pores
between 1.7000 nm and 300.0000 nm diameter: 0.075760 cm³/g

BJH Desorption cumulative volume of pores
between 1.7000 nm and 300.0000 nm diameter: 0.073420 cm³/g

Pore Size

Adsorption average pore width (4V/A by BET): 2.52262 nm

BJH Adsorption average pore diameter (4V/A): 3.9001 nm

BJH Desorption average pore diameter (4V/A): 3.8480 nm

D-H Adsorption average pore diameter (4V/A): 4.4201 nm

D-H Desorption average pore diameter (4V/A): 4.6071 nm



TriStar II 3020 2.00

TriStar II 3020 Version 2.00 Unit
1 Port 1

Serial #: 1108

Page 2

Sample: KTK
Operator: Sarah
Submitter: 37897

File: C:\TriStar II 3020\data\SAMPEL\2022\Me\Sample ID...KTK.SMP

Started: 5/10/2022 6:39:58 AM	Analysis Adsorptive: N2
Completed: 5/10/2022 12:03:41 PM	Analysis Bath Temp.: -195.850 °C
Report Time: 5/12/2022 1:00:40 PM	Thermal Correction: No
Sample Mass: 0.6066 g	Warm Free Space: 10.8303 cm ³ Measured
Cold Free Space: 32.1203 cm ³	Equilibration Interval: 5 s
Low Pressure Dose: None	Sample Density: 1.000 g/cm ³
Automatic Degas: No	

FreundlichQm C: 88.1658 ± 0.3140 cm³/g STP

m: 19.3202 ± 0.6727

Temkinq-alpha/Qm: 0.115434 ± 0.005706 kJ/mol·(cm³/g STP)

A: 5540294.1207 ± 4431874.8891 mmHg

DFT Pore Size

Volume in Pores	<	1.483 nm	:	0.13452 cm ³ /g
Total Volume in Pores	<=	218.632 nm	:	0.18737 cm ³ /g
Area in Pores	>	218.632 nm	:	1.630 m ² /g
Total Area in Pores	>=	1.483 nm	:	26.511 m ² /g

DFT Surface EnergyTotal Area : 533.318 m²/g**Nanoparticle Size:**

Average Particle Size: 17.0933 nm

Horvath-KawazoeMaximum pore volume at P/P₀ = 0.993943708: 0.221368 cm³/g

Median pore width: 1.0512 nm

MP-MethodCumulative surface area of pores between
0.26688 nm and 1.96000 nm hydraulic radius: 559.4454 m²/gCumulative pore volume of pores between
0.26688 nm and 1.96000 nm hydraulic radius: 0.198571 cm³/g

