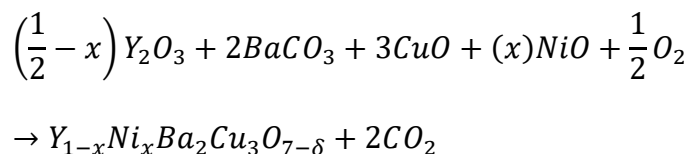




LAMPIRAN-LAMPIRAN

Lampiran 1. Reaksi Kimia dan Stoikiometri Sintesis Superkonduktor YBCO

Reaksi kimia dalam sintesis superkonduktor YBCO dengan doping nikel



Untuk dapat mensintesis material superkonduktor YBCO diperlukan bahan *precursor* yaitu Yttrium Oksida (Y_2O_3), Barium Carbonate ($BaCO_3$), Tembaga II Oksida (CuO) dan Nikel Oksida (NiO) sebagai *doping*.

Stoikiometri bahan *precursor* yang diperlukan untuk sintesis superkonduktor YBCO dengan doping nikel

Perhitungan secara stoikiometri diperlukan untuk sintesis superkonduktor YBCO. Persamaan yang digunakan untuk menentukan massa *precursor* yang diperlukan yaitu:

$$m = \text{koefisien} \times \text{mol} \times Mr$$

dengan:

m = massa bahan yang diperlukan (gram)

koefisien = koefisien dari bahan yang digunakan

mol = mol senyawa hasil reaksi kimia (mol)

Mr = massa relatif bahan yang digunakan (mol/gram)

Pada penelitian ini sampel yang dibuat yaitu sebanyak 0,01 mol zat. Berikut merupakan perhitungan *precursor* yang diperlukan.

Doping Ni	x = 0	x = 0.002
<i>Precursor</i>		
Y_2O_3	1.1291 gram	1.1245 gram
$BaCO_3$	3.9468 gram	3.9468 gram
CuO	2.3864 gram	2.3864 gram
NiO	0 gram	0.0015 gram

1. Yttrium Oksida (Y_2O_3)a. Sampel tanpa doping ($x=0$)

$$\text{massa } Y_2O_3 = \text{koef. } Y_2O_3 \times \text{mol} \times \text{Mr } Y_2O_3$$

$$\text{massa } Y_2O_3 = \frac{1}{2} \times 0.01 \times 225.812$$

$$\text{massa } Y_2O_3 = 1.1291 \text{ gram}$$

b. Sampel dengan doping nikel ($x=0,002$)

$$\text{massa } Y_2O_3 = \text{koef. } Y_2O_3 \times \text{mol} \times \text{Mr } Y_2O_3$$

$$\text{massa } Y_2O_3 = \left(\frac{1}{2} - 0.002\right) \times 0.01 \times 225.812$$

$$\text{massa } Y_2O_3 = 1.1245 \text{ gram}$$

2. Barrium Carbonate ($BaCO_3$)

$$\text{massa } BaCO_3 = \text{koef. } BaCO_3 \times \text{mol} \times \text{Mr } BaCO_3$$

$$\text{massa } BaCO_3 = 2 \times 0.01 \times 197.338$$

$$\text{massa } BaCO_3 = 3.9468 \text{ gram}$$

Massa $BaCO_3$ yang sama diperlukan untuk mensintesis YBCO dengan doping maupun tanpa doping karena doping nikel ditujukan untuk mensubstitusi atom Y.

3. Tembaga II Oksida (CuO)

$$\text{massa } CuO = \text{koef. } CuO \times \text{mol} \times \text{Mr } CuO$$

$$\text{massa } CuO = 3 \times 0.01 \times 79.546$$

$$\text{massa } CuO = 2.3864 \text{ gram}$$

Massa CuO yang sama diperlukan untuk mensintesis YBCO dengan doping maupun tanpa doping karena doping nikel ditujukan untuk mensubstitusi atom Y.

4. Nikel Oksida (NiO)

a. Sampel tanpa doping ($x=0$)

Pada sampel tanpa doping nikel tidak diperlukan unsur nikel, sehingga massa NiO yang digunakan yaitu 0.

c. Sampel dengan doping nikel ($x=0,002$)

$$\text{massa NiO} = \text{koef. NiO} \times \text{mol} \times \text{MrNiO}$$

$$\text{massa NiO} = 0.002 \times 0.01 \times 74.6934$$

$$\text{massa NiO} = 0.0015 \text{ gram}$$



Lampiran 2. Data Hasil Uji XRD

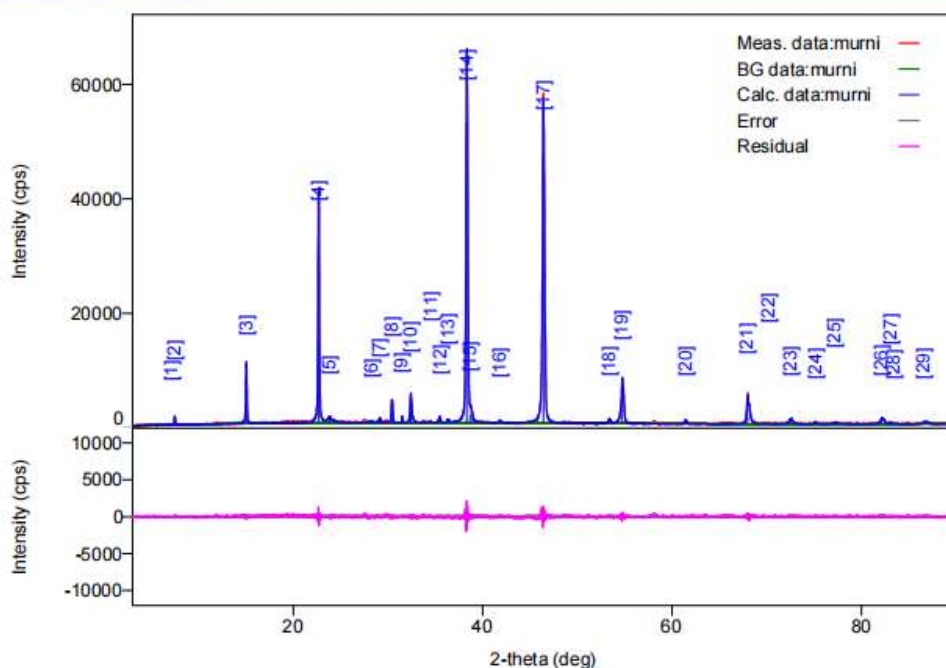
1. Data hasil uji XRD untuk sampel YBCO tanpa doping nikel

Peak List

General information

Analysis date	2023/11/21 16:00:18	Measurement date	2023/11/21 15:15:27
Sample name		Operator	ADMINISTRATOR
File name	murni.ras		
Comment			

Measurement profile



Peak list

No.	2-theta(deg)	d(ang.)	Height(cps)	FWHM(deg)	Int. I(cps deg)	Int. W(deg)	Asym. factor
1	7.06(5)	12.50(9)	88(27)	0.07(4)	7(5)	0.08(8)	0.5(18)
2	7.460(3)	11.840(4)	1026(92)	0.098(7)	118(8)	0.115(18)	0.6(3)
3	15.023(4)	5.8924(16)	7885(256)	0.105(3)	1168(14)	0.148(7)	0.85(15)
4	22.660(2)	3.9209(4)	31168(510)	0.1253(17)	5217(30)	0.167(4)	0.99(8)
5	23.80(2)	3.735(4)	700(76)	0.42(4)	546(20)	0.78(11)	1.0(3)
6	28.31(3)	3.150(3)	170(38)	0.48(15)	160(22)	0.9(3)	5(7)
7	29.11(2)	3.065(2)	668(75)	0.12(5)	158(14)	0.24(5)	1.1(12)
8	30.398(11)	2.9381(10)	3166(162)	0.146(8)	549(18)	0.173(15)	0.8(2)
9	31.478(3)	2.8398(2)	1121(97)	0.045(4)	61(4)	0.054(8)	1.6(4)
10	32.403(4)	2.7608(3)	3878(180)	0.158(7)	878(16)	0.226(15)	1.8(3)
11	34.47(4)	2.600(3)	137(34)	0.24(18)	59(16)	0.4(2)	2(6)
12	35.469(13)	2.5288(9)	756(79)	0.183(14)	149(11)	0.20(3)	3.4(14)
13	36.292(13)	2.4733(8)	435(60)	0.18(4)	82(16)	0.19(6)	0.8(9)
14	38.308(2)	2.34767(14)	52136(659)	0.169(2)	11214(91)	0.215(4)	1.24(7)

15	38.754(14)	2.3217(8)	1303(104)	0.27(4)	455(70)	0.35(8)	1.24(7)
16	41.804(14)	2.1591(7)	307(51)	0.18(4)	69(11)	0.22(7)	3(4)
17	46.391(3)	1.95571(13)	47005(626)	0.190(3)	11587(69)	0.247(5)	1.03(7)
18	53.38(3)	1.7148(8)	557(68)	0.22(3)	128(14)	0.23(5)	2.1(11)
19	54.723(4)	1.67602(11)	6853(239)	0.189(5)	1959(21)	0.286(13)	0.70(6)
20	61.424(6)	1.50824(13)	694(76)	0.079(16)	111(7)	0.16(3)	1.6(5)
21	67.972(6)	1.37801(11)	4618(196)	0.202(8)	1427(19)	0.309(17)	1.02(16)
22	70.227(13)	1.3392(2)	128(33)	0.09(6)	23(6)	0.18(9)	4(9)
23	72.546(15)	1.3020(2)	732(78)	0.36(3)	400(13)	0.55(8)	2.1(5)
24	75.13(2)	1.2634(3)	303(50)	0.21(5)	104(11)	0.34(9)	2.0(8)
25	77.10(3)	1.2361(4)	219(43)	0.55(16)	218(15)	1.0(3)	0.5(4)
26	82.158(18)	1.1723(2)	895(86)	0.33(3)	405(18)	0.45(6)	0.9(2)
27	83.000(19)	1.1625(2)	238(44)	0.17(4)	54(9)	0.23(8)	0.9(2)
28	83.41(3)	1.1578(3)	110(30)	0.14(6)	22(8)	0.20(12)	0.9(2)
29	86.61(2)	1.1230(2)	305(50)	0.43(6)	159(15)	0.52(13)	0.5(3)

