

LAMPIRAN

Lampiran 01. Perhitungan Pembuatan Larutan

1. Pembuatan larutan prekursor $\text{Cu}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$ 1 M

$$M = \frac{\text{massa}}{Mr} \times \frac{1000}{V}$$

$$1 \text{ M} = \frac{\text{massa}}{199,65 \text{ g/mol}} \times \frac{1000 \text{ mL}}{100 \text{ mL}}$$

$$\text{massa} = \frac{199,65 \text{ g} \times 100 \text{ mL}}{1000 \text{ mL}}$$

$$\text{massa} = \frac{199,65 \text{ g}}{10}$$

$$\text{massa} = 19,965 \text{ g}$$

2. Pembuatan larutan prekursor $\text{ZnCl}_2 \cdot 6\text{H}_2\text{O}$ 1 M

$$M = \frac{\text{massa}}{Mr} \times \frac{1000}{V}$$

$$1 \text{ M} = \frac{\text{massa}}{136,29 \text{ g/mol}} \times \frac{1000 \text{ mL}}{100 \text{ mL}}$$

$$\text{massa} = \frac{136,29 \text{ g} \times 100 \text{ mL}}{1000 \text{ mL}}$$

$$\text{massa} = \frac{136,29 \text{ g}}{10}$$

$$\text{massa} = 13,629 \text{ g}$$

3. Pembuatan larutan prekursor NaOH 4 M

$$M = \frac{\text{massa}}{Mr} \times \frac{1000}{V}$$

$$4 \text{ M} = \frac{\text{massa}}{40 \text{ g/mol}} \times \frac{1000 \text{ mL}}{100 \text{ mL}}$$

$$\text{massa} = \frac{40 \text{ g/mol} \times 100 \text{ mL}}{1000 \text{ mL}} \times 4 \text{ M}$$

$$\text{massa} = \frac{160 \text{ g}}{10}$$

$$\text{massa} = 16 \text{ g}$$

Lampiran 02. Perhitungan Hasil Karakterisasi Nanopartikel

a) Perhitungan Ukuran Kristalit

Perhitungan ukuran kristalit dilakukan dengan menggunakan Persamaan Scherrer sebagai berikut.

$$D = \frac{K\lambda}{\beta \cos \theta}$$

Keterangan:

D : ukuran kristal

K : konstanta Scherrer (0,9-1)

β : pelebaran garis pada setengah intensitas maksimum *Full Width a Half Maximum* (FWHM) dalam radian

θ : sudut yang diperoleh dari nilai 2θ dengan puncak paling kuat dari pengukuran XRD untuk sampel tertentu

- Langkah awal yang dilakukan adalah menentukan theta dan FWHM dengan satuan radian. Data yang diperoleh adalah 2θ dan FWHM (deg), maka perhitungan adalah sebagai berikut.

- $2\theta = 30,32^\circ$; maka $\theta = \frac{30,32^\circ}{2} = 15,16^\circ = 0,26455 \text{ radian}$

- FWHM = $0,21^\circ = 0,00367 \text{ radian}$

Adapun hasil perhitungan dalam bentuk radian untuk data difaktogram nanopartikel adalah sebagai berikut.

CuO-NPs

No	2-theta(deg)	theta (deg)	theta (rad)	FWHM (deg)	FWHM (rad)
1	30,32	15,16	0,26455	0,21	0,00367
2	32,58	16,29	0,28433	0,36	0,00621
3	33,78	16,89	0,29476	0,18	0,00312
4	34,40	17,20	0,30020	0,20	0,00349
5	35,74	17,87	0,31187	0,27	0,00464
6	36,61	18,30	0,31947	0,43	0,00750
7	38,07	19,03	0,33220	0,22	0,00389
8	38,90	19,45	0,33949	0,34	0,00590
9	40,17	20,09	0,35055	0,55	0,00960
10	41,54	20,77	0,36249	0,23	0,00401
11	42,52	21,26	0,37106	0,11	0,00192
12	43,57	21,78	0,38020	0,07	0,00122
13	44,04	22,02	0,38432	0,12	0,00209

14	45,31	22,66	0,39540	0,25	0,00436
15	46,52	23,26	0,40596	0,28	0,00489
16	48,89	24,45	0,42668	0,29	0,00511
17	53,72	26,86	0,46880	0,35	0,00611
18	57,11	28,56	0,49838	0,26	0,00454
19	57,47	28,74	0,50152	0,19	0,00332
20	58,51	29,26	0,51060	0,33	0,00576
21	61,78	30,89	0,53909	0,27	0,00468
22	66,00	33,00	0,57596	0,51	0,00890
23	66,43	33,22	0,57973	0,25	0,00436
24	68,24	34,12	0,59551	0,45	0,00785
25	72,46	36,23	0,63233	0,56	0,00977
26	75,19	37,60	0,65616	0,60	0,01047
27	80,44	40,22	0,70197	0,30	0,00524
28	82,49	41,25	0,71988	0,14	0,00244
29	83,62	41,81	0,72972	1,25	0,02182

ZnO-NPs

No	2-theta(deg)	theta (deg)	theta (rad)	FWHM (deg)	FWHM (rad)
1	30,32	15,16	0,26455	0,21	0,00367
2	32,58	16,29	0,28433	0,36	0,00621
3	33,78	16,89	0,29476	0,18	0,00312
4	34,40	17,20	0,30020	0,20	0,00349
5	35,74	17,87	0,31187	0,27	0,00464
6	36,61	18,30	0,31947	0,43	0,00750
7	38,07	19,03	0,33220	0,22	0,00389
8	38,90	19,45	0,33949	0,34	0,00590
9	40,17	20,09	0,35055	0,55	0,00960
10	41,54	20,77	0,36249	0,23	0,00401
11	42,52	21,26	0,37106	0,11	0,00192
12	43,57	21,78	0,38020	0,07	0,00122
13	44,04	22,02	0,38432	0,12	0,00209
14	45,31	22,66	0,39540	0,25	0,00436
15	46,52	23,26	0,40596	0,28	0,00489
16	48,89	24,45	0,42668	0,29	0,00511
17	53,72	26,86	0,46880	0,35	0,00611
18	57,11	28,56	0,49838	0,26	0,00454
19	57,47	28,74	0,50152	0,19	0,00332
20	58,51	29,26	0,51060	0,33	0,00576
21	61,78	30,89	0,53909	0,27	0,00468

CuO/ZnO-NPs (1:1)

No	2-theta(deg)	theta (deg)	theta (rad)	FWHM (deg)	FWHM (rad)
1	11,63	5,816	0,101508	0,26	0,004538
2	16,55	8,275	0,144426	0,28	0,004887
3	16,98	8,490	0,148179	0,19	0,003316
4	22,49	11,245	0,196262	0,27	0,004712
5	22,93	11,465	0,200102	0,19	0,003316
6	25,22	12,610	0,220086	0,22	0,003804
7	27,72	13,858	0,241877	0,09	0,001571
8	28,47	14,236	0,248474	0,23	0,004014
9	30,75	15,375	0,268344	0,19	0,003316
10	31,41	15,705	0,274104	0,12	0,002147
11	32,09	16,045	0,280038	0,12	0,002164
12	33,21	16,605	0,289812	0,19	0,003316
13	33,87	16,935	0,295580	0,10	0,001833
14	34,89	17,443	0,304438	0,22	0,003805
15	35,93	17,966	0,313566	0,19	0,003368
16	36,66	18,331	0,319945	0,18	0,003159
17	38,24	19,118	0,333672	0,17	0,002967
18	39,11	19,556	0,341325	0,18	0,003124
19	45,27	22,635	0,395055	0,58	0,010123
20	45,88	22,913	0,399916	0,13	0,002304
21	46,60	23,300	0,406662	0,55	0,009599
22	47,88	23,940	0,417832	0,17	0,002967
23	49,09	24,546	0,428409	0,18	0,003211
24	51,28	25,640	0,447503	0,70	0,012217
25	51,93	25,965	0,453175	0,22	0,003840
26	53,89	26,914	0,469738	0,14	0,002443
27	54,36	27,180	0,474381	0,66	0,011519
28	56,87	28,435	0,496285	0,32	0,005585
29	58,59	29,295	0,511294	0,35	0,006126
30	59,80	29,902	0,521889	0,20	0,003491
31	61,91	30,957	0,540302	0,24	0,004241
32	63,15	31,575	0,551088	0,29	0,005061
33	66,14	33,070	0,577181	0,26	0,004538
34	66,58	33,290	0,581012	0,19	0,003246
35	68,41	34,205	0,596990	0,38	0,006650
36	69,43	34,715	0,605891	0,82	0,014312
37	72,70	36,350	0,634427	0,39	0,006807
38	75,53	37,765	0,659124	0,43	0,007505
39	77,30	38,650	0,674570	0,52	0,009076
40	80,42	40,210	0,701797	0,23	0,004014
41	82,72	41,360	0,721868	0,24	0,004189

42	83,88	41,940	0,731991	1,26	0,021991
43	86,98	43,490	0,759044	0,30	0,005236

CuO/ZnO-NPs (CBest)

No	2-theta(deg)	theta (deg)	theta (rad)	FWHM (deg)	FWHM (rad)
1	31,96	15,978	0,278878	0,37	0,006545
2	32,67	16,335	0,285100	0,54	0,009425
3	34,64	17,321	0,302309	0,34	0,006004
4	35,75	17,873	0,311952	0,32	0,005515
5	36,47	18,236	0,318278	0,45	0,007941
6	38,15	19,075	0,332922	0,13	0,002269
7	38,96	19,481	0,340008	0,41	0,007086
8	42,53	21,265	0,371144	0,42	0,007330
9	45,64	22,820	0,398284	0,25	0,004363
10	47,73	23,865	0,416523	0,57	0,009948
11	48,96	24,480	0,427257	0,38	0,006632
12	53,91	26,955	0,470454	0,47	0,008203
13	56,80	28,400	0,495674	0,54	0,009390
14	58,45	29,227	0,510108	0,36	0,006283
15	61,75	30,875	0,538871	0,32	0,005585
16	63,05	31,523	0,550180	0,55	0,009634
17	66,56	33,280	0,580846	0,70	0,012217
18	68,15	34,077	0,594756	0,59	0,010245
19	69,25	34,625	0,604321	0,58	0,010123
20	72,70	36,350	0,634427	0,51	0,008901
21	75,37	37,685	0,657728	0,46	0,008029
22	83,20	41,600	0,726057	2,76	0,048171
23	31,96	15,9785	0,278878	0,37	0,006545

- Menentukan ukuran kristalit rata-rata

$$D = \frac{K\lambda}{\beta \cos \theta} = \frac{0,94, 1,54056 \text{ \AA}}{0,00367, 0,96521} = 409,93431 \text{ \AA} = 40,93431 \text{ nm}$$

Adapun hasil perhitungan ukuran kristalit untuk data difraktogram nanopartikel adalah sebagai berikut.

CuO-NPs

No	K	λ	FWHM (rad)	Cos- theta	D	D (nm)
1	0,94	1,54056	0,00367	0,96521	409,34313	40,93431
2	0,94	1,54056	0,00621	0,95985	242,81519	24,28152
3	0,94	1,54056	0,00312	0,95687	484,42003	48,44200

4	0,94	1,54056	0,00349	0,95528	434,27917	43,42792
5	0,94	1,54056	0,00464	0,95176	327,73256	32,77326
6	0,94	1,54056	0,00750	0,94940	203,24079	20,32408
7	0,94	1,54056	0,00389	0,94533	393,58771	39,35877
8	0,94	1,54056	0,00590	0,94292	260,33687	26,03369
9	0,94	1,54056	0,00960	0,93918	160,62586	16,06259
10	0,94	1,54056	0,00401	0,93502	385,81694	38,58169
11	0,94	1,54056	0,00192	0,93194	809,36825	80,93682
12	0,94	1,54056	0,00122	0,92859	1276,4598	127,6460
13	0,94	1,54056	0,00209	0,92705	745,83562	74,58356
14	0,94	1,54056	0,00436	0,92284	359,63513	35,96351
15	0,94	1,54056	0,00489	0,91872	322,54229	32,25423
16	0,94	1,54056	0,00511	0,91034	311,06817	31,10682
17	0,94	1,54056	0,00611	0,89211	265,73023	26,57302
18	0,94	1,54056	0,00454	0,87836	363,31533	36,33153
19	0,94	1,54056	0,00332	0,87685	498,02225	49,80223
20	0,94	1,54056	0,00576	0,87245	288,18595	28,81860
21	0,94	1,54056	0,00468	0,85818	360,75915	36,07591
22	0,94	1,54056	0,00890	0,83867	193,98467	19,39847
23	0,94	1,54056	0,00436	0,83661	396,70275	39,67028
24	0,94	1,54056	0,00785	0,82786	222,71895	22,27190
25	0,94	1,54056	0,00977	0,80665	183,67723	18,36772
26	0,94	1,54056	0,01047	0,79234	174,52779	17,45278
27	0,94	1,54056	0,00524	0,76357	362,20841	36,22084
28	0,94	1,54056	0,00244	0,75189	788,22299	78,82230
29	0,94	1,54056	0,02182	0,74536	89,05394	8,90539
					D (nm)	39,01454

ZnO-NPs

No	K	λ	FWHM (rad)	Cos-theta	D	D (nm)
1	0,94	1,54056	0,004014	0,971290	371,4087	37,14087
2	0,94	1,54056	0,004154	0,961490	362,5829	36,25829
3	0,94	1,54056	0,004084	0,954683	371,4103	37,14103
4	0,94	1,54056	0,004136	0,949860	368,5708	36,85708
5	0,94	1,54056	0,002618	0,921779	600,0827	60,00827
6	0,94	1,54056	0,003787	0,914498	418,1062	41,81062
7	0,94	1,54056	0,004014	0,890967	404,8923	40,48923
8	0,94	1,54056	0,004765	0,879761	345,4632	34,54632
9	0,94	1,54056	0,003403	0,852471	499,131	49,91310
10	0,94	1,54056	0,002443	0,839288	706,1387	70,61387
11	0,94	1,54056	0,006912	0,836812	250,3836	25,03836
12	0,94	1,54056	0,003508	0,828495	498,2448	49,82448
13	0,94	1,54056	0,003386	0,822953	519,6994	51,96994

14	0,94	1,54056	0,003491	0,805359	515,1209	51,51209
15	0,94	1,54056	0,004014	0,803129	449,1750	44,91750
16	0,94	1,54056	0,002758	0,791271	663,6611	66,36611
17	0,94	1,54056	0,002443	0,788918	751,2235	75,12235
18	0,94	1,54056	0,004363	0,781792	424,5193	42,45193
19	0,94	1,54056	0,00384	0,757422	497,9298	49,79298
20	0,94	1,54056	0,003421	0,742747	569,9434	56,99434
21	0,94	1,54056	0,00377	0,708635	542,0663	54,20663
					D (nm)	48,23692

CuO/ZnO-NPs (1:1)

No	K	λ	FWHM (rad)	Cos-theta	D	D (nm)
1	0,94	1,54056	0,004538	0,994852	320,7723	32,07723
2	0,94	1,54056	0,004887	0,989589	299,4444	29,94444
3	0,94	1,54056	0,003316	0,989042	441,5305	44,15305
4	0,94	1,54056	0,004712	0,980802	313,3168	31,33168
5	0,94	1,54056	0,003316	0,980046	445,5831	44,55831
6	0,94	1,54056	0,003840	0,975879	386,4652	38,64652
7	0,94	1,54056	0,001571	0,970890	949,5466	94,95466
8	0,94	1,54056	0,004014	0,969289	372,1756	37,21756
9	0,94	1,54056	0,003316	0,964211	452,9009	45,29009
10	0,94	1,54056	0,002147	0,962668	700,7244	70,07244
11	0,94	1,54056	0,002164	0,961045	696,2474	69,62474
12	0,94	1,54056	0,003316	0,958298	455,6957	45,56957
13	0,94	1,54056	0,001833	0,956633	826,0268	82,60268
14	0,94	1,54056	0,003805	0,954016	398,9486	39,89486
15	0,94	1,54056	0,003368	0,951240	451,9409	45,19409
16	0,94	1,54056	0,003159	0,949253	482,9126	48,29126
17	0,94	1,54056	0,002967	0,944846	516,5578	51,65578
18	0,94	1,54056	0,003124	0,942312	491,9050	49,19050
19	0,94	1,54056	0,010123	0,922975	154,9926	15,49926
20	0,94	1,54056	0,002304	0,921094	682,4192	68,24192
21	0,94	1,54056	0,009599	0,918446	164,2527	16,42527
22	0,94	1,54056	0,002967	0,913971	534,0079	53,40079
23	0,94	1,54056	0,003211	0,909628	495,7324	49,57324
24	0,94	1,54056	0,012217	0,901531	131,4772	13,14772
25	0,94	1,54056	0,003840	0,899062	419,4853	41,94853
26	0,94	1,54056	0,002443	0,891687	664,6431	66,46431
27	0,94	1,54056	0,011519	0,889576	141,3195	14,13195
28	0,94	1,54056	0,005585	0,879358	294,8583	29,48583
29	0,94	1,54056	0,006126	0,872112	271,0501	27,10501
30	0,94	1,54056	0,003491	0,866879	478,5643	47,85643
31	0,94	1,54056	0,004241	0,857553	398,1635	39,81635

32	0,94	1,54056	0,005061	0,851955	335,8258	33,58258
33	0,94	1,54056	0,004538	0,838004	380,8108	38,08108
34	0,94	1,54056	0,003246	0,835908	533,6513	53,36513
35	0,94	1,54056	0,006650	0,827031	263,3189	26,33189
36	0,94	1,54056	0,014312	0,821995	123,0966	12,30966
37	0,94	1,54056	0,006807	0,805411	264,1476	26,41476
38	0,94	1,54056	0,007505	0,790529	244,0858	24,40858
39	0,94	1,54056	0,009076	0,780976	204,3093	20,43093
40	0,94	1,54056	0,004014	0,763683	472,3760	47,23760
41	0,94	1,54056	0,004189	0,750572	460,6012	46,06012
42	0,94	1,54056	0,021991	0,743845	88,52705	8,852705
43	0,94	1,54056	0,005236	0,725494	381,2182	38,12182
					D (nm)	40,89681

CuO/ZnO-NPs (CBest)

No	K	λ	FWHM (rad)	Cos-theta	D	D (nm)
1	0,94	1,54056	0,006545	0,961365	230,1491	23,01491
2	0,94	1,54056	0,009425	0,959634	160,1141	16,01141
3	0,94	1,54056	0,006004	0,954652	252,6536	25,26536
4	0,94	1,54056	0,005515	0,951736	275,8831	27,58831
5	0,94	1,54056	0,007941	0,949776	191,9979	19,19979
6	0,94	1,54056	0,002269	0,945092	675,3232	67,53232
7	0,94	1,54056	0,007086	0,942752	216,7731	21,67731
8	0,94	1,54056	0,007330	0,931913	211,9846	21,19846
9	0,94	1,54056	0,004363	0,921728	360,0694	36,00694
10	0,94	1,54056	0,009948	0,914501	159,1731	15,91731
11	0,94	1,54056	0,006632	0,910106	239,9128	23,99128
12	0,94	1,54056	0,008203	0,891363	198,0508	19,80508
13	0,94	1,54056	0,009390	0,879648	175,3224	17,53224
14	0,94	1,54056	0,006283	0,872692	264,0982	26,40982
15	0,94	1,54056	0,005585	0,858289	302,0964	30,20964
16	0,94	1,54056	0,009634	0,85243	176,3319	17,63319
17	0,94	1,54056	0,012217	0,835999	141,7833	14,17833
18	0,94	1,54056	0,010245	0,828285	170,6518	17,06518
19	0,94	1,54056	0,010123	0,822888	173,8441	17,38441
20	0,94	1,54056	0,008901	0,805411	201,9952	20,19952
21	0,94	1,54056	0,008029	0,791383	227,9209	22,79209
22	0,94	1,54056	0,048171	0,747798	40,20088	4,020088
					D (nm)	22,93786

b) Perhitungan *d-spacing*

Penentuan *d-spacing* dilakukan dengan menggunakan persamaan sebagai berikut,

$$n\lambda = 2d\sin\theta$$

$$2d = \frac{n\lambda}{\sin\theta} = \frac{1,54056\text{\AA}}{0,26147} = 5,89184\text{\AA} = \frac{5,89184\text{\AA}}{2} = 2,94592\text{\AA} = 0,29459\text{ nm}$$

Adapun hasil perhitungan *d-spacing* berdasarkan data difraktogram yang diberikan dapat dilihat pada rincian berikut,

CuO-NPs

No	λ	sin-theta	$n\lambda/\sin\theta$	d	d (nm)
1	1,54056	0,26147	5,89184	2,94592	0,29459
2	1,54056	0,28052	5,49188	2,74594	0,27459
3	1,54056	0,29051	5,30295	2,65147	0,26515
4	1,54056	0,29571	5,20973	2,60487	0,26049
5	1,54056	0,30684	5,02070	2,51035	0,25103
6	1,54056	0,31407	4,90519	2,45260	0,24526
7	1,54056	0,32612	4,72389	2,36194	0,23619
8	1,54056	0,33301	4,62618	2,31309	0,23131
9	1,54056	0,34341	4,48601	2,24301	0,22430
10	1,54056	0,35460	4,34449	2,17224	0,21722
11	1,54056	0,36260	4,24864	2,12432	0,21243
12	1,54056	0,37111	4,15124	2,07562	0,20756
13	1,54056	0,37493	4,10892	2,05446	0,20545
14	1,54056	0,38518	3,99957	1,99978	0,19998
15	1,54056	0,39490	3,90110	1,95055	0,19505
16	1,54056	0,41385	3,72249	1,86125	0,18612
17	1,54056	0,45181	3,40974	1,70487	0,17049
18	1,54056	0,47800	3,22291	1,61146	0,16115
19	1,54056	0,48076	3,20443	1,60222	0,16022
20	1,54056	0,48870	3,15238	1,57619	0,15762
21	1,54056	0,51335	3,00097	1,50048	0,15005
22	1,54056	0,54464	2,82859	1,41429	0,14143
23	1,54056	0,54780	2,81228	1,40614	0,14061
24	1,54056	0,56093	2,74645	1,37322	0,13732
25	1,54056	0,59103	2,60658	1,30329	0,13033
26	1,54056	0,61008	2,52519	1,26260	0,12626
27	1,54056	0,64572	2,38579	1,19289	0,11929
28	1,54056	0,65929	2,33668	1,16834	0,11683
29	1,54056	0,66666	2,31085	1,15543	0,11554
				d (nm)	0,19082

ZnO-NPs

No	λ	sin-theta	$n\lambda/\sin\theta$	d	d (nm)
1	1,54056	0,23790	6,47572	3,23786	0,32379
2	1,54056	0,27484	5,60529	2,80264	0,28026
3	1,54056	0,29762	5,17618	2,58809	0,25881
4	1,54056	0,31267	4,92703	2,46352	0,24635
5	1,54056	0,38772	3,97342	1,98671	0,19867
6	1,54056	0,40459	3,80770	1,90385	0,19038
7	1,54056	0,45407	3,39279	1,69640	0,16964
8	1,54056	0,47542	3,24044	1,62022	0,16202
9	1,54056	0,52277	2,94689	1,47345	0,14734
10	1,54056	0,54369	2,83354	1,41677	0,14168
11	1,54056	0,54749	2,81386	1,40693	0,14069
12	1,54056	0,56000	2,75102	1,37551	0,13755
13	1,54056	0,56811	2,71173	1,35586	0,13559
14	1,54056	0,59279	2,59884	1,29942	0,12994
15	1,54056	0,59580	2,58568	1,29284	0,12928
16	1,54056	0,61147	2,51946	1,25973	0,12597
17	1,54056	0,61450	2,50702	1,25351	0,12535
18	1,54056	0,62354	2,47067	1,23534	0,12353
19	1,54056	0,65293	2,35947	1,17974	0,11797
20	1,54056	0,66957	2,30081	1,15041	0,11504
21	1,54056	0,70558	2,18341	1,09171	0,10917
				d (nm)	0,16710

CuO/ZnO-NPs (1:1)

No	λ	sin-theta	$n\lambda/\sin\theta$	d	d (nm)
1	1,54056	0,101334	15,20277	7,601385	0,760139
2	1,54056	0,143924	10,70395	5,351973	0,535197
3	1,54056	0,147637	10,43479	5,217396	0,521740
4	1,54056	0,195005	7,900113	3,950056	0,395006
5	1,54056	0,198769	7,750490	3,875245	0,387524
6	1,54056	0,218314	7,056636	3,528318	0,352832
7	1,54056	0,239525	6,431730	3,215865	0,321587
8	1,54056	0,245925	6,264348	3,132174	0,313217
9	1,54056	0,265136	5,810462	2,905231	0,290523
10	1,54056	0,270685	5,691348	2,845674	0,284567
11	1,54056	0,276392	5,573815	2,786908	0,278691
12	1,54056	0,285772	5,390869	2,695434	0,269543
13	1,54056	0,291295	5,288658	2,644329	0,264433
14	1,54056	0,299757	5,139363	2,569682	0,256968
15	1,54056	0,308453	4,994477	2,497239	0,249724

16	1,54056	0,314515	4,898216	2,449108	0,244911
17	1,54056	0,327515	4,703786	2,351893	0,235189
18	1,54056	0,334736	4,602308	2,301154	0,230115
19	1,54056	0,384859	4,002917	2,001458	0,200146
20	1,54056	0,389341	3,956838	1,978419	0,197842
21	1,54056	0,395546	3,894772	1,947386	0,194739
22	1,54056	0,405780	3,796541	1,898270	0,189827
23	1,54056	0,415424	3,708405	1,854203	0,185420
24	1,54056	0,432715	3,560215	1,780108	0,178011
25	1,54056	0,437822	3,518689	1,759344	0,175934
26	1,54056	0,452653	3,403403	1,701702	0,170170
27	1,54056	0,456788	3,372596	1,686298	0,168630
28	1,54056	0,476162	3,235372	1,617686	0,161769
29	1,54056	0,489307	3,148456	1,574228	0,157423
30	1,54056	0,498518	3,090278	1,545139	0,154514
31	1,54056	0,514395	2,994898	1,497449	0,149745
32	1,54056	0,523614	2,942165	1,471082	0,147108
33	1,54056	0,545663	2,823279	1,411639	0,141164
34	1,54056	0,548870	2,806786	1,403393	0,140339
35	1,54056	0,562156	2,740450	1,370225	0,137023
36	1,54056	0,569495	2,705134	1,352567	0,135257
37	1,54056	0,592716	2,599152	1,299576	0,129958
38	1,54056	0,612424	2,515510	1,257755	0,125776
39	1,54056	0,624562	2,466626	1,233313	0,123331
40	1,54056	0,645591	2,386278	1,193139	0,119314
41	1,54056	0,660788	2,331397	1,165699	0,116570
42	1,54056	0,668352	2,305012	1,152506	0,115251
43	1,54056	0,688228	2,238444	1,119222	0,111922
				d (nm)	0,233002

CuO/ZnO-NPs (Cbest)

No	λ	sin-theta	$n\lambda/\sin\theta$	d	d (nm)
1	1,54056	0,275277	5,596405	2,79820	0,27982
2	1,54056	0,281253	5,477487	2,73874	0,273874
3	1,54056	0,297725	5,174441	2,58722	0,258722
4	1,54056	0,306917	5,019475	2,50974	0,250974
5	1,54056	0,312932	4,922988	2,46149	0,246149
6	1,54056	0,326806	4,713994	2,35700	0,2357
7	1,54056	0,333494	4,619448	2,30972	0,230972
8	1,54056	0,362682	4,247686	2,12384	0,212384
9	1,54056	0,387838	3,972179	1,98609	0,198609
10	1,54056	0,404583	3,807771	1,90389	0,190389
11	1,54056	0,414376	3,717785	1,85889	0,185889

12	1,54056	0,453291	3,398613	1,69931	0,169931
13	1,54056	0,475624	3,239026	1,61951	0,161951
14	1,54056	0,488271	3,155132	1,57757	0,157757
15	1,54056	0,513167	3,002064	1,50103	0,150103
16	1,54056	0,522841	2,946517	1,47326	0,147326
17	1,54056	0,548731	2,807495	1,40375	0,140375
18	1,54056	0,560307	2,749494	1,37475	0,137475
19	1,54056	0,568203	2,711284	1,35564	0,135564
20	1,54056	0,592716	2,599152	1,29958	0,129958
21	1,54056	0,611320	2,520055	1,26003	0,126003
22	1,54056	0,663926	2,320378	1,16019	0,116019
23	1,54056	0,663926	2,320378	1,16019	0,116019
				d (nm)	0,184868

c) Perhitungan Parameter Kisi

- CuO-NPs

$$\frac{1}{d_{hkl}^2} = \frac{1}{\sin^2 \beta^\circ} \left[\frac{h^2}{a^2} + \frac{k^2}{b^2} \sin^2 \beta^\circ + \frac{l^2}{c^2} - \frac{2hlc \cos \beta^\circ}{ac} \right]$$