Average pore hydraulic radius (V/A): 0.35494 nm



TriStar II 3020 2.00

TriStar II 3020 Version 2.00 Unit
1 Port 1

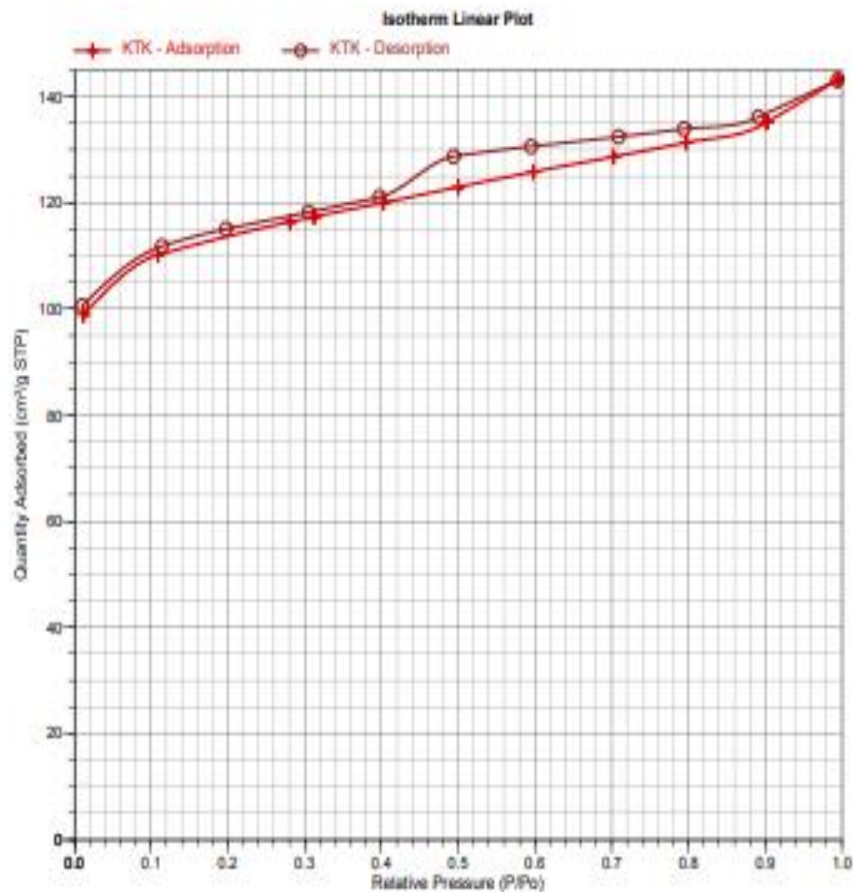
Serial #: 1108

Page 4

Sample: KTK
 Operator: Sarah
 Submitter: 37897
 File: C:\TriStar II 3020\data\SAMPLE\2022\Mel\Sample ID...KTK.SMP

Started: 5/10/2022 6:39:56 AM
 Completed: 5/10/2022 12:03:41 PM
 Report Time: 5/12/2022 1:00:40 PM
 Sample Mass: 0.6066 g
 Cold Free Space: 32.1203 cm³
 Low Pressure Dose: None
 Automatic Degas: No

Analysis Adsorptive: N₂
 Analysis Bath Temp.: -195.850 °C
 Thermal Correction: No
 Warm Free Space: 10.8303 cm³ Measured
 Equilibration Interval: 5 s
 Sample Density: 1.000 g/cm³



2. KATK



TriStar II 3020 2.00

TriStar II 3020 Version 2.00 Unit
1 Port 2

Serial #: 1108

Page 1

Sample: KATK
 Operator: Sarah
 Submitter: 37897
 File: C:\TriStar II 3020\data\SAMPLE\2022\Me\Sample L..KATK.SMP

Started: 5/10/2022 6:39:56 AM	Analysis Adsorptive: N2
Completed: 5/10/2022 12:03:41 PM	Analysis Bath Temp.: -195.850 °C
Report Time: 5/12/2022 1:01:23 PM	Thermal Correction: No
Sample Mass: 0.5833 g	Warm Free Space: 11.1636 cm ³ Measured
Cold Free Space: 33.6423 cm ³	Equilibration Interval: 5 s
Low Pressure Dose: None	Sample Density: 1.000 g/cm ³
Automatic Degas: No	

Summary Report**Surface Area**Single point surface area at P/P₀ = 0.315935998: 517.7737 m²/gBET Surface Area: 518.5501 m²/gt-Plot Micropore Area: 381.8623 m²/gt-Plot External Surface Area: 156.6878 m²/gBJH Adsorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 145.580 m²/gBJH Desorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 143.0602 m²/gD-H Adsorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 115.687 m²/gD-H Desorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 128.0632 m²/g**Pore Volume**Single point adsorption total pore volume of pores
less than 275.6684 nm diameter at P/P₀ = 0.993011555: 0.329341 cm³/gt-Plot micropore volume: 0.189350 cm³/gBJH Adsorption cumulative volume of pores
between 1.7000 nm and 300.0000 nm diameter: 0.127683 cm³/gBJH Desorption cumulative volume of pores
between 1.7000 nm and 300.0000 nm diameter: 0.125727 cm³/g**Pore Size**