Qualitative Analysis Results

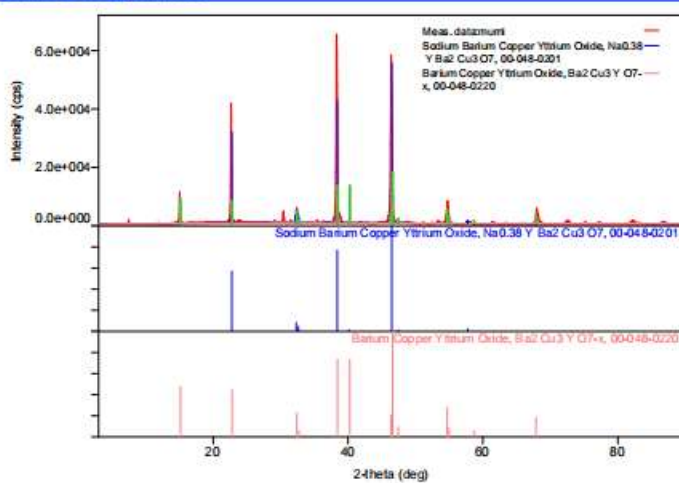
General information

Analysis date	2023/11/21 16:01:01	Measurement date	2023/11/21 15:15:27
Sample name		Operator	ADMINISTRATOR
File name	murni.ras		
Comment			

Qualitative analysis results

Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Sodium Barium Copper Yttrium Oxide	Na _{0.38} Y Ba ₂ Cu ₃ O ₇	0.814	ICDD (PDF2.DAT)	00-048-0201
Barium Copper Yttrium Oxide	Ba ₂ Cu ₃ Y O _{7-x}	1.594	ICDD (PDF2.DAT)	00-048-0220

Phase data pattern



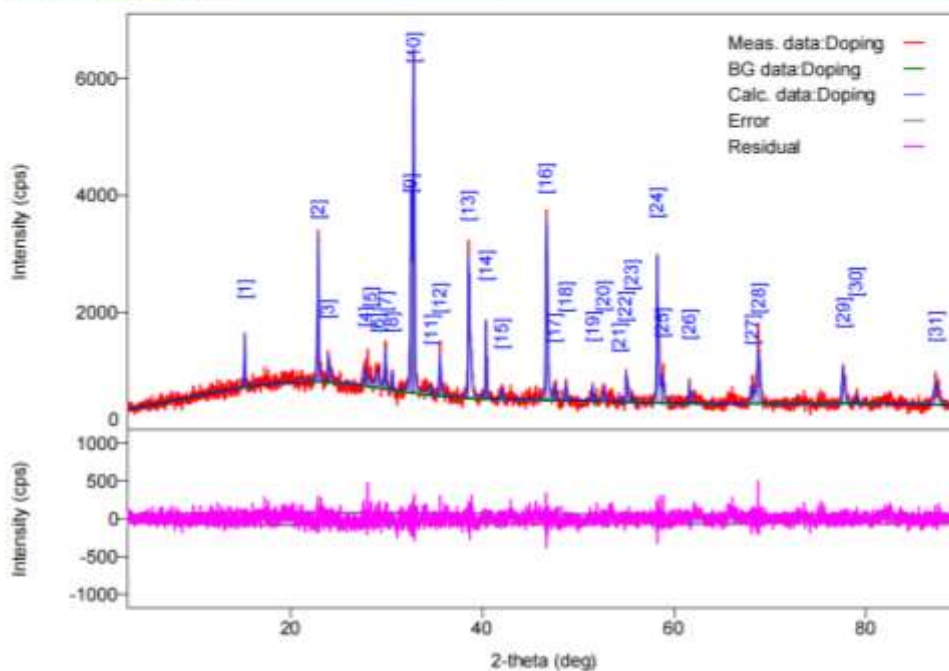
2. Data hasil uji XRD untuk sampel YBCO tanpa doping nikel ($x=0.002$)

Peak List

General information

Analysis date	2023/11/21 16:02:05	Measurement date	2023/11/21 14:54:23
Sample name	Doping_ras	Operator	ADMINISTRATOR
File name			
Comment			

Measurement profile



Peak list

No.	2-theta(deg)	d(ang.)	Height(cps)	FWHM(deg)	Int. I(cps deg)	Int. W(deg)	Asym. factor
1	15.222(3)	5.8159(13)	754(79)	0.063(7)	91(5)	0.12(2)	1.2(13)
2	22.877(5)	3.8843(9)	2023(130)	0.096(10)	336(10)	0.166(16)	1.0(3)
3	23.925(11)	3.7163(17)	332(53)	0.19(5)	112(10)	0.34(8)	0.5(5)
4	27.80(2)	3.206(2)	254(46)	0.19(7)	103(23)	0.40(17)	0.6(8)
5	28.36(10)	3.145(11)	60(22)	0.3(5)	42(19)	0.7(6)	0.6(8)
6	29.09(8)	3.067(8)	190(40)	0.38(6)	78(18)	0.41(18)	1.3(10)
7	29.885(19)	2.9874(19)	586(70)	0.12(4)	122(10)	0.21(4)	1.4(11)
8	30.604(15)	2.9188(14)	238(45)	0.14(5)	35(11)	0.15(7)	1(2)
9	32.565(5)	2.7474(4)	2658(149)	0.149(11)	517(23)	0.19(2)	0.77(11)
10	32.825(4)	2.7262(3)	4895(202)	0.133(5)	850(26)	0.174(12)	0.77(11)
11	34.65(3)	2.586(2)	116(31)	0.32(15)	73(13)	0.6(3)	5(9)
12	35.567(11)	2.5221(7)	583(70)	0.123(15)	141(9)	0.24(4)	0.71(16)
13	38.566(6)	2.3332(3)	2276(138)	0.130(11)	548(13)	0.24(2)	0.59(14)
14	40.393(3)	2.23118(16)	1270(103)	0.090(5)	152(5)	0.119(13)	1.5(2)

15	42.03(2)	2.1478(12)	118(31)	0.33(7)	42(11)	0.35(19)	2(2)
16	46.692(6)	1.9438(2)	2768(152)	0.159(7)	591(11)	0.213(16)	0.93(15)
17	47.542(17)	1.9110(6)	230(44)	0.17(5)	46(9)	0.20(8)	0.6(7)
18	48.74(3)	1.8669(12)	254(46)	0.17(4)	46(9)	0.18(7)	1.7(14)
19	51.534(5)	1.77198(17)	263(47)	0.07(2)	36(5)	0.14(4)	3(3)
20	52.66(10)	1.737(3)	146(35)	0.33(7)	51(12)	0.35(17)	1.3(4)
21	54.285(11)	1.6885(3)	95(28)	0.06(4)	6(5)	0.06(7)	4(18)
22	55.014(14)	1.6678(4)	454(61)	0.16(2)	96(6)	0.21(4)	0.8(3)
23	55.634(15)	1.8507(4)	125(32)	0.10(4)	14(6)	0.11(8)	0.5(11)
24	58.259(2)	1.58241(6)	2409(142)	0.126(7)	452(13)	0.188(16)	1.5(5)
25	58.802(13)	1.5691(3)	361(55)	0.21(4)	113(12)	0.31(8)	1.5(5)
26	61.599(9)	1.5044(2)	344(54)	0.09(3)	51(8)	0.15(5)	1.0(13)
27	68.15(2)	1.3748(4)	264(47)	0.32(5)	94(8)	0.36(9)	1.5(4)
28	68.79(2)	1.3636(4)	755(79)	0.30(2)	250(9)	0.33(5)	1.5(4)
29	77.656(11)	1.22858(15)	540(67)	0.230(19)	160(9)	0.30(5)	2.4(5)
30	79.052(19)	1.2103(2)	126(32)	0.19(5)	26(8)	0.20(11)	2(3)
31	87.32(2)	1.1157(2)	333(53)	0.39(4)	177(13)	0.53(12)	2.5(5)

Qualitative Analysis Results

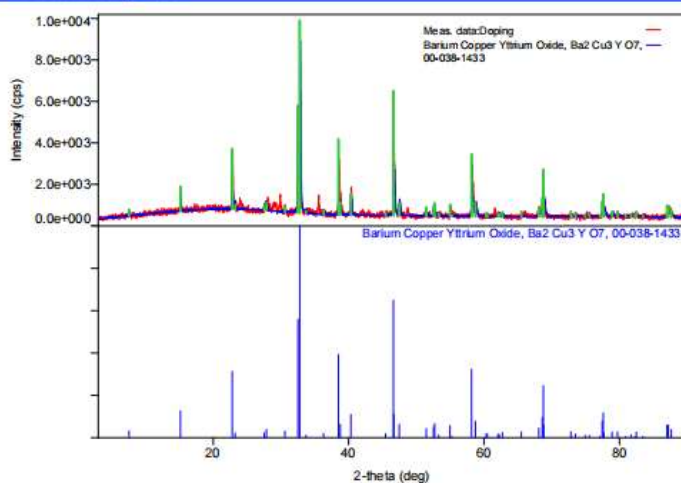
General information

Analysis date	2023/11/21 16:03:27	Measurement date	2023/11/21 14:54:23
Sample name		Operator	ADMINISTRATOR
File name	Doping.ras		
Comment			

