LAMPIRAN-LAMPIRAN

Lampiran 1. Perhitungan Massa CaO dan Volume H_3PO_4 85% Sintesis HAp.

Diketahui

Molaritas (M) Rasio Ca:P = 10:6 = 2,222:1,333 = 1,67 Dalam 100 mL Akuabides

Menghitung Massa CaO

Molaritas Kalsium (MCaO) = $\frac{mol\ CaO}{L}$

mol CaO $= 2{,}222 \times 0{,}1 = 0{,}2222\ mol$

Massa (mCaO) = 0,2222 mol × 56,08 g / mol = 12,46 g CaO dicampurkan ke dalam 100 mL akuabides.

Menghitung Volume H_3PO_4 85%

Molaritas Fosfat (MH_3PO_4) = $\frac{mol\ H_3PO_4}{L}$

mol $H_3PO_4 = 1{,}333 \times 0{,}1 = 0{,}1333\ mol$

Massa (mH_3PO_4) = 0,1333 mol × 98 g / mol = 13,06 g H_3PO_4 murni

Massa (mH_3PO_4 85%) = $\frac{13{,}06}{85} \times 100 = 15{,}36\ g\ H_3PO_4$ 85%

Volume H_3PO_4 85% = $\frac{15{,}36\ g}{1{,}685\ g/mL} = 9{,}12\ mL$ H_3PO_4 85% dilarutkan dengan akuabides sampai volume larutannya mencapai 100 mL.

Lampiran 2. Perhitungan Nilai *d-spacing*.

$$d_{spacing} = \frac{n\lambda}{2 \sin \theta}$$

Keterangan: λ = 1,5406 Å); n =1

2θ(°)	θ(°)	θ *(rad)*	*d-spacing* (Å)
25,283	12,6415	0,220635	3,5197
28,111	14,0555	0,245314	3,1717
28,948	14,474	0,252618	3,0819
31,668	15,834	0,276355	2,8231
32,172	16,086	0,280753	2,7800
32,800	16,4	0,286233	2,7282
39,183	19,5915	0,341936	2,2972
43,787	21,8935	0,382113	2,0658
44,291	22,1455	0,386511	2,0434
46,66	23,33	0,407185	1,9450
48,863	24,4315	0,426410	1,8624

Peak 1

$$d_{spacing} = \frac{n\lambda}{2 \sin \theta} = \frac{1,5406}{2 \sin 0,220635} = 3,5197 \text{ Å}$$

Peak 2

$$d_{spacing} = \frac{n\lambda}{2 \sin \theta} = \frac{1,5406}{2 \sin 0,245314} = 3,1717 \text{ Å}$$

Peak 3

$$d_{spacing} = \frac{n\lambda}{2 \sin \theta} = \frac{1,5406}{2 \sin 0,252618} = 3,0819 \text{ Å}$$

Peak 4

$$d_{spacing} = \frac{n\lambda}{2 \sin \theta} = \frac{1,5406}{2 \sin 0,276355} = 2,8231 \text{ Å}$$

Peak 5

$$d_{spacing} = \frac{n\lambda}{2 \sin \theta} = \frac{1,5406}{2 \sin 0,280753} = 2,7800 \text{ Å}$$

Peak 6

$$d_{spacing} = \frac{n\lambda}{2\sin\theta} = \frac{1{,}5406}{2\sin 0{,}286233} = 2{,}7282 \text{ Å}$$

Peak 7

$$d_{spacing} = \frac{n\lambda}{2\sin\theta} = \frac{1{,}5406}{2\sin 0{,}341936} = 2{,}2972 \text{ Å}$$

Peak 8

$$d_{spacing} = \frac{n\lambda}{2\sin\theta} = \frac{1{,}5406}{2\sin 0{,}382113} = 2{,}0658 \text{ Å}$$

Peak 9

$$d_{spacing} = \frac{n\lambda}{2\sin\theta} = \frac{1{,}5406}{2\sin 0{,}386511} = 2{,}0434 \text{ Å}$$

Peak 10

$$d_{spacing} = \frac{n\lambda}{2\sin\theta} = \frac{1{,}5406}{2\sin 0{,}407185} = 1{,}9450 \text{ Å}$$

Peak 11

$$d_{spacing} = \frac{n\lambda}{2\sin\theta} = \frac{1{,}5406}{2\sin 0{,}426410} = 1{,}8624 \text{ Å}$$

Lampiran 3. Perhitungan Ukuran Kristal *Hidroksiapatit* Batu Kapur.