Adsorption average pore width (4V/A by BET): 2.54047 nm

BJH Adsorption average pore diameter (4V/A): 3.5082 nm

BJH Desorption average pore diameter (4V/A): 3.5154 nm

D-H Adsorption average pore diameter (4V/A): 3.9667 nm

D-H Desorption average pore diameter (4V/A): 3.8685 nm



TriStar II 3020 2.00

TriStar II 3020 Version 2.00 Unit
1 Port 2

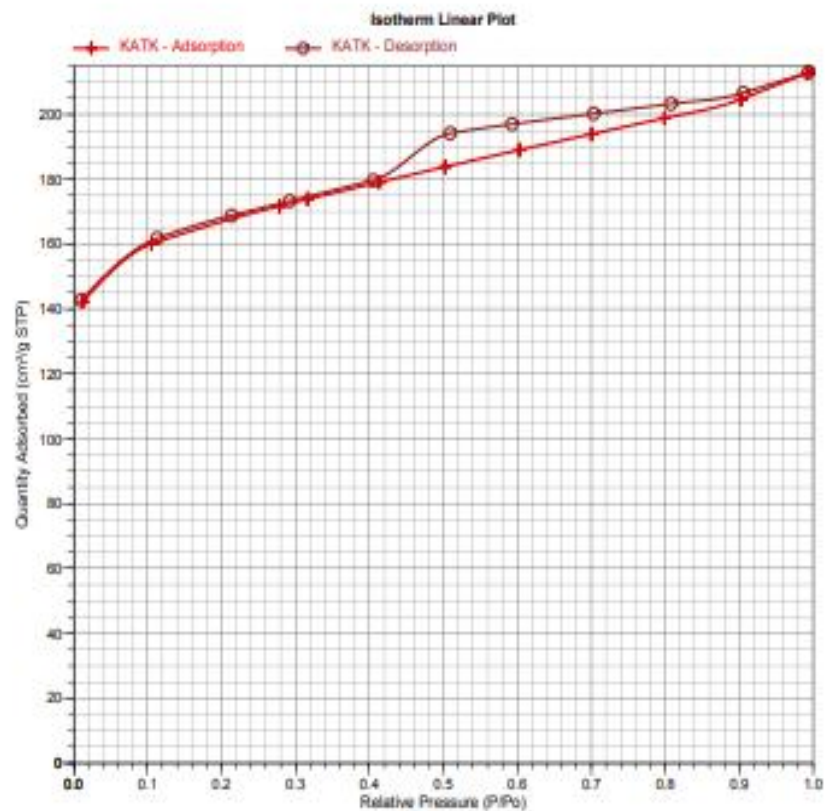
Serial #: 1108

Page 4

Sample: KATK
 Operator: Sarah
 Submitter: 37897
 File: C:\TriStar II 3020\data\SAMPLE\2022\Mel\Sample 1...KATK.SMP

Started: 5/10/2022 6:39:58 AM
 Completed: 5/10/2022 12:03:41 PM
 Report Time: 5/12/2022 1:01:24 PM
 Sample Mass: 0.5833 g
 Cold Free Space: 33.6423 cm³
 Low Pressure Dose: None
 Automatic Degas: No

Analysis Adsorptive: N2
 Analysis Bath Temp.: -195.850 °C
 Thermal Correction: No
 Warm Free Space: 11.1636 cm³ Measured
 Equilibration Interval: 5 s
 Sample Density: 1.000 g/cm³



3.KATK+MnO₂

TriStar II 3020 2.00

TriStar II 3020 Version 2.00 Unit
1 Part 3

Serial #: 1108

Page 1

Sample: KATK-MnO₂
 Operator: Sarah
 Submitter: 37897
 File: C:\TriStar II 3020\data\SAMPEL\2022\Me75am...KATK-MnO₂.SMP

Started: 5/10/2022 6:39:58 AM	Analysis Adsorptive: N ₂
Completed: 5/10/2022 12:03:42 PM	Analysis Bath Temp.: -195.850 °C
Report Time: 5/12/2022 1:03:15 PM	Thermal Correction: No
Sample Mass: 0.3707 g	Warm Free Space: 11.2842 cm ³ Measured
Cold Free Space: 32.9975 cm ³	Equilibration Interval: 5 s
Low Pressure Dose: None	Sample Density: 1.000 g/cm ³
Automatic Degas: No	