Qualitative analysis results

Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
Barium Yttrium Oxide	Copper Ba ₂ Cu ₃ Y O ₇	0.652	ICDD (PDF2.DAT)	00-038-1433

Phase data pattern



Lampiran 3. Data Hasil Uji *four point probe*

No	T (K)	Resistivitas x=0 ($\mu\Omega\text{cm}$)	Resistivitas x=0.002 ($\mu\Omega\text{cm}$)	Smoothed (x=0)	Smoothed (x=0,002)
1	80	0	0	0	0
2	81	0	0	0	0
3	82	0	0	0	0
4	83	0	0	0	0
5	84	0	0	0	0
6	85	0	0	0	0
7	86	0	0	0	0
8	87	0	0	1.41E-04	0
9	88	0	0	4.06E-04	0
10	89	0	0	7.80E-04	0
11	90	0	0	0.00127	2.29E-06
12	91	0	0	0.00187	7.37E-05
13	92	0.00221	0	0.00258	1.74E-04
14	93	0.00283	0	0.00337	3.03E-04
15	94	0.00565	0	0.00421	4.59E-04
16	95	0.00565	0	0.00509	6.40E-04
17	96	0.00565	0	0.00596	8.39E-04
18	97	0.00722	0.00094	0.0068	0.00105
19	98	0.00785	0.00157	0.00758	0.00127
20	99	0.00942	0.00214	0.00829	0.00148
21	100	0.00942	0.00214	0.00892	0.00169
22	101	0.00942	0.00232	0.00946	0.00188
23	102	0.00942	0.00232	0.00991	0.00205
24	103	0.01036	0.00232	0.01028	0.00219
25	104	0.01099	0.00248	0.01058	0.00231
26	105	0.01099	0.00248	0.01082	0.00241
27	106	0.0114	0.00248	0.01101	0.00248
28	107	0.0114	0.00251	0.01116	0.00253
29	108	0.0114	0.00251	0.01128	0.00257
30	109	0.0114	0.00251	0.01138	0.0026
31	110	0.01146	0.00251	0.01145	0.00262
32	111	0.01146	0.00251	0.0115	0.00264
33	112	0.01146	0.00251	0.01154	0.00265
34	113	0.01146	0.00276	0.01157	0.00267
35	114	0.01162	0.00276	0.01159	0.00269
36	115	0.01162	0.00276	0.01161	0.00272
37	116	0.01162	0.00283	0.01162	0.00274
38	117	0.01162	0.00283	0.01164	0.00277

39	118	0.01162	0.00283	0.01166	0.00279
40	119	0.01162	0.00283	0.01169	0.00281
41	120	0.01162	0.00283	0.01172	0.00282
42	121	0.01162	0.00283	0.01176	0.00284
43	122	0.01162	0.00283	0.01179	0.00284
44	123	0.01193	0.00283	0.01183	0.00285
45	124	0.01193	0.00283	0.01186	0.00285
46	125	0.01193	0.00283	0.01189	0.00285
47	126	0.01193	0.00283	0.01191	0.00285
48	127	0.01193	0.00283	0.01193	0.00286
49	128	0.01193	0.00283	0.01195	0.00287
50	129	0.01193	0.00283	0.01197	0.00288
51	130	0.01193	0.00283	0.01199	0.0029
52	131	0.01193	0.00283	0.01202	0.00293
53	132	0.01193	0.00283	0.01204	0.00296
54	133	0.01193	0.00283	0.01206	0.003
55	134	0.01193	0.00283	0.01207	0.00304
56	135	0.01193	0.00350	0.01208	0.00307
57	136	0.01225	0.00350	0.01208	0.00311
58	137	0.01225	0.00314	0.01206	0.00313
59	138	0.01225	0.00314	0.01204	0.00316
60	139	0.01225	0.00314	0.012	0.00317
61	140	0.01225	0.00314	0.01197	0.00318
62	141	0.01162	0.00314	0.01194	0.00318
63	142	0.01162	0.00314	0.01191	0.00318
64	143	0.01162	0.00314	0.0119	0.00317
65	144	0.01162	0.00314	0.0119	0.00316
66	145	0.01162	0.00314	0.01192	0.00315
67	146	0.01162	0.00314	0.01195	0.00314
68	147	0.01225	0.00314	0.01199	0.00313
69	148	0.01225	0.00314	0.01203	0.00313
70	149	0.01225	0.00314	0.01208	0.00313
71	150	0.01225	0.00314	0.01212	0.00313
72	151	0.01225	0.00314	0.01215	0.00313
73	152	0.01225	0.00314	0.01218	0.00314
74	153	0.01225	0.00314	0.01219	0.00315
75	154	0.01209	0.00314	0.01219	0.00317
76	155	0.01209	0.00314	0.01219	0.00318
77	156	0.01209	0.00314	0.01218	0.0032
78	157	0.01209	0.00314	0.01216	0.00321
79	158	0.01209	0.00314	0.01215	0.00323

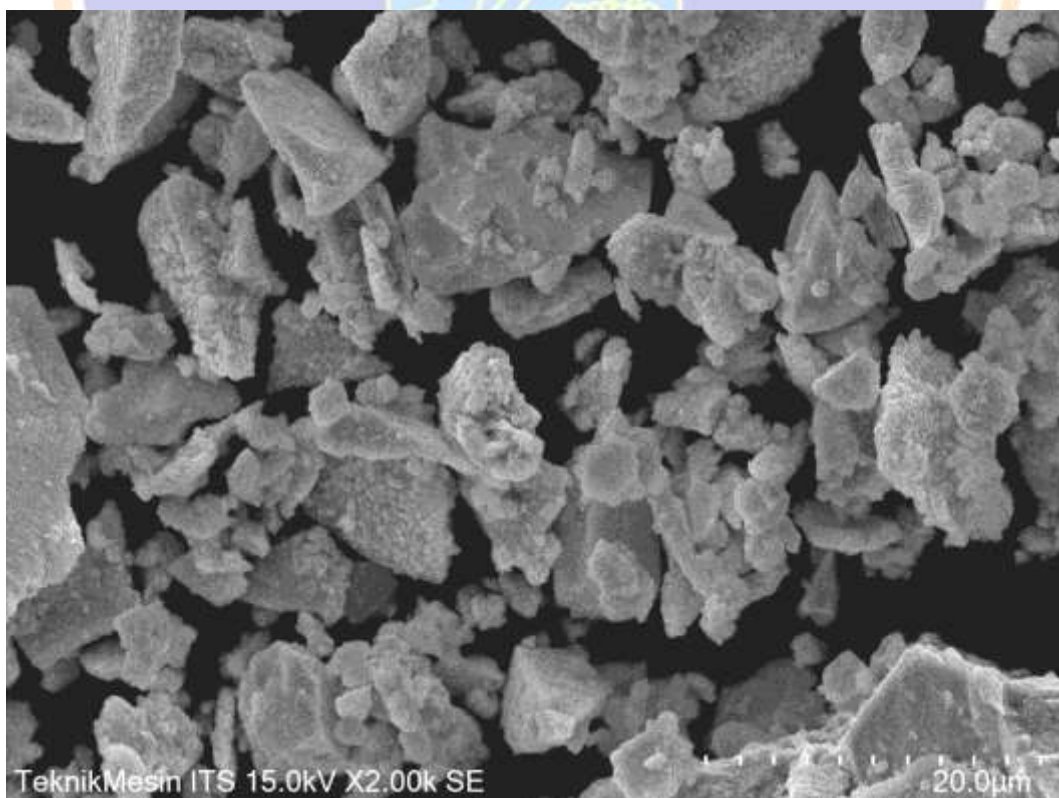
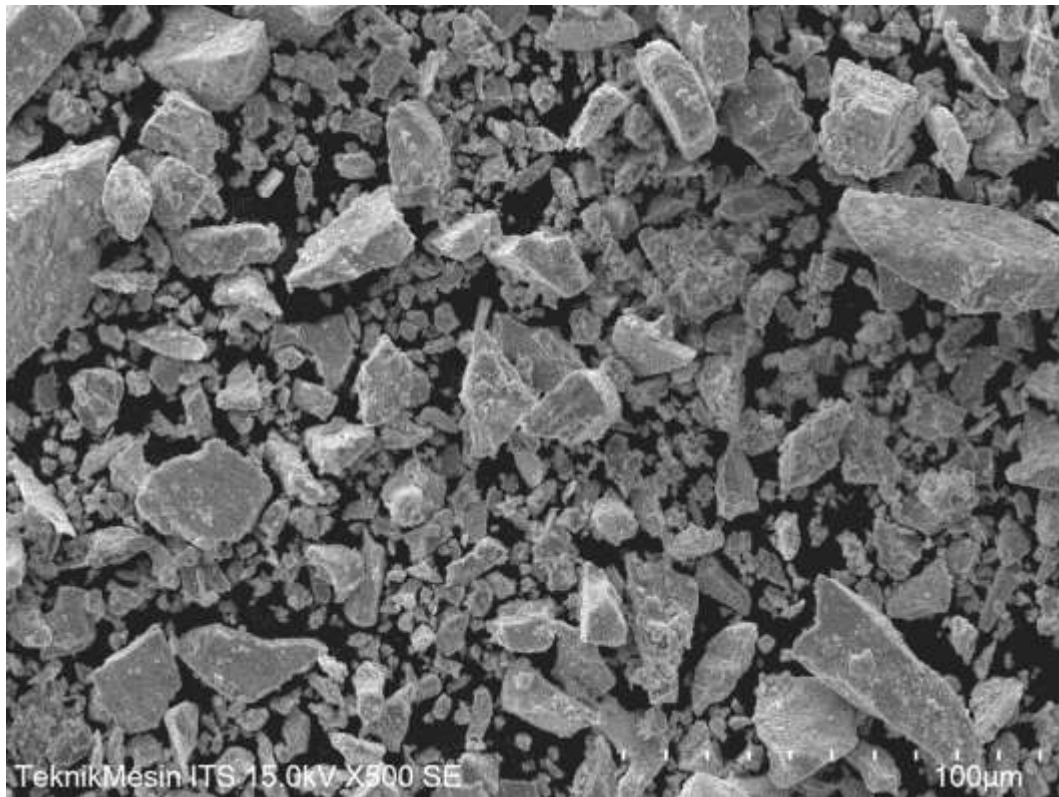
80	159	0.01209	0.0033	0.01213	0.00325
81	160	0.01209	0.0033	0.0121	0.00327
82	161	0.01225	0.0033	0.01207	0.00329
83	162	0.01225	0.0033	0.01203	0.00331
84	163	0.01225	0.0033	0.01198	0.00333
85	164	0.01225	0.00345	0.01193	0.00336
86	165	0.01162	0.00345	0.01187	0.00338
87	166	0.01162	0.00345	0.0118	0.0034
88	167	0.01162	0.00345	0.01174	0.00342
89	168	0.01162	0.00345	0.01169	0.00344
90	169	0.01162	0.00345	0.01164	0.00345
91	170	0.01162	0.00345	0.01162	0.00346
92	171	0.01162	0.00345	0.01162	0.00346
93	172	0.01162	0.00345	0.01164	0.00346
94	173	0.01162	0.00345	0.01167	0.00345
95	174	0.01162	0.00345	0.01172	0.00345
96	175	0.01162	0.00345	0.01179	0.00344
97	176	0.01162	0.00345	0.01186	0.00343
98	177	0.01225	0.00345	0.01193	0.00343
99	178	0.01225	0.00345	0.01201	0.00344
100	179	0.01225	0.00345	0.01208	0.00344
101	180	0.01225	0.00345	0.01214	0.00346
102	181	0.01225	0.00345	0.01221	0.00348
103	182	0.01225	0.00345	0.01226	0.0035
104	183	0.01225	0.00345	0.01232	0.00353
105	184	0.01225	0.00361	0.01237	0.00356
106	185	0.01256	0.00361	0.01241	0.00359
107	186	0.01256	0.00361	0.01245	0.00362
108	187	0.01256	0.00361	0.01248	0.00364
109	188	0.01256	0.00361	0.0125	0.00366
110	189	0.01256	0.00377	0.0125	0.00368
111	190	0.01256	0.00377	0.01249	0.0037
112	191	0.01256	0.00377	0.01248	0.00371
113	192	0.01256	0.00377	0.01246	0.00372
114	193	0.01256	0.00377	0.01243	0.00372
115	194	0.01256	0.00377	0.01241	0.00373
116	195	0.01256	0.00377	0.0124	0.00374
117	196	0.01225	0.00377	0.01239	0.00376
118	197	0.01225	0.00377	0.01239	0.00377
119	198	0.01225	0.00377	0.01239	0.00378
120	199	0.01225	0.00377	0.01239	0.00379