1. Mencari c (h=0, k=0, l=4)

$$\frac{1}{1,26260^2} = \frac{1}{0,97287} \left[\frac{0^2}{a^2} + \frac{0^2}{b^2} 0,97287 + \frac{4^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{1,59416} = \frac{1}{0,97287} \left[\frac{4^2}{c^2} \right]$$

$$\frac{1}{1,59416} = \frac{1}{0,97287} \left[\frac{4^2}{c^2} \right]$$

$$0,62729 = 1,02789 \left[\frac{16}{c^2} \right]$$

$$0,62729 = 16,44618 \frac{1}{c^2}$$

$$c^2 = \frac{16,446185}{0,627994}$$

$$c^2 = 26,21783$$

$$c = 5,12033 \text{ \AA}$$

$$c = 0,512033 \text{ nm}$$

2. Mencari b (h=0, k=2, l=0)

$$\frac{1}{1,70487^2} = \frac{1}{0,97287} \left[\frac{0^2}{a^2} + \frac{2^2}{b^2} 0,97287 + \frac{0^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{2,90657} = \frac{1}{0,97287} \left[\frac{4}{b^2} 0,97287 \right]$$

$$0,34405 = \left[\frac{4}{b^2} \right]$$

$$b^2 = \frac{4}{0,344048}$$

$$b^2 = 11,6263$$

$$b = 3,40973 \text{ \AA}$$

$$\mathbf{b = 0,340973 \text{ nm}}$$

3. Mencari a (h=1, k=1, l=0)

$$\frac{1}{2,74594^2} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{b^2} 0,97287 + \frac{0^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{7,54018} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{3,40973^2} 0,97287 \right]$$

$$\frac{1}{7,54018} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{11,62626} 0,97287 \right]$$

$$\frac{1}{7,54018} = \frac{1}{0,97287 a^2} \left[\frac{1}{0,97287} \times \frac{1}{11,62626} 0,97287 \right]$$

$$\frac{1}{7,54018} = \frac{1}{0,97287 a^2} + \frac{1}{11,62626}$$

$$\frac{1}{7,54018} = \frac{1}{0,97287 a^2} + 0,08601$$

$$0,13262 = \frac{1}{0,97287 a^2} + 0,08601$$

$$0,13262 - 0,08601 = \frac{1}{0,97287 a^2}$$

$$0,04662 = \frac{1}{0,97287 a^2}$$

$$a^2 = \frac{1}{0,97287 \times 0,04662}$$

$$a^2 = 22,04819$$

$$a = 4,69555 \text{ \AA}$$

$$\mathbf{a = 0,49655 \text{ nm}}$$

Perhitungan Volume Unit Sel

$$V = abc \sin \beta^\circ$$

$$V = 4,69555 \times 3,40973 \times 5,12033 \sin 99,53^\circ$$

$$V = 81,97934 \times 0,98634$$

$$V = 80,848 \text{ \AA}^3$$

- ZnO-NPs

$$\frac{1}{d_{hkl}^2} = \frac{4}{c} \left(\frac{h^2 + hk + k^2}{a^2} \right) + \frac{l^2}{c^2}$$

1. Mencari c (h=0, k=0, l=2)

$$\frac{1}{d_{hkl}^2} = \frac{l^2}{c^2}$$

$$\frac{1}{d_{hkl}^2} = \frac{2^2}{c^2}$$

$$c = 2d$$

$$c = 2 \times 2,58809$$

$$c = 5,1762 \text{ \AA}$$

$$c = \mathbf{0,51762 \text{ nm}}$$

2. Mencari b = a

$$b = 3,2362 \text{ \AA}$$

$$b = \mathbf{0,32362 \text{ nm}}$$

3. Mencari a (h=1, k=0, l=0)

$$\frac{1}{d_{hkl}^2} = \frac{4}{3} \left(\frac{h^2 + hk + k^2}{a^2} \right)$$

$$\frac{1}{d_{hkl}^2} = \frac{4}{3} \left(\frac{1+0+0}{a^2} \right)$$

$$\frac{1}{d_{hkl}^2} = \frac{4}{3a^2}$$

$$a = \frac{2d}{\sqrt{3}}$$

$$a = \frac{2 \times 2,80264}{\sqrt{3}}$$

$$a = \frac{2 \times 2,80264}{1,73205}$$

$$a = 3,2362 \text{ \AA}$$

$$a = \mathbf{0,32362 \text{ nm}}$$

Perhitungan Volume Unit Sel

$$V = \frac{\sqrt{3}}{2} \times a^2 c$$

$$V = \frac{1,73205}{2} \times (3,2362)^2 \times 5,1762$$

$$V = 0,866025 \times 10,0473 \times 5,1762$$

$$V = 46,95 \text{ \AA}^3$$

- CuO/ZnO-NPs (Cbest)

Hexagonal

$$\frac{1}{d_{hkl}^2} = \frac{4}{c} \left(\frac{h^2 + hk + k^2}{a^2} \right) + \frac{l^2}{c^2}$$

1. Mencari c (h=0, k=0, l=2)

$$\frac{1}{d_{hkl}^2} = \frac{l^2}{c^2}$$

$$\frac{1}{d_{hkl}^2} = \frac{2^2}{c^2}$$

$$c = 2d$$

$$c = 2 \times 2,58772$$

$$c = 5,1754 \text{ \AA}$$

$$\mathbf{c = 0,51754 \text{ nm}}$$

2. Mencari b = a

$$b = 3,2310 \text{ \AA}$$

$$\mathbf{b = 0,3231 \text{ nm}}$$

3. Mencari a (h=1, k=0, l=0)

$$\frac{1}{d_{hkl}^2} = \frac{4}{3} \left(\frac{h^2 + hk + k^2}{a^2} \right)$$

$$\frac{1}{d_{hkl}^2} = \frac{4}{3} \left(\frac{1+0+0}{a^2} \right)$$

$$\frac{1}{d_{hkl}^2} = \frac{4}{3a^2}$$

$$a = \frac{2d}{\sqrt{3}}$$

$$a = \frac{2 \times 2,7982}{\sqrt{3}}$$

$$a = \frac{2 \times 2,7982}{1,73205}$$

$$a = 3,2310 \text{ \AA}$$

$$\mathbf{a = 0,3231 \text{ nm}}$$

Perhitungan Volume Unit Sel

$$V = \frac{\sqrt{3}}{2} \times a^2 c$$

$$V = \frac{1,73205}{2} \times (3,2310)^2 \times 5,1754$$

$$V = 0,866025 \times 10,044 \times 5,1754$$

$$V = 45,0175 \text{ \AA}^3$$

Monoklinik

$$\frac{1}{d_{hkl}^2} = \frac{1}{\sin^2 \beta^\circ} \left[\frac{h^2}{a^2} + \frac{k^2}{b^2} \sin^2 \beta^\circ + \frac{l^2}{c^2} - \frac{2hlc \cos \beta^\circ}{ac} \right]$$

1. Mencari c (h=2, k=2, l=2)

$$\frac{1}{1,26003^2} = \frac{1}{0,97287} \left[\frac{0^2}{a^2} + \frac{0^2}{b^2} 0,97287 + \frac{4^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{1,58768} = \frac{1}{0,97287} \left[\frac{4^2}{c^2} \right]$$

$$0,62985 = 1,02789 \left[\frac{16}{c^2} \right]$$

$$0,62985 = 16,44618 \frac{1}{c^2}$$

$$c^2 = \frac{16,446185}{0,62985}$$

$$c^2 = 26,11127$$

$$c = 5,10992 \text{ \AA}$$

$$\mathbf{c = 0,510992 \text{ nm}}$$

2. Mencari b (h=0, k=2, l=0)

$$\frac{1}{1,69931^2} = \frac{1}{0,97287} \left[\frac{0^2}{a^2} + \frac{2^2}{b^2} 0,97287 + \frac{0^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{2,88765} = \frac{1}{0,97287} \left[\frac{4}{b^2} 0,97287 \right]$$

$$0,34630 = \left[\frac{4}{b^2} \right]$$

$$b^2 = \frac{4}{0,34630}$$

$$b^2 = 11,55068$$

$$b = 3,39863 \text{ \AA}$$

$$\mathbf{b = 0,33986 \text{ nm}}$$

3. Mencari a (h=1, k=1, l=0)

$$\frac{1}{2,73874^2} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{b^2} 0,97287 + \frac{0^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{7,50070} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{3,40973^2} 0,97287 \right]$$

$$\frac{1}{7,50070} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{11,62626} 0,97287 \right]$$

$$\frac{1}{7,50070} = \frac{1}{0,97287a^2} \left[\frac{1}{0,97287} \times \frac{1}{11,62626} 0,97287 \right]$$

$$\frac{1}{7,50070} = \frac{1}{0,97287a^2} + \frac{1}{11,62626}$$

$$\frac{1}{7,50070} = \frac{1}{0,97287a^2} + 0,08601$$

$$0,13332 = \frac{1}{0,97287a^2} + 0,08601$$

$$0,13332 - 0,08601 = \frac{1}{0,97287a^2}$$

$$0,04731 = \frac{1}{0,97287a^2}$$

$$a^2 = \frac{1}{0,97287 \times 0,04731}$$

$$a^2 = 21,72662$$

$$a = 4,66118 \text{ \AA}$$

$$a = 0,466118 \text{ nm}$$

Perhitungan Volume Unit Sel

$$V = abc \sin \beta^\circ$$

$$V = 4,66118 \times 3,39863 \times 5,10992 \sin 99,53^\circ$$

$$V = 80,94944 \times 0,9862$$

$$V = 79,83226 \text{ \AA}^3$$

• CuO/ZnO-NPs (1:1)

Hexagonal

$$\frac{1}{d_{hkl}^2} = \frac{4}{c} \left(\frac{h^2 + hk + k^2}{a^2} \right) + \frac{l^2}{c^2}$$

1. Mencari c (h=0, k=0, l=2)

$$\frac{1}{d_{hkl}^2} = \frac{l^2}{c^2}$$

$$\frac{1}{d_{hkl}^2} = \frac{2^2}{c^2}$$

$$c = 2d$$

$$c = 2 \times 2,56982$$

$$c = 5,13964 \text{ \AA}$$

$$c = \mathbf{0,513964 \text{ nm}}$$

2. Mencari b = a

$$b = 3,2859 \text{ \AA}$$

$$b = \mathbf{0,32859 \text{ nm}}$$

3. Mencari a (h=1, k=0, l=0)

$$\frac{1}{d_{hkl}^2} = \frac{4}{3} \left(\frac{h^2 + hk + k^2}{a^2} \right)$$

$$\frac{1}{d_{hkl}^2} = \frac{4}{3} \left(\frac{1+0+0}{a^2} \right)$$

$$\frac{1}{d_{hkl}^2} = \frac{4}{3a^2}$$

$$a = \frac{2d}{\sqrt{3}}$$

$$a = \frac{2 \times 2,845674}{\sqrt{3}}$$

$$a = \frac{2 \times 2,845674}{1,73205}$$

$$a = 3,2859 \text{ \AA}$$

$$a = \mathbf{0,32859 \text{ nm}}$$

Perhitungan Volume Unit Sel

$$V = \frac{\sqrt{3}}{2} \times a^2 c$$

$$V = \frac{1,73205}{2} \times (3,2859)^2 \times 5,13964$$

$$V = 0,866025 \times 10,797 \times 5,13964$$

$$V = 48,058 \text{ \AA}^3$$

Monoklinik

$$\frac{1}{d_{hkl}^2} = \frac{1}{\sin^2 \beta^\circ} \left[\frac{h^2}{a^2} + \frac{k^2}{b^2} \sin^2 \beta^\circ + \frac{l^2}{c^2} - \frac{2hlc \cos \beta^\circ}{ac} \right]$$

1. Mencari c (h=0, k=0, l=4)

$$\frac{1}{1,299576^2} = \frac{1}{0,97287} \left[\frac{0^2}{a^2} + \frac{0^2}{b^2} 0,97287 + \frac{4^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{1,68890} = \frac{1}{0,97287} \left[\frac{4^2}{c^2} \right]$$

$$0,59210 = 1,02789 \left[\frac{16}{c^2} \right]$$

$$0,59210 = 16,44618 \frac{1}{c^2}$$

$$c^2 = \frac{16,446185}{0,59210}$$

$$c^2 = 27,77603$$

$$c = 5,2703 \text{ \AA}$$

$$\mathbf{c = 0,52703 \text{ nm}}$$

2. Mencari b (h=0, k=2, l=0)

$$\frac{1}{1,701702^2} = \frac{1}{0,97287} \left[\frac{0^2}{a^2} + \frac{2^2}{b^2} 0,97287 + \frac{0^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{2,89579} = \frac{1}{0,97287} \left[\frac{4}{b^2} 0,97287 \right]$$

$$0,34533 = \left[\frac{4}{b^2} \right]$$

$$b^2 = \frac{4}{0,34533}$$

$$b^2 = 11,58312$$

$$b = 3,4034 \text{ \AA}$$

$$\mathbf{b = 0,34034 \text{ nm}}$$

3. Mencari a (h=1, k=1, l=0)

$$\frac{1}{2,78690^2} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{b^2} 0,97287 + \frac{0^2}{c^2} - \frac{2 \times 0 \times 0 \cos \beta^\circ}{ac} \right]$$

$$\frac{1}{7,76681} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{3,4034^2} 0,97287 \right]$$

$$\frac{1}{7,76681} = \frac{1}{0,97287} \left[\frac{1^2}{a^2} + \frac{1^2}{11,15827} 0,97287 \right]$$

$$\frac{1}{7,76681} = \frac{1}{0,97287 a^2} \left[\frac{1}{0,97287} \times \frac{1}{11,15827} 0,97287 \right]$$

$$\frac{1}{7,76681} = \frac{1}{0,97287a^2} + \frac{1}{11,15827}$$

$$\frac{1}{7,76681} = \frac{1}{0,97287a^2} + 0,08962$$

$$0,12875 = \frac{1}{0,97287a^2} + 0,08962$$

$$0,12875 - 0,08962 = \frac{1}{0,97287a^2}$$

$$0.03913 = \frac{1}{0,97287a^2}$$

$$a^2 = \frac{1}{0,97287 \times 0.03913}$$

$$a^2 = 26,2685$$

$$a = 5,12528$$

$$a = 0,512528 \text{ nm}$$

Perhitungan Volume Unit Sel

$$V = abc \sin \beta^\circ$$

$$V = 5,12528 \times 3,4034 \times 5,2703 \sin 99,53^\circ$$

$$V = 91,93183 \times 0,98634$$

$$V = 90,663 \text{ \AA}^3$$



Lampiran 03. Dokumentasi Penelitian



Larutan $\text{CH}_3(\text{COO})_2$ 1M



Larutan NaOH 4M



Larutan $\text{CH}_3(\text{COO})_2$ setelah penambahan ekstrak daun kelor



Larutan CuO-NPs setelah pemanasan selama 1 jam 30 menit



Larutan sebelum di sentrifugasi



Filtrat CuO-NPs setelah disentrifugasi



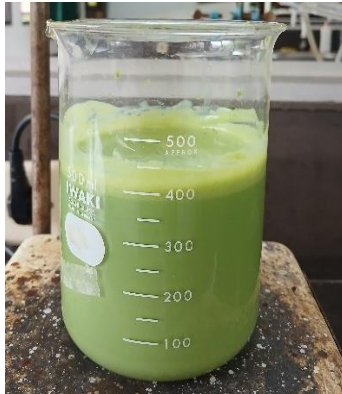
Larutan setelah di sentrifugasi



CuO-NPs setelah di oven pada suhu 80°C



Larutan ZnCl_2 1M



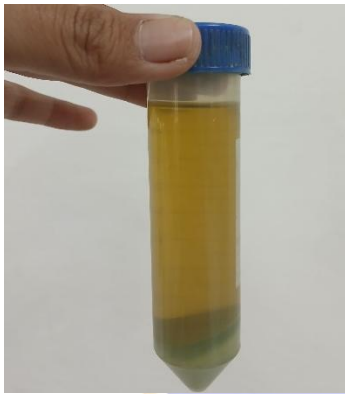
Larutan ZnCl_2 setelah penambahan ekstrak daun kelor



Larutan ZnO-NPs setelah pemanasan selama 1 jam 30 menit



Larutan ZnO-NPs sebelum disentrifugasi



Larutan CuO-NPs sebelum disentrifugasi



Endapan ZnO-NPs hasil sentrifugasi



Endapan ZnO-NPs setelah di oven pada suhu 80°C



Filtrat ZnO-NPs hasil sentrifugasi



Endapan ZnO-NPs sebelum di furnace pada suhu 500°C



Endapan ZnO-NPs setelah di furnace pada suhu 500°C



Larutan $\text{CH}_3(\text{COO})_2$ dan ZnCl_2 1M



Larutan $\text{CH}_3(\text{COO})_2$ dan ZnCl_2 1M setelah dicampurkan



Campuran $\text{CH}_3(\text{COO})_2$ dan ZnCl_2 1M setelah ditambahkan ekstrak daun kelor



Campuran $\text{CH}_3(\text{COO})_2$ dan ZnCl_2 1M setelah ditambahkan ekstrak daun kelor dan NaOH



Larutan CuO/ZnO-NPs setelah pemanasan selama 1 jam 30 menit



Endapan CuO/ZnO-NPs hasil sentrifugasi



Larutan CuO/ZnO-NPs sebelum disentrifugasi



Filtrat CuO/ZnO-NPs setelah disentrifugasi



Endapan CuO/ZnO-NPs setelah di oven pada suhu 80°C



CuO-NPs (1:1)



CuO-NPs (1:2)



CuO-NPs (1:3)



CuO-NPs (1:4)



ZnO-NPs (1:1)



ZnO-NPs (1:2)



ZnO-NPs (1:3)



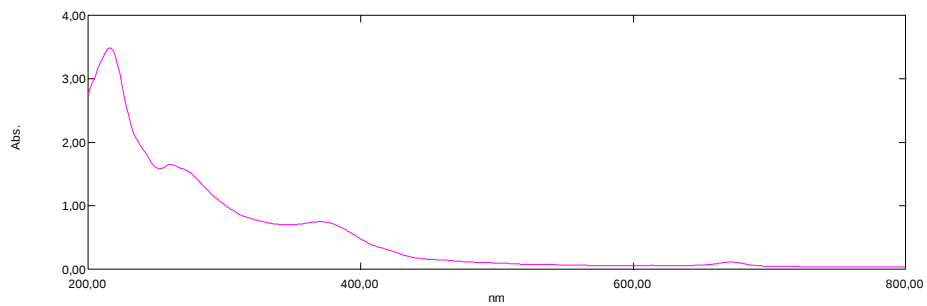
ZnO-NPs (1:4)



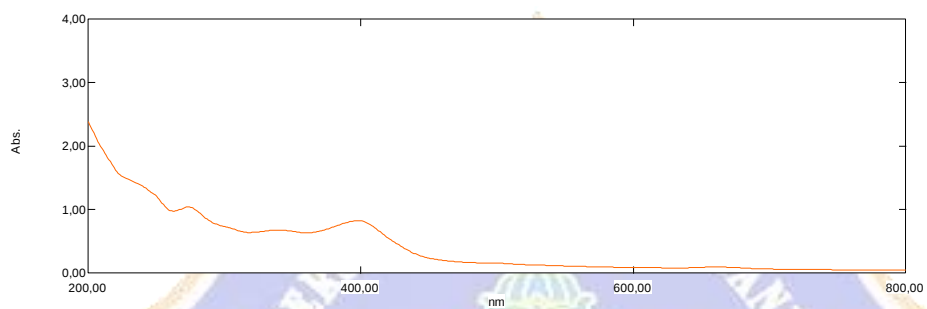
CuO/ZnO-NPs (1:1)

Lampiran 04. Karakterisasi UV-Vis Nanopartikel

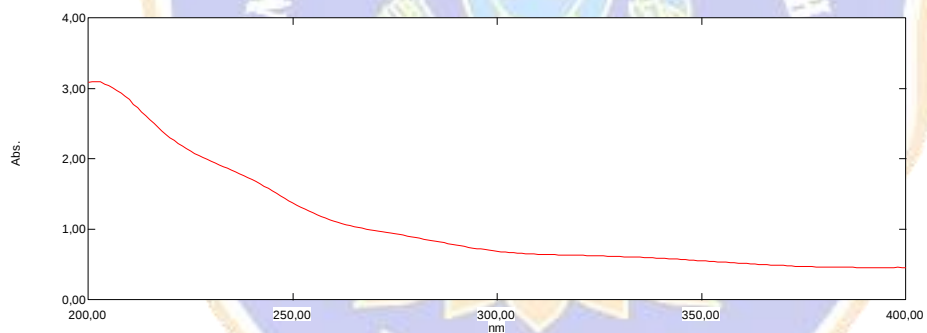
Ekstrak Daun Kelor



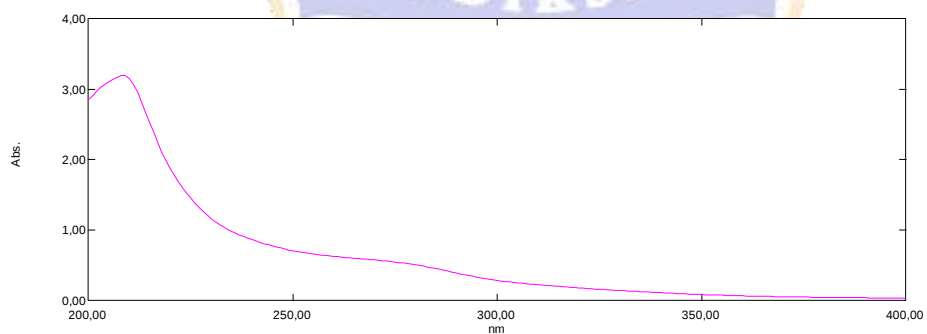
Ekstrak Daun Kelor pH 8



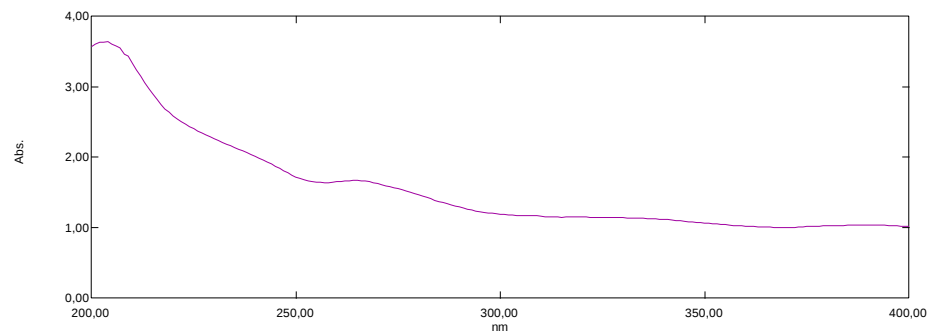
CuO-NPs



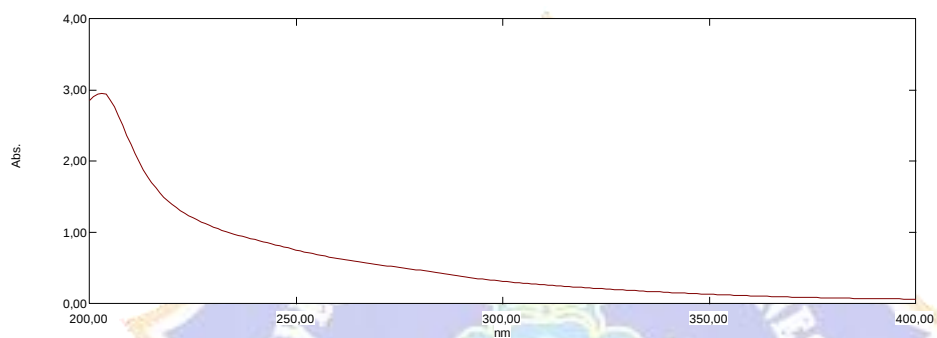
Filtrat CuO-NPs



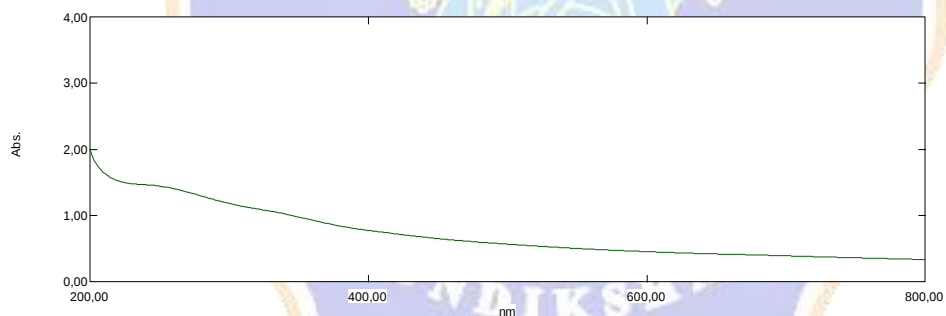
ZnO-NPs



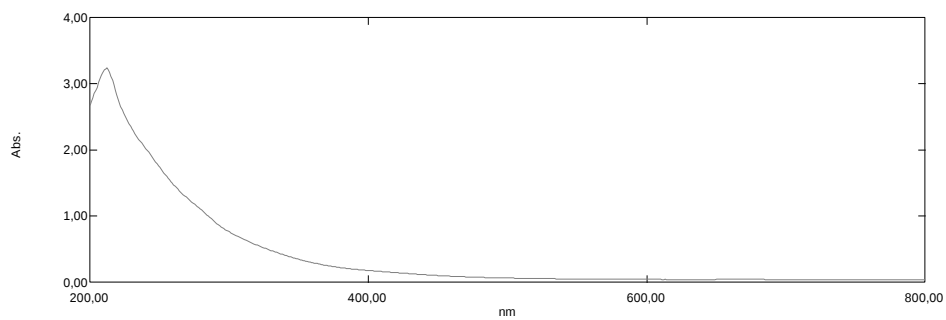
Filtrat ZnO-NPs



CuO/ZnO-NPs



Filtrat CuO/ZnO-NPs



Wavelength (nm)	Raw Data			
	CuO-NPs	Filtrat CuO-NPs	ZnO-NPs	Filtrat ZnO-NPs
200,0	30,854	28,548	35,670	28,524
201,0	30,946	29,012	36,103	29,101
202,0	30,974	29,709	36,363	29,421
203,0	30,938	30,253	36,344	29,555
204,0	30,639	30,658	36,457	29,430
205,0	30,470	31,033	36,024	28,659
206,0	30,082	31,395	35,796	27,689
207,0	29,753	31,709	35,556	26,409
208,0	29,308	31,930	34,665	25,045
209,0	28,873	31,937	34,333	23,634
210,0	28,419	31,521	33,297	22,362
211,0	27,769	30,730	32,392	21,090
212,0	27,278	29,643	31,539	19,875
213,0	26,690	28,205	30,617	18,823
214,0	26,126	26,615	29,682	17,850
215,0	25,617	25,203	28,965	17,026
216,0	25,076	23,778	28,212	16,265
217,0	24,491	22,330	27,487	15,572
218,0	24,002	21,017	26,880	14,967
219,0	23,473	19,848	26,366	14,410
220,0	23,021	18,767	25,861	13,923
221,0	22,608	17,811	25,389	13,473
222,0	22,177	16,898	25,039	13,078
223,0	21,790	16,059	24,697	12,705
224,0	21,446	15,288	24,361	12,373
225,0	21,096	14,578	24,050	12,063
226,0	20,789	13,898	23,758	11,782
227,0	20,472	13,262	23,427	11,493
228,0	20,204	12,691	23,164	11,240
229,0	19,946	12,157	22,890	10,988
230,0	19,688	11,659	22,644	10,743
231,0	19,409	11,206	22,356	10,520
232,0	19,165	10,792	22,111	10,299
233,0	18,920	10,430	21,862	10,112
234,0	18,684	10,108	21,622	0,9934
235,0	18,451	0,9815	21,379	0,9763
236,0	18,190	0,9558	21,158	0,9613
237,0	17,924	0,9324	20,935	0,9466
238,0	17,658	0,9091	20,671	0,9305
239,0	17,393	0,8874	20,414	0,9157
240,0	17,114	0,8665	20,127	0,9015
241,0	16,794	0,8462	19,834	0,8868
242,0	16,469	0,8272	19,570	0,8722

