LAMPIRAN

Lampiran 1.

STOIKIOMETRI SINTESIS SUPERKONDUKTOR $YBa_2Cu_3O_{7-x}$

Reaksi Pembentukan yang terjadi:

$$\frac{1}{2}Y_2O_3 + 2BaCO_3 + 3CuO + \frac{1}{2}O_2 \rightarrow YBa_2Cu_3O_{7-x} + 2CO_2$$

Berdasarkan pembentukan reaksi di atas, maka dibutuhkan tiga bahan utama yang memiliki purity > 98%. Adapun perhitungan bahan yang dibutuhkan dalam membuat 0,02 Superkonduktor adalah sebagai berikut.

1. Yttrium (III) Oxide (Y_2O_3)

   $$Koef.\,Y_2O_3 \times Mol \times Mr\ Y_2O_3$$
   $$= \tfrac{1}{2} \times 0{,}01Mol \times 225{,}8082\,{}^{gram}\!/_{mol} = 1{,}129041\ gram$$

2. Barrium Carbonate ($BaCO_3$)

   $$Koef.\,BaCO_3 \times Mol \times Mr\ BaCO_3$$
   $$= 2 \times 0{,}01Mol \times 197{,}3493\,{}^{gram}\!/_{mol} = 3{,}946986\ gram$$

3. Cuprate (II) Oxide (CuO)

   $$Koef.\,CuO \times Mol \times Mr\ CuO$$
   $$= 3 \times 0{,}01Mol \times 79{,}5394\,{}^{gram}\!/_{mol} = 2{,}386082\ gram$$

   CuO didoping Ni

   $$Koef.\,CuO \times Mol \times Mr\ CuO$$
   $$= 3 - 0{,}1 \times 0{,}01Mol \times 79{,}5394\,{}^{gram}\!/_{mol} = 2{,}3066426 gram$$

4. NiO

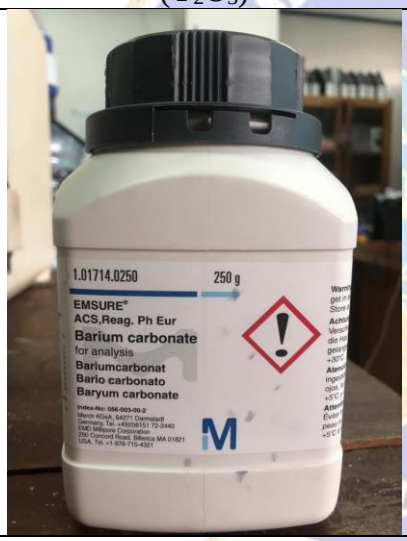
   $$Koef.\,NiO \times Mol \times Mr\ NiO$$
   $$= 0{,}1 \times 0{,}01Mol \times 74{,}6928\,{}^{gram}\!/_{mol} = 0,\ 0746982 gram$$

Lampiran 2.

DOKUMENTASI PENELITIAN

Gambar 1. Bahan Yttrium III Oxide (Y_2O_3)

Gambar 2. Bahan Copper II Oxide (CuO)



Gambar 3. Bahan Barrium Carbonate ($BaCO_3$)

Gambar 4. Container + Liquid Nitrogen

Gambar 5. Penimbangan Bahan

Gambar 6. Pencampuran Bahan

Gambar 7. Prosesn Kalsinasi	**Gambar 8.** Hasil Proses Kalsinasi
Gambar 9. Proses Peletisasi (kompaksi menggunakan *Press Hydraullic*	**Gambar 10.** Cetakan Pellet
Gambar 11. Alat Furnace Atmoshphere	**Gambar 12.** Tabung Oksigen untuk proses Annealing

Lampiran 3.