Summary Report**Surface Area**Single point surface area at P/P₀ = 0.324924007: 392.3282 m²/gBET Surface Area: 395.6897 m²/gt-Plot Micropore Area: 259.2675 m²/gt-Plot External Surface Area: 136.4222 m²/gBJH Adsorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 118.474 m²/gBJH Desorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 125.9909 m²/gD-H Adsorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 102.193 m²/gD-H Desorption cumulative surface area of pores
between 1.7000 nm and 300.0000 nm diameter: 113.7304 m²/g**Pore Volume**Single point adsorption total pore volume of pores
less than 257.2334 nm diameter at P/P₀ = 0.992505284: 0.290335 cm³/gt-Plot micropore volume: 0.136829 cm³/gBJH Adsorption cumulative volume of pores
between 1.7000 nm and 300.0000 nm diameter: 0.140700 cm³/gBJH Desorption cumulative volume of pores
between 1.7000 nm and 300.0000 nm diameter: 0.141620 cm³/g**Pore Size**

Adsorption average pore width (4V/A by BET): 2.93498 nm

BJH Adsorption average pore diameter (4V/A): 4.7504 nm

BJH Desorption average pore diameter (4V/A): 4.4962 nm

D-H Adsorption average pore diameter (4V/A): 5.1629 nm

D-H Desorption average pore diameter (4V/A): 4.7112 nm



TriStar II 3020 2.00

TriStar II 3020 Version 2.00 Unit
1 Port 1

Serial #: 1108

Page 2:

Sample: KTK
 Operator: Sarah
 Submitter: 37897
 File: C:\TriStar II 3020\data\SAMPEL\2022\Me\Sample ID...KTK.SMP

Started: 5/10/2022 8:39:56 AM	Analysis Adsorptive: N2
Completed: 5/10/2022 12:03:41 PM	Analysis Bath Temp.: -195.850 °C
Report Time: 5/12/2022 1:00:40 PM	Thermal Correction: No
Sample Mass: 0.8066 g	Warm Free Space: 10.8393 cm ³ Measured
Cold Free Space: 32.1203 cm ³	Equilibration Interval: 5 s
Low Pressure Dose: None	Sample Density: 1.000 g/cm ³
Automatic Degas: No	

FreundlichQm C: 88.1658 ± 0.3140 cm³/g STP

m: 19.3292 ± 0.8727

Temkinq-alpha/Qm: 0.115434 ± 0.005706 kJ/mol (cm³/g STP)

A: 5540294.1207 ± 4431874.8901 mmHg

DFT Pore Size

Volume in Pores	<	1.483 nm	:	0.13452 cm ³ /g
Total Volume in Pores	<=	216.632 nm	:	0.18737 cm ³ /g
Area in Pores	>	216.632 nm	:	1.630 m ² /g
Total Area in Pores	>=	1.483 nm	:	26.511 m ² /g

DFT Surface EnergyTotal Area : 533.318 m²/g**Nanoparticle Size:**

Average Particle Size: 17.0933 nm

Horvath-KawazoeMaximum pore volume at P/Po = 0.993943706: 0.221368 cm³/g

Median pore width: 1.0512 nm

MP-MethodCumulative surface area of pores between
0.26688 nm and 1.96000 nm hydraulic radius: 559.4454 m²/gCumulative pore volume of pores between
0.26688 nm and 1.96000 nm hydraulic radius: 0.198571 cm³/g

Average pore hydraulic radius (V/A): 0.35494 nm



TriStar II 3020 2.00

TriStar II 3020 Version 2.00 - Unit
1 Port 3

Serial #: 1108

Page 4

Sample: KATK-MnO2
 Operator: Sarah
 Submitter: 37897
 File: C:\TriStar II 3020\data\SAMPLE\0022\MnO2\Sam...KATK-MnO2 SMP

Started: 5/10/2022 6:39:58 AM	Analysis Adsorptive: N2
Completed: 5/10/2022 12:03:42 PM	Analysis Bath Temp.: -195.850 °C
Report Time: 5/12/2022 1:03:15 PM	Thermal Correction: No
Sample Mass: 0.3707 g	Warm Free Space: 11.2842 cm ³ Measured
Cold Free Space: 32.9675 cm ³	Equilibration Interval: 5 s
Low Pressure Dose: None	Sample Density: 1.000 g/cm ³
Automatic Degas: No	