243,0	16,141	0,8091	19,293	0,8571
244,0	15,822	0,7926	19,037	0,8427
245,0	15,464	0,7767	18,738	0,8274
246,0	15,118	0,7616	18,426	0,8126
247,0	14,766	0,7472	18,092	0,7983
248,0	14,425	0,7334	17,764	0,7836
249,0	14,075	0,7197	17,453	0,7691
250,0	13,750	0,7075	17,192	0,7549
251,0	13,430	0,6965	16,988	0,7412
252,0	13,133	0,6869	16,815	0,7276
253,0	12,852	0,6780	16,670	0,7155
254,0	12,580	0,6693	16,556	0,7029
255,0	12,316	0,6623	16,479	0,6908
256,0	12,063	0,6551	16,426	0,6794
257,0	11,833	0,6483	16,392	0,6680
258,0	11,603	0,6413	16,418	0,6564
259,0	11,401	0,6350	16,474	0,6456
260,0	11,198	0,6289	16,534	0,6350
261,0	11,008	0,6224	16,586	0,6243
262,0	10,835	0,6167	16,636	0,6145
263,0	10,677	0,6120	16,687	0,6047
264,0	10,530	0,6066	16,716	0,5954
265,0	10,400	0,6021	16,712	0,5869
266,0	10,279	0,5975	16,671	0,5780
267,0	10,166	0,5930	16,622	0,5696
268,0	10,057	0,5884	16,531	0,5616
269,0	0,9952	0,5835	16,404	0,5545
270,0	0,9852	0,5784	16,255	0,5465
271,0	0,9752	0,5735	16,094	0,5390
272,0	0,9648	0,5676	15,928	0,5314
273,0	0,9560	0,5609	15,799	0,5242
274,0	0,9457	0,5543	15,679	0,5161
275,0	0,9364	0,5474	15,549	0,5090
276,0	0,9273	0,5405	15,386	0,5014
277,0	0,9182	0,5336	15,210	0,4937
278,0	0,9076	0,5263	15,043	0,4863
279,0	0,8968	0,5187	14,869	0,4783
280,0	0,8853	0,5101	14,696	0,4701
281,0	0,8742	0,5006	14,510	0,4617
282,0	0,8632	0,4904	14,315	0,4536
283,0	0,8531	0,4787	14,108	0,4445
284,0	0,8428	0,4672	13,893	0,4361
285,0	0,8322	0,4552	13,712	0,4277
286,0	0,8210	0,4431	13,566	0,4191
287,0	0,8101	0,4305	13,413	0,4102
288,0	0,7994	0,4179	13,254	0,4012

289,0	0,7884	0,4049	13,103	0,3921
290,0	0,7788	0,3924	12,937	0,3837
291,0	0,7684	0,3799	12,775	0,3757
292,0	0,7570	0,3674	12,638	0,3675
293,0	0,7469	0,3554	12,506	0,3599
294,0	0,7382	0,3447	12,390	0,3526
295,0	0,7291	0,3339	12,271	0,3455
296,0	0,7208	0,3235	12,193	0,3389
297,0	0,7124	0,3133	12,122	0,3324
298,0	0,7041	0,3043	12,039	0,3266
299,0	0,6965	0,2957	11,974	0,3209
300,0	0,6897	0,2872	11,918	0,3149
301,0	0,6841	0,2796	11,885	0,3095
302,0	0,6784	0,2726	11,842	0,3044
303,0	0,6736	0,2661	11,809	0,2995
304,0	0,6689	0,2596	11,758	0,2945
305,0	0,6649	0,2536	11,721	0,2897
306,0	0,6607	0,2477	11,760	0,2847
307,0	0,6571	0,2419	11,740	0,2800
308,0	0,6533	0,2367	11,708	0,2754
309,0	0,6499	0,2321	11,680	0,2712
310,0	0,6471	0,2266	11,621	0,2661
311,0	0,6450	0,2216	11,562	0,2618
312,0	0,6437	0,2171	11,530	0,2577
313,0	0,6421	0,2123	11,524	0,2533
314,0	0,6413	0,2080	11,512	0,2494
315,0	0,6392	0,2027	11,488	0,2450
316,0	0,6390	0,1988	11,528	0,2413
317,0	0,6374	0,1943	11,534	0,2370
318,0	0,6356	0,1900	11,530	0,2330
319,0	0,6341	0,1856	11,521	0,2293
320,0	0,6328	0,1815	11,515	0,2256
321,0	0,6314	0,1774	11,514	0,2218
322,0	0,6291	0,1733	11,494	0,2180
323,0	0,6278	0,1693	11,491	0,2142
324,0	0,6262	0,1653	11,480	0,2107
325,0	0,6249	0,1616	11,479	0,2072
326,0	0,6231	0,1581	11,464	0,2036
327,0	0,6213	0,1544	11,438	0,2001
328,0	0,6183	0,1507	11,416	0,1967
329,0	0,6162	0,1474	11,411	0,1934
330,0	0,6139	0,1439	11,410	0,1901
331,0	0,6117	0,1405	11,392	0,1870
332,0	0,6098	0,1371	11,382	0,1836
333,0	0,6081	0,1337	11,388	0,1806
334,0	0,6069	0,1306	11,358	0,1776

335,0	0,6043	0,1272	11,339	0,1743
336,0	0,6014	0,1243	11,300	0,1714
337,0	0,5991	0,1209	11,270	0,1682
338,0	0,5974	0,1182	11,248	0,1656
339,0	0,5946	0,1151	11,219	0,1624
340,0	0,5910	0,1120	11,180	0,1595
341,0	0,5871	0,1092	11,168	0,1562
342,0	0,5841	0,1065	11,121	0,1536
343,0	0,5806	0,1036	11,045	0,1506
344,0	0,5772	0,1010	10,986	0,1482
345,0	0,5738	0,0985	10,923	0,1453
346,0	0,5702	0,0959	10,857	0,1426
347,0	0,5667	0,0936	10,808	0,1400
348,0	0,5627	0,0912	10,761	0,1374
349,0	0,5592	0,0890	10,731	0,1350
350,0	0,5558	0,0869	10,692	0,1326
351,0	0,5521	0,0846	10,652	0,1301
352,0	0,5480	0,0827	10,596	0,1278
353,0	0,5444	0,0808	10,526	0,1256
354,0	0,5405	0,0787	10,483	0,1234
355,0	0,5367	0,0768	10,436	0,1210
356,0	0,5331	0,0751	10,370	0,1190
357,0	0,5290	0,0733	10,307	0,1169
358,0	0,5253	0,0714	10,275	0,1146
359,0	0,5223	0,0701	10,254	0,1129
360,0	0,5187	0,0683	10,223	0,1109
361,0	0,5148	0,0668	10,194	0,1089
362,0	0,5110	0,0657	10,170	0,1072
363,0	0,5075	0,0639	10,154	0,1053
364,0	0,5053	0,0627	10,146	0,1034
365,0	0,5024	0,0613	10,121	0,1016
366,0	0,4991	0,0601	10,086	0,1000
367,0	0,4957	0,0587	10,067	0,0982
368,0	0,4931	0,0577	10,038	0,0965
369,0	0,4905	0,0565	10,020	0,0951
370,0	0,4877	0,0555	10,028	0,0939
371,0	0,4848	0,0545	10,040	0,0922
372,0	0,4822	0,0534	10,040	0,0907
373,0	0,4782	0,0521	10,143	0,0889
374,0	0,4759	0,0512	10,151	0,0876
375,0	0,4740	0,0504	10,166	0,0865
376,0	0,4721	0,0494	10,171	0,0851
377,0	0,4702	0,0487	10,194	0,0840
378,0	0,4685	0,0478	10,229	0,0827
379,0	0,4672	0,0471	10,256	0,0814
380,0	0,4665	0,0464	10,273	0,0806

381,0	0,4655	0,0457	10,289	0,0794
382,0	0,4644	0,0449	10,314	0,0783
383,0	0,4632	0,0443	10,308	0,0774
384,0	0,4626	0,0437	10,315	0,0766
385,0	0,4620	0,0433	10,336	0,0758
386,0	0,4616	0,0428	10,363	0,0750
387,0	0,4610	0,0421	10,376	0,0739
388,0	0,4607	0,0414	10,393	0,0730
389,0	0,4607	0,0411	10,382	0,0721
390,0	0,4604	0,0405	10,381	0,0715
391,0	0,4600	0,0401	10,390	0,0707
392,0	0,4593	0,0397	10,396	0,0700
393,0	0,4594	0,0392	10,387	0,0692
394,0	0,4595	0,0387	10,352	0,0686
395,0	0,4598	0,0384	10,324	0,0679
396,0	0,4602	0,0379	10,300	0,0673
397,0	0,4605	0,0376	10,273	0,0665
398,0	0,4609	0,0371	10,243	0,0658
399,0	0,4608	0,0368	10,192	0,0652
400,0	0,4605	0,0362	10,160	0,0646

Wavelength (nm)	Raw Data			
	Ekstrak Daun Kelor	Ekstrak Daun Kelor pH 8	CuO/ZnO- NPs	Filtrat CuO/ZnO- NPs
200,0	2,7428	2,3866	2,7304	2,6792
201,0	2,8346	2,3362	2,6835	2,7400
202,0	2,8825	2,2974	2,6324	2,7842
203,0	2,9430	2,2565	2,5763	2,8533
204,0	2,9869	2,2102	2,5292	2,9096
205,0	3,0457	2,1564	2,4936	2,9472
206,0	3,1069	2,1167	2,4598	3,0245
207,0	3,1713	2,0741	2,4094	3,0713
208,0	3,2051	2,0350	2,3792	3,1236
209,0	3,2665	1,9959	2,3565	3,1678
210,0	3,3120	1,9632	2,3307	3,2123
211,0	3,3535	1,9278	2,3011	3,2239
212,0	3,3995	1,8912	2,2797	3,2460
213,0	3,4315	1,8586	2,2577	3,2106
214,0	3,4753	1,8250	2,2388	3,1754
215,0	3,4849	1,7919	2,2233	3,1160
216,0	3,4929	1,7579	2,2068	3,0529
217,0	3,4723	1,7236	2,1892	2,9822
218,0	3,4570	1,6897	2,1740	2,9092
219,0	3,4113	1,6577	2,1594	2,8360
220,0	3,3445	1,6265	2,1453	2,7730

221,0	3,2684	1,5986	2,1353	2,7182
222,0	3,1834	1,5729	2,1237	2,6563
223,0	3,0850	1,5527	2,1161	2,6057
224,0	2,9735	1,5362	2,1122	2,5610
225,0	2,8682	1,5218	2,1034	2,5194
226,0	2,7591	1,5109	2,0996	2,4762
227,0	2,6529	1,5008	2,0956	2,4359
228,0	2,5571	1,4940	2,0903	2,3987
229,0	2,4599	1,4848	2,0851	2,3595
230,0	2,3746	1,4770	2,0844	2,3221
231,0	2,2955	1,4669	2,0805	2,2842
232,0	2,2237	1,4565	2,0785	2,2474
233,0	2,1628	1,4471	2,0757	2,2148
234,0	2,1108	1,4366	2,0739	2,1879
235,0	2,0664	1,4259	2,0733	2,1570
236,0	2,0300	1,4157	2,0721	2,1312
237,0	1,9947	1,4057	2,0717	2,1062
238,0	1,9613	1,3945	2,0707	2,0791
239,0	1,9304	1,3818	2,0692	2,0520
240,0	1,8992	1,3685	2,0679	2,0242
241,0	1,8682	1,3539	2,0661	1,9966
242,0	1,8350	1,3386	2,0643	1,9684
243,0	1,8012	1,3227	2,0622	1,9406
244,0	1,7658	1,3078	2,0597	1,9123
245,0	1,7298	1,2930	2,0570	1,8824
246,0	1,6957	1,2781	2,0536	1,8535
247,0	1,6643	1,2633	2,0504	1,8248
248,0	1,6367	1,2480	2,0459	1,7954
249,0	1,6147	1,2311	2,0417	1,7659
250,0	1,6001	1,2113	2,0366	1,7369
251,0	1,5897	1,1887	2,0312	1,7083
252,0	1,5858	1,1635	2,0278	1,6802
253,0	1,5874	1,1358	2,0216	1,6536
254,0	1,5936	1,1084	2,0157	1,6274
255,0	1,6047	1,0812	2,0104	1,6012
256,0	1,6166	1,0561	2,0037	1,5767
257,0	1,6296	1,0334	1,9972	1,5516
258,0	1,6406	1,0147	1,9884	1,5265
259,0	1,6478	0,9998	1,9824	1,5024
260,0	1,6522	0,9890	1,9739	1,4773
261,0	1,6503	0,9819	1,9671	1,4530
262,0	1,6467	0,9785	1,9582	1,4304
263,0	1,6394	0,9782	1,9500	1,4083
264,0	1,6314	0,9808	1,9423	1,3869
265,0	1,6231	0,9854	1,9329	1,3670
266,0	1,6139	0,9919	1,9250	1,3460

267,0	1,6045	1,0006	1,9153	1,3262
268,0	1,5953	1,0095	1,9070	1,3071
269,0	1,5873	1,0188	1,8984	1,2889
270,0	1,5791	1,0273	1,8878	1,2699
271,0	1,5705	1,0347	1,8786	1,2518
272,0	1,5614	1,0400	1,8686	1,2339
273,0	1,5497	1,0424	1,8593	1,2163
274,0	1,5367	1,0420	1,8489	1,1988
275,0	1,5214	1,0386	1,8396	1,1815
276,0	1,5032	1,0320	1,8299	1,1642
277,0	1,4832	1,0225	1,8206	1,1469
278,0	1,4610	1,0098	1,8106	1,1295
279,0	1,4384	0,9949	1,8015	1,1110
280,0	1,4162	0,9780	1,7906	1,0936
281,0	1,3938	0,9601	1,7816	1,0750
282,0	1,3700	0,9410	1,7714	1,0559
283,0	1,3480	0,9216	1,7621	1,0375
284,0	1,3259	0,9032	1,7521	1,0185
285,0	1,3041	0,8849	1,7426	1,0002
286,0	1,2821	0,8678	1,7331	0,9813
287,0	1,2601	0,8522	1,7251	0,9629
288,0	1,2396	0,8374	1,7155	0,9441
289,0	1,2171	0,8238	1,7055	0,9254
290,0	1,1964	0,8116	1,6973	0,9072
291,0	1,1761	0,8007	1,6882	0,8897
292,0	1,1562	0,7902	1,6790	0,8720
293,0	1,1368	0,7809	1,6704	0,8557
294,0	1,1191	0,7726	1,6618	0,8404
295,0	1,1013	0,7643	1,6531	0,8265
296,0	1,0836	0,7572	1,6456	0,8124
297,0	1,0669	0,7503	1,6374	0,7990
298,0	1,0500	0,7437	1,6289	0,7860
299,0	1,0340	0,7384	1,6219	0,7737
300,0	1,0182	0,7334	1,6141	0,7618
301,0	1,0034	0,7285	1,6067	0,7502
302,0	0,9882	0,7233	1,5992	0,7389
303,0	0,9733	0,7179	1,5919	0,7281
304,0	0,9591	0,7127	1,5848	0,7171
305,0	0,9437	0,7064	1,5772	0,7063
306,0	0,9305	0,7003	1,5727	0,6955
307,0	0,9164	0,6930	1,5656	0,6848
308,0	0,9027	0,6852	1,5589	0,6745
309,0	0,8909	0,6777	1,5535	0,6654
310,0	0,8786	0,6703	1,5464	0,6552
311,0	0,8670	0,6633	1,5396	0,6450
312,0	0,8566	0,6570	1,5331	0,6352

313,0	0,8474	0,6519	1,5278	0,6258
314,0	0,8382	0,6481	1,5206	0,6162
315,0	0,8316	0,6457	1,5156	0,6071
316,0	0,8245	0,6438	1,5100	0,5983
317,0	0,8175	0,6418	1,5040	0,5890
318,0	0,8113	0,6414	1,4989	0,5801
319,0	0,8052	0,6415	1,4941	0,5714
320,0	0,7995	0,6419	1,4895	0,5629
321,0	0,7932	0,6426	1,4846	0,5540
322,0	0,7872	0,6440	1,4787	0,5459
323,0	0,7810	0,6462	1,4732	0,5373
324,0	0,7752	0,6480	1,4682	0,5292
325,0	0,7693	0,6504	1,4630	0,5213
326,0	0,7636	0,6530	1,4579	0,5130
327,0	0,7578	0,6559	1,4528	0,5051
328,0	0,7523	0,6589	1,4473	0,4975
329,0	0,7471	0,6612	1,4423	0,4898
330,0	0,7426	0,6642	1,4368	0,4819
331,0	0,7382	0,6671	1,4311	0,4753
332,0	0,7343	0,6694	1,4255	0,4678
333,0	0,7300	0,6719	1,4195	0,4603
334,0	0,7264	0,6737	1,4140	0,4531
335,0	0,7228	0,6757	1,4080	0,4457
336,0	0,7199	0,6772	1,4016	0,4387
337,0	0,7171	0,6782	1,3947	0,4316
338,0	0,7148	0,6789	1,3886	0,4250
339,0	0,7119	0,6794	1,3815	0,4180
340,0	0,7100	0,6796	1,3748	0,4112
341,0	0,7077	0,6789	1,3674	0,4043
342,0	0,7063	0,6782	1,3613	0,3977
343,0	0,7052	0,6766	1,3539	0,3909
344,0	0,7042	0,6750	1,3475	0,3841
345,0	0,7034	0,6729	1,3402	0,3780
346,0	0,7034	0,6706	1,3332	0,3716
347,0	0,7031	0,6676	1,3257	0,3651
348,0	0,7040	0,6649	1,3192	0,3594
349,0	0,7043	0,6620	1,3121	0,3539
350,0	0,7053	0,6587	1,3050	0,3480
351,0	0,7069	0,6555	1,2984	0,3425
352,0	0,7085	0,6523	1,2912	0,3369
353,0	0,7103	0,6491	1,2837	0,3314
354,0	0,7129	0,6465	1,2773	0,3262
355,0	0,7155	0,6438	1,2700	0,3209
356,0	0,7178	0,6415	1,2634	0,3162
357,0	0,7208	0,6398	1,2571	0,3111
358,0	0,7239	0,6380	1,2502	0,3061

359,0	0,7272	0,6372	1,2434	0,3017
360,0	0,7303	0,6366	1,2365	0,2969
361,0	0,7334	0,6369	1,2295	0,2925
362,0	0,7367	0,6372	1,2230	0,2881
363,0	0,7393	0,6384	1,2166	0,2836
364,0	0,7423	0,6402	1,2093	0,2795
365,0	0,7453	0,6427	1,2025	0,2756
366,0	0,7471	0,6454	1,1957	0,2713
367,0	0,7495	0,6490	1,1891	0,2677
368,0	0,7506	0,6530	1,1823	0,2636
369,0	0,7514	0,6574	1,1759	0,2601
370,0	0,7521	0,6625	1,1692	0,2566
371,0	0,7516	0,6677	1,1630	0,2528
372,0	0,7506	0,6736	1,1568	0,2493
373,0	0,7493	0,6807	1,1494	0,2453
374,0	0,7469	0,6871	1,1436	0,2421
375,0	0,7437	0,6941	1,1376	0,2389
376,0	0,7400	0,7014	1,1317	0,2355
377,0	0,7355	0,7087	1,1257	0,2325
378,0	0,7299	0,7157	1,1202	0,2295
379,0	0,7238	0,7238	1,1148	0,2267
380,0	0,7162	0,7309	1,1097	0,2236
381,0	0,7089	0,7382	1,1041	0,2210
382,0	0,7004	0,7456	1,0987	0,2184
383,0	0,6911	0,7535	1,0936	0,2157
384,0	0,6810	0,7607	1,0879	0,2130
385,0	0,6708	0,7677	1,0833	0,2106
386,0	0,6592	0,7748	1,0780	0,2081
387,0	0,6481	0,7813	1,0729	0,2057
388,0	0,6363	0,7877	1,0676	0,2033
389,0	0,6239	0,7943	1,0633	0,2011
390,0	0,6109	0,8005	1,0583	0,1989
391,0	0,5981	0,8062	1,0533	0,1966
392,0	0,5852	0,8117	1,0484	0,1945
393,0	0,5724	0,8164	1,0437	0,1926
394,0	0,5596	0,8208	1,0394	0,1907
395,0	0,5469	0,8244	1,0353	0,1887
396,0	0,5341	0,8268	1,0313	0,1869
397,0	0,5214	0,8284	1,0274	0,1853
398,0	0,5085	0,8287	1,0231	0,1834
399,0	0,4950	0,8275	1,0186	0,1813
400,0	0,4823	0,8249	1,0150	0,1797
401,0	0,4696	0,8210	1,0111	0,1779
402,0	0,4575	0,8152	1,0076	0,1762
403,0	0,4457	0,8081	1,0040	0,1746
404,0	0,4339	0,7993	1,0003	0,1729

405,0	0,4225	0,7890	0,9969	0,1712
406,0	0,4117	0,7775	0,9936	0,1697
407,0	0,4008	0,7644	0,9902	0,1680
408,0	0,3911	0,7504	0,9868	0,1664
409,0	0,3823	0,7356	0,9830	0,1648
410,0	0,3740	0,7198	0,9792	0,1632
411,0	0,3664	0,7038	0,9757	0,1617
412,0	0,3591	0,6873	0,9718	0,1601
413,0	0,3522	0,6704	0,9682	0,1586
414,0	0,3459	0,6540	0,9646	0,1570
415,0	0,3399	0,6377	0,9613	0,1555
416,0	0,3335	0,6202	0,9573	0,1536
417,0	0,3276	0,6037	0,9540	0,1523
418,0	0,3214	0,5875	0,9506	0,1506
419,0	0,3153	0,5718	0,9474	0,1490
420,0	0,3090	0,5561	0,9440	0,1474
421,0	0,3024	0,5415	0,9409	0,1457
422,0	0,2954	0,5264	0,9375	0,1441
423,0	0,2885	0,5120	0,9340	0,1426
424,0	0,2816	0,4980	0,9306	0,1409
425,0	0,2743	0,4840	0,9272	0,1394
426,0	0,2667	0,4700	0,9239	0,1377
427,0	0,2592	0,4562	0,9202	0,1360
428,0	0,2514	0,4430	0,9168	0,1343
429,0	0,2437	0,4295	0,9134	0,1327
430,0	0,2363	0,4165	0,9102	0,1311
431,0	0,2294	0,4040	0,9073	0,1296
432,0	0,2224	0,3911	0,9036	0,1279
433,0	0,2158	0,3786	0,9004	0,1263
434,0	0,2102	0,3668	0,8973	0,1250
435,0	0,2047	0,3553	0,8942	0,1234
436,0	0,1996	0,3440	0,8909	0,1218
437,0	0,1950	0,3332	0,8875	0,1202
438,0	0,1911	0,3232	0,8844	0,1189
439,0	0,1872	0,3132	0,8813	0,1174
440,0	0,1839	0,3041	0,8780	0,1162
441,0	0,1806	0,2954	0,8750	0,1148
442,0	0,1774	0,2870	0,8716	0,1134
443,0	0,1746	0,2794	0,8688	0,1121
444,0	0,1719	0,2721	0,8658	0,1106
445,0	0,1694	0,2653	0,8629	0,1094
446,0	0,1673	0,2591	0,8599	0,1082
447,0	0,1652	0,2530	0,8571	0,1068
448,0	0,1635	0,2475	0,8541	0,1056
449,0	0,1618	0,2424	0,8515	0,1045
450,0	0,1603	0,2377	0,8488	0,1033

451,0	0,1591	0,2332	0,8461	0,1023
452,0	0,1578	0,2291	0,8435	0,1010
453,0	0,1569	0,2252	0,8407	0,0999
454,0	0,1559	0,2217	0,8382	0,0989
455,0	0,1549	0,2184	0,8357	0,0979
456,0	0,1537	0,2151	0,8330	0,0968
457,0	0,1527	0,2121	0,8307	0,0959
458,0	0,1515	0,2091	0,8278	0,0948
459,0	0,1503	0,2065	0,8249	0,0938
460,0	0,1491	0,2038	0,8222	0,0929
461,0	0,1477	0,2012	0,8195	0,0919
462,0	0,1464	0,1987	0,8169	0,0910
463,0	0,1447	0,1962	0,8143	0,0899
464,0	0,1430	0,1938	0,8122	0,0890
465,0	0,1415	0,1915	0,8098	0,0881
466,0	0,1397	0,1893	0,8074	0,0873
467,0	0,1378	0,1872	0,8047	0,0863
468,0	0,1359	0,1851	0,8022	0,0854
469,0	0,1339	0,1829	0,7996	0,0846
470,0	0,1322	0,1811	0,7974	0,0838
471,0	0,1304	0,1794	0,7950	0,0831
472,0	0,1286	0,1775	0,7929	0,0823
473,0	0,1271	0,1760	0,7909	0,0815
474,0	0,1253	0,1744	0,7887	0,0807
475,0	0,1238	0,1730	0,7864	0,0800
476,0	0,1225	0,1717	0,7844	0,0793
477,0	0,1212	0,1705	0,7824	0,0787
478,0	0,1199	0,1694	0,7800	0,0781
479,0	0,1188	0,1684	0,7780	0,0774
480,0	0,1177	0,1675	0,7756	0,0767
481,0	0,1168	0,1666	0,7733	0,0761
482,0	0,1159	0,1659	0,7712	0,0755
483,0	0,1148	0,1651	0,7690	0,0748
484,0	0,1140	0,1646	0,7666	0,0742
485,0	0,1132	0,1641	0,7645	0,0737
486,0	0,1124	0,1637	0,7626	0,0732
487,0	0,1116	0,1633	0,7604	0,0725
488,0	0,1109	0,1630	0,7583	0,0721
489,0	0,1099	0,1626	0,7564	0,0714
490,0	0,1093	0,1624	0,7544	0,0711
491,0	0,1085	0,1620	0,7523	0,0706
492,0	0,1076	0,1617	0,7500	0,0699
493,0	0,1070	0,1613	0,7480	0,0694
494,0	0,1063	0,1610	0,7458	0,0691
495,0	0,1056	0,1607	0,7435	0,0686
496,0	0,1049	0,1602	0,7413	0,0681

497,0	0,1041	0,1597	0,7393	0,0677
498,0	0,1033	0,1592	0,7371	0,0673
499,0	0,1027	0,1587	0,7360	0,0669
500,0	0,1018	0,1578	0,7340	0,0664
501,0	0,1011	0,1572	0,7321	0,0661
502,0	0,1002	0,1562	0,7302	0,0656
503,0	0,0994	0,1552	0,7286	0,0652
504,0	0,0986	0,1543	0,7268	0,0649
505,0	0,0977	0,1532	0,7247	0,0644
506,0	0,0968	0,1520	0,7227	0,0640
507,0	0,0960	0,1509	0,7206	0,0637
508,0	0,0949	0,1495	0,7185	0,0631
509,0	0,0940	0,1483	0,7166	0,0629
510,0	0,0928	0,1468	0,7148	0,0625
511,0	0,0917	0,1455	0,7131	0,0621
512,0	0,0905	0,1442	0,7113	0,0616
513,0	0,0892	0,1428	0,7094	0,0612
514,0	0,0879	0,1415	0,7074	0,0609
515,0	0,0867	0,1402	0,7055	0,0607
516,0	0,0853	0,1390	0,7035	0,0601
517,0	0,0842	0,1379	0,7020	0,0599
518,0	0,0830	0,1368	0,7005	0,0595
519,0	0,0819	0,1356	0,6988	0,0592
520,0	0,0809	0,1345	0,6970	0,0586
521,0	0,0800	0,1336	0,6953	0,0585
522,0	0,0792	0,1327	0,6935	0,0582
523,0	0,0784	0,1319	0,6919	0,0579
524,0	0,0778	0,1310	0,6901	0,0576
525,0	0,0774	0,1303	0,6884	0,0573
526,0	0,0769	0,1295	0,6865	0,0569
527,0	0,0764	0,1287	0,6843	0,0566
528,0	0,0763	0,1283	0,6827	0,0564
529,0	0,0762	0,1277	0,6809	0,0560
530,0	0,0763	0,1271	0,6792	0,0558
531,0	0,0763	0,1267	0,6774	0,0557
532,0	0,0766	0,1261	0,6759	0,0554
533,0	0,0767	0,1255	0,6743	0,0551
534,0	0,0770	0,1249	0,6727	0,0549
535,0	0,0772	0,1245	0,6711	0,0547
536,0	0,0774	0,1238	0,6695	0,0544
537,0	0,0775	0,1230	0,6675	0,0540
538,0	0,0775	0,1224	0,6659	0,0539
539,0	0,0772	0,1216	0,6641	0,0536
540,0	0,0769	0,1209	0,6624	0,0533
541,0	0,0765	0,1203	0,6609	0,0532
542,0	0,0758	0,1196	0,6591	0,0529