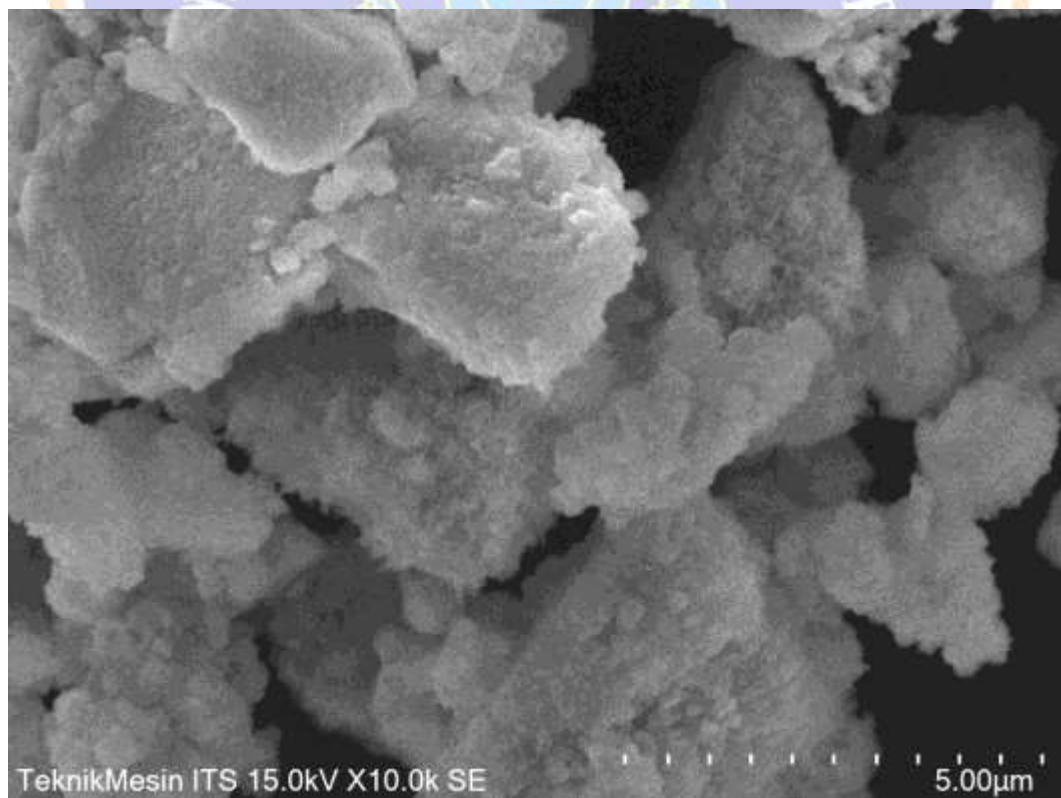
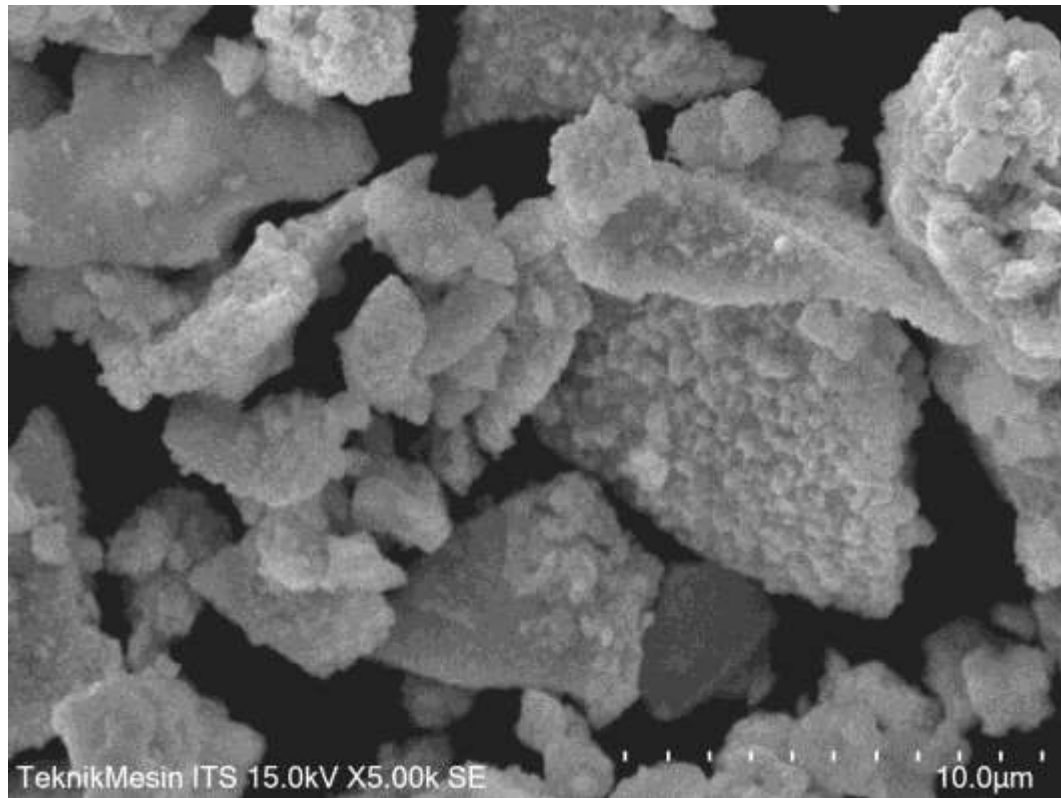
121	200	0.01225	0.00377	0.01239	0.0038
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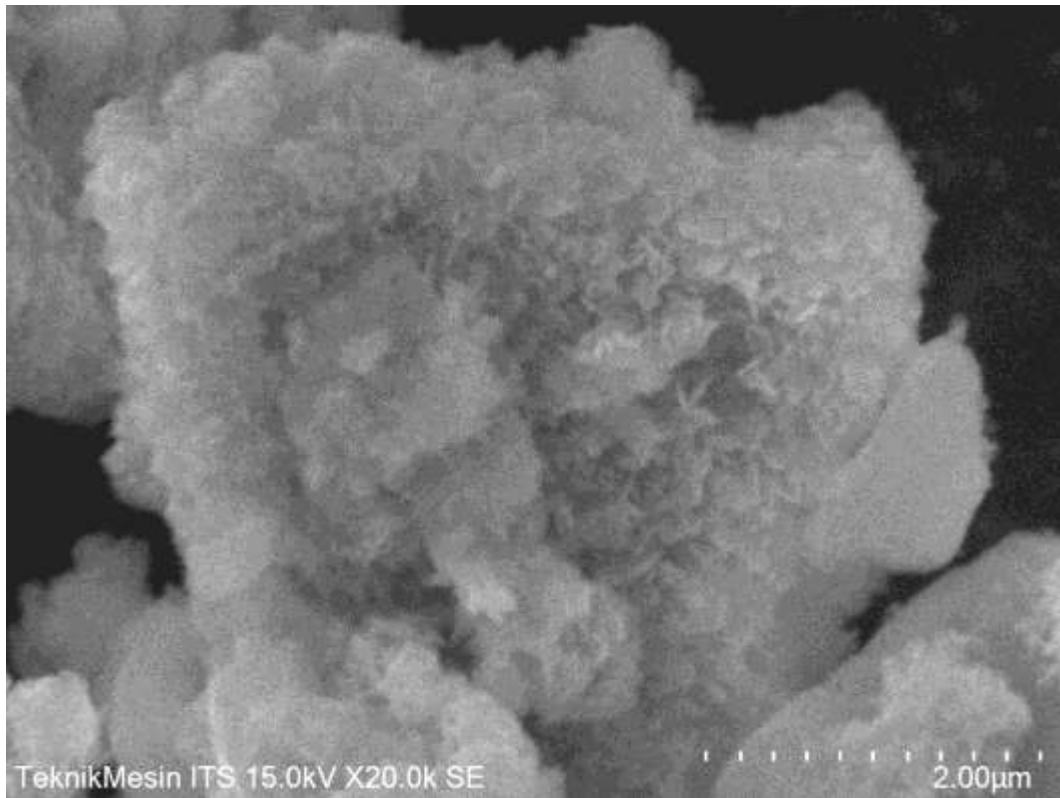