DATA HASIL XRD DAN PERHITUNGAN PARAMETER KISI

Sampel	2θ	d(Å)	h	k	l
$YBa_2Cu_3O_{7-x}$	68.82	1.363	2	2	0
	46.84	1.938	0	2	0
	32.73	2.734	0	1	3
$YBa_2Cu_{3-0.1}Ni_{0.1}O_{7-x}$	47.78	1.902	2	0	0
	32.82	2.726	1	1	0
	38.78	2.32	1	0	4

Perhitungan parameter kisi dengan:

Hukum Bragg :

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

Keterangan:

n = Orde Sinar x (XRD gunakan orde 1)

λ= Panjang Gelombang (Å)

θ= sudut pantulan

d= jarang bidang pemantul

Dalam menentukan nilai Parameter kisi (Indeks Miller) untuk struktur kristal Orthorhombic maka persamaan di atas dapat diturunkan menjadi:

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

Dengan, $a \neq b \neq c \; dan \; \alpha = \beta = \gamma = 90°$

Maka, dari puncak-puncak difraksi yang di pilih pada sampel, dapat dihitung parameter kisinya adalah sebagai berikut.

- Superkonduktor $YBa_2Cu_3O_{7-x}$

  A. 2θ =68.82, d=1.363Å , d(220)

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

$$\frac{1}{(1.363)^2} = \left(\frac{2}{a}\right)^2 + \left(\frac{2}{b}\right)^2 + \left(\frac{0}{c}\right)^2$$

$$\frac{1}{(1.363)^2} = \left(\frac{4}{a^2}\right) + \left(\frac{4}{b^2}\right)$$

$$\frac{1}{1{,}8577} - \frac{4}{15{,}023376} = \frac{4}{a^2}$$

$$0.272028 = \frac{4}{a^2}$$

$$a^2 = \frac{4}{0.272028}$$

$$a^2 = 14.70435$$

$$a = 3{,}834625$$

B. 2θ =46.84, d=1.938Å, d(020)

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

$$\frac{1}{(1.938)^2} = \left(\frac{0}{a}\right)^2 + \left(\frac{2}{b}\right)^2 + \left(\frac{0}{c}\right)^2$$

$$\frac{1}{(1.938)^2} = \left(\frac{4}{b^2}\right)$$

$$b^2 = 4 \times (1.938)^2$$

$$b^2 = 15{,}023$$

$$b = 3{,}876$$

C. 2θ =32.73, d=2.734Å, d(013)

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

$$\frac{1}{(2.734)^2} = \left(\frac{0}{a}\right)^2 + \left(\frac{1}{b}\right)^2 + \left(\frac{3}{c}\right)^2$$

$$\frac{1}{(2.734)^2} = \left(\frac{1}{b^2}\right) + \left(\frac{9}{c^2}\right)$$

$$\frac{1}{7{,}47456} - \frac{1}{15{,}023376} = \frac{9}{c^2}$$

$$0.067221 = \frac{9}{c^2}$$

$$c^2 = \frac{9}{0.067221}$$

$$c^2 = 133.8873$$

$$a = 11{,}57097$$

- Superkonduktor $YBa_2Cu_{3-0,1}Ni_{0,1}O_{7-x}$
  - 2θ =47.78, d=1.9023Å , d(200)

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

$$\frac{1}{(1.9023)^2} = \left(\frac{2}{a}\right)^2 + \left(\frac{0}{b}\right)^2 + \left(\frac{0}{c}\right)^2$$

$$\frac{1}{(1.9023)^2} = \left(\frac{4}{a^2}\right)$$

$$a^2 = 4 \times (1.9023)^2$$

$$a^2 = 14{,}47498$$

$$a = 3{,}8046$$

  - 2θ =32.82, d=2.276Å, d(110)

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

$$\frac{1}{(2.726)^2} = \left(\frac{1}{a}\right)^2 + \left(\frac{1}{b}\right)^2 + \left(\frac{0}{c}\right)^2$$

$$\frac{1}{(2.726)^2} = \left(\frac{1}{a^2}\right) + \left(\frac{1}{b^2}\right)$$

$$\frac{1}{7,431076} - \frac{1}{14.47498} = \frac{4}{b^2}$$

$$0.065485 = \frac{1}{b^2}$$

$$b^2 = \frac{1}{0.065485}$$

$$b^2 = 15.2706$$

$$b = 3,907762$$

- 2θ =38.78, d=2.32Å, d(104)