543,0	0,0751	0,1187	0,6574	0,0526
544,0	0,0745	0,1180	0,6559	0,0525
545,0	0,0737	0,1171	0,6543	0,0522
546,0	0,0730	0,1165	0,6528	0,0520
547,0	0,0722	0,1158	0,6514	0,0518
548,0	0,0714	0,1150	0,6501	0,0515
549,0	0,0709	0,1143	0,6488	0,0512
550,0	0,0702	0,1137	0,6475	0,0510
551,0	0,0697	0,1131	0,6463	0,0509
552,0	0,0692	0,1123	0,6447	0,0507
553,0	0,0687	0,1116	0,6428	0,0505
554,0	0,0682	0,1109	0,6413	0,0501
555,0	0,0678	0,1103	0,6397	0,0500
556,0	0,0675	0,1097	0,6382	0,0498
557,0	0,0672	0,1091	0,6368	0,0497
558,0	0,0669	0,1084	0,6354	0,0495
559,0	0,0665	0,1078	0,6337	0,0493
560,0	0,0663	0,1072	0,6324	0,0491
561,0	0,0661	0,1068	0,6309	0,0491
562,0	0,0658	0,1062	0,6298	0,0489
563,0	0,0655	0,1056	0,6286	0,0487
564,0	0,0652	0,1050	0,6273	0,0486
565,0	0,0650	0,1046	0,6262	0,0485
566,0	0,0648	0,1040	0,6251	0,0484
567,0	0,0645	0,1035	0,6238	0,0482
568,0	0,0641	0,1029	0,6225	0,0480
569,0	0,0640	0,1025	0,6212	0,0478
570,0	0,0636	0,1020	0,6201	0,0478
571,0	0,0634	0,1015	0,6190	0,0477
572,0	0,0630	0,1009	0,6176	0,0475
573,0	0,0627	0,1004	0,6165	0,0473
574,0	0,0623	0,0999	0,6152	0,0472
575,0	0,0621	0,0994	0,6141	0,0471
576,0	0,0617	0,0989	0,6128	0,0470
577,0	0,0615	0,0985	0,6114	0,0470
578,0	0,0612	0,0979	0,6100	0,0468
579,0	0,0609	0,0975	0,6088	0,0466
580,0	0,0607	0,0970	0,6075	0,0466
581,0	0,0603	0,0964	0,6059	0,0464
582,0	0,0601	0,0960	0,6048	0,0463
583,0	0,0600	0,0957	0,6034	0,0463
584,0	0,0597	0,0952	0,6020	0,0461
585,0	0,0596	0,0948	0,6005	0,0460
586,0	0,0596	0,0945	0,5992	0,0460
587,0	0,0593	0,0940	0,5978	0,0460
588,0	0,0593	0,0937	0,5968	0,0460

589,0	0,0593	0,0933	0,5956	0,0458
590,0	0,0592	0,0929	0,5946	0,0456
591,0	0,0593	0,0927	0,5941	0,0456
592,0	0,0593	0,0923	0,5928	0,0455
593,0	0,0594	0,0920	0,5916	0,0455
594,0	0,0594	0,0917	0,5903	0,0455
595,0	0,0596	0,0913	0,5891	0,0455
596,0	0,0598	0,0910	0,5879	0,0453
597,0	0,0599	0,0906	0,5867	0,0452
598,0	0,0602	0,0903	0,5855	0,0452
599,0	0,0606	0,0901	0,5846	0,0453
600,0	0,0608	0,0898	0,5835	0,0451
601,0	0,0614	0,0896	0,5824	0,0452
602,0	0,0615	0,0892	0,5813	0,0451
603,0	0,0621	0,0890	0,5803	0,0451
604,0	0,0623	0,0885	0,5793	0,0450
605,0	0,0628	0,0883	0,5783	0,0450
606,0	0,0632	0,0881	0,5774	0,0450
607,0	0,0636	0,0878	0,5764	0,0449
608,0	0,0640	0,0875	0,5753	0,0450
609,0	0,0642	0,0873	0,5744	0,0449
610,0	0,0644	0,0871	0,5733	0,0448
611,0	0,0646	0,0868	0,5723	0,0448
612,0	0,0647	0,0864	0,5711	0,0448
613,0	0,0648	0,0864	0,5705	0,0448
614,0	0,0647	0,0861	0,5694	0,0448
615,0	0,0647	0,0858	0,5686	0,0448
616,0	0,0646	0,0855	0,5677	0,0447
617,0	0,0644	0,0853	0,5668	0,0447
618,0	0,0642	0,0850	0,5661	0,0447
619,0	0,0638	0,0848	0,5651	0,0446
620,0	0,0636	0,0847	0,5645	0,0447
621,0	0,0633	0,0845	0,5638	0,0446
622,0	0,0628	0,0842	0,5632	0,0445
623,0	0,0626	0,0840	0,5625	0,0446
624,0	0,0622	0,0838	0,5616	0,0446
625,0	0,0619	0,0837	0,5609	0,0445
626,0	0,0616	0,0835	0,5604	0,0446
627,0	0,0612	0,0832	0,5594	0,0445
628,0	0,0610	0,0831	0,5588	0,0445
629,0	0,0608	0,0831	0,5581	0,0445
630,0	0,0607	0,0828	0,5573	0,0445
631,0	0,0606	0,0828	0,5567	0,0445
632,0	0,0606	0,0828	0,5561	0,0444
633,0	0,0606	0,0828	0,5553	0,0445
634,0	0,0606	0,0827	0,5545	0,0444

635,0	0,0608	0,0829	0,5537	0,0446
636,0	0,0610	0,0830	0,5529	0,0444
637,0	0,0610	0,0831	0,5521	0,0445
638,0	0,0614	0,0834	0,5514	0,0444
639,0	0,0619	0,0838	0,5508	0,0445
640,0	0,0622	0,0842	0,5502	0,0445
641,0	0,0627	0,0847	0,5495	0,0445
642,0	0,0632	0,0852	0,5488	0,0445
643,0	0,0639	0,0861	0,5481	0,0447
644,0	0,0645	0,0867	0,5473	0,0447
645,0	0,0651	0,0876	0,5467	0,0446
646,0	0,0660	0,0885	0,5458	0,0447
647,0	0,0668	0,0893	0,5450	0,0446
648,0	0,0677	0,0904	0,5443	0,0447
649,0	0,0688	0,0914	0,5437	0,0447
650,0	0,0699	0,0923	0,5430	0,0449
651,0	0,0710	0,0932	0,5423	0,0449
652,0	0,0724	0,0941	0,5415	0,0449
653,0	0,0738	0,0948	0,5410	0,0450
654,0	0,0755	0,0954	0,5401	0,0451
655,0	0,0773	0,0959	0,5394	0,0452
656,0	0,0792	0,0964	0,5386	0,0452
657,0	0,0814	0,0966	0,5377	0,0453
658,0	0,0836	0,0969	0,5374	0,0454
659,0	0,0861	0,0970	0,5366	0,0455
660,0	0,0890	0,0968	0,5358	0,0455
661,0	0,0919	0,0967	0,5350	0,0458
662,0	0,0950	0,0965	0,5341	0,0458
663,0	0,0982	0,0965	0,5334	0,0459
664,0	0,1015	0,0961	0,5327	0,0460
665,0	0,1047	0,0958	0,5319	0,0461
666,0	0,1080	0,0956	0,5313	0,0463
667,0	0,1109	0,0952	0,5306	0,0463
668,0	0,1135	0,0948	0,5298	0,0463
669,0	0,1155	0,0941	0,5290	0,0463
670,0	0,1172	0,0935	0,5281	0,0465
671,0	0,1182	0,0928	0,5275	0,0466
672,0	0,1183	0,0918	0,5266	0,0465
673,0	0,1176	0,0909	0,5256	0,0463
674,0	0,1161	0,0899	0,5248	0,0464
675,0	0,1139	0,0887	0,5241	0,0462
676,0	0,1110	0,0874	0,5233	0,0461
677,0	0,1074	0,0862	0,5224	0,0460
678,0	0,1036	0,0849	0,5218	0,0459
679,0	0,0992	0,0836	0,5208	0,0457
680,0	0,0948	0,0824	0,5200	0,0455

681,0	0,0904	0,0810	0,5189	0,0454
682,0	0,0860	0,0798	0,5183	0,0452
683,0	0,0819	0,0786	0,5174	0,0451
684,0	0,0781	0,0774	0,5166	0,0448
685,0	0,0745	0,0763	0,5157	0,0447
686,0	0,0714	0,0753	0,5149	0,0446
687,0	0,0685	0,0743	0,5141	0,0444
688,0	0,0657	0,0734	0,5132	0,0443
689,0	0,0635	0,0725	0,5124	0,0443
690,0	0,0615	0,0718	0,5116	0,0443
691,0	0,0597	0,0710	0,5107	0,0442
692,0	0,0581	0,0702	0,5097	0,0439
693,0	0,0568	0,0696	0,5090	0,0439
694,0	0,0556	0,0690	0,5081	0,0438
695,0	0,0546	0,0684	0,5071	0,0437
696,0	0,0537	0,0679	0,5063	0,0437
697,0	0,0527	0,0673	0,5056	0,0435
698,0	0,0520	0,0668	0,5049	0,0434
699,0	0,0515	0,0664	0,5041	0,0436
700,0	0,0508	0,0658	0,5032	0,0435
701,0	0,0502	0,0654	0,5022	0,0433
702,0	0,0498	0,0650	0,5017	0,0433
703,0	0,0493	0,0646	0,5009	0,0432
704,0	0,0490	0,0643	0,5002	0,0432
705,0	0,0486	0,0639	0,4996	0,0431
706,0	0,0483	0,0635	0,4987	0,0430
707,0	0,0479	0,0631	0,4978	0,0430
708,0	0,0475	0,0628	0,4970	0,0429
709,0	0,0474	0,0625	0,4964	0,0429
710,0	0,0473	0,0623	0,4956	0,0429
711,0	0,0468	0,0619	0,4949	0,0429
712,0	0,0466	0,0616	0,4940	0,0428
713,0	0,0463	0,0613	0,4932	0,0427
714,0	0,0460	0,0611	0,4924	0,0426
715,0	0,0459	0,0607	0,4913	0,0424
716,0	0,0456	0,0605	0,4906	0,0425
717,0	0,0455	0,0603	0,4902	0,0425
718,0	0,0454	0,0601	0,4896	0,0425
719,0	0,0452	0,0598	0,4886	0,0424
720,0	0,0450	0,0596	0,4879	0,0422
721,0	0,0449	0,0593	0,4872	0,0423
722,0	0,0447	0,0591	0,4865	0,0422
723,0	0,0446	0,0590	0,4857	0,0422
724,0	0,0444	0,0586	0,4846	0,0420
725,0	0,0443	0,0585	0,4839	0,0420
726,0	0,0443	0,0583	0,4832	0,0420

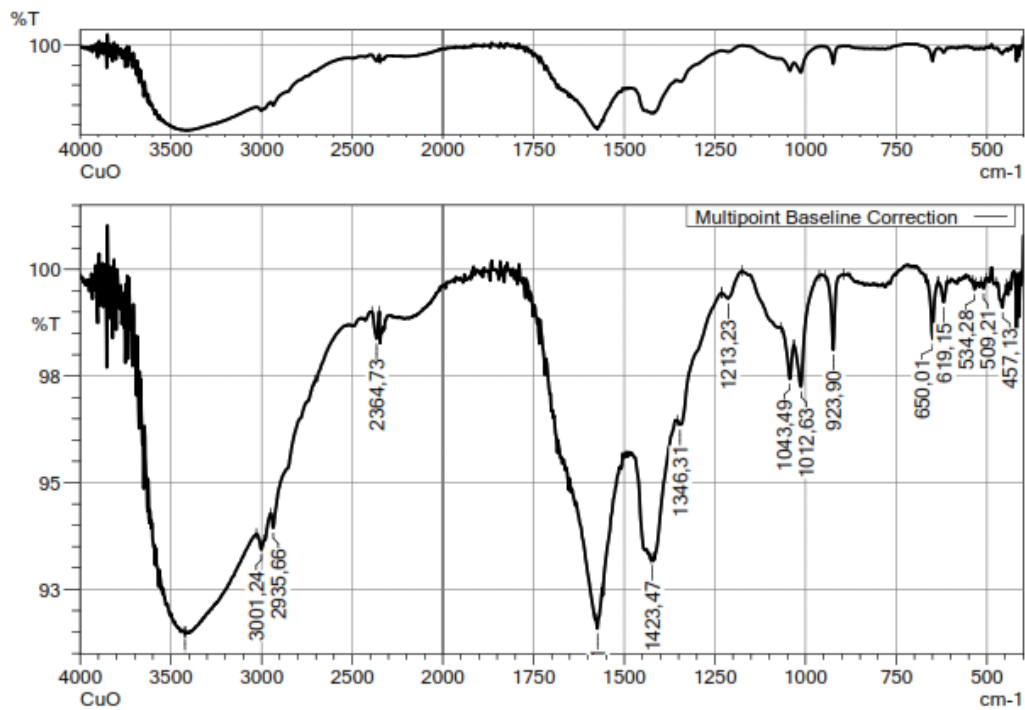
727,0	0,0440	0,0580	0,4824	0,0419
728,0	0,0440	0,0578	0,4817	0,0418
729,0	0,0438	0,0576	0,4810	0,0417
730,0	0,0436	0,0575	0,4804	0,0417
731,0	0,0437	0,0571	0,4796	0,0415
732,0	0,0435	0,0570	0,4790	0,0416
733,0	0,0432	0,0569	0,4782	0,0415
734,0	0,0432	0,0567	0,4775	0,0413
735,0	0,0430	0,0563	0,4766	0,0412
736,0	0,0431	0,0563	0,4761	0,0412
737,0	0,0429	0,0560	0,4753	0,0410
738,0	0,0429	0,0558	0,4747	0,0411
739,0	0,0427	0,0555	0,4738	0,0410
740,0	0,0427	0,0554	0,4732	0,0410
741,0	0,0426	0,0553	0,4726	0,0409
742,0	0,0427	0,0553	0,4719	0,0408
743,0	0,0423	0,0551	0,4711	0,0407
744,0	0,0423	0,0548	0,4705	0,0405
745,0	0,0423	0,0548	0,4701	0,0407
746,0	0,0422	0,0546	0,4692	0,0404
747,0	0,0420	0,0544	0,4684	0,0403
748,0	0,0419	0,0542	0,4677	0,0403
749,0	0,0421	0,0542	0,4669	0,0403
750,0	0,0421	0,0540	0,4661	0,0402
751,0	0,0421	0,0538	0,4657	0,0401
752,0	0,0419	0,0537	0,4649	0,0399
753,0	0,0418	0,0536	0,4642	0,0400
754,0	0,0419	0,0533	0,4636	0,0399
755,0	0,0419	0,0532	0,4630	0,0398
756,0	0,0418	0,0529	0,4621	0,0396
757,0	0,0416	0,0528	0,4616	0,0393
758,0	0,0416	0,0526	0,4608	0,0393
759,0	0,0417	0,0525	0,4602	0,0392
760,0	0,0416	0,0523	0,4592	0,0392
761,0	0,0416	0,0523	0,4589	0,0391
762,0	0,0417	0,0522	0,4583	0,0390
763,0	0,0417	0,0521	0,4576	0,0390
764,0	0,0417	0,0520	0,4570	0,0389
765,0	0,0416	0,0516	0,4562	0,0386
766,0	0,0415	0,0514	0,4556	0,0385
767,0	0,0416	0,0514	0,4548	0,0385
768,0	0,0415	0,0512	0,4541	0,0385
769,0	0,0416	0,0513	0,4533	0,0384
770,0	0,0416	0,0509	0,4526	0,0382
771,0	0,0413	0,0508	0,4517	0,0382
772,0	0,0415	0,0506	0,4511	0,0380

773,0	0,0412	0,0505	0,4506	0,0380
774,0	0,0414	0,0504	0,4502	0,0379
775,0	0,0412	0,0504	0,4495	0,0379
776,0	0,0414	0,0502	0,4491	0,0378
777,0	0,0413	0,0499	0,4481	0,0376
778,0	0,0410	0,0497	0,4471	0,0374
779,0	0,0414	0,0497	0,4466	0,0375
780,0	0,0413	0,0497	0,4463	0,0373
781,0	0,0411	0,0495	0,4457	0,0371
782,0	0,0409	0,0492	0,4448	0,0370
783,0	0,0406	0,0490	0,4441	0,0368
784,0	0,0409	0,0490	0,4435	0,0368
785,0	0,0409	0,0488	0,4430	0,0368
786,0	0,0407	0,0487	0,4422	0,0367
787,0	0,0407	0,0486	0,4417	0,0366
788,0	0,0408	0,0484	0,4409	0,0365
789,0	0,0406	0,0482	0,4402	0,0363
790,0	0,0404	0,0480	0,4394	0,0360
791,0	0,0402	0,0478	0,4387	0,0358
792,0	0,0404	0,0478	0,4381	0,0358
793,0	0,0403	0,0477	0,4373	0,0356
794,0	0,0403	0,0476	0,4368	0,0358
795,0	0,0401	0,0474	0,4362	0,0356
796,0	0,0401	0,0471	0,4355	0,0355
797,0	0,0399	0,0471	0,4347	0,0353
798,0	0,0398	0,0469	0,4340	0,0353
799,0	0,0398	0,0466	0,4335	0,0351
800,0	0,0397	0,0465	0,4327	0,0350

Lampiran 05. Karakterisasi FTIR Nanopartikel

CuO-NPs

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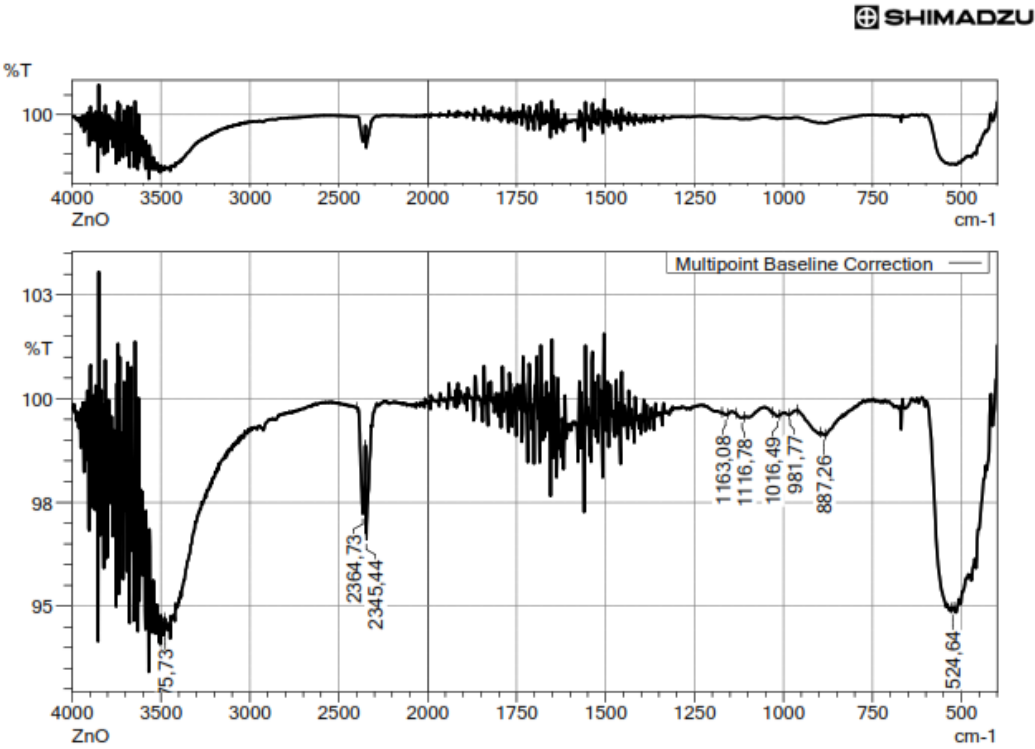
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CuO

	Item		Value						
2	Sample name			CuO					
3	Sample ID			1					
4	Option			CuO					
5	Intensity Mode			%Transmittance					
6	Apodization			Happ-Genzel					
9	No. of Scans			30					
10	Resolution			4 cm-1					

	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area	Comment
1	457,13	99,11	0,56	472,56	445,56	16,442	7,399	
2	509,21	99,56	0,20	516,92	503,42	4,530	1,129	
3	534,28	99,53	0,19	538,14	528,50	3,644	0,834	
4	619,15	99,23	0,48	634,58	609,51	12,149	5,001	
5	650,01	98,38	1,36	665,44	634,58	22,895	14,754	
6	923,90	98,12	1,75	947,05	894,97	27,106	20,427	
7	1012,63	97,25	1,42	1031,92	962,48	86,530	19,928	
8	1043,49	97,43	0,92	1068,56	1031,92	69,458	11,922	
9	1213,23	99,32	0,29	1230,58	1174,65	23,288	6,775	
10	1346,31	96,36	0,29	1354,03	1230,58	232,429	-20,238	
11	1423,47	93,19	0,05	1425,40	1419,61	39,240	0,129	
12	1573,91	91,58	0,39	1577,77	1560,41	139,909	3,936	
13	2364,73	98,38	0,63	2391,73	2351,23	53,358	13,092	
14	2935,66	93,94	0,53	2951,09	2704,20	1027,353	-0,571	

ZnO-NPs



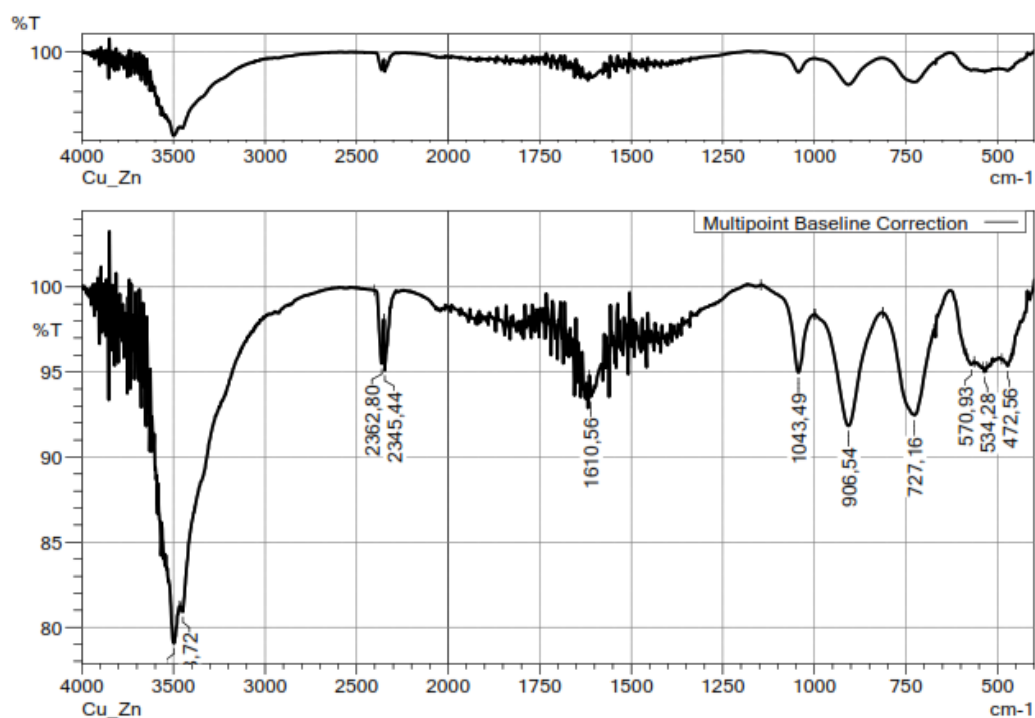
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ZnO

Item		Value	
2	Sample name	ZnO	
3	Sample ID	1	
4	Option	ZnO	
5	Intensity Mode	%Transmittance	
6	Apodization	Happ-Genzel	
9	No. of Scans	30	
10	Resolution	4 cm-1	

	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area	Comment
1	524.64	94.92	0.04	528.50	520.78	39.021	0.141	
2	887.26	99.12	0.03	894.97	883.40	9.873	0.174	
3	981.77	99.62	0.01	983.70	960.55	7.479	-0.059	
4	1016.49	99.57	0.05	1029.99	1010.70	7.552	0.556	
5	1116.78	99.54	0.05	1134.14	1111.00	9.930	0.832	
6	1163.08	99.61	0.04	1172.72	1157.29	5.672	0.318	
7	2345.44	96.61	2.34	2351.23	2316.51	68.284	37.498	
8	2364.73	97.23	1.91	2397.52	2351.23	69.303	38.117	
9	3475.73	94.45	0.18	3479.58	3471.87	41.944	0.547	

CuO/ZnO-NPs

SHIMADZU



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Cu_Zn

	Item		Value	
2	Sample name	Cu_Zn		
3	Sample ID	3		
4	Option	Cu_Zn		
5	Intensity Mode	%Transmittance		
6	Apodization	Happ-Genzel		
9	No. of Scans	30		
10	Resolution	4 cm-1		

	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area	Comment
1	472,56	95,35	0,58	487,99	460,99	117,978	7,630	
2	534,28	95,02	0,27	540,07	528,50	55,905	1,375	
3	570,93	95,44	0,33	584,43	563,21	93,445	5,056	
4	727,16	92,47	5,41	813,96	673,16	675,633	393,061	
5	906,54	91,84	6,60	999,13	813,96	755,358	468,126	
6	1043,49	94,97	3,95	1145,72	999,13	240,177	132,546	
7	1610,56	93,55	0,81	1614,42	1606,70	47,320	3,774	
8	2345,44	95,10	3,11	2351,23	2316,51	107,017	52,721	
9	2362,80	95,49	2,99	2401,38	2351,23	109,252	56,332	
10	3448,72	80,90	1,17	3460,30	3388,93	1158,020	13,865	
11	3496,94	79,06	0,47	3500,80	3466,08	689,996	5,312	

Lampiran 06. Karakterisasi XRD Nanopartikel

a) Kristalinitas CuO-NPs

Crystallinity

General information

Analysis date	2026/03/30 17:42:14	Measurement date	2026/03/30 15:36:14
Sample name		Operator	administrator
File name	CuO-NPS.ras		
Comment			

Peak list

No.	2-theta(deg)	d(ang.)	Height(cps)	FWHM(deg)	Int. I(cps deg)	Int. W(deg)	Asym. factor
1	30.315(13)	2.9460(12)	356(55)	0.21(3)	91(14)	0.26(8)	5(5)
2	32.582(14)	2.7460(11)	1677(118)	0.356(10)	636(23)	0.38(4)	0.96(14)
3	33.777(6)	2.6516(5)	1076(95)	0.179(16)	354(19)	0.33(5)	2.5(12)
4	34.40(6)	2.605(4)	308(51)	0.20(10)	103(20)	0.33(12)	1(2)
5	35.738(6)	2.5104(4)	8269(263)	0.266(5)	2957(32)	0.358(15)	1.41(14)
6	36.609(15)	2.4527(10)	735(78)	0.43(3)	428(25)	0.58(10)	1.41(14)
7	38.067(6)	2.3620(4)	1510(112)	0.223(13)	434(15)	0.29(3)	0.58(6)
8	38.903(7)	2.3131(4)	7764(254)	0.338(6)	3375(33)	0.435(18)	0.58(6)
9	40.17(5)	2.243(2)	172(38)	0.55(11)	122(21)	0.7(3)	0.58(6)
10	41.538(18)	2.1723(9)	309(51)	0.23(5)	93(12)	0.30(9)	0.58(6)
11	42.52(3)	2.1244(14)	108(30)	0.11(10)	12(13)	0.11(15)	5(37)
12	43.568(13)	2.0757(6)	224(43)	0.07(3)	18(10)	0.08(6)	1(3)
13	44.04(3)	2.0545(13)	367(55)	0.12(3)	46(13)	0.13(5)	1.5(16)
14	45.31(6)	2.000(3)	431(60)	0.25(5)	115(20)	0.27(8)	1.3(13)
15	46.52(16)	1.951(6)	149(35)	0.28(12)	44(19)	0.3(2)	0.8(18)
16	48.894(5)	1.86130(17)	2123(133)	0.293(13)	765(24)	0.36(3)	0.50(15)
17	53.72(4)	1.7050(11)	587(70)	0.35(3)	218(19)	0.37(8)	2.1(10)
18	57.11(3)	1.6116(7)	294(49)	0.26(5)	88(13)	0.30(9)	2.2(11)
19	57.47(2)	1.6022(6)	238(44)	0.19(6)	53(11)	0.22(9)	2.2(11)
20	58.51(3)	1.5763(6)	997(91)	0.33(2)	386(17)	0.39(5)	1.5(5)
21	61.775(6)	1.50051(13)	1840(124)	0.268(11)	712(17)	0.39(4)	3.2(3)
22	66.00(3)	1.4143(6)	890(86)	0.51(15)	658(168)	0.7(3)	0.8(4)
23	66.432(18)	1.4062(3)	1117(96)	0.25(5)	407(164)	0.36(18)	0.8(4)
24	68.24(3)	1.3733(5)	1323(105)	0.45(3)	801(23)	0.61(7)	1.4(5)
25	72.46(6)	1.3033(10)	396(57)	0.56(14)	412(26)	1.0(2)	0.6(4)
26	75.19(7)	1.2626(10)	566(69)	0.60(7)	474(27)	0.84(15)	0.7(4)
27	80.44(3)	1.1930(4)	194(40)	0.30(16)	111(18)	0.6(2)	4(7)
28	82.492(8)	1.16837(10)	371(56)	0.14(3)	67(16)	0.18(7)	4(3)
29	83.62(3)	1.1554(4)	264(47)	1.25(18)	434(33)	1.6(4)	4(3)

Crystallinity

Data set name	Crystallinity(%)
CuO-NPS	99.1(2)

b) Ukuran Kristal dan Regangan Kisi CuO-NPs

Crystallite Size and Lattice Strain

General information

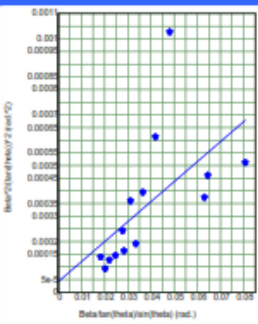
Analysis date	2026/03/30 17:39:26	Measurement date	2026/03/30 15:36:14
Sample name		Operator	administrator
File name	CuO-NPS.ras		
Comment			