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

Keterangan: D = Ukuran kristal (nm); K = Konstanta Scherrer (0,94); λ = Panjang gelombang sinar-X (Cu Kα=1,5406 Å); β = Lebar puncak setengah tinggi atau Full Width Half Maximum (radian); θ = Posisi sudut dari puncak difraksi (rad).

hkl	θ (rad)	$FWHM$ (°)	$FWHM$ (rad)	D (nm)	Rerata Ukuran Kristal (nm)
201	0,220635	1,00692	0,017574	8,45	8,70
102	0,245314	1,00701	0,017575	8,49	
210	0,252618	1,00689	0,017573	8,51	
211	0,276355	1,00689	0,017573	8,57	
112	0,280753	1,00689	0,017573	8,58	
300	0,286233	1,00689	0,017573	8,59	
212	0,341936	1,00691	0,017573	8,75	
113	0,382113	1,00708	0,017576	8,88	
400	0,386511	1,007	0,017575	8,90	
222	0,407185	1,00703	0,017575	8,97	
320	0,426410	1,0069	0,017573	9,05	

Peak 1

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017574 \cos 0{,}220635} = 8{,}445\ nm$$

Peak 2

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017575 \cos 0{,}245314} = 8{,}494\ nm$$

Peak 3

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017573 \cos 0{,}252618} = 8{,}510\ nm$$

Peak 4

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017573 \cos 0{,}276355} = 8{,}565\ nm$$

Peak 5

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017573 \cos 0{,}280753} = 8{,}576\ nm$$

Peak 6

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017573 \cos 0{,}286233} = 8{,}590\ nm$$

Peak 7

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017573 \cos 0{,}341936} = 8{,}747\ nm$$

Peak 8

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017576 \cos 0{,}382113} = 8{,}879\ nm$$

Peak 9

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017575 \cos 0{,}386511} = 8{,}896\ nm$$

Peak 10

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017575 \cos 0{,}407185} = 8{,}973\ nm$$

Peak 11

$$D = \frac{K\lambda}{\beta \cos\theta} = \frac{0{,}94 \times 0{,}15406}{0{,}017573 \cos 0{,}426410} = 9{,}051\ nm$$

Lampiran 4. Perhitungan Persentase Kristalinitas $Ca_{10}(PO_4)_6(OH)_2$.

Dalam menentukan persentase kristalinitas HAp, digunakan metode Landi. Menurut hasil penelitian oleh Landi et al. (2000), pola difraksi HAp mengandung fase kristal dan amorf, sehingga dalam menghitung persentase kristalnya dibutuhkan pemisahan puncak kristal dan latar belakang amorf seperti ditunjukkan pada persamaan berikut.

$$X_c = \frac{Fraksi\ Luas\ Kristal}{Fraksi\ Luas\ Kristal + Luas\ Amorf} \times 100\%$$

$Diketahui$:

2θ(°)	$FWHM$ (°)	Height	h	k	l
25,283	1,00692	4684,56463	2	0	1
28,111	1,00701	2899,2026	1	0	2
28,948	1,00689	1925,82338	2	1	0
31,668	1,00689	7837,37264	2	1	1
32,172	1,00689	5238,62939	1	1	2
32,800	1,00689	5645,45244	3	0	0
39,183	1,00691	295,27751	2	1	2
43,787	1,00708	1001,68788	1	1	3
44,291	1,007	977,96261	4	0	0
46,66	1,00703	2702,27818	2	2	2
48,863	1,0069	2689,63974	3	2	0