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

$$\frac{1}{(2.32)^2} = \left(\frac{1}{a}\right)^2 + \left(\frac{0}{b}\right)^2 + \left(\frac{4}{c}\right)^2$$

$$\frac{1}{5,3824} = \left(\frac{1}{a^2}\right) + \left(\frac{16}{c^2}\right)$$

$$\frac{1}{5,3824} - \frac{1}{14,47498} = \frac{16}{c^2}$$

$$0.116706 = \frac{16}{c^2}$$

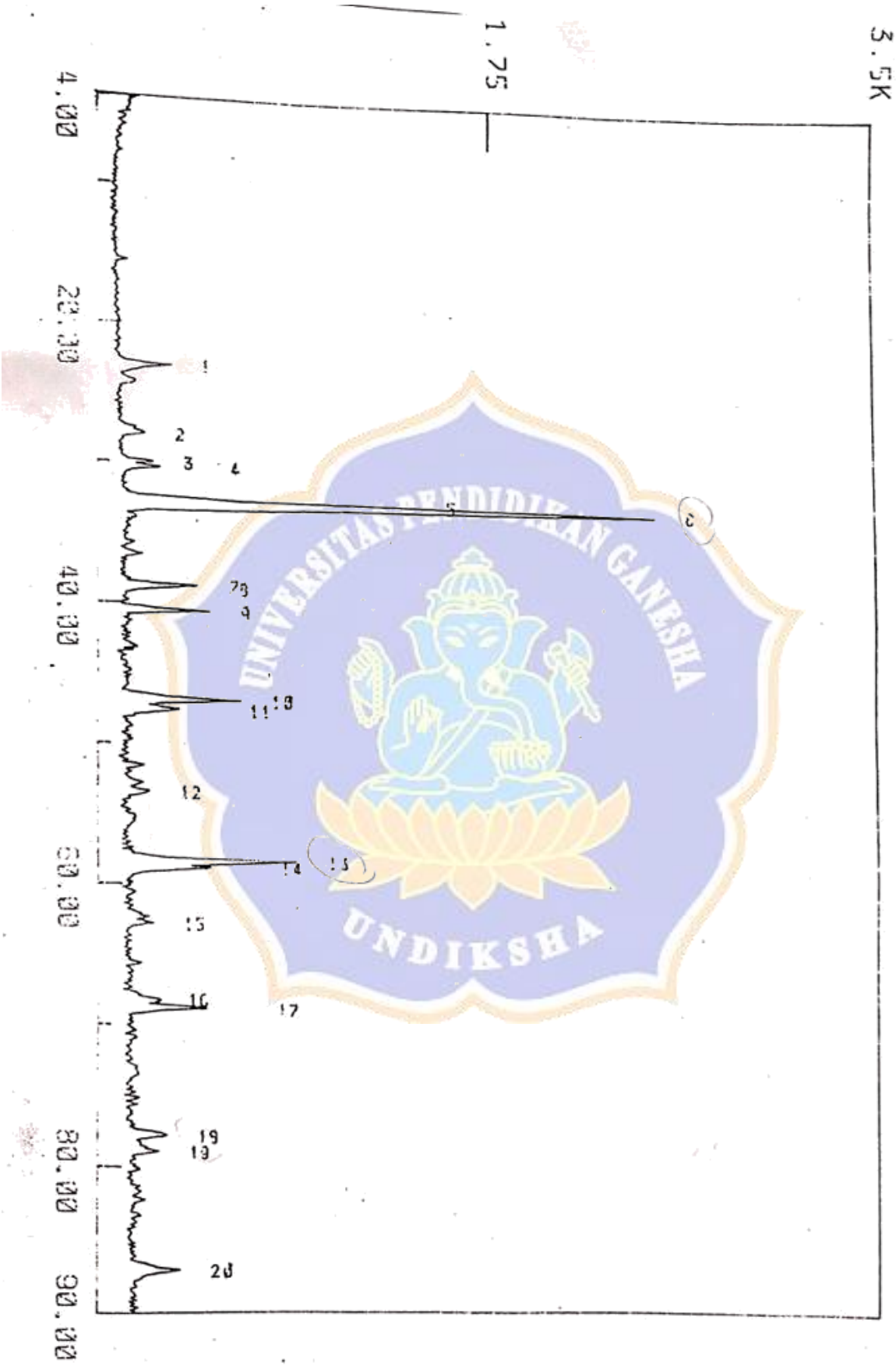
$$c^2 = \frac{9}{0.116706}$$

$$c^2 = 137,0966$$

$$a = 11,80883$$

Berdasarkan perhitungan di atas, maka terbukti bahwa nilai $a \neq b \neq c \; dan \; \alpha = \beta = \gamma = 90°$ sehingga nilai parameter kisi masing-masing sampel adalah sebagai berikut.