Lampiran 4. Data Hasil Uji SEM

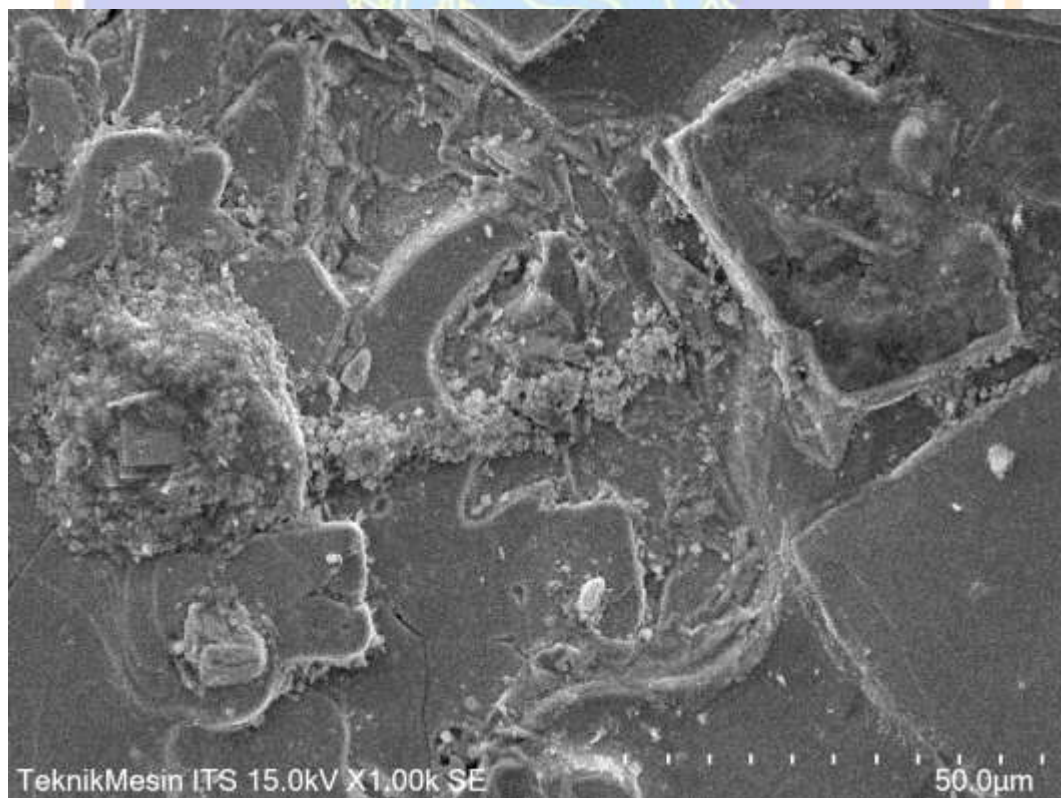
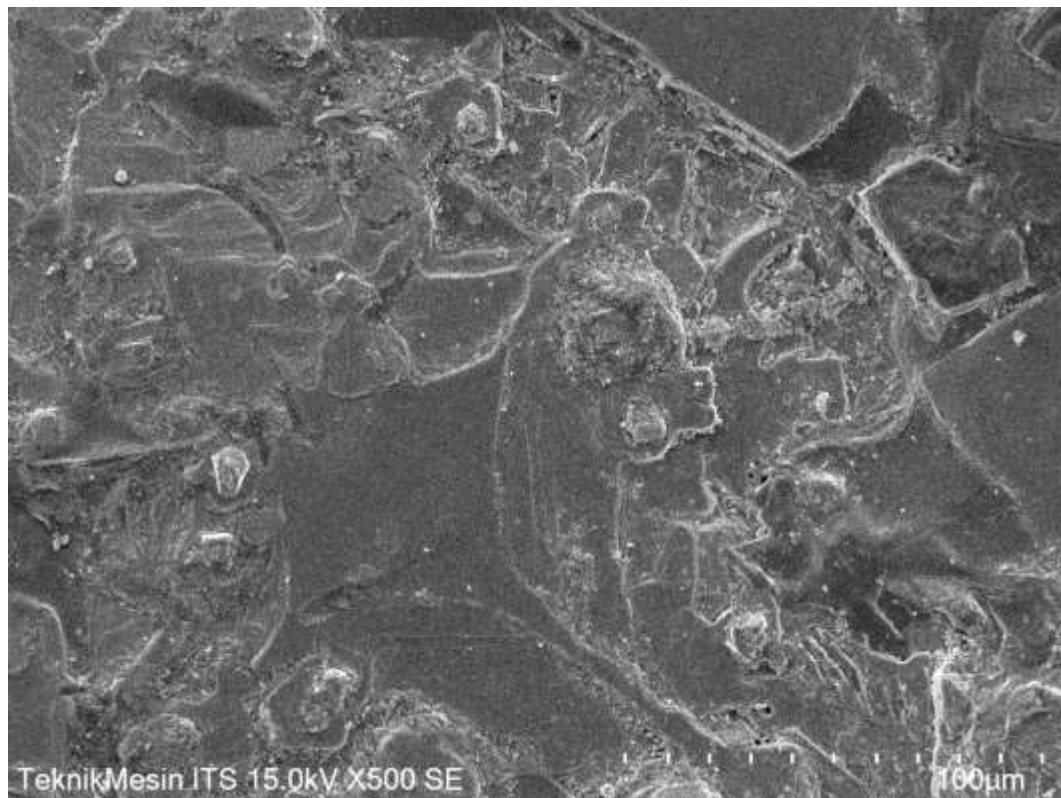
1. Data hasil uji XRD untuk sampel YBCO tanpa doping nikel