Qualitative analysis results

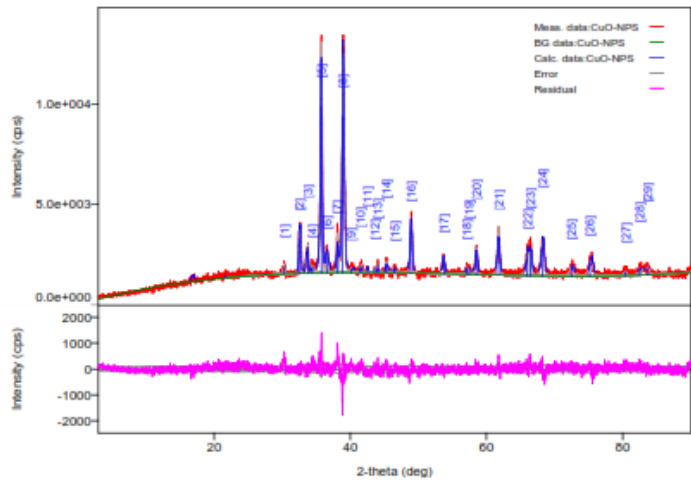
Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Tenorite	Cu O	0.389	ICDD (PDF2.DAT)	00-072-0629
Sodium Carbonate	Na2 C O3 H2 O	1.182	ICDD (PDF2.DAT)	00-070-2148
Copper Oxide	Cu2 O	2.692	ICDD (PDF2.DAT)	00-074-1230

Crystallite size and lattice strain

Phase name	Crystallite size(A)	Strain(%)
Tenorite	205(81)	0.2(3)
Equation		
Y=0.008X+0.00004		



Measurement profile



c) Hasil Analisis Kualitatif CuO-NPs

Qualitative Analysis Results

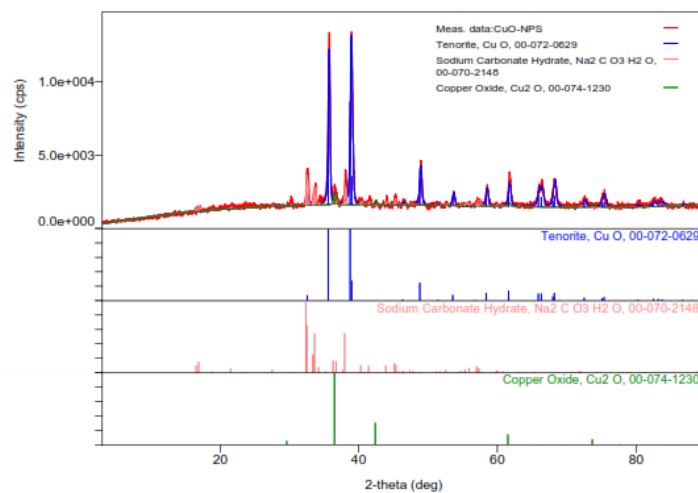
General information

Analysis date	2026/03/30 17:38:42	Measurement date	2026/03/30 15:36:14
Sample name	CuO-NPS.ras	Operator	administrator
File name			
Comment			

Qualitative analysis results

Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Tenorite	CuO	0.389	ICDD (PDF2.DAT)	00-072-0629
Sodium Carbonate	Na ₂ CO ₃ H ₂ O	1.182	ICDD (PDF2.DAT)	00-070-2148
Copper Oxide	Cu ₂ O	2.692	ICDD (PDF2.DAT)	00-074-1230

Phase data pattern



d) Kristalinitas ZnO-NPs

Crystallinity

General information

Analysis date	2026/03/30 17:55:07	Measurement date	2026/03/30 15:57:20
Sample name		Operator	administrator
File name	ZnO-NPs.ras		
Comment			

Peak list

No.	2-theta(deg)	d(ang.)	Height(cps)	FWHM(deg)	Int. I(cps deg)	Int. W(deg)	Asym. factor
1	27.525(8)	3.2379(9)	479(63)	0.23(4)	180(10)	0.38(7)	1.6(15)
2	31.905(5)	2.8027(4)	10809(300)	0.238(4)	3461(23)	0.320(11)	1.56(14)
3	34.630(7)	2.5881(5)	4806(200)	0.234(6)	1463(16)	0.304(16)	2.3(3)
4	36.441(5)	2.4636(3)	11078(304)	0.237(5)	3658(23)	0.330(11)	2.0(2)
5	45.625(4)	1.98673(18)	4323(190)	0.150(5)	926(12)	0.214(12)	2.0(3)
6	47.731(6)	1.9039(2)	2812(153)	0.217(10)	933(11)	0.33(2)	1.9(3)
7	54.01(7)	1.6964(19)	117(31)	0.23(6)	32(5)	0.27(12)	1.1(13)
8	56.773(5)	1.62025(14)	4370(191)	0.273(7)	1656(15)	0.38(2)	2.6(3)
9	63.037(4)	1.47348(9)	4055(184)	0.195(6)	1284(10)	0.317(17)	1.51(18)
10	65.87(3)	1.4168(5)	58(22)	0.14(6)	9(5)	0.15(14)	0.66(14)
11	66.39(2)	1.4070(4)	664(74)	0.396(16)	282(12)	0.42(7)	0.66(14)
12	68.111(6)	1.37553(10)	3297(166)	0.201(8)	1093(12)	0.33(2)	1.3(2)
13	69.237(7)	1.35589(12)	1665(118)	0.194(10)	546(9)	0.33(3)	0.97(19)
14	72.71(2)	1.2994(3)	275(48)	0.20(3)	78(9)	0.28(8)	1.2(6)
15	73.14(3)	1.2929(5)	86(27)	0.23(8)	27(8)	0.32(19)	1.2(6)
16	75.391(6)	1.25976(9)	1429(109)	0.158(7)	296(6)	0.21(2)	0.85(16)
17	75.831(19)	1.2535(3)	78(26)	0.14(4)	15(3)	0.19(10)	0.85(16)
18	77.15(2)	1.2354(3)	449(61)	0.25(2)	160(6)	0.36(6)	2.3(11)
19	81.525(9)	1.17976(11)	239(45)	0.22(3)	82(5)	0.34(8)	0.6(3)
20	84.068(12)	1.15043(13)	691(76)	0.196(11)	188(6)	0.27(4)	1.3(4)
21	89.752(11)	1.09173(11)	1014(92)	0.216(15)	373(11)	0.37(4)	1.2(3)

Crystallinity

Data set name	Crystallinity(%)
ZnO-NPs	99.85(5)



e) Ukuran Kristal dan Regangan Kisi ZnO-NPs

Crystallite Size and Lattice Strain

General information

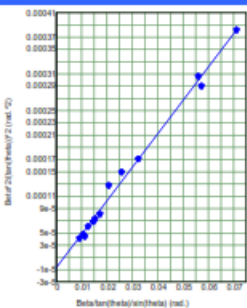
Analysis date	2026/03/30 17:53:34	Measurement date	2026/03/30 15:57:20
Sample name		Operator	administrator
File name	ZnO-NPs.ras		
Comment			

Qualitative analysis results

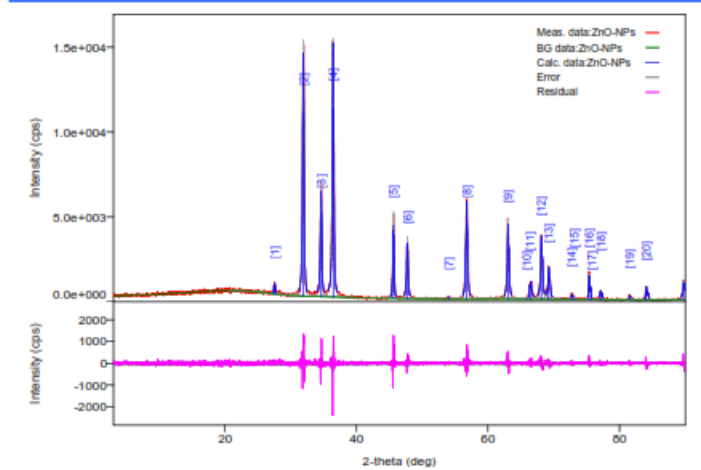
Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Zinc Oxide	ZnO	0.316	ICDD (PDF2.DAT)	00-075-0576
Sodium Chloride	NaCl	0.570	ICDD (PDF2.DAT)	00-078-0751

Crystallite size and lattice strain

Phase name	Crystallite size(A)	Strain(%)
Zinc Oxide	296(8)	0.000000
Equation		
Y=0.00547X-0.000007		



Measurement profile



f) Hasil Analisis Kualitatif ZnO-NPs

Qualitative Analysis Results

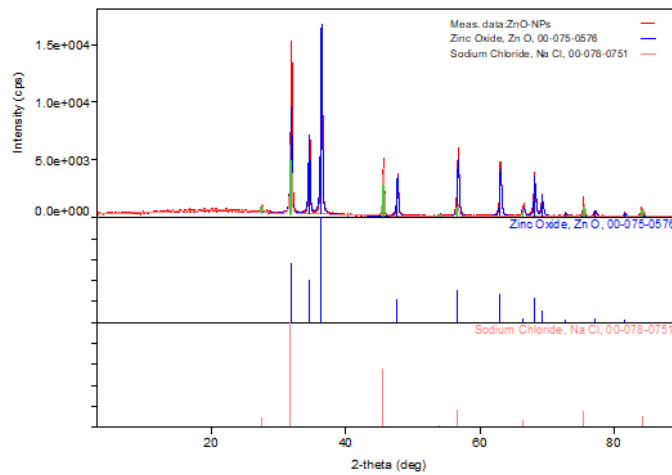
General information

Analysis date	2026/03/30 17:47:00		
Sample name		Measurement date	2026/03/30 15:57:20
File name	ZnO-NPs.ras	Operator	administrator
Comment			

Qualitative analysis results

Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Zinc Oxide	Zn O	0.316	ICDD (PDF2.DAT)	00-075-0576
Sodium Chloride	Na Cl	0.570	ICDD (PDF2.DAT)	00-078-0751

Phase data pattern



g) Kristalinitas CuO/ZnO-NPs (1:1)

Crystallinity

General Information

Analysis date	2026/03/30 17:02:57	Measurement date	2026/03/30 15:25:48
Sample name		Operator	administrator
File name	Cu_Zn-NPS (1_1).ras		
Comment			

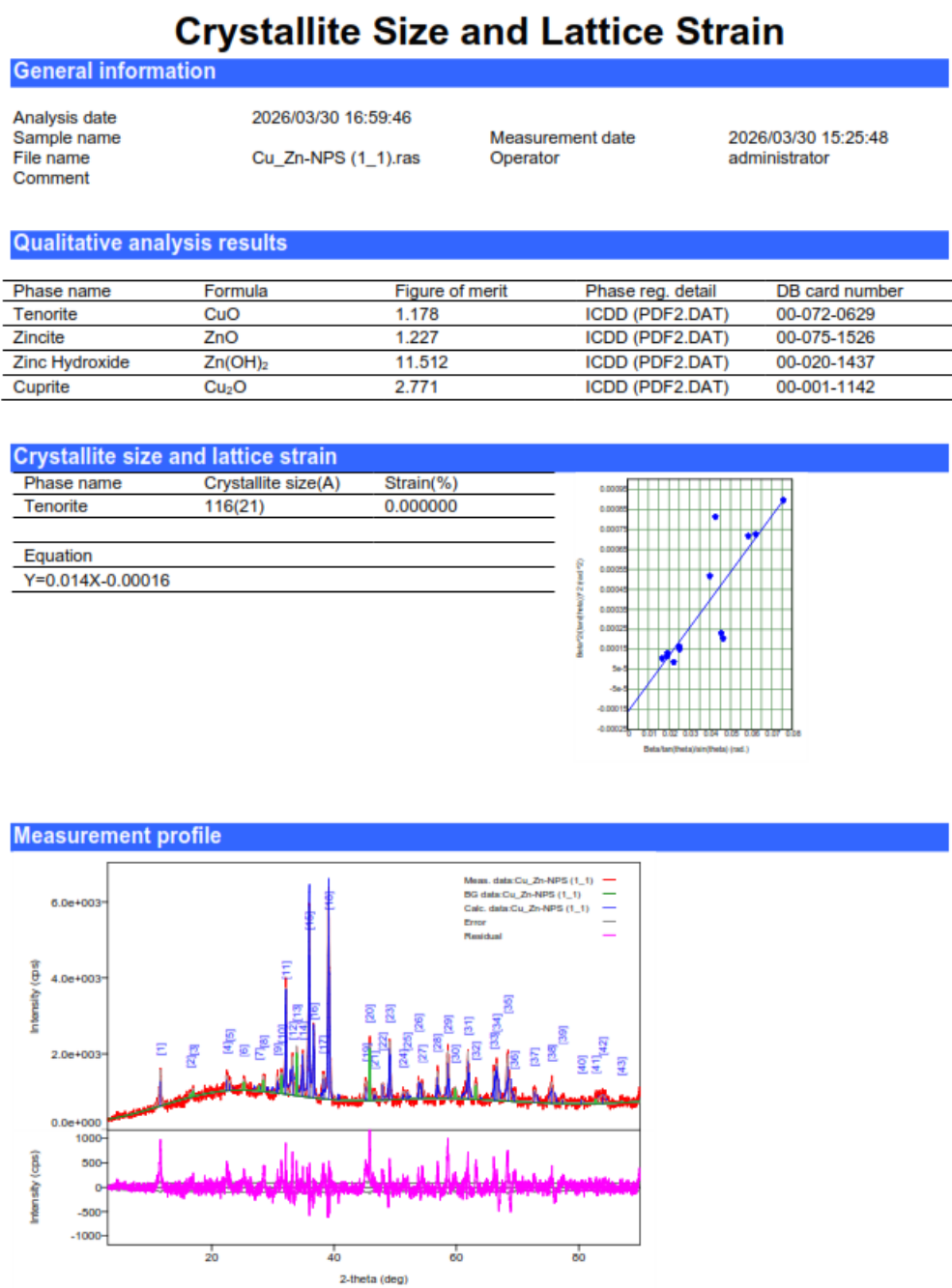
Peak list

No.	2-theta(deg)	d(ang.)	Height(cps)	FWHM(deg)	Int. I(cps deg)	Int. W(deg)	Asym. factor
1	11.632(16)	7.601(11)	651(74)	0.26(3)	290(10)	0.45(7)	1.8(7)
2	16.55(8)	5.35(2)	90(27)	0.28(9)	27(8)	0.30(19)	3(4)
3	16.98(5)	5.218(16)	150(35)	0.19(6)	30(6)	0.20(9)	3(4)
4	22.49(5)	3.951(9)	284(49)	0.27(5)	111(20)	0.39(14)	1.1(9)
5	22.93(4)	3.875(7)	180(39)	0.19(9)	50(16)	0.28(15)	1.1(9)
6	25.22(6)	3.528(9)	218(43)	0.22(10)	88(12)	0.40(13)	1.0(16)
7	27.717(18)	3.216(2)	137(34)	0.09(5)	13(7)	0.10(7)	0.5(11)
8	28.473(11)	3.1323(12)	298(50)	0.23(3)	74(12)	0.25(8)	0.7(6)
9	30.75(5)	2.906(4)	318(52)	0.19(4)	74(11)	0.23(7)	0.8(8)
10	31.410(8)	2.8457(7)	482(63)	0.123(17)	126(10)	0.26(5)	0.5(3)
11	32.090(4)	2.7869(4)	2353(140)	0.124(7)	454(12)	0.193(17)	0.59(7)
12	33.21(2)	2.6954(15)	769(80)	0.19(3)	276(13)	0.36(5)	1.9(10)
13	33.871(6)	2.6444(4)	1123(97)	0.105(11)	251(9)	0.22(3)	1.3(4)
14	34.886(11)	2.5698(8)	809(82)	0.218(16)	228(11)	0.28(4)	4.5(15)
15	35.932(6)	2.4973(4)	3735(176)	0.193(6)	994(13)	0.266(16)	2.2(4)
16	36.663(8)	2.4491(5)	1362(107)	0.181(18)	413(12)	0.30(3)	2.2(4)
17	38.236(11)	2.3519(6)	522(66)	0.17(3)	168(13)	0.32(7)	1.0(7)
18	39.113(6)	2.3012(3)	4305(189)	0.179(11)	1333(23)	0.310(19)	1.6(3)
19	45.27(3)	2.0014(14)	347(54)	0.58(6)	268(20)	0.77(18)	1.5(3)
20	45.827(6)	1.9785(3)	1359(106)	0.132(9)	241(13)	0.18(2)	1.5(3)
21	46.60(4)	1.9476(16)	159(36)	0.55(10)	117(17)	0.7(3)	1.5(3)
22	47.88(2)	1.8982(8)	395(57)	0.17(4)	131(10)	0.33(7)	0.7(6)
23	49.092(13)	1.8542(5)	1350(106)	0.184(16)	329(12)	0.24(3)	0.8(3)
24	51.28(4)	1.7803(12)	140(34)	0.70(16)	104(16)	0.7(3)	0.5(4)
25	51.93(2)	1.7595(6)	179(39)	0.22(6)	43(15)	0.24(13)	0.5(4)
26	53.828(14)	1.7017(4)	441(61)	0.14(2)	73(18)	0.16(6)	1.9(9)
27	54.36(6)	1.6863(16)	277(48)	0.66(10)	218(17)	0.8(2)	1.9(9)
28	56.87(3)	1.6177(8)	553(68)	0.32(2)	189(13)	0.34(6)	0.9(3)
29	58.59(2)	1.5742(5)	931(88)	0.351(17)	369(14)	0.40(5)	1.7(4)
30	59.804(19)	1.5452(4)	265(47)	0.20(5)	88(11)	0.33(10)	1.2(10)
31	61.914(10)	1.4975(2)	995(91)	0.243(18)	440(18)	0.44(6)	3.2(5)
32	63.15(5)	1.4710(10)	360(55)	0.29(4)	110(13)	0.31(8)	0.7(4)
33	66.140(16)	1.4117(3)	655(74)	0.26(4)	237(18)	0.36(7)	1.2(3)
34	66.579(11)	1.4034(2)	897(86)	0.186(17)	231(18)	0.26(4)	1.2(3)
35	68.410(18)	1.3703(3)	905(87)	0.381(18)	381(27)	0.42(7)	2.8(7)
36	69.43(5)	1.3526(8)	180(39)	0.82(17)	162(22)	0.9(3)	2.8(7)
37	72.70(2)	1.2996(3)	280(48)	0.39(6)	135(13)	0.48(13)	0.5(4)
38	75.53(5)	1.2577(7)	407(58)	0.43(4)	186(15)	0.46(10)	1.8(8)
39	77.3(2)	1.233(3)	92(28)	0.52(16)	51(16)	0.6(3)	0.9(14)
40	80.42(4)	1.1931(4)	104(29)	0.23(9)	25(10)	0.24(17)	0.5(9)
41	82.72(4)	1.1657(5)	119(32)	0.24(8)	33(12)	0.28(17)	1.8(10)
42	83.88(15)	1.1525(16)	151(36)	1.26(18)	222(24)	1.5(5)	1.8(10)
43	86.98(11)	1.1192(12)	41(18)	0.3(3)	13(12)	0.3(4)	1(5)

Crystallinity

Data set name	Crystallinity(%)
Cu_Zn-NPS (1_1)	82.3(17)

h) Ukuran Kristal dan Regangan Kisi CuO/ZnO-NPs (1:1)



i) Hasil Analisis Kualitatif CuO/ZnO-NPs (1:1)

Qualitative Analysis Results

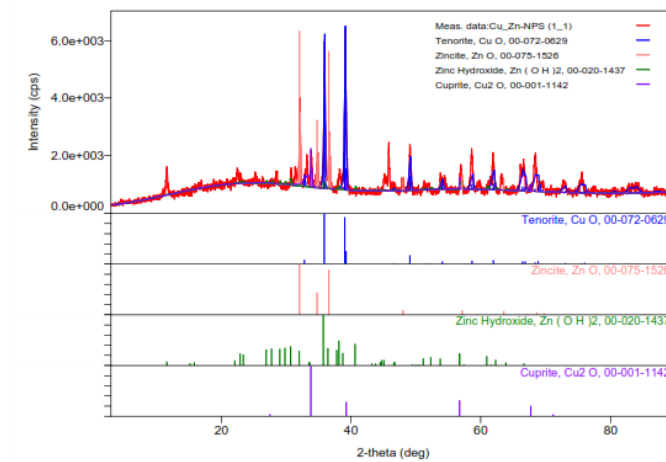
General information

Analysis date	2026/03/30 16:55:03	Measurement date	2026/03/30 15:25:48
Sample name		Operator	administrator
File name	Cu_Zn-NPS (1_1).ras		
Comment			

Qualitative analysis results

Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Tenorite	Cu O	1.178	ICDD (PDF2.DAT)	00-072-0629
Zincite	Zn O	1.227	ICDD (PDF2.DAT)	00-075-1526
Zinc Hydroxide	Zn(OH) ₂	11.512	ICDD (PDF2.DAT)	00-020-1437
Cuprite	Cu ₂ O	2.771	ICDD (PDF2.DAT)	00-001-1142

Phase data pattern



j) Kristalinitas CuO/ZnO-NPs (Cbest)

Crystallinity

General information

Analysis date	2026/03/30 17:19:49	Measurement date	2026/03/30 15:46:55
Sample name		Operator	administrator
File name	Cu_Zn-NPS CBest.ras		
Comment			

Peak list

No.	2-theta(deg)	d(ang.)	Height(cps)	FWHM(deg)	Int. I(cps deg)	Int. W(deg)	Asym. factor
1	31.957(9)	2.7983(8)	3534(172)	0.375(10)	1705(105)	0.48(5)	0.87(9)
2	32.67(2)	2.738(2)	506(65)	0.54(11)	289(101)	0.6(3)	3.1(18)
3	34.642(6)	2.5873(4)	2558(146)	0.344(8)	1164(19)	0.45(3)	0.84(6)
4	35.747(15)	2.5098(10)	2520(145)	0.316(11)	986(82)	0.39(5)	1.0(2)
5	36.472(7)	2.4616(4)	5310(210)	0.455(9)	3199(82)	0.60(4)	0.84(6)
6	38.15(5)	2.357(3)	252(46)	0.13(5)	36(14)	0.14(8)	1.0(13)
7	38.962(7)	2.3098(4)	2483(144)	0.406(9)	1335(22)	0.54(4)	0.84(6)
8	42.53(15)	2.124(7)	98(29)	0.42(14)	50(15)	0.5(3)	0.8(12)
9	45.64(2)	1.9860(9)	503(65)	0.25(3)	175(11)	0.35(7)	0.9(3)
10	47.73(2)	1.9040(9)	886(86)	0.57(2)	613(18)	0.69(9)	0.82(15)
11	48.96(3)	1.8588(11)	737(78)	0.38(3)	399(18)	0.54(8)	0.9(3)
12	53.91(2)	1.6994(6)	185(39)	0.47(7)	92(16)	0.50(19)	5(5)
13	56.80(2)	1.6195(5)	1693(119)	0.538(17)	1254(22)	0.74(7)	0.93(15)
14	58.454(18)	1.5776(5)	311(51)	0.36(4)	143(12)	0.46(11)	0.86(12)
15	61.75(4)	1.5012(8)	688(76)	0.32(5)	345(21)	0.50(9)	1.0(5)
16	63.046(18)	1.4733(4)	1224(101)	0.552(18)	863(25)	0.70(8)	0.86(12)
17	66.56(4)	1.4037(8)	638(73)	0.70(5)	564(29)	0.88(15)	3.8(18)
18	68.154(18)	1.3748(3)	1437(109)	0.587(19)	1075(28)	0.75(8)	0.86(12)
19	69.25(2)	1.3557(3)	535(67)	0.58(4)	395(20)	0.74(13)	0.86(12)
20	72.70(6)	1.2996(10)	220(43)	0.51(7)	148(19)	0.7(2)	1.5(7)
21	75.37(7)	1.2601(11)	303(50)	0.46(5)	150(17)	0.49(14)	1.4(9)
22	83.2(2)	1.160(2)	131(33)	2.76(19)	385(39)	2.9(10)	0.8(2)

Crystallinity

Data set name	Crystallinity(%)
Cu_Zn-NPS CBest	99.69(12)



k) Ukuran Kristal dan Regangan Kisi CuO/ZnO-NPs (Cbest)

Crystallite Size and Lattice Strain

General information

Analysis date	2026/03/30 17:15:16	Measurement date	2026/03/30 15:46:55
Sample name		Operator	administrator
File name	Cu_Zn-NPS CBest.ras		
Comment			

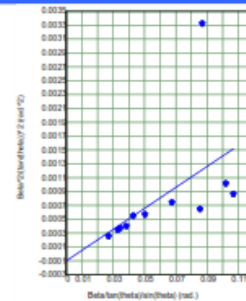
Qualitative analysis results

Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Zinc Oxide	ZnO	0.302	ICDD (PDF2.DAT)	00-079-0205
Copper Oxide	CuO	0.390	ICDD (PDF2.DAT)	00-074-1021
Sodium Chloride	NaCl	0.771	ICDD (PDF2.DAT)	00-072-1668
Copper Oxide	Cu ₂ O	1.298	ICDD (PDF2.DAT)	00-077-0199

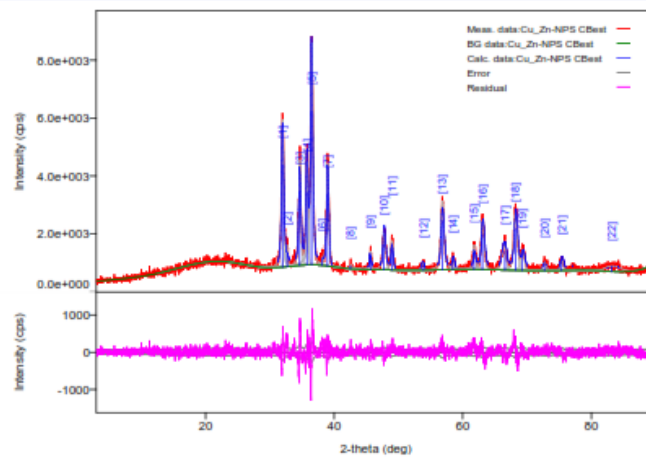
Crystallite size and lattice strain

Phase name	Crystallite size(A)	Strain(%)
Zinc Oxide	107(59)	0.000000

Equation
Y=0.015X-0.0001



Measurement profile



1) Hasil Analisis Kualitatif CuO/ZnO-NPs (Cbest)

Qualitative Analysis Results

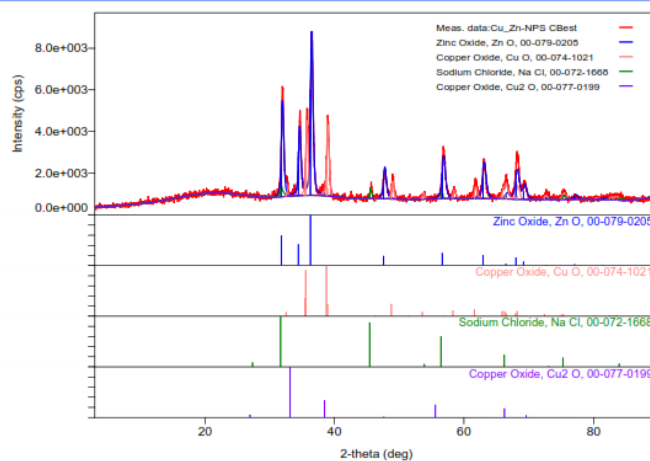
General information

Analysis date	2026/03/30 17:14:55	Measurement date	2026/03/30 15:46:55
Sample name		Operator	administrator
File name	Cu_Zn-NPS CBest.ras		
Comment			