Sampel	**Parameter kisi (Å)**		
	a	*b*	*c*
$YBa_2Cu_3O_7$–x (Jorgensen *et al.*, 1978)	3.8415	3.8778	11.747
$YBa_2Cu_3O_7$–x	3.834625	3.876	11.5709
$YBa_2Cu_{3-0.1}Ni_{0,1}O_7$–x	3.804	3.9077	11,80883



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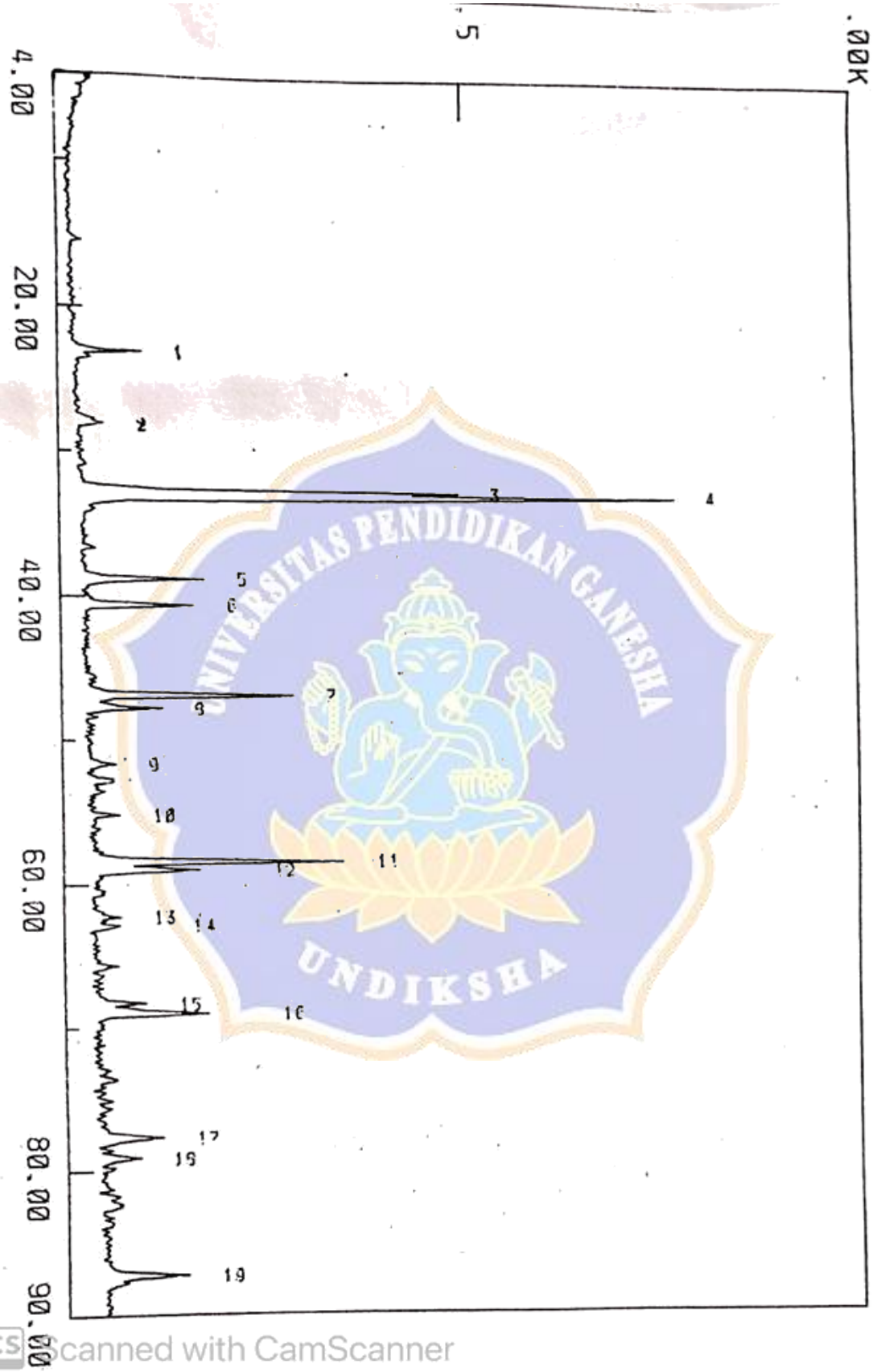

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Lampiran 4.