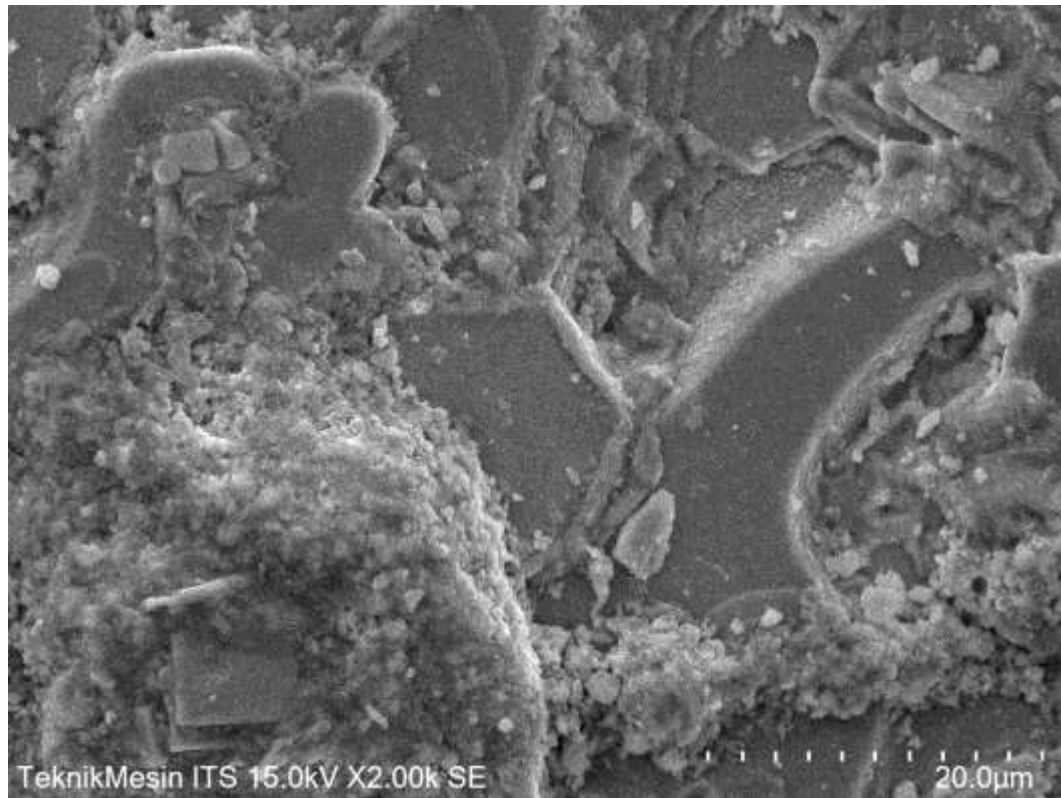


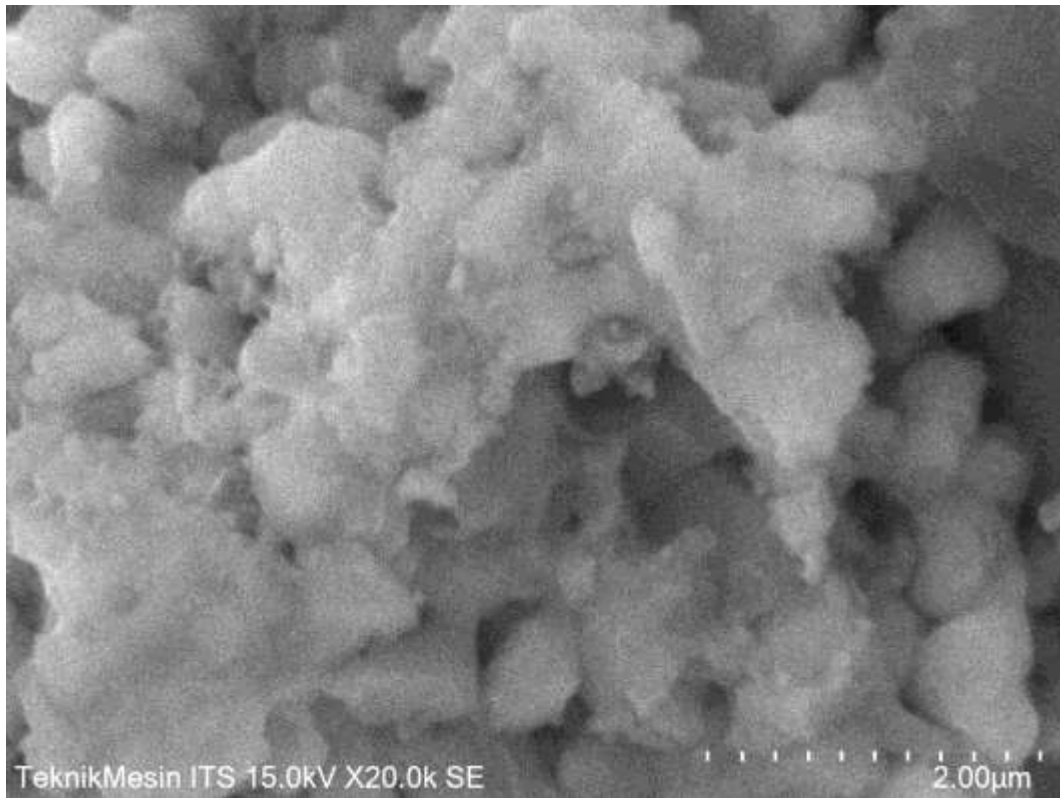




2. Data hasil uji XRD untuk sampel YBCO dengan doping nikel ($x=0.002$)







Lampiran 5. Analisis Parameter Kisi Kristal

- 1. Miller indices (h,k,l) untuk masing-masing puncak difraksi sampel superkonduktor YBCO tanpa doping Nikel**

2-theta (°)	h	k	l	theta (°)	d = interplanar space (Å)
7.46	0	0	1	3.73	4.154958156
15.023	0	0	2	7.5115	5.892514117
22.66	0	0	3	11.33	3.920908591
23.1	1	0	0	11.505	3.862054063
28.31	1	0	2	14.155	3.149919788
32.76	1	1	0	16.38	2.731496588
36.292	1	1	2	18.146	2.473353951
38.308	0	0	5	19.154	2.347700104
38.754	1	0	4	19.377	2.321701918
46.391	0	0	6	23.1955	1.955722823
54.723	0	0	7	27.3615	1.676011281
61.424	1	0	7	30.712	1.508254003
67.972	2	0	6	33.986	1.378020298
70.227	1	0	8	35.1135	1.339191008
75.13	2	0	7	37.565	1.263488913
83	3	1	3	41.5	1.162506329

- 2. Miller indices (h,k,l) untuk masing-masing puncak difraksi sampel superkonduktor YBCO dengan doping Nikel (x=0,002)**

2-theta (°)	h	k	l	theta (°)	d = interplanar space (Å)
15.27	0	0	2	7.611	5.815924991
23.00	0	0	3	11.4385	3.884205189
23.1	1	0	0	11.9625	3.716382546
27.73	1	0	2	13.9	3.206536556
32.76	1	0	3	16.2825	2.747406193
32.76	1	1	0	16.4125	2.726236003
36.33	1	1	2	17.7835	2.522091641
38.81	0	0	5	19.278	2.333167931
40.41	1	1	3	20.1965	2.231195866
46.99	0	0	6	23.346	1.943814102

47.01	2	0	0	23.771	1.911024875
51.67	1	1	5	25.767	1.771975809
55.44	0	0	7	27.507	1.667832328
55.46	2	1	2	27.817	1.650705064
58.47	1	1	6	29.1295	1.582422812
58.48	2	1	3	29.401	1.569098088
60.81	1	0	7	30.7995	1.504388264
68.66	2	0	6	34.075	1.374854102
68.67	2	2	0	34.395	1.363616256
87.38	2	2	6	43.66	1.115766348

3. Perhitungan parameter kisi (*lattice parameter*) untuk sampel superkonduktor YBCO tanpa doping nikel

Untuk menghitung parameter kisi kristal dengan bentuk orthorhombic menggunakan persamaan:

$$\frac{1}{d^2} = \left(\frac{h}{a}\right)^2 + \left(\frac{k}{b}\right)^2 + \left(\frac{l}{c}\right)^2$$

Dimana:

d = interplanar space

h, k, l = miller indices

a, b, c = lattice parameter

Berikut merupakan perhitungan parameter kisi (*lattice parameter*) untuk sampel superkonduktor YBCO tanpa doping nikel.

- a. Menentukan nilai a , dengan menggunakan puncak difraksi yang memiliki nilai miller indices $k = l = 0$

$$\frac{1}{d^2} = \left(\frac{h}{a}\right)^2 + \left(\frac{k}{b}\right)^2 + \left(\frac{l}{c}\right)^2$$

$$\frac{1}{3.8620^2} = \left(\frac{1}{a}\right)^2 + \left(\frac{0}{b}\right)^2 + \left(\frac{0}{c}\right)^2$$

$$\frac{1}{3.8620^2} = \frac{1^2}{a^2}$$

$$a = 1 \times 3.8620$$

$$a = 3.8621 \text{ \AA}$$

- b. Menentukan nilai c , dengan menggunakan puncak difraksi yang memiliki nilai *miller indices* $h = k = 0$

$$\frac{1}{d^2} = \left(\frac{h}{a}\right)^2 + \left(\frac{k}{b}\right)^2 + \left(\frac{l}{c}\right)^2$$

$$\frac{1}{2.3477^2} = \left(\frac{0}{a}\right)^2 + \left(\frac{0}{b}\right)^2 + \left(\frac{5}{c}\right)^2$$

$$\frac{1}{2.3477^2} = \frac{5^2}{c^2}$$

$$c = 5 \times 2.3477$$

$$c = 11.7385 \text{ \AA}$$

- c. Menentukan nilai b , dengan mensubstitusi nilai a dan c yang telah diketahui pada persamaan.

$$\frac{1}{d^2} = \left(\frac{h}{a}\right)^2 + \left(\frac{k}{b}\right)^2 + \left(\frac{l}{c}\right)^2$$

$$\frac{1}{2.7314^2} = \left(\frac{1}{3.8621}\right)^2 + \left(\frac{1}{b}\right)^2 + \left(\frac{0}{11.6629}\right)^2$$

$$\frac{1}{7.4610} = \frac{1}{14.9155} + \frac{1}{b^2}$$

$$0.134028968 = 0.067044523 + \frac{1}{b^2}$$

$$\frac{1}{b^2} = 0.134028968 - 0.067044523$$

$$\frac{1}{b^2} = 0.066984446$$

$$b^2 = \frac{1}{0.066984446}$$

$$b^2 = 14.92883887$$

$$b = 3.8638 \text{ \AA}$$

4. Perhitungan parameter kisi (*lattice parameter*) untuk sampel superkonduktor YBCO dengan doping nikel (x=0.002)

Berikut merupakan perhitungan parameter kisi (*lattice parameter*) untuk sampel superkonduktor YBCO dengan doping nikel (x=0.002).