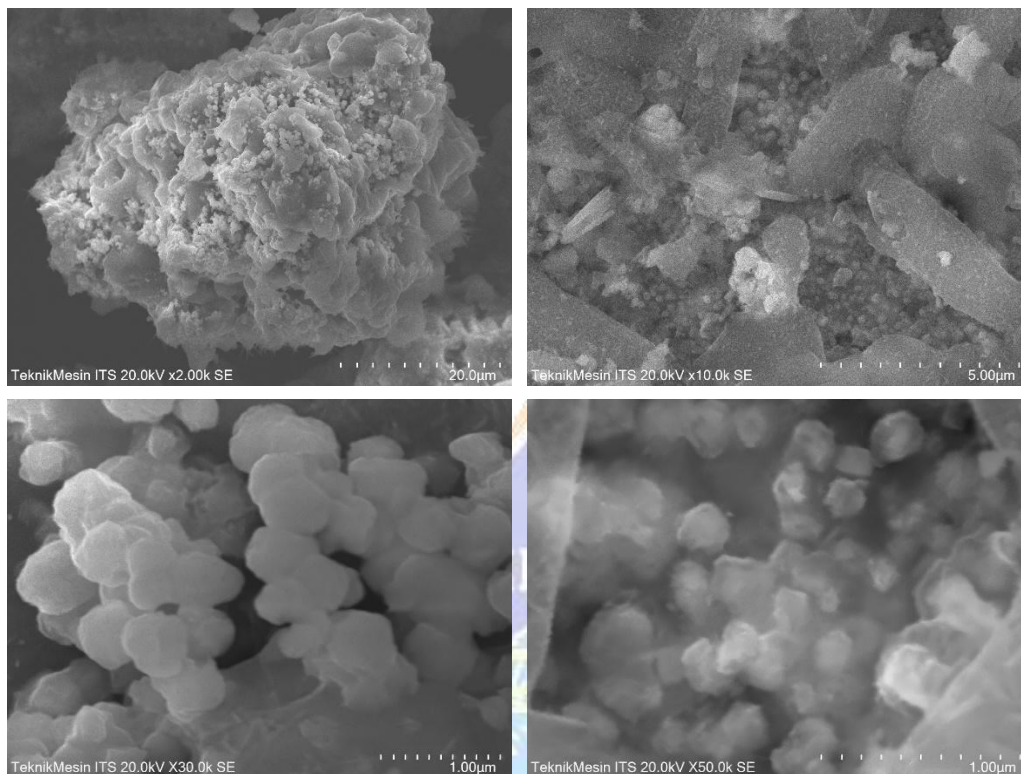
Qualitative analysis results

Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Zinc Oxide	ZnO	0.302	ICDD (PDF2.DAT)	00-079-0205
Copper Oxide	CuO	0.390	ICDD (PDF2.DAT)	00-074-1021
Sodium Chloride	NaCl	0.771	ICDD (PDF2.DAT)	00-072-1668
Copper Oxide	Cu ₂ O	1.298	ICDD (PDF2.DAT)	00-077-0199

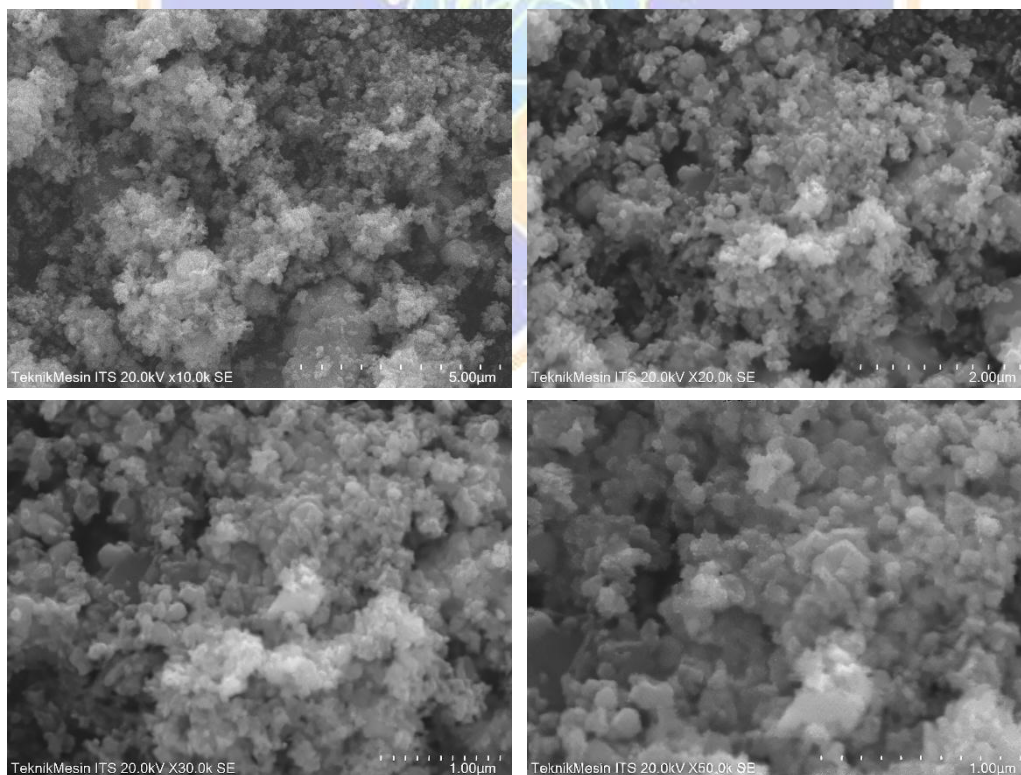
Phase data pattern



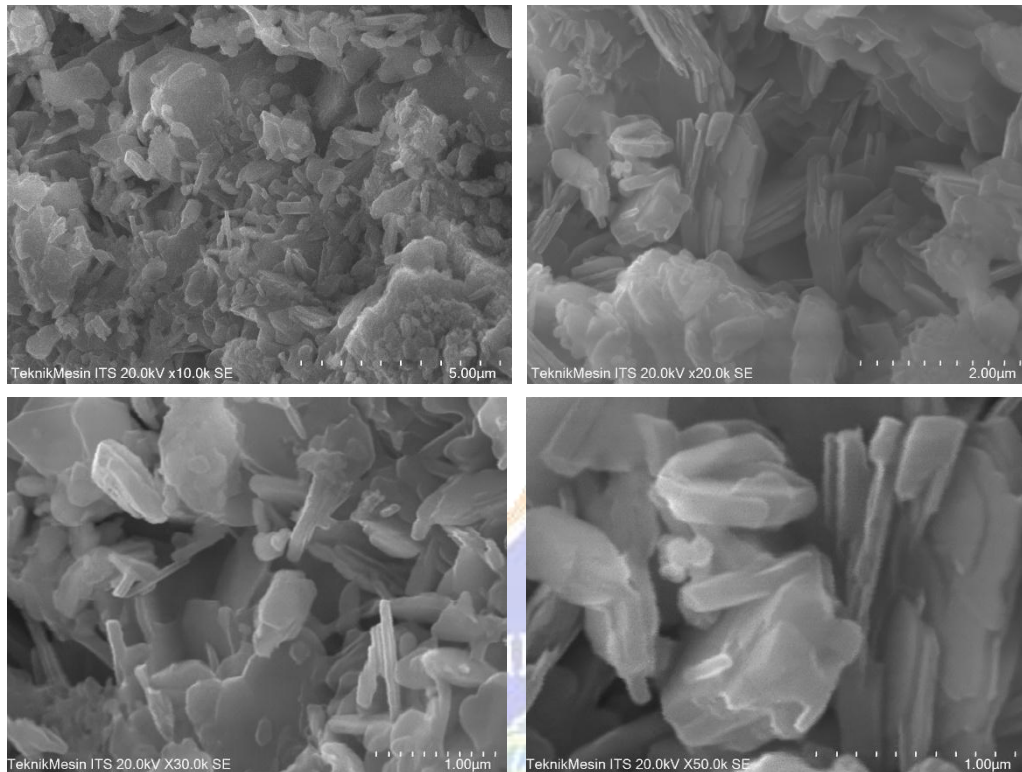
Lampiran 07. Karakterisasi SEM-EDS Nanopartikel



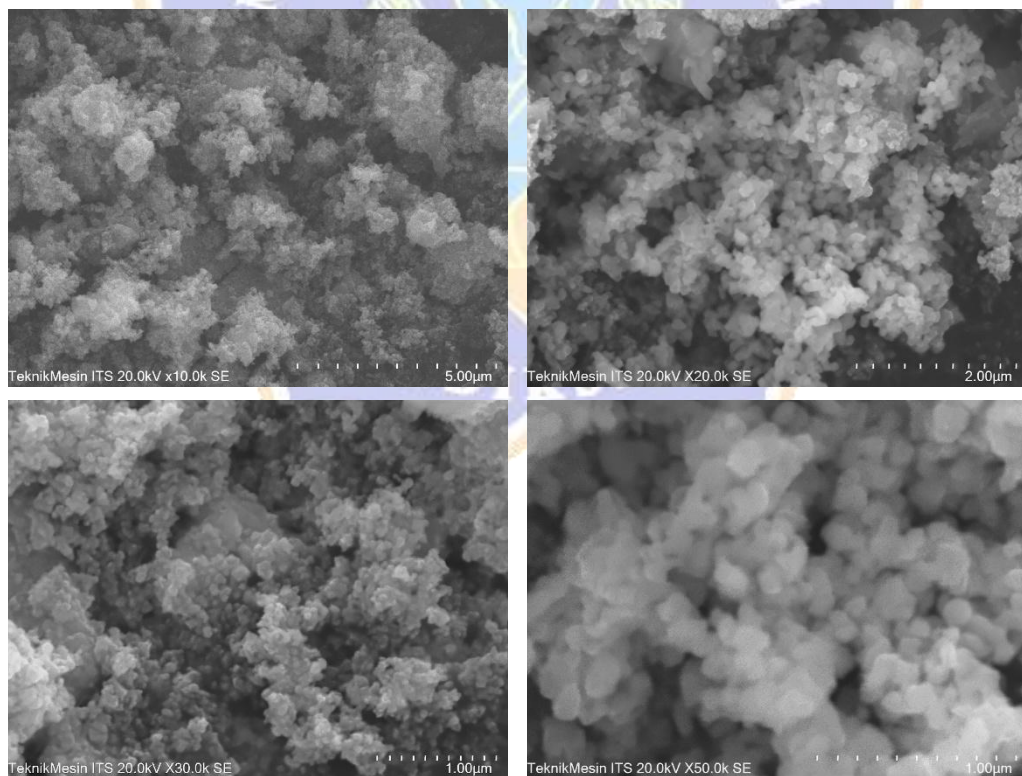
Morfologi CuO-NPs



Morfologi ZnO-NPs



Morfologi CuO/ZnO-NPs



Morfologi CuO/ZnO-NPs

Karakterisasi EDS *Mapping*

a) CuO-NPs

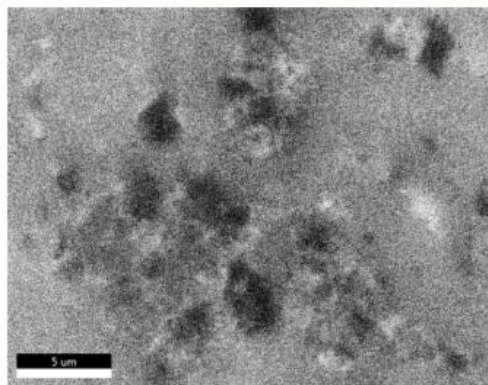
EDAX APEX

Page 1

01042026

Author: Teknik Mesin ITS
Creation: 04/08/2026 10:55:15 AM
Sample Name: Suryani Undiksha

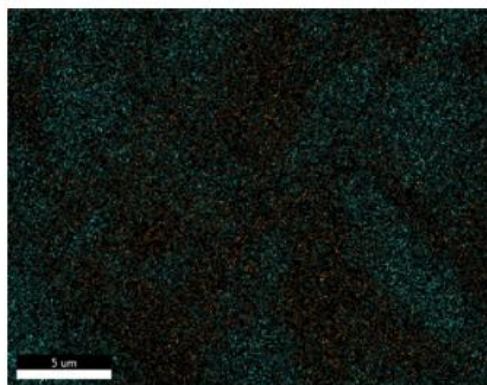
CuO



Image

PhaseROI 2

ElementOverlay



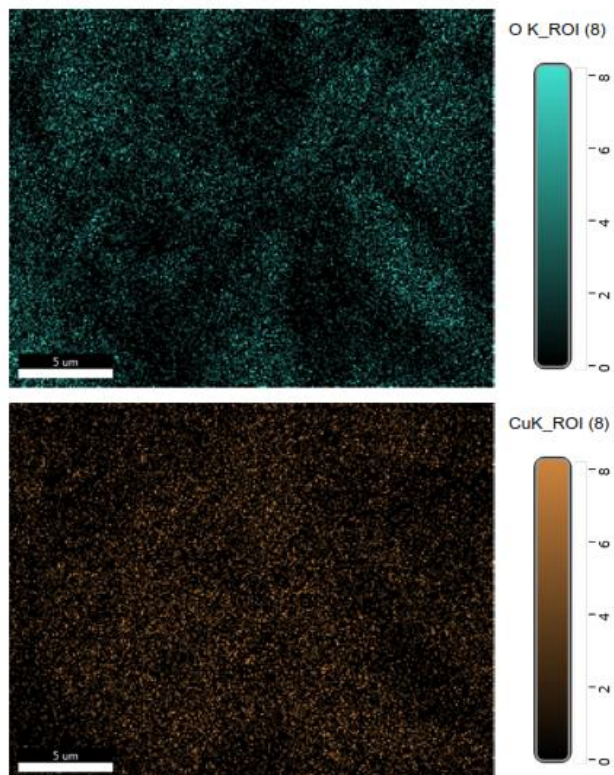
58% O K



42% CuK

EDAX APEX

Page 2

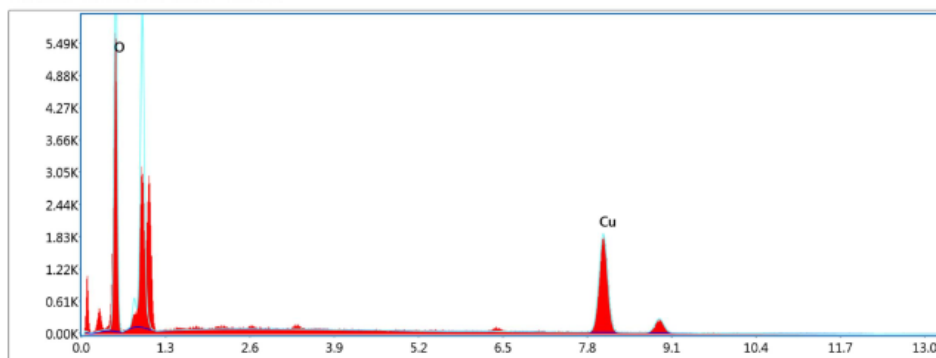


EDAX APEX

Page 3

kV: 20	Mag: 5000	Takeoff: 30	Live Time(s): 102.4	Amp Time(μs): 3.54	Resolution(eV): 130
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Sum Spectrum



Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
O K	39.27	71.97	423.56	6.86	0.2083	1.1636	0.4557	1.0000
CuK	60.73	28.03	293.34	2.45	0.5384	0.8735	1.0086	1.0060

b) ZnO-NPs

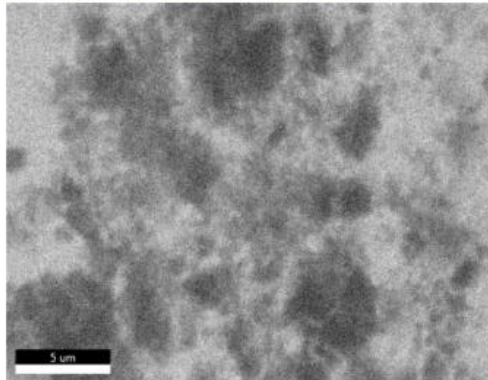
EDAX APEX

Page 1

01042026

Author: Teknik Mesin ITS
Creation: 04/08/2026 11:00:25 AM
Sample Name: Suryani Undiksha

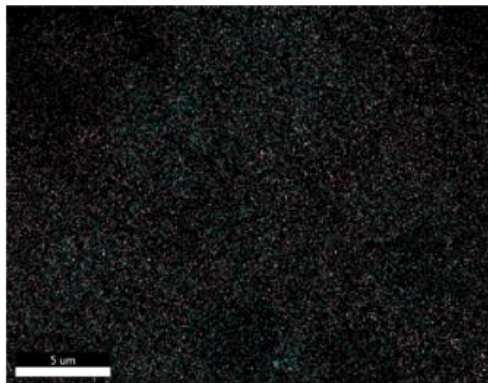
ZnO



Image

PhaseROI 2

ElementOverlay



27% O K

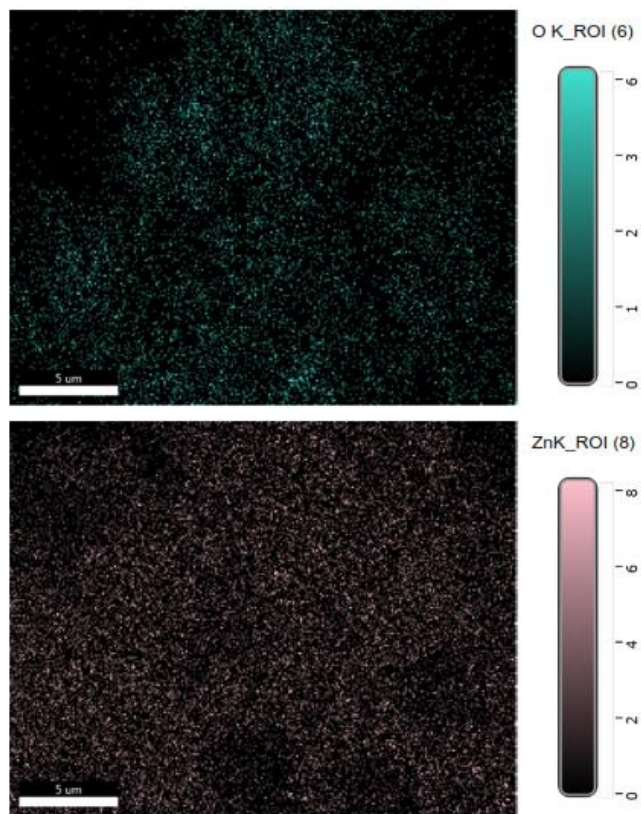


73% Zn K



EDAX APEX

Page 2

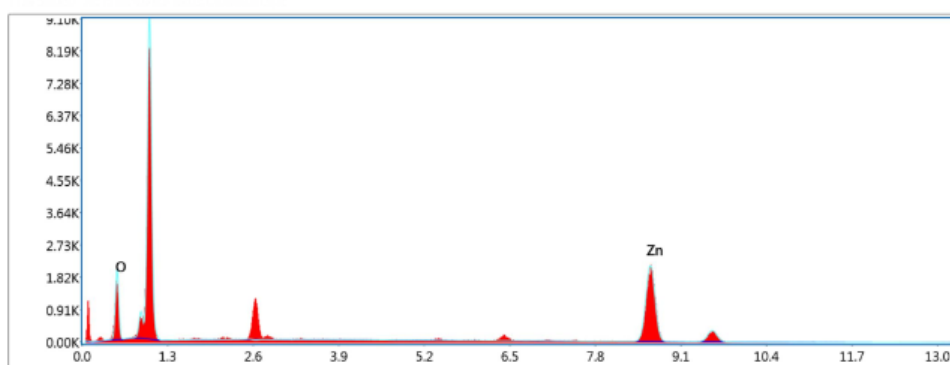


EDAX APEX

Page 3

kV: 20 Mag: 5000 Takeoff: 30 Live Time(s): 112.6 Amp Time(μs): 3.84 Resolution(eV): 130

Sum Spectrum



Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
O K	16.68	44.99	107.21	9.13	0.0600	1.2414	0.2896	1.0000
ZnK	83.32	55.01	316.43	2.39	0.7890	0.9417	1.0035	1.0021

c) CuO/ZnO-NPs (1:1)

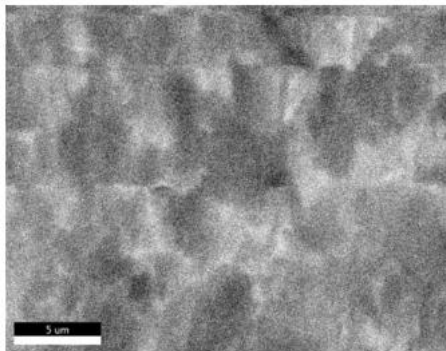
EDAX APEX

Page 1



Author: Teknik Mesin ITS
Creation: 04/08/2026 10:56:38 AM
Sample Name: Suryani Undiksha

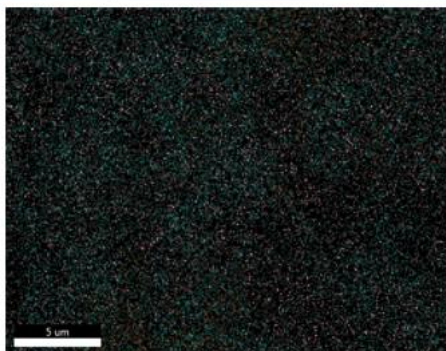
Cu-Zn 1-1



Image

PhaseROI 2

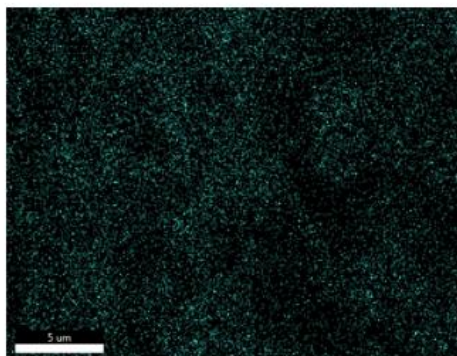
ElementOverlay



46% O K
14% CuK
40% ZnK

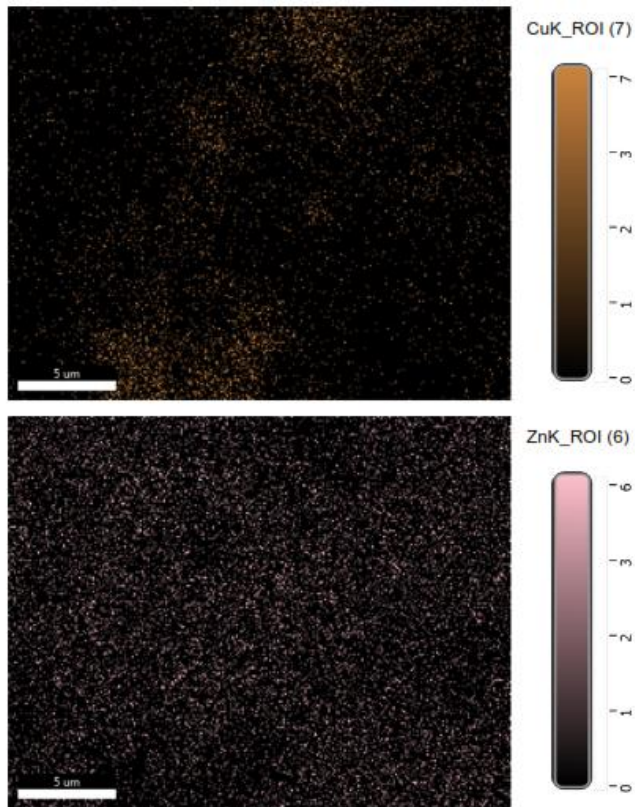
EDAX APEX

Page 2



O K_ROI (6)



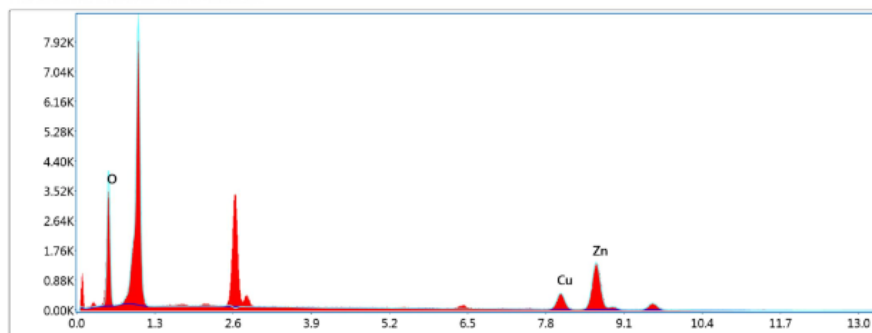


EDAX APEX

Page 3

kV: 20	Mag: 5000	Takeoff: 30	Live Time(s): 102.4	Amp Time(μs): 3.84	Resolution(eV): 130
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Sum Spectrum



Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
O K	29.70	63.18	240.29	8.29	0.1220	1.1947	0.3440	1.0000
CuK	14.04	7.52	74.31	4.50	0.1409	0.9015	1.0050	1.1076
ZnK	56.26	29.30	225.88	2.69	0.5114	0.9003	1.0046	1.0050

d) CuO/ZnO-NPs (Cbest)

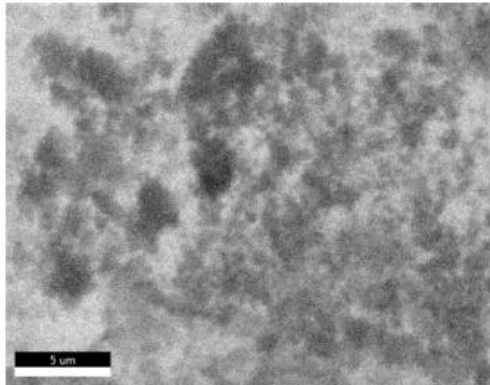
EDAX APEX

Page 1

01042026

Author: Teknik Mesin ITS
Creation: 04/08/2026 10:57:42 AM
Sample Name: Suryani Undiksha

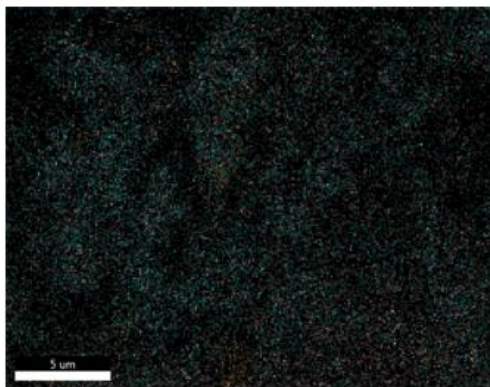
Cu-Zn Cbest



Image

PhaseROI 2

ElementOverlay



49% O K



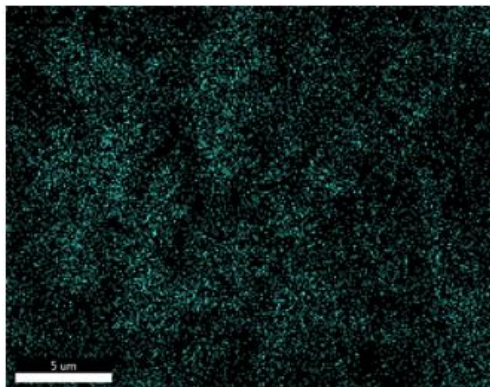
5% Cu K



46% Zn K

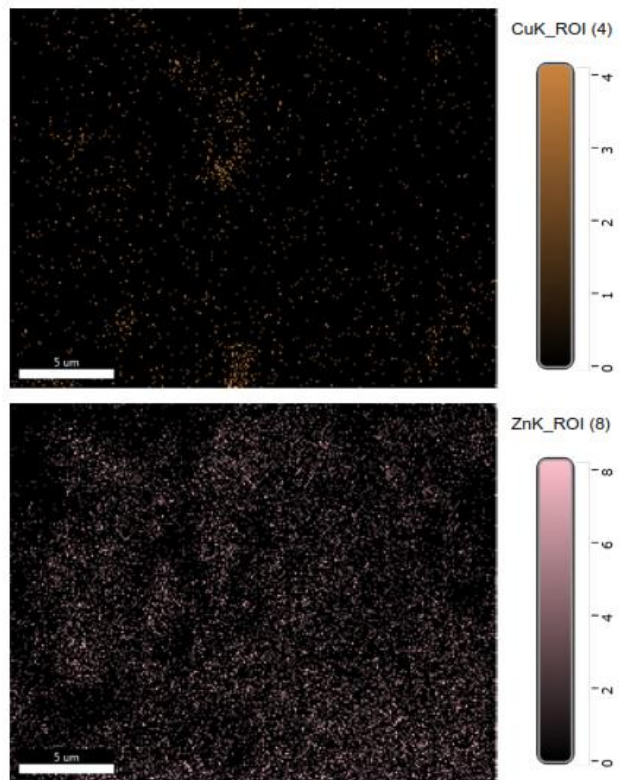
EDAX APEX

Page 2



O K_ROI (6)



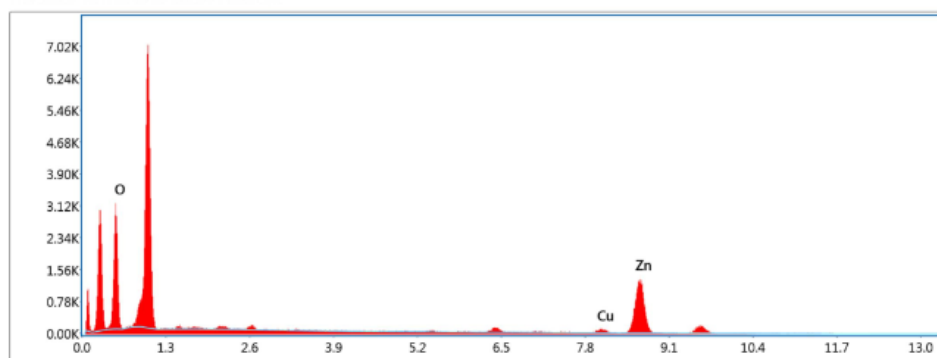


EDAX APEX

Page 3

kV: 20	Mag: 5000	Takeoff: 30	Live Time(s): 102.4	Amp Time(μs): 3.84	Resolution(eV): 130
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Sum Spectrum



Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
O K	31.95	65.70	213.28	8.36	0.1293	1.1867	0.3410	1.0000
CuK	3.66	1.89	17.43	9.99	0.0394	0.8948	1.0053	1.1998
ZnK	64.39	32.41	215.28	2.69	0.5817	0.8934	1.0061	1.0050

Distribusi Partikel

a) CuO-NPs

No	Area	Mean	Min	Max	Angle	Length	R2	r	Diameter
1	4.26E-04	116.477	87	134.941	-52.496	0.214	1.36E-04	0.01164	0.02329
2	4.92E-04	141.243	91	165	-38.517	0.248	1.57E-04	0.01252	0.02504
3	3.40E-04	114.181	100.814	134.558	-37.405	0.169	1.08E-04	0.0104	0.02081
4	7.03E-04	106.55	84.292	133.335	22.276	0.355	2.24E-04	0.01496	0.02993
5	4.96E-04	185.689	175	193.383	52.765	0.248	1.58E-04	0.01257	0.02514
6	3.24E-04	156.359	146	162.293	-30.964	0.161	1.03E-04	0.01016	0.02032
7	2.70E-04	121.461	90	132.824	-49.764	0.135	8.58E-05	0.00926	0.01853
8	5.08E-04	119.281	98.046	134.503	95.356	0.254	1.62E-04	0.01272	0.02543
9	4.61E-04	119.448	93	137.87	-64.093	0.231	1.47E-04	0.01212	0.02423
10	7.27E-04	165.123	136.814	190	13.134	0.365	2.31E-04	0.01521	0.03042
11	6.13E-04	195.038	176.722	204.972	-74.358	0.308	1.95E-04	0.01397	0.02795
12	5.82E-04	131.654	118.411	146.78	35.942	0.293	1.85E-04	0.01361	0.02723
13	4.14E-04	102.176	68	114.222	-13.241	0.207	1.32E-04	0.01148	0.02296
14	4.22E-04	104.423	91	115.907	-11.31	0.212	1.34E-04	0.01159	0.02318
15	4.49E-04	141.879	116.289	157.895	-77.8	0.224	1.43E-04	0.01196	0.02392

b) ZnO-NPs

No	Area	Mean	Min	Max	Angle	Length	R2	r	Diameter
1	1.64E-04	131.094	113	150	-43.025	0.081	5.22E-05	0.00723	0.01445397
2	1.84E-04	119.427	111.256	128.665	-58.392	0.091	5.85E-05	0.00765	0.01529331
3	2.27E-04	128.768	110	159	-42.879	0.113	7.21E-05	0.00849	0.01698632
4	1.72E-04	129.037	98.163	151	-56.31	0.086	5.47E-05	0.0074	0.014798
5	2.15E-04	81.564	66	91	0	0.107	6.84E-05	0.00827	0.01654178
6	2.50E-04	127.113	111	137.286	2.726	0.125	7.96E-05	0.00892	0.01784577
7	2.19E-04	167.685	148	184.62	-22.38	0.109	6.96E-05	0.00835	0.01669128
8	2.73E-04	104.782	91.565	116.669	-64.179	0.136	8.71E-05	0.00933	0.01866227
9	6.13E-04	173.028	142.179	206.12	-37.164	0.308	1.95E-04	0.01397	0.027949
10	5.43E-04	99.168	78	114.435	19.486	0.273	1.73E-04	0.01315	0.02629814
11	4.73E-04	131.167	89.75	153	4.764	0.238	1.51E-04	0.01227	0.02453647
12	1.00E-03	167.575	138.471	192.93	4.054	0.503	3.18E-04	0.01784	0.03568975
13	4.26E-04	150.977	132.104	169.333	35.166	0.213	1.36E-04	0.01164	0.02328719
14	7.15E-04	134.908	90.451	167.934	0.63	0.36	2.28E-04	0.01509	0.0301736
15	7.42E-04	98.611	80.006	131.883	-51.435	0.374	2.36E-04	0.01537	0.03074655

c) CuO/ZnO-NPs (1:1)

No	Area	Mean	Min	Max	Angle	Length	R2	r	Diameter
1	0.002	164.706	105	197.904	-2.936	0.775	0.00064	0.02524	0.05047545
2	0.001	143.465	123.466	162	148.61	0.549	0.00032	0.01785	0.03569153
3	0.001	138.532	100.635	171.322	-77.33	0.525	0.00032	0.01785	0.03569153
4	0.002	141.35	115.249	177.881	28.045	0.962	0.00064	0.02524	0.05047545
5	8.31E-04	121.221	110	138	53.13	0.417	0.00026	0.01627	0.03253024
6	0.001	114.533	99.388	131.906	25.278	0.632	0.00032	0.01785	0.03569153
7	5.95E-04	95.537	62	122.844	-33.056	0.298	0.00019	0.01376	0.02751954
8	0.001	139.237	107	181.24	16.972	0.639	0.00032	0.01785	0.03569153
9	5.59E-04	94.704	72.243	127.032	-52.481	0.28	0.00018	0.01334	0.02668524
10	4.33E-04	93.619	76.049	137.081	13.782	0.217	0.00014	0.01174	0.023486
11	8.19E-04	105.513	80.493	117.83	-20.362	0.411	0.00026	0.01615	0.0322964
12	4.45E-04	173.475	147	199.714	4.086	0.223	0.00014	0.0119	0.02380655
13	8.82E-04	142.447	104.428	183.495	-72.216	0.442	0.00028	0.01676	0.03351585
14	4.21E-04	80.948	73	87.623	1.081	0.21	0.00013	0.01158	0.02316378
15	4.76E-04	72.058	54.2	100	-9.62	0.237	0.00015	0.01232	0.02463233

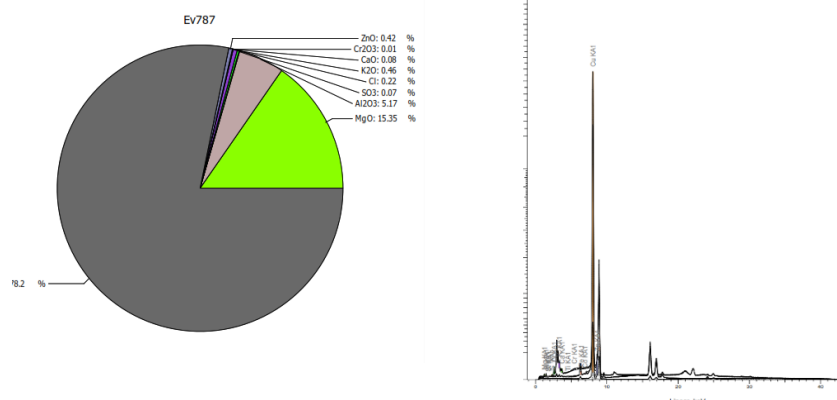
d) CuO/ZnO-NPs (Cbest)

No	Area	Mean	Min	Max	Angle	Length	R2	r	Diameter
1	4.33E-04	139.688	124.472	148.305	46.507	0.214	1.38E-04	0.01174	0.02347
2	3.57E-04	157.934	125	172.615	-28.301	0.176	1.14E-04	0.01066	0.02133
3	4.01E-04	137.707	121.86	147.334	-22.443	0.198	1.28E-04	0.0113	0.0226
4	5.28E-04	78.62	70	84.566	19.537	0.262	1.68E-04	0.01296	0.02593
5	3.29E-04	175.53	165	183	0	0.163	1.05E-04	0.01024	0.02048
6	3.49E-04	151.984	114	163.926	-28.926	0.173	1.11E-04	0.01055	0.02109
7	3.85E-04	159.67	145	173	0	0.191	1.23E-04	0.01107	0.02214
8	4.17E-04	121.943	86.942	137.615	-3.302	0.208	1.33E-04	0.01152	0.02304
9	2.82E-04	151.944	131	169	0	0.139	8.97E-05	0.00947	0.01894
10	3.89E-04	139.723	123	152.568	-34.019	0.192	1.24E-04	0.01113	0.02226
11	3.73E-04	133.225	102	150.686	-99.866	0.186	1.19E-04	0.0109	0.0218
12	1.83E-04	153.741	143	161.864	26.565	0.089	5.81E-05	0.00762	0.01525
13	2.38E-04	160.202	129.601	174.558	-113.96	0.118	7.58E-05	0.00871	0.01742
14	3.89E-04	121.433	103.944	135.013	-68.199	0.193	1.24E-04	0.01113	0.02226
15	3.89E-04	171.237	128.372	187.724	-7.125	0.193	1.24E-04	0.01113	0.02226

Lampiran 08. Karakterisasi XRF Nanopartikel

a) CuO-NPs

Sample Information			
Sample ID	RF058		
Application	SMART-Oxides		
Start Time	4/11/2026 2:51 PM		
Preparation	Powder		
Evaluation Date	4/11/2026 2:57 PM		
Results Table			
Z	Formula	Concentration	Line Name
11	Na2O	0.00 %	
12	MgO	15.35 %	Mg KA
13	Al2O3	5.17 %	Al KA
14	SiO2	0.00 %	Si KA
15	P2O5	0.00 %	P KA
16	SO3	0.07 %	S KA
17	Cl	0.22 %	Cl KA
19	K2O	0.46 %	K KA
20	CaO	0.08 %	Ca KA
21	Sc2O3	0.00 %	
22	TiO2	0.00 %	Ti KA
23	V2O5	0.00 %	
24	Cr2O3	0.01 %	Cr KA
25	MnO	0.00 %	
26	Fe2O3	0.00 %	Fe KA
27	CoO	0.00 %	Co KA
28	NiO	0.00 %	
29	CuO	78.22 %	Cu KA
30	ZnO	0.42 %	Zn KA
31	Ga2O3	0.00 %	
32	GeO2	0.00 %	
33	As2O3	0.00 %	
34	SeO2	0.00 %	
35	Br	0.00 %	
37	Rb2O	0.00 %	
38	SrO	0.00 %	
39	Y2O3	0.00 %	
40	ZrO2	0.00 %	
41	Nb2O5	0.00 %	
42	MoO3	0.00 %	
44	RuO2	0.00 %	
45	Rh2O3	0.00 %	



Concentrations of

Name	Color	Ev787
Na ₂ O		0
MgO		0.153460925916191
Al ₂ O ₃		0.0517089419096322
SiO ₂		0
P ₂ O ₅		0
SO ₃		0.000708896071648353
Cl		0.00224725200845736
K ₂ O		0.00459199611736673
CaO		0.000811489451975702
Sc ₂ O ₃		0
TiO ₂		0
V ₂ O ₅		0
Cr ₂ O ₃		0.000100534772586491
MnO		0
Fe ₂ O ₃		0
NiO		0
ZnO		0.00416052510733472
As ₂ O ₃		0
Br		0
Rb ₂ O		0
SrO		0
Y ₂ O ₃		0
CdO		0
SnO ₂		0
Sb ₂ O ₃		0
BaO		0
HfO ₂		0
Ta ₂ O ₅		0
HgO		0
Tl ₂ O		0
PbO		0
Bi ₂ O ₃		0



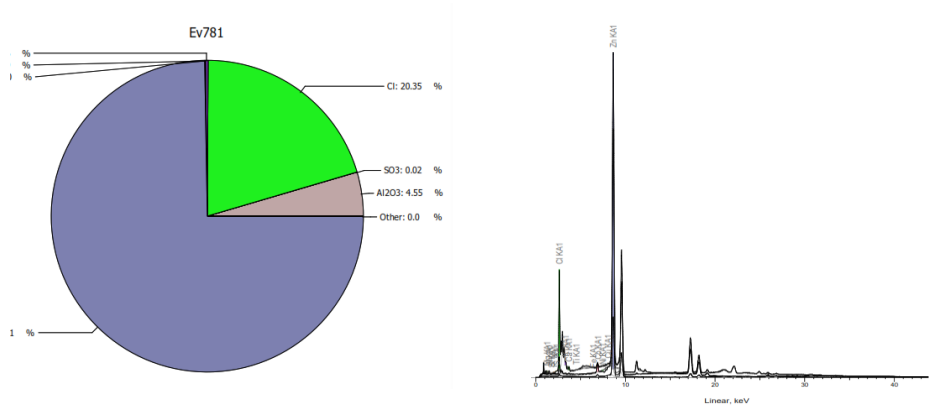
b) ZnO-NPs

Sample Information

Sample ID	RF055
Application	SMART-Oxides
Start Time	4/11/2026 2:02 PM
Preparation	Powder
Evaluation Date	4/11/2026 2:08 PM

Results Table

Z	Formula	Concentration		Line Name
11	Na2O	0.00	%	
12	MgO	0.00	%	Mg KA1
13	Al2O3	4.55	%	Al KA1
14	SiO2	0.00	%	Si KA1
15	P2O5	0.00	%	P KA1
16	SO3	0.02	%	S KA1
17	Cl	20.35	%	Cl KA1
19	K2O	0.26	%	K KA1
20	CaO	0.09	%	Ca KA1
21	Sc2O3	0.00	%	
22	TiO2	0.00	%	Ti KA1
23	V2O5	0.00	%	
24	Cr2O3	0.00	%	
25	MnO	0.00	%	
26	Fe2O3	0.00	%	Fe KA1
27	CoO	0.00	%	Co KA1
28	NiO	0.00	%	Ni KA1
29	CuO	0.02	%	Cu KA1
30	ZnO	74.71	%	Zn KA1
31	Ga2O3	0.00	%	
32	GeO2	0.00	%	
33	As2O3	0.00	%	
34	SeO2	0.00	%	
35	Br	0.00	%	
37	Rb2O	0.00	%	
38	SrO	0.00	%	
39	Y2O3	0.00	%	
40	ZrO2	0.00	%	
41	Nb2O5	0.00	%	
42	MoO3	0.00	%	
44	RuO2	0.00	%	
45	Rh2O3	0.00	%	



Concentrations of

Name	Color	Ev781
Na ₂ O		0
MgO		0
Al ₂ O ₃		0.0455410745593905
SiO ₂		0
P ₂ O ₅		0
SO ₃		0.000161097611160798
Cl		0.203513812374033
K ₂ O		0.00259955551374828
CaO		0.000900567953734556
Sc ₂ O ₃		0
TiO ₂		3.95315776933962E-05
V ₂ O ₅		0
Cr ₂ O ₃		0
MnO		0
Fe ₂ O ₃		0
NiO		0
ZnO		0.747087266596605
As ₂ O ₃		0
Br		0
Rb ₂ O		0
SrO		0
Y ₂ O ₃		0
CdO		0
SnO ₂		0
Sb ₂ O ₃		0
BaO		0
HfO ₂		0
Ta ₂ O ₅		0
HgO		0
Tl ₂ O		0
PbO		0
Bi ₂ O ₃		0



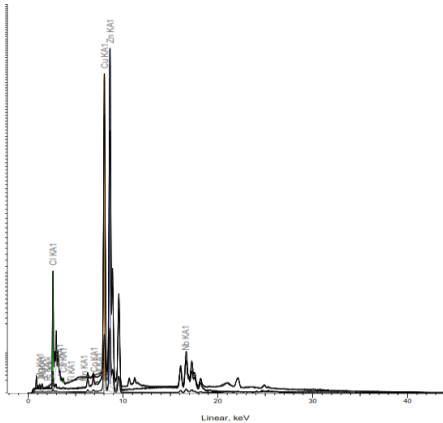
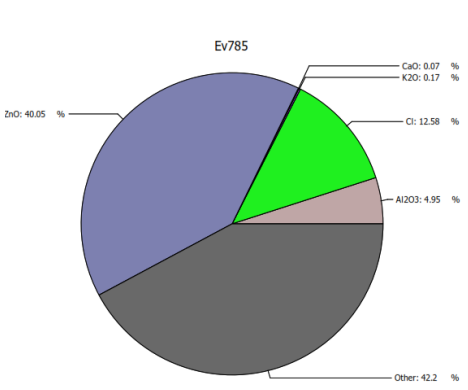
c) CuO/ZnO-NPs (1:1)

Sample Information

Sample ID	RF057
Application	SMART-Oxides
Start Time	4/11/2026 2:36 PM
Preparation	Powder
Evaluation Date	4/11/2026 2:42 PM

Results Table

Z	Formula	Concentration	Line Name
11	Na2O	0.00 %	
12	MgO	0.00 %	Mg KA1
13	Al2O3	4.95 %	Al KA1
14	SiO2	0.00 %	
15	P2O5	0.00 %	P KA1
16	SO3	0.00 %	S KA1
17	Cl	12.58 %	Cl KA1
19	K2O	0.17 %	K KA1
20	CaO	0.07 %	Ca KA1
21	Sc2O3	0.00 %	
22	TiO2	0.00 %	Ti KA1
23	V2O5	0.00 %	
24	Cr2O3	0.00 %	
25	MnO	0.00 %	Mn KA1
26	Fe2O3	0.00 %	
27	CoO	0.00 %	Co KA1
28	NiO	0.00 %	Ni KA1
29	CuO	42.18 %	Cu KA1
30	ZnO	40.05 %	Zn KA1
31	Ga2O3	0.00 %	
32	GeO2	0.00 %	
33	As2O3	0.00 %	
34	SeO2	0.00 %	
35	Br	0.00 %	
37	Rb2O	0.00 %	
38	SrO	0.00 %	
39	Y2O3	0.00 %	
40	ZrO2	0.00 %	
41	Nb2O5	0.01 %	Nb KA1
42	MoO3	0.00 %	
44	RuO2	0.00 %	
45	Rh2O3	0.00 %	



Concentrations of

Name	Color	Ev785
Na ₂ O		0
MgO		0
Al ₂ O ₃		0.0495272419228708
SiO ₂		0
P ₂ O ₅		0
SO ₃		0
Cl		0.125752565942056
K ₂ O		0.00170659779011197
CaO		0.00069255421980835
Sc ₂ O ₃		0
TiO ₂		0
V ₂ O ₅		0
Cr ₂ O ₃		0
MnO		0
Fe ₂ O ₃		0
NiO		0
ZnO		0.40046462512666
As ₂ O ₃		0
Br		0
Rb ₂ O		0
SrO		0
Y ₂ O ₃		0
CdO		0
SnO ₂		0
Sb ₂ O ₃		0
BaO		0
HfO ₂		0
Ta ₂ O ₅		0
HgO		0
Tl ₂ O		0
PbO		0
Bi ₂ O ₃		0



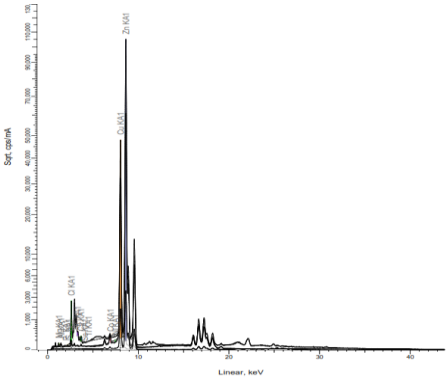
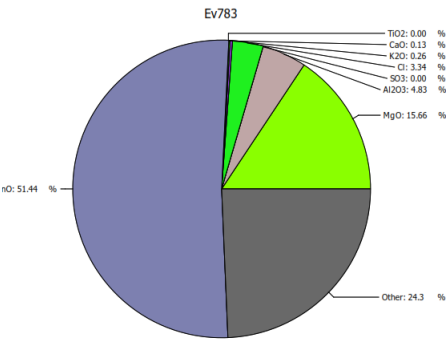
d) CuO/ZnO-NPs (Cbest)

Sample Information

Sample ID	RF056
Application	SMART-Oxides
Start Time	4/11/2026 2:18 PM
Preparation	Powder
Evaluation Date	4/11/2026 2:24 PM

Results Table

Z	Formula	Concentration	Line Name
11	Na2O	0.00 %	
12	MgO	15.66 %	Mg KA1
13	Al2O3	4.83 %	Al KA1
14	SiO2	0.00 %	
15	P2O5	0.00 %	P KA1
16	SO3	0.00 %	S KA1
17	Cl	3.34 %	Cl KA1
19	K2O	0.26 %	K KA1
20	CaO	0.13 %	Ca KA1
21	Sc2O3	0.00 %	Sc KA1
22	TiO2	0.00 %	Ti KA1
23	V2O5	0.00 %	
24	Cr2O3	0.00 %	
25	MnO	0.00 %	
26	Fe2O3	0.00 %	
27	CoO	0.00 %	Co KA1
28	NiO	0.00 %	Ni KA1
29	CuO	24.33 %	Cu KA1
30	ZnO	51.44 %	Zn KA1
31	Ga2O3	0.00 %	
32	GeO2	0.00 %	
33	As2O3	0.00 %	
34	SeO2	0.00 %	
35	Br	0.00 %	
37	Rb2O	0.00 %	
38	SrO	0.00 %	
39	Y2O3	0.00 %	
40	ZrO2	0.00 %	
41	Nb2O5	0.00 %	
42	MoO3	0.00 %	
44	RuO2	0.00 %	
45	Rh2O3	0.00 %	



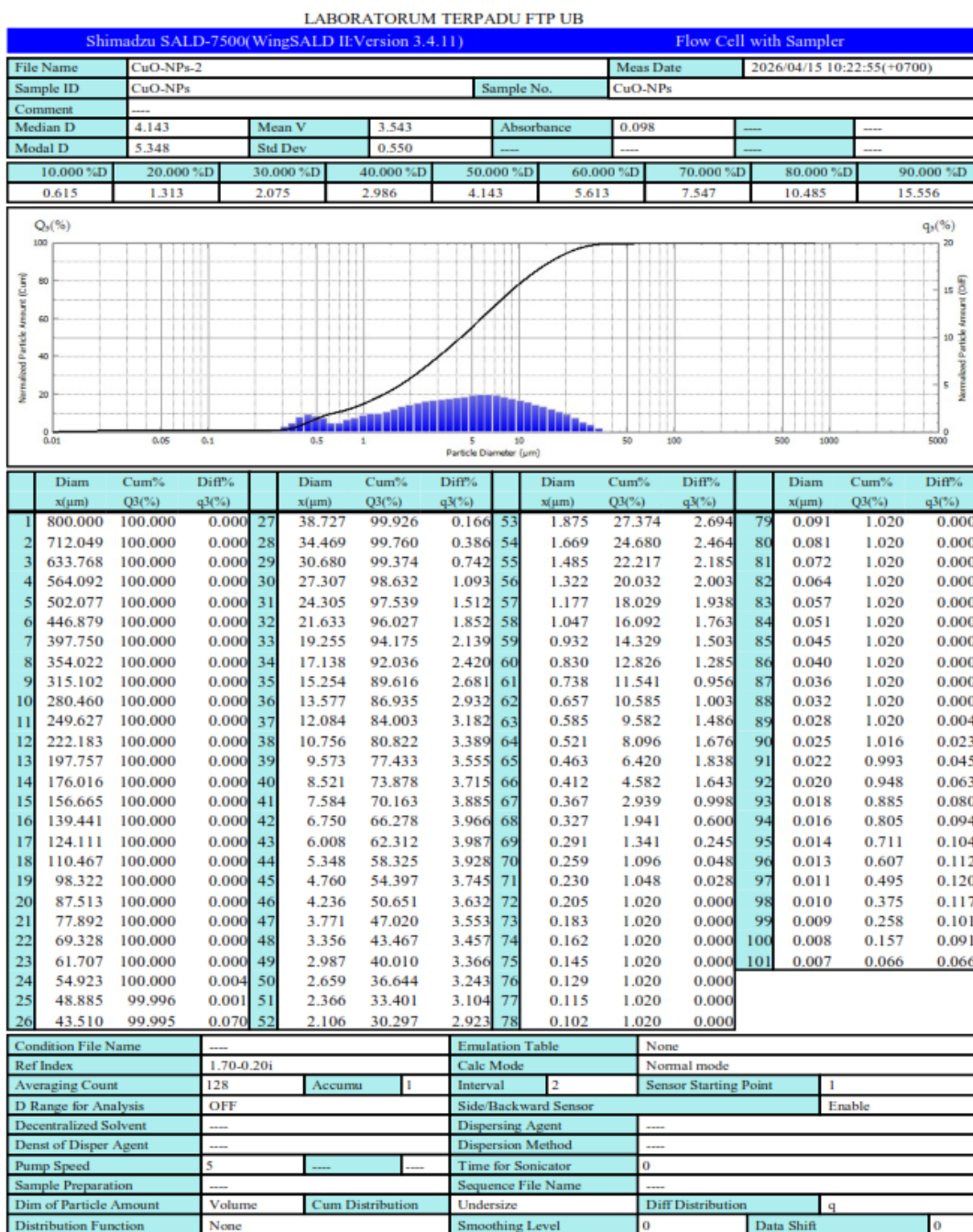
Concentrations of

Name	Color	Ev783
Na ₂ O		0
MgO		0.156620003611505
Al ₂ O ₃		0.0482876905759472
SiO ₂		0
P ₂ O ₅		0
SO ₃		2.98647652870952E-05
Cl		0.0334451046227066
K ₂ O		0.00260523578119878
CaO		0.00134124368304774
Sc ₂ O ₃		0
TiO ₂		1.03513300070173E-05
V ₂ O ₅		0
Cr ₂ O ₃		0
MnO		0
Fe ₂ O ₃		0
NiO		0
ZnO		0.514394038098569
As ₂ O ₃		0
Br		0
Rb ₂ O		0
SrO		0
Y ₂ O ₃		0
CdO		0
SnO ₂		0
Sb ₂ O ₃		0
BaO		0
HfO ₂		0
Ta ₂ O ₅		0
HgO		0
Tl ₂ O		0
PbO		0
Bi ₂ O ₃		0