PENGUKURAN RESISTIVITAS DAN TEMPERATUR KRITIS (TC)

SUPERKONDUKTOR $YBa_2Cu_3O_{7-X}$

T	V	T ukur	R
80	0	71.9583	0
81	0	73	0
82	0	74.0417	0
83	0	75.0833	0
84	0	76.125	0
85	0	77.167	0
86	0	78.2084	0
87	0	79.25	0
88	0	80.2917	0
89	0	81.3334	0
90	0	82.375	0
91	0	83.4167	0
92	0.07	84.4584	0.0022
93	0.09	85.5	0.00283
94	0.18	86.5417	0.00565
95	0.18	87.5834	0.00565
96	0.18	88.6251	0.00565
97	0.23	89.6667	0.00722
98	0.25	90.7084	0.00785
99	0.3	91.7501	0.00942
100	0.3	92.7917	0.00942
101	0.3	93.8334	0.00942
102	0.3	94.8751	0.00942
103	0.33	95.9167	0.01036
104	0.35	96.9584	0.01099
105	0.35	98.0001	0.01099
106	0.363	99.0418	0.0114
107	0.363	100.083	0.0114
108	0.363	101.125	0.0114
109	0.363	102.167	0.0114
110	0.35	103.208	0.01146
111	0.35	104.25	0.01146
112	0.35	105.292	0.01146
113	0.35	106.333	0.01146
114	0.37	107.375	0.01162
115	0.37	108.417	0.01162
116	0.37	109.458	0.01162

117	0.37	110.5	0.01162
118	0.37	111.542	0.01162
119	0.37	112.583	0.01162
120	0.37	113.625	0.01162
121	0.37	114.667	0.01162
122	0.37	115.708	0.01162
123	0.38	116.75	0.01193
124	0.38	117.792	0.01193
125	0.38	118.833	0.01193
126	0.38	119.875	0.01193
127	0.38	120.917	0.01193
128	0.38	121.958	0.01193
129	0.38	123	0.01193
130	0.38	124.042	0.01193
131	0.38	125.084	0.01193
132	0.38	126.125	0.01193
133	0.38	127.167	0.01193
134	0.38	128.209	0.01193
135	0.38	129.25	0.01193
136	0.39	130.292	0.01225
137	0.39	131.334	0.01225
138	0.39	132.275	0.01225
139	0.39	133.417	0.01225
140	0.39	134.459	0.01225
141	0.37	135.5	0.01162
142	0.37	136.542	0.01162
143	0.37	137.584	0.01162
144	0.37	138.625	0.01162
145	0.37	139.667	0.01162
146	0.37	140.709	0.01162
147	0.39	141.75	0.01225
148	0.39	142.792	0.01225
149	0.39	143.834	0.01225
150	0.39	144.875	0.01225
151	0.39	145.917	0.01225
152	0.39	146.959	0.01225
153	0.39	148	0.01225
154	0.385	149.042	0.01209
155	0.385	150.084	0.01209
156	0.385	151.125	0.01209
157	0.385	152.167	0.01209
158	0.385	153.209	0.01209
159	0.385	154.25	0.01209
160	0.385	155.292	0.01209

161	0.39	156.334	0.01225
162	0.39	157.375	0.01225
163	0.39	158.147	0.01225
164	0.39	159.459	0.01225
165	0.37	160.5	0.01162
166	0.37	161.542	0.01162
167	0.37	162.584	0.01162
168	0.37	163.625	0.01162
169	0.37	164.667	0.01162
170	0.37	165.709	0.01162
171	0.37	166.75	0.01162
172	0.37	167.792	0.01162
173	0.37	168.834	0.01162
174	0.37	169.875	0.01162
175	0.37	170.917	0.01162
176	0.37	171.959	0.01162
177	0.39	173	0.01225
178	0.39	174.042	0.01225
179	0.39	175.084	0.01225
180	0.39	176.125	0.01225
181	0.39	177.167	0.01225
182	0.39	178.209	0.01225
183	0.39	179.25	0.01225
184	0.39	180.292	0.01225
185	0.4	181.334	0.01256
186	0.4	182.375	0.01256
187	0.4	183.417	0.01256
188	0.4	184.459	0.01256
189	0.4	185.5	0.01256
190	0.4	186.542	0.01256
191	0.4	187.584	0.01256
192	0.4	188.625	0.01256
193	0.4	189.667	0.01256
194	0.4	190.709	0.01256
195	0.4	191.75	0.01256
196	0.39	192.792	0.01225
197	0.39	193.834	0.01225
198	0.39	194.875	0.01225
199	0.39	195.917	0.01225
200	0.39	196.959	0.01225