- d. Menentukan nilai a , dengan menggunakan puncak difraksi yang memiliki nilai *miller indices* $k = l = 0$

$$\frac{1}{d^2} = \left(\frac{h}{a}\right)^2 + \left(\frac{k}{b}\right)^2 + \left(\frac{l}{c}\right)^2$$

$$\frac{1}{1.9110^2} = \left(\frac{2}{a}\right)^2 + \left(\frac{0}{b}\right)^2 + \left(\frac{0}{c}\right)^2$$

$$\frac{1}{1.9110^2} = \frac{2^2}{a^2}$$

$$a = 2 \times 1.9110$$

$$a = 3.8220 \text{ \AA}$$

- e. Menentukan nilai c , dengan menggunakan puncak difraksi yang memiliki nilai *miller indices* $h = k = 0$

$$\frac{1}{d^2} = \left(\frac{h}{a}\right)^2 + \left(\frac{k}{b}\right)^2 + \left(\frac{l}{c}\right)^2$$

$$\frac{1}{1.9438^2} = \left(\frac{0}{a}\right)^2 + \left(\frac{0}{b}\right)^2 + \left(\frac{6}{c}\right)^2$$

$$\frac{1}{1.9438^2} = \frac{6^2}{c^2}$$

$$c = 6 \times 1.9438$$

$$c = 11.6629 \text{ \AA}$$

- f. Menentukan nilai b , dengan mensubstitusi nilai a dan c yang telah diketahui pada persamaan.

$$\frac{1}{d^2} = \left(\frac{h}{a}\right)^2 + \left(\frac{k}{b}\right)^2 + \left(\frac{l}{c}\right)^2$$

$$\frac{1}{2.7263^2} = \left(\frac{1}{3.8220}\right)^2 + \left(\frac{1}{b}\right)^2 + \left(\frac{0}{11.6629}\right)^2$$

$$\frac{1}{7.4323} = \frac{1}{14.6081} + \frac{1^2}{b^2}$$

$$0.134546716 = 0.068455339 + \frac{1}{b^2}$$

$$\frac{1}{b^2} = 0.134546716 - 0.068455339$$

$$\frac{1}{b^2} = 0.066091377$$

$$b^2 = \frac{1}{0.066091377}$$

$$b^2 = 15.13056697$$

$$b = 3.8898 \text{ \AA}$$

Lampiran 6. Analisis Ukuran Kristalit

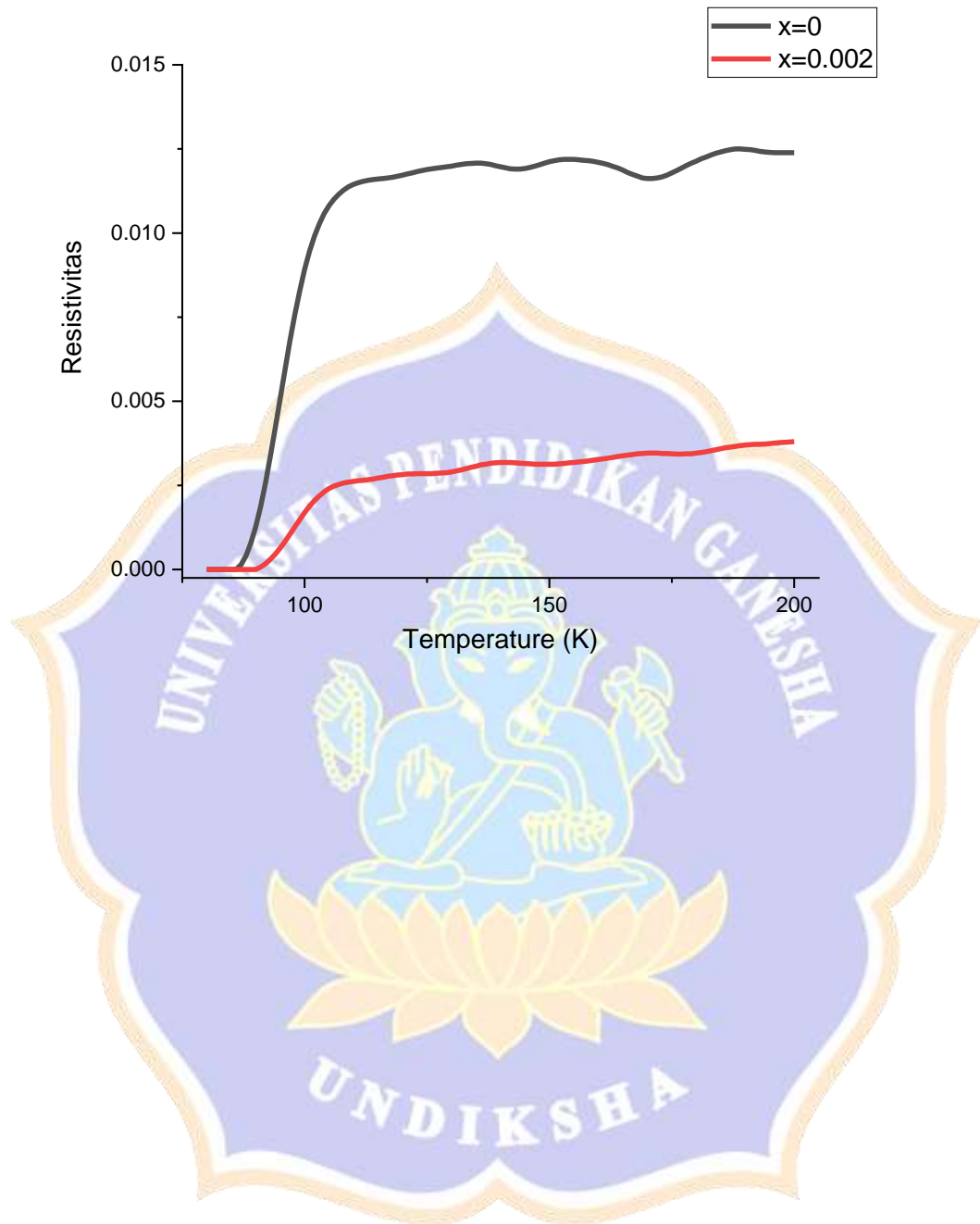
1. Analisis ukuran kristalait untuk sampel superkonduktor YBCO tanpa doping nikel.

No.	2-theta(deg)	Height(cps)	FWHM(deg)	D
1	7.06	88	0.07	113.705577
2	7.46	1026(92)	0.098	81.23625697
3	15.023	7885(256)	0.105	76.31477972
4	22.66	31168(510)	0.1253	64.66229039
5	23.8	700(76)	0.42	19.33040384
6	28.31	170(38)	0.48	17.06885144
7	29.11	668(75)	0.12	68.39749988
8	30.398	3166(162)	0.146	56.38523356
9	31.478	1121(97)	0.045	183.416531
10	32.403	3878(180)	0.158	52.3597035
11	34.47	137(34)	0.24	34.65740683
12	35.469	756(79)	0.183	45.57733039
13	36.292	435(60)	0.18	46.44482602
14	38.308	52136(659)	0.169	49.76247297
15	38.754	1303(104)	0.27	31.19002279
16	41.804	307(51)	0.18	47.24396907
17	46.391	47005(626)	0.19	45.48910083
18	53.38	557(68)	0.22	40.41682563
19	54.723	6853(239)	0.189	47.32813827
20	61.424	694(76)	0.079	116.9655914
21	67.972	4618(196)	0.202	47.43052083
22	70.227	128(33)	0.09	107.9075114
23	72.546	732(78)	0.36	27.37195877
24	75.13	303(50)	0.21	47.72518118
25	77.1	219(43)	0.55	18.46926918
26	82.158	895(86)	0.33	31.93614528
27	83	238(44)	0.17	62.39502622
28	83.41	110(30)	0.14	76.00647199
29	86.61	305(50)	0.43	25.38788384
D				58.0201

2. Analisis ukuran kristal untuk sampel superkonduktor YBCO dengan doping nikel ($x=0.002$).

No.	2-theta(deg)	Height(cps)	FWHM(deg)	D
1	15.222	754(79)	0.063	127.2206227
2	22.877	2023(130)	0.096	84.42994657
3	23.925	332(53)	0.19	42.74021667
4	27.8	254(46)	0.19	43.07338778
5	28.36	60(22)	0.3	27.31317057
6	29.09	190(40)	0.38	21.59823207
7	29.885	586(70)	0.12	68.5193859
8	30.604	238(45)	0.14	58.83057074
9	32.565	2658(149)	0.149	55.54524157
10	32.825	4895(202)	0.133	62.26880347
11	34.65	116(31)	0.32	26.00575966
12	35.567	583(70)	0.123	67.82875047
13	38.556	2276(138)	0.13	64.74003213
14	40.393	1270(103)	0.09	94.0527975
15	42.03	118(31)	0.33	25.78891196
16	46.692	2768(152)	0.159	54.41948561
17	47.542	230(44)	0.17	51.06311206
18	48.74	254(46)	0.17	51.30214096
19	51.534	263(47)	0.07	126.0201113
20	52.66	146(35)	0.33	26.8602367
21	54.285	95(28)	0.06	148.7904128
22	55.014	454(61)	0.16	55.9801108
23	55.634	125(32)	0.1	89.82255494
24	58.259	2409(142)	0.126	72.17898801
25	58.802	361(55)	0.21	43.42254363
26	61.599	344(54)	0.09	102.763143
27	68.15	264(47)	0.32	29.97193877
28	68.79	755(79)	0.3	32.09180473
29	77.656	540(67)	0.23	44.33759112
30	79.052	126(32)	0.19	54.20731689
31	87.32	333(53)	0.39	28.15673735
D				62.0338