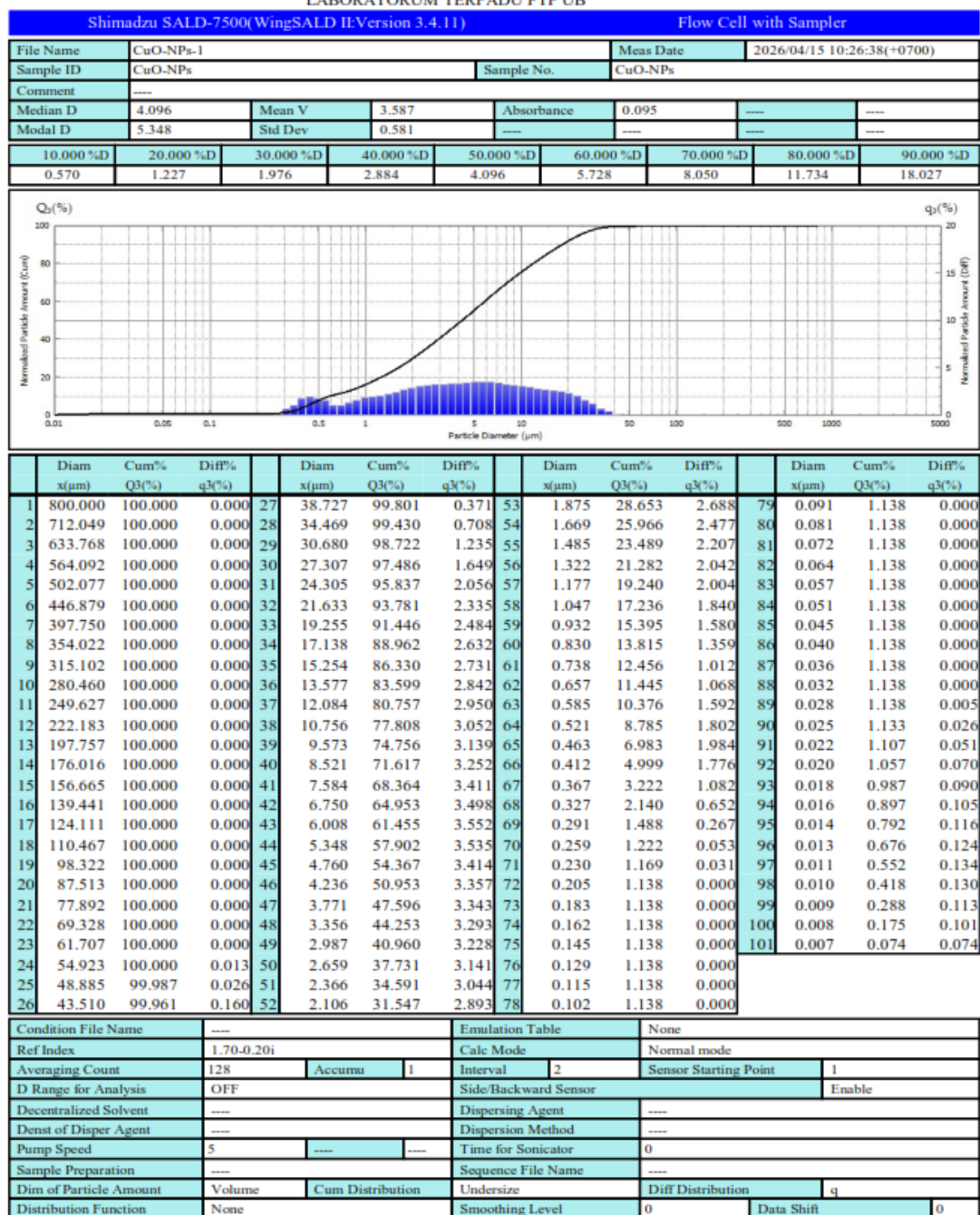


Lampiran 09. Karakterisasi PSA

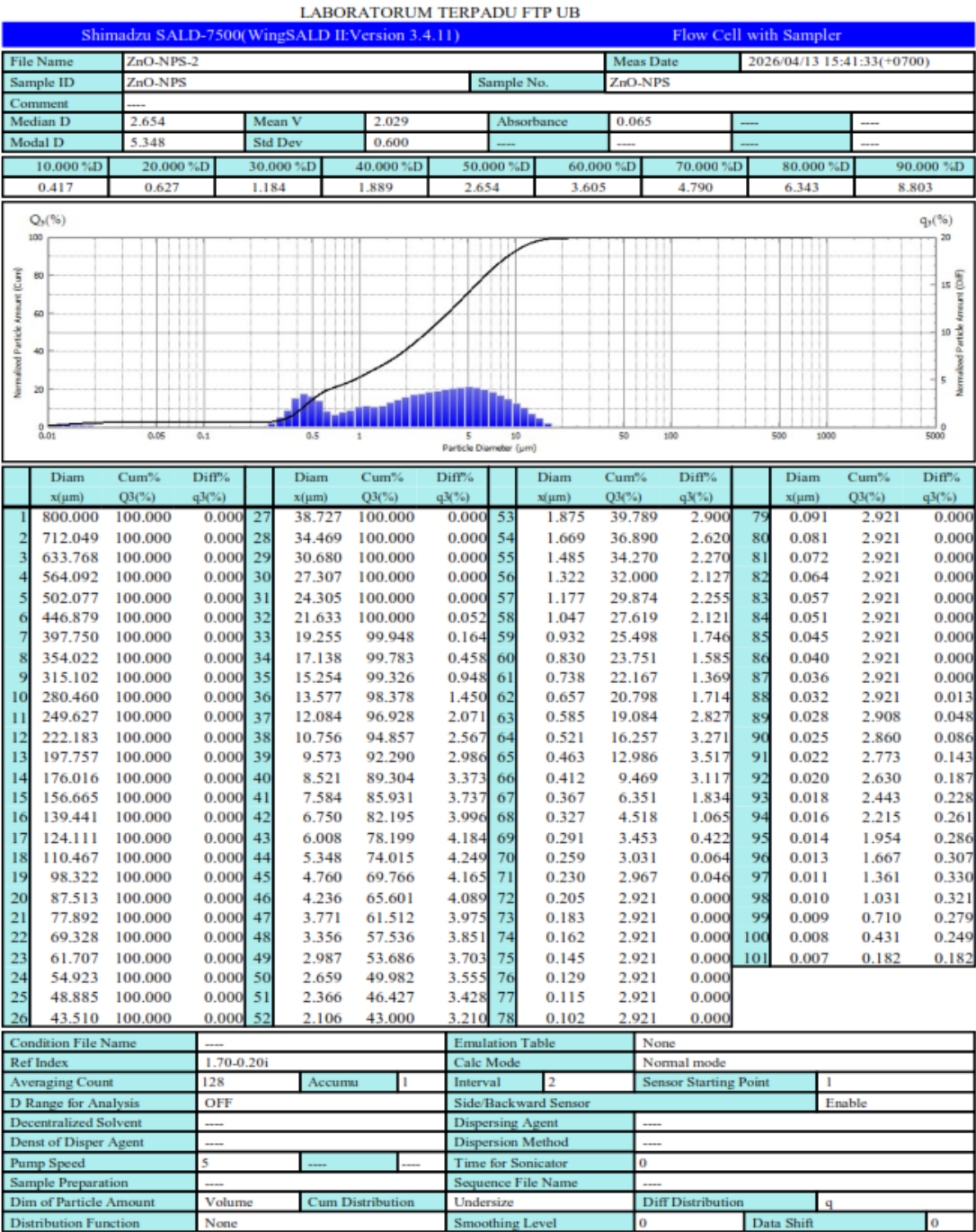
a) CuO-NPs

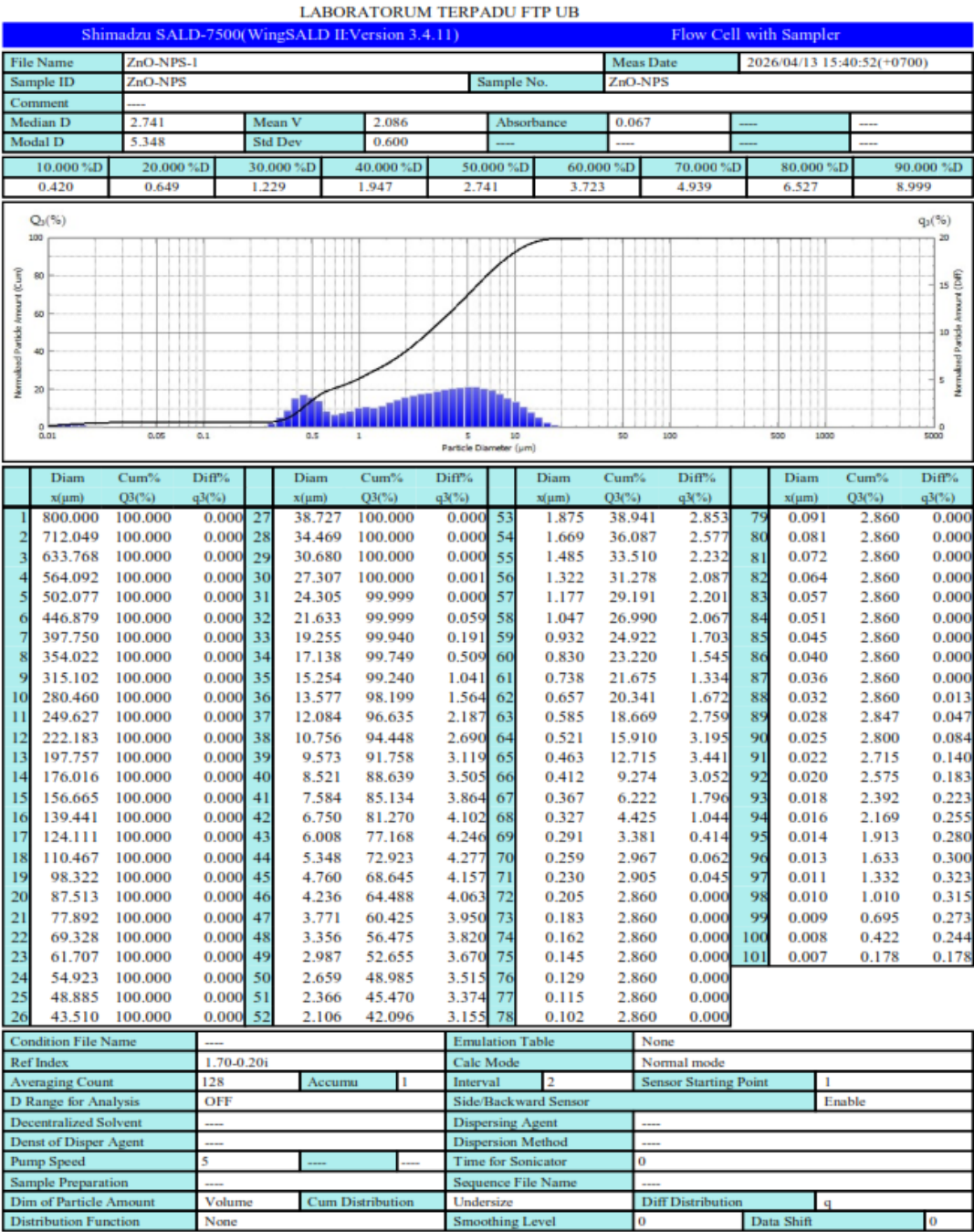


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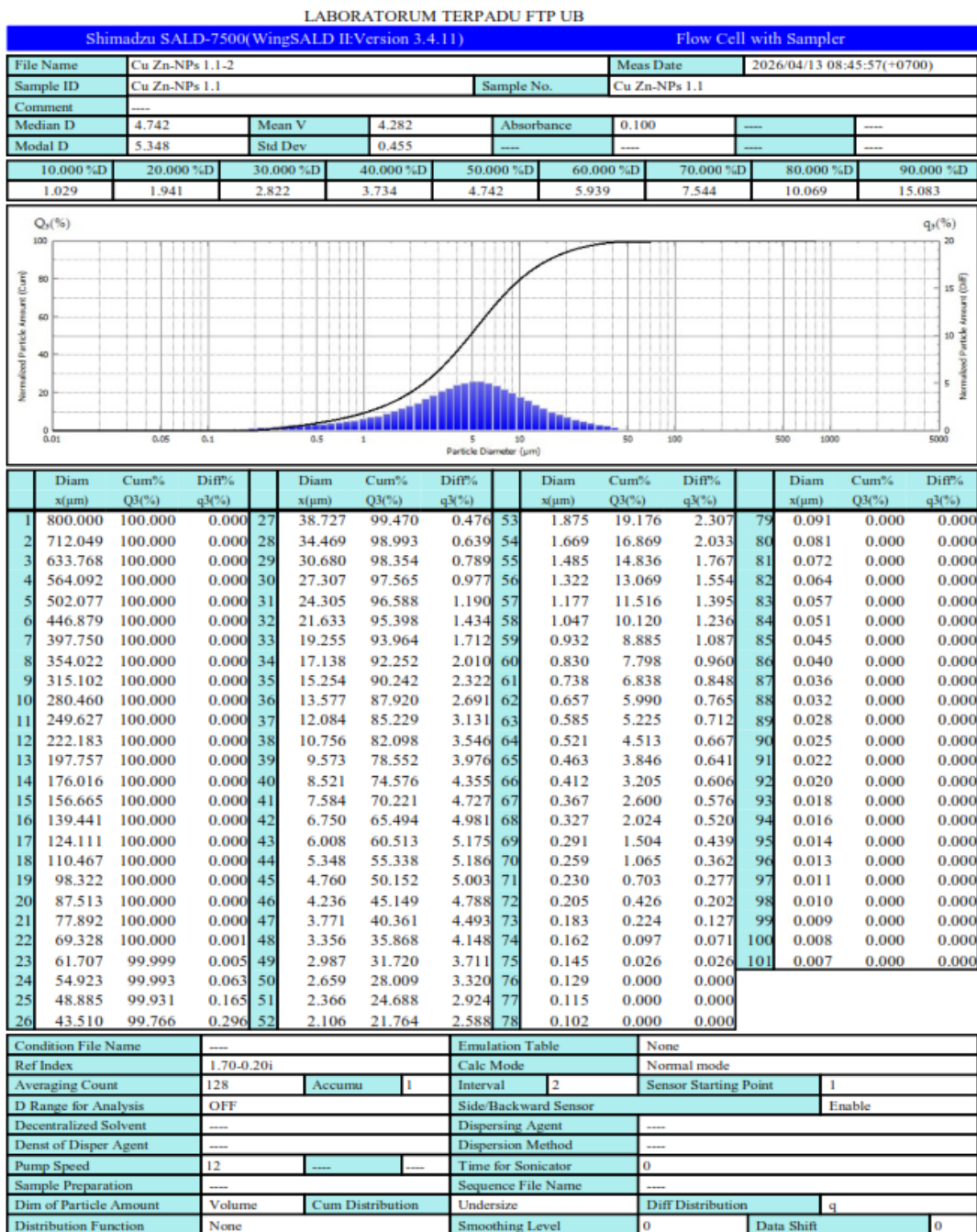


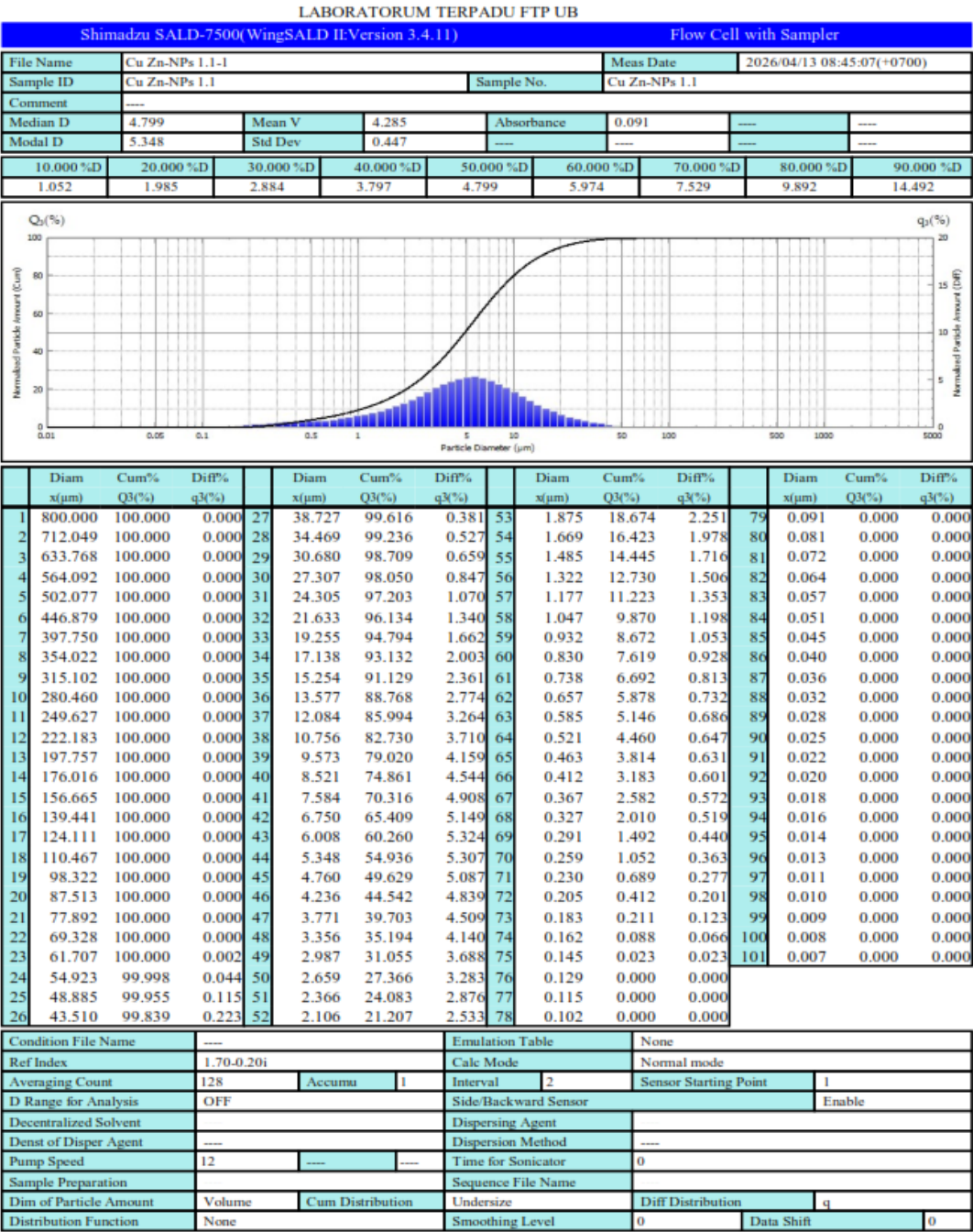
b) ZnO-NPs



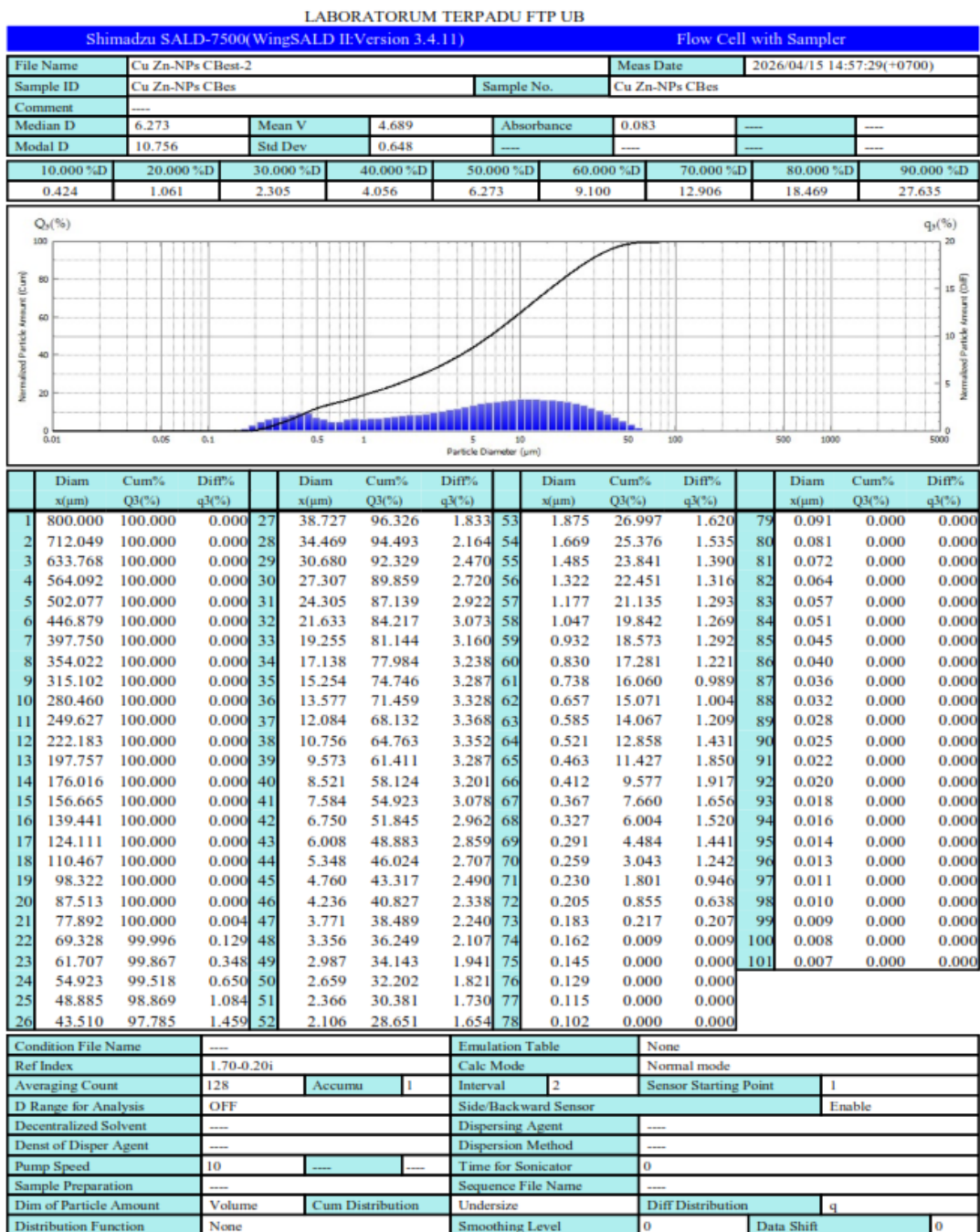


c) CuO/ZnO-NPS (1:1)

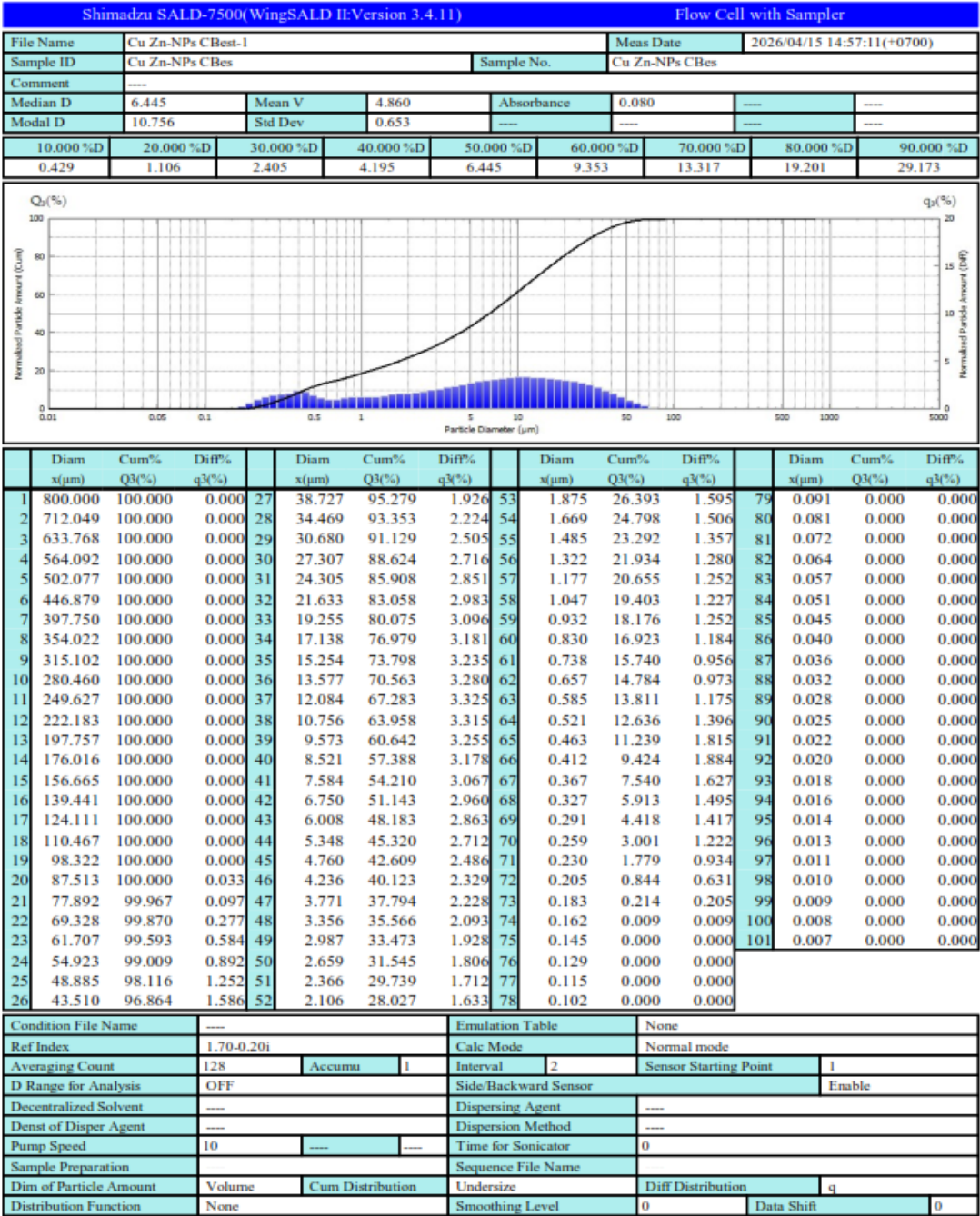




d) CuO/ZnO-NPs (Cbest)



LABORATORIUM TERPADU FTP UB



Lampiran 10. Uji Statistik Anova One Way dan Uji Lanjut (LSD)

a) *Staphylococcus aureus*

Tests of Normality

		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
Nanopartikel		Statistic	df	Sig.	Statistic	df	Sig.
<i>Staphylococcus aureus</i>	CuO (1:2)	.376	3	.	.773	3	.052
	ZnO (1:2)	.314	3	.	.893	3	.363
	CuO/ZnO (Cbest)	.269	3	.	.949	3	.567
	CuO/ZnO (1:1)	.260	2	.	.981	3	.738

a. Lilliefors Significance Correction

Descriptives

Staphylococcus aureus

		95% Confidence Interval for Mean						
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
CuO (1:2)	3	9.6967	.36964	.21341	8.7784	10.6149	9.27	9.92
ZnO (1:2)	3	9.0800	.05292	.03055	8.9486	9.2114	9.02	9.12
CuO/ZnO (1:1)	3	6.9033	.05132	.41382	5.1228	8.6838	9.96	10.06
CuO/ZnO (Cbest)	3	10.0167	.71675	.02963	9.8892	10.1441	6.25	7.67
Total	12	8.9242	1.31449	.37946	8.0890	9.7594	6.25	10.06

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
<i>Staphylococcus aureus</i>		4.477	3	8	.040

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	17.695	3	5.898	35.977	.000
Within Groups	1.312	8	.164		
Total	19.007	11			

Multiple Comparisons

Dependent Variable: *Staphylococcus aureus*

LSD

(I) Nanoparti kel	(J) Nanopartikel	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
CuO (1:2)	ZnO (1:2)	.61667	.33061	.099	-.1457	1.3790
	CuO/ZnO (Cbest)	-.32000	.33061	.361	-1.0824	.4424
	CuO/ZnO (1:1)	2.79333*	.33061	.000	2.0310	3.5557
ZnO (1:2)	CuO (1:2)	-.61667	.33061	.099	-1.3790	.1457
	CuO/ZnO (Cbest)	-.93667*	.33061	.022	-1.6990	-.1743
	CuO/ZnO (1:1)	2.17667*	.33061	.000	1.4143	2.9390
CuO/ZnO (1:1)	CuO (1:2)	.32000	.33061	.361	-.4424	1.0824
	ZnO (1:2)	.93667*	.33061	.022	.1743	1.6990
	CuO/ZnO (Cbest)	3.11333*	.33061	.000	2.3510	3.8757
CuO/ZnO (Cbest)	CuO (1:2)	-2.79333*	.33061	.000	-3.5557	-2.0310
	ZnO (1:2)	-2.17667*	.33061	.000	-2.9390	-1.4143
	CuO/ZnO (1:1)	-3.11333*	.33061	.000	-3.8757	-2.3510

*. The mean difference is significant at the 0.05 level

b) *Escherichia coli*

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
<i>Escherichia coli</i>	.185	12	.200.	.860	12	.049

a. Lilliefors Significance Correction

Descriptives

Escherichia coli

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Mini- mun	Maxi- mum
					Lower Bound	Upper Bound		
CuO (1:2)	3	15.3867	.27538	.15899	14.7026	16.0707	15.12	15.67
ZnO (1:2)	3	3.0100	.20518	.11846	2.5003	3.5197	2.80	3.21
CuO/ZnO (Cbest)	3	8.4133	.63129	.36448	6.8451	9.9816	7.70	8.90
CuO/ZnO (1:1)	3	5.6300	.59025	.34078	4.1637	7.0963	4.95	6.01
Total	12	8.1100	4.83676	1.39625	5.0369	11.1831	2.80	15.67

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
<i>Escherichia coli</i>	2.720	3	8	.115

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	255.607	3	85.202	394.060	.000
Within Groups	1.730	8	.216		
Total	257.337	11			

Multiple Comparisons

Dependent Variable: *Staphylococcus aureus*

LSD

(I) Nanoparti kel	(J) Nanopartikel	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
CuO (1:2)	ZnO (1:2)	12.37667 *	.37966	.000	-.1457	1.3790
	CuO/ZnO (Cbest)	6.97333 *	.37966	.000	-1.0824	.4424
	CuO/ZnO (1:1)	9.75667 *	.37966	.000	2.0310	3.5557
ZnO (1:2)	CuO (1:2)	-12.37667 *	.37966	.000	-1.3790	.1457
	CuO/ZnO (Cbest)	-5.40333 *	.37966	.000	-1.6990	-.1743
	CuO/ZnO (1:1)	-2.62000 *	.37966	.000	1.4143	2.9390
CuO/ZnO (1:1)	CuO (1:2)	-6.97333 *	.37966	.000	-.4424	1.0824
	ZnO (1:2)	5.40333 *	.37966	.000	.1743	1.6990
	CuO/ZnO (Cbest)	2.78333 *	.37966	.000	2.3510	3.8757
CuO/ZnO (Cbest)	CuO (1:2)	-9.75667 *	.37966	.000	-3.5557	-2.0310
	ZnO (1:2)	2.62000 *	.37966	.000	-2.9390	-1.4143
	CuO/ZnO (1:1)	-2.78333 *	.37966	.000	-3.8757	-2.3510

*, The mean difference is significant at the 0.05 level

Lampiran 11. Riwayat Hidup**RIWAYAT HIDUP**

Ni Ketut Eri Suryani lahir di Kalibukbuk pada tanggal 7 Juni 2003. Penulis merupakan anak keempat dari pasangan suami istri Bapak Wayan Widiadil dan Ibu Luh Kerti. Penulis berkebangsaan Indonesia dan beragama Hindu. Penulis beralamat di BTN Lovina Permai Blok Mawar No.31. Penulis menyelesaikan pendidikan dasar di SD Negeri 1 Kalibukbuk dan lulus pada tahun 2016. Kemudian melanjutkan pendidikan ke jenjang SMP/MTs di SMP Negeri 6 Singaraja dan lulus pada tahun 2019. Kemudian pada tahun 2022, penulis menyelesaikan pendidikan jenjang SMA/MA di SMA Negeri 1 Singaraja dan melanjutkan pendidikan Strata 1 pada Program Studi Kimia, Jurusan Kimia, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Ganesha. Pada tahun 2026 penulis telah menyelesaikan studi S1 Kimia dengan skripsi yang berjudul “*Green Synthesis Nanopartikel Bimetal Oksida CuO/ZnO Menggunakan Ekstrak Daun Kelor (Moringa oleifera) dan Uji Daya Hambatnya Terhadap Bakteri*”