Lampiran 5.

PENGUKURAN RESISTIVITAS DAN TEMPERATUR KRITIS (TC)

SUPERKONDUKTOR $YBa_2Cu_{3-0.1}Ni_X O_{7-X}$,

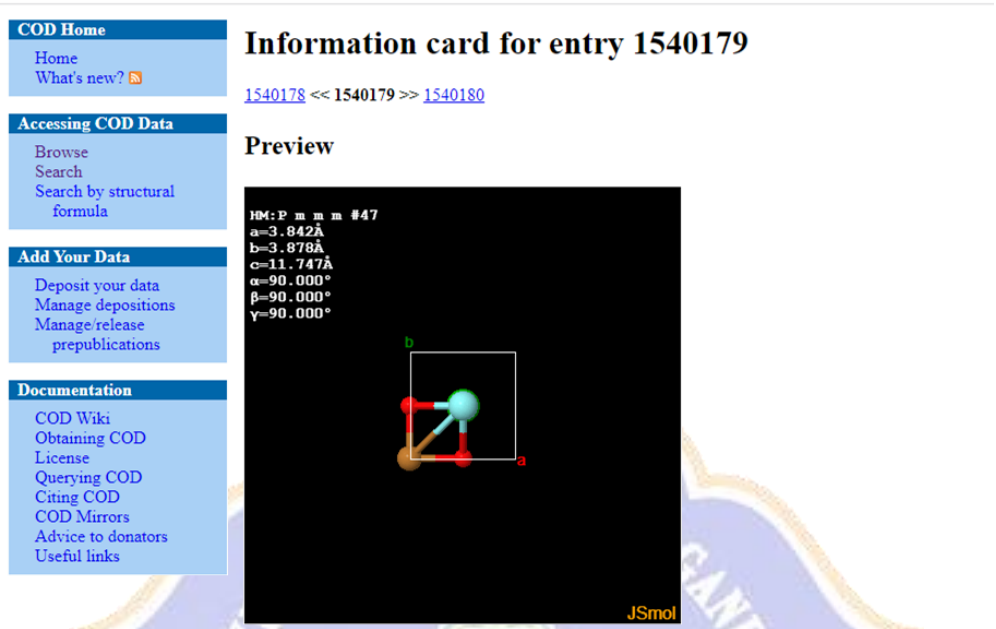
T	V	T ukur	R
80	0	71.9583	0
81	0	73	0
82	0	74.0417	0
83	0	75.0833	0
84	0	76.125	0
85	0	77.1667	0
86	0	78.2084	0
87	0	79.25	0
88	0	80.2917	0
89	0	81.3334	0
90	0	82.375	0
91	0	83.4167	0
92	0	84.4584	0
93	0	85.5	0
94	0	86.5417	0
95	0	87.5834	0
96	0	88.6251	0
97	0.03	89.6667	0.00094
98	0.05	90.7084	0.00157
99	0.068	91.7501	0.00214
100	0.068	92.7917	0.00214
101	0.074	93.8334	0.00232
102	0.074	94.8751	0.00232
103	0.074	95.9167	0.00232
104	0.079	96.9584	0.00248
105	0.079	98.0001	0.00248
106	0.079	99.0418	0.00248
107	0.08	100.083	0.00251
108	0.08	101.125	0.00251
109	0.08	102.167	0.00251
110	0.08	103.208	0.00251
111	0.08	104.25	0.00251
112	0.08	105.292	0.00251
113	0.088	106.333	0.00276
114	0.088	107.375	0.00276
115	0.088	108.417	0.00276
116	0.09	109.458	0.00283
117	0.09	110.5	0.00283
118	0.09	111.542	0.00283