Lampiran 7. Grafik hubungan temperatur terhadap resistivitas sampel



Lampiran 8. Analisis ukuran partikel

1. Hasil analisis ukuran partikel sampel superkonduktor YBCO tanpa doping nikel menggunakan aplikasi *ImageJ*.

	Label	Area	Mean	Min	Max	Angle	Length
1		1029.311	140.214	112	156.302	-39.094	204.114
2		1421.429	173.427	156	190.877	-8.13	280.042
3		1691.011	164.71	152	181	0	336.634
4		1396.922	146.063	115	164.432	-27.474	278.99
5		1641.996	126.394	114	137.826	-14.036	326.583
6		1960.592	126.444	112.679	138.538	-35.707	390.179
7		1347.907	118.322	109	127.667	-38.991	267.51
8		2254.681	110.868	83	129.982	-8.842	450.903
9		2107.637	96.579	62	117.303	173.211	418.778
10		1200.863	131.398	120	144	-87.614	237.83
11		1862.562	131.015	115.4	141	-89.236	371.32
12		1078.326	99.32	93.767	108	-131.186	210.498
13		1789.04	131.941	119.938	146	-107.684	358.527
14		1936.085	151.215	111	181	0	386.139
15		857.759	139.334	114.875	166	69.444	169.188
16		1249.877	120.517	81	166	28.61	248.118
17		1372.414	136.084	114.41	164.585	160.907	272.412
18		1396.922	145.386	96	197	0	277.228
19		955.789	138.466	112	166	47.121	189.158
20		1470.444	137.538	105.903	157.531	9.782	291.365
21		1789.04	133.066	96	173	-12.875	355.472
22		1764.533	138.75	113	172.286	-17.928	353.813
23		1225.37	152.49	128.585	186.351	78.232	242.726
24		1470.444	149.467	107.368	185.903	7.853	289.847
25		1200.863	152.542	117.458	184.333	-2.386	237.83
26		1298.892	129.853	89.192	167.923	2.203	257.616
27		1372.414	158.458	95	198.8	43.531	273.131
28		1396.922	118.692	88	155.857	75.466	276.165
29		1421.429	136.347	105.066	165.579	12.095	283.521
30		1323.4	162.441	136	183.738	12.995	264.191
31		1445.937	130.149	102	159.284	26.565	287.811
32		1249.877	141.797	101	173.682	28.61	248.118
33		1274.385	161.743	124.055	195.221	45	252.038
34		1225.37	134.648	112	169.067	11.768	242.726
35		1151.848	136.819	100.011	168.786	17.65	228.582
36		1470.444	127.013	97.77	155.361	17.819	291.197
37		1372.414	169.487	136	195.36	43.531	273.131
38		1200.863	144.415	119.646	171	38.29	239.678

39		1004.803	138.488	83	167	0	198.02
40		1347.907	131.311	101.37	171.519	-4.236	268.059
41		1396.922	106.333	90.25	127	34.824	277.404
42		906.774	128.234	91	160	170.538	180.676
43		1102.833	142.143	124.347	163.285	35.838	219.838
44		1274.385	135.732	110.398	160.339	20.556	253.782
45		1225.37	117.72	70	149.465	-21.371	244.536
46		637.192	147.618	125	179.72	18.435	125.239
47		563.67	146.951	126.529	176.397	32.276	111.249
48		588.178	165.295	120	195.414	43.264	115.57
49		808.744	185.2	149.625	217.344	88.21	158.493
50		759.729	180.21	155	204	42.274	147.189
51	Mean	1325.85	139.373	110.293	166.281	15.802	263.263
52	SD	368.701	18.932	20.167	22.86	58.692	74.108
53	Min	563.67	96.579	62	108	-131.186	111.249
54	Max	2254.681	185.2	156	217.344	173.211	450.903















2. Hasil analisis ukuran partikel sampel superkonduktor YBCO dengan doping nikel ($x=0.002$) menggunakan aplikasi *ImageJ*

	Label	Area	Mean	Min	Max	Angle	Length
1		3009.114	189.173	157.026	229.091	44.474	478.742
2		2623.33	171.584	139.722	218	-134.397	417.258
3		3047.693	165.651	132	196.473	-133.958	483.194
4		3009.114	138.062	73.692	179.087	-171.764	476.966
5		3472.055	184.666	124.999	244.465	21.084	552.513
6		2121.811	176.173	102.37	255	26.565	333.325
7		2160.39	142.894	102	179.694	25.641	344.481
8		1465.979	156.306	98.187	237.49	-30.7	231.152
9		1658.871	123.777	90.683	145.571	19.29	263.224
10		1736.027	105.879	81.884	161.579	-10.539	271.662
11		2121.811	91.174	67	124	51.009	335.632
12		2276.125	96.841	67	136.962	33.69	358.314
13		2970.536	100.715	65	127.789	4.514	473.516
14		2584.752	94.935	70.956	128.807	25.017	411.251
15		2469.017	146.968	102.531	183.642	-26.565	388.88
16		3356.32	183.413	122.329	228.032	14.199	531.77
17		1581.714	179.732	105.46	215.32	11.592	247.279
18		1697.449	142.055	106.161	181	-20.556	265.34
19		1504.557	126.943	68	158.206	35.362	236.105
20		1427.4	161.61	119	206	33.69	223.946
21		1543.135	173.794	135.564	219.179	-1.469	242.314
22		1427.4	174.723	140.185	217	9.728	220.561
23		1311.665	169.634	136.174	215.047	15.709	206.468
24		1504.557	139.9	100	172.125	13.671	236.514
25		1851.763	136.301	100	172.142	24.944	294.555
26		2044.654	158.191	123	196.231	40.365	326.071
27		3009.114	147.243	112.088	188.156	28.909	475.386
28		2314.703	159.157	94	204.163	19.654	369.342
29		2121.811	153.225	121.975	176.237	21.801	334.481
30		3626.368	145.623	115.168	187.463	43.264	580.003
31		2816.222	137.892	111	183	-153.435	444.434
32		2584.752	123.936	66	148.347	-154.983	411.251
33		3086.271	107.952	62	159.862	117.216	488.909
34		2739.065	119.399	87.588	161	-30.964	434.603
35		1851.763	98.524	61	124.381	-30.964	289.735
36		1543.135	94.723	67	123.646	30.466	245.006
37		1736.027	134.721	96.955	179.364	7.765	275.82
38		2391.86	173.464	123.996	215.853	-133.668	377.81
39		1620.292	152.494	112.084	201.744	11.31	253.366
40		2044.654	138.469	89	219.251	-152.447	322.262

41		2353.282	142.257	80.356	188.64	-15.422	373.703
42		4127.887	111.365	71.53	136.831	-42.709	659.319
43		3819.26	90.657	33	144.473	-33.366	609.832
44		3124.849	118.004	78.4	166	4.289	498.288
45		3896.417	109.827	70.5	148.4	5.711	624.213
46		3086.271	155.7	127.823	186.844	30.466	490.012
47		4822.298	141.947	49	173.476	-25.741	772.284
48		3510.633	156.451	106.311	202.044	2.545	559.555
49		1774.606	99.475	54.187	146.033	-69.146	279.156
50		2546.174	81.222	51.398	125.664	-45	404.059
51		1658.871	72.604	0	93.293	-16.699	259.385
52		1273.087	116.771	91	149.5	-21.801	200.688
53		1620.292	112.932	78	132.406	-11.31	253.366
54		1736.027	100.037	77	131.364	-149.931	272.725
55		2160.39	85.492	38.028	163.041	-25.641	344.481
56		1581.714	148.356	113.58	199.13	20.225	251.532
57	Mean	2367.06	135.018	92.337	176.563	-15.161	375.108
58	SD	820.004	30.564	30.89	36.313	62.368	132.138
59	Min	1273.087	72.604	0	93.293	-171.764	200.688
60	Max	4822.298	189.173	157.026	255	117.216	772.284



Lampiran 9. Dokumentasi Penelitian

		
Preparasi alat dan bahan		
		
Penimbangan <i>precursor</i>	Pencampuran <i>precursor</i>	Persiapan penggerusan
		
Penggerusan <i>precursor</i>	Menuangkan <i>precursor</i> ke crucible	Kompaksi sampel
		
Sintering sampel	Annealing sampel	Pengiriman sampel untuk uji XRD dan SEM

RIWAYAT HIDUP



I Putu Wahyudi Maylastika Utama lahir di Bongkasa pada tanggal 12 Mei 2001. Penulis lahir dari pasangan suami istri Bapak I Made Terpi Astika dan Ibu Ni Nyoman Ayu Lastini. Penulis berkebangsaan Indonesia dan beragama Hindu. Kini penulis beralamat di Br. Pengembungan, Bongkasa, Abiansemal, Badung. Penulis menyelesaikan Pendidikan dasar di SD Negeri 1 Bongkasa dan lulus pada tahun 2013. Kemudian penulis melanjutkan pendidikan di SMP Negeri 4 Abiansemal dan lulus pada tahun 2016. Pada tahun 2019, penulis lulus dari SMA Negeri 1 Abiansemal jurusan Matematika dan Ilmu Pengetahuan Alam dan melanjutkan ke program S1 Jurusan Fisika dan Pengajaran IPA di Universitas Pendidikan Ganesha. Pada semester akhir tahun 2024 penulis telah menyelesaikan skripsi yang berjudul “Sintesis dan Karakterisasi Superkonduktor $Y_{1-x}Ni_xBa_2Cu_3O_{7-\delta}$ dengan Doping Nikel Melalui Metode Reaksi Padatan”