119	0.09	112.583	0.00283
120	0.09	113.625	0.00283
121	0.09	114.667	0.00283
122	0.09	115.708	0.00283
123	0.09	116.75	0.00283
124	0.09	117.792	0.00283
125	0.09	118.833	0.00283
126	0.09	119.875	0.00283
127	0.09	120.917	0.00283
128	0.09	121.958	0.00283
129	0.095	123	0.00298
130	0.095	124.042	0.00298
131	0.095	125.084	0.00298
132	0.095	126.125	0.00298
133	0.095	127.167	0.00298
134	0.095	128.209	0.00298
135	0.097	129.25	0.0035
136	0.097	130.292	0.0035
137	0.1	131.334	0.00314
138	0.1	132.375	0.00314
139	0.1	133.417	0.00314
140	0.1	134.459	0.00314
141	0.1	135.5	0.00314
142	0.1	136.542	0.00314
143	0.1	137.584	0.00314
144	0.1	138.625	0.00314
145	0.1	139.667	0.00314
146	0.1	140.709	0.00314
147	0.1	141.75	0.00314
148	0.1	142.792	0.00314
149	0.1	143.834	0.00314
150	0.1	144.875	0.00314
151	0.1	145.917	0.00314
152	0.1	146.959	0.00314
153	0.1	148	0.00314
154	0.1	149.042	0.00314
155	0.1	150.084	0.00314
156	0.1	151.125	0.00314
157	0.1	152.167	0.00314
158	0.1	153.209	0.00314
159	0.105	154.25	0.0033
160	0.105	155.292	0.0033
161	0.105	156.334	0.0033
162	0.105	157.375	0.0033

163	0.105	158.417	0.0033
164	0.11	159.459	0.00345
165	0.11	160.5	0.00345
166	0.11	161.542	0.00345
167	0.11	162.584	0.00345
168	0.11	163.625	0.00345
169	0.11	164.667	0.00345
170	0.11	165.709	0.00345
171	0.11	166.75	0.00345
172	0.11	167.792	0.00345
173	0.11	168.834	0.00345
174	0.11	169.875	0.00345
175	0.11	170.917	0.00345
176	0.11	171.959	0.00345
177	0.11	173	0.00345
178	0.11	174.042	0.00345
179	0.11	175.084	0.00345
180	0.11	176.125	0.00345
181	0.11	177.167	0.00345
182	0.11	178.209	0.00345
183	0.11	179.25	0.00345
184	0.115	180.292	0.00361
185	0.115	181.334	0.00361
186	0.115	182.375	0.00361
187	0.115	183.417	0.00361
188	0.115	184.459	0.00361
189	0.12	185.5	0.00377
190	0.12	186.542	0.00377
191	0.12	187.584	0.00377
192	0.12	188.425	0.00377
193	0.12	189.667	0.00377
194	0.12	190.709	0.00377
195	0.12	191.75	0.00377
196	0.12	192.792	0.00377
197	0.12	193.834	0.00377
198	0.12	194.875	0.00377
199	0.12	195.917	0.00377
200	0.12	196.959	0.00377

Lampiran 6.

CRYSTALLOGRAPHY OPEN DATA (COD) SUPERKONDUKTOR $YBa_2Cu_3O_{7-x}$



Chemical name	Y Ba2 Cu3 O6.48
Formula	Ba2 Cu3 O6.48 Y
Calculated formula	Ba2 Cu3 O6.58 Y
Title of publication	Structural properties of oxygen-deficient YBa2Cu3O7-d
Authors of publication	Jorgensen, J.D.; Veal, B.W.; Paulikas, A.P.; Nowicki, L.J.; Crabtree, G.W.; Claus, H.; Kwok, W.K.
Journal of publication	Physical Review, Serie 3. B - Condensed Matter (18,1978-)
Year of publication	1990
Journal volume	41
Pages of publication	1863 - 1877
a	3.8415 Å
b	3.8778 Å
c	11.747 Å
α	90°
β	90°
γ	90°
Cell volume	174.99 $Å^3$

Number of distinct elements	4
Hermann-Mauguin symmetry space group	P m m m
Hall symmetry space group	-P 2 2
Has coordinates	Yes
Has disorder	No
Has F_{obs}	No

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