Maka,

$$Fraksi\ Luas\ Kristal = 1{,}00689 \times 7837{,}37264 = 7891{,}372$$

$$Fraksi\ Luas\ Kristal = 1{,}00689 \times 5238{,}62939 = 5274{,}723$$

$$Fraksi\ Luas\ Amorf = 1{,}00708 \times 1001{,}68788 = 1008{,}779$$

$$X_c = \frac{7891{,}372 + 5274{,}723}{(7891{,}372 + 5274{,}723) + 1008{,}779} \times 100\%$$

$$X_c = 92{,}88\ \%$$

Lampiran 5. Perhitungan Parameter Kisi *Hidroksiapatit* Kristal Heksagonal.

$\text{Sin}^2\theta = \frac{\lambda^2}{3} = \frac{h^2+hk+k^2}{a^2} + \frac{\lambda^2}{4c^2} l^2$

$\lambda = 1{,}5406$ Å

2θ(°)	θ(°)	h k l	θ (rad)	$Sin^2\theta$ (rad)
25,283	12,6415	2 0 1	0,220635	0,047895345
28,111	14,0555	1 0 2	0,245314	0,058981789
28,948	14,474	2 1 0	0,252618	0,062470327
31,668	15,834	2 1 1	0,276355	0,074447772
32,172	16,086	1 1 2	0,280753	0,076773261
32,800	16,4	3 0 0	0,286233	0,079716698
39,183	19,5915	2 1 2	0,341936	0,112434009
43,787	21,8935	1 1 3	0,382113	0,139041374
44,291	22,1455	4 0 0	0,386511	0,142098784
46,66	23,33	2 2 2	0,407185	0,156836867
48,863	24,4315	3 2 0	0,426410	0,171069131

A. Parameter Kisi a [3 0 0]

$0{,}079716 = \frac{(1{,}5406\ 10^{-10})^2}{3} \frac{3^2+3.0+0^2}{a^2} + \frac{(1{,}5406\ 10^{-10})^2}{4c^2} 0^2$

$0{,}079716 = \frac{(1{,}5406\ 10^{-10})^2}{3} \frac{9}{a^2}$

$0{,}079716 = 9 \times 7{,}9115 \times 10^{-21} = 7{,}1203 \times 10^{-20}$

$0{,}079716 = \frac{7{,}1203 \times 10^{-20}}{a^2}$

$a^2 = \frac{7{,}1203 \times 10^{-20}}{0{,}079716}$

$a^2 = \frac{7{,}1203 \times 10^{-20}}{0{,}079716}$

$a^2 = 8.9321 \times 10^{-19}$

$a = \sqrt{8{,}9321 \times 10^{-19}} = 9{,}45 \times 10^{-10}$

$a = 9{,}45$ Å

B. Parameter Kisi c [2 2 2]

$$0{,}156836 = \frac{(1{,}5406\ 10^{-10})^2}{3}\frac{2^2+2.2+2^2}{(9{,}45\times10^{-10})^2} + \frac{(1{,}5406\ 10^{-10})^2}{4c^2}2^2$$

$$0{,}156836 = \frac{2{,}3734\times10^{-20}}{3}\frac{2^2+2.2+2^2}{8{,}93\times10^{-19}} + \frac{(1{,}5406\ 10^{-10})^2}{4c^2}2^2$$

$$0{,}156836 = 7{,}9113\times10^{-21}\times1{,}344\times10^{19} + \frac{(1{,}5406\ 10^{-10})^2}{4c^2}2^2$$

$$0{,}156836 = 0{,}1063 + \frac{2{,}3734\times10^{-20}}{4c^2}4$$

$$0{,}156836 = 0{,}1063 + \frac{2{,}3734\times10^{-20}}{c^2}$$

$$0{,}156836 - 0{,}1063 = \frac{2{,}3734\times10^{-20}}{c^2}$$

$$0{,}050536 = \frac{2{,}3734\times10^{-20}}{c^2}$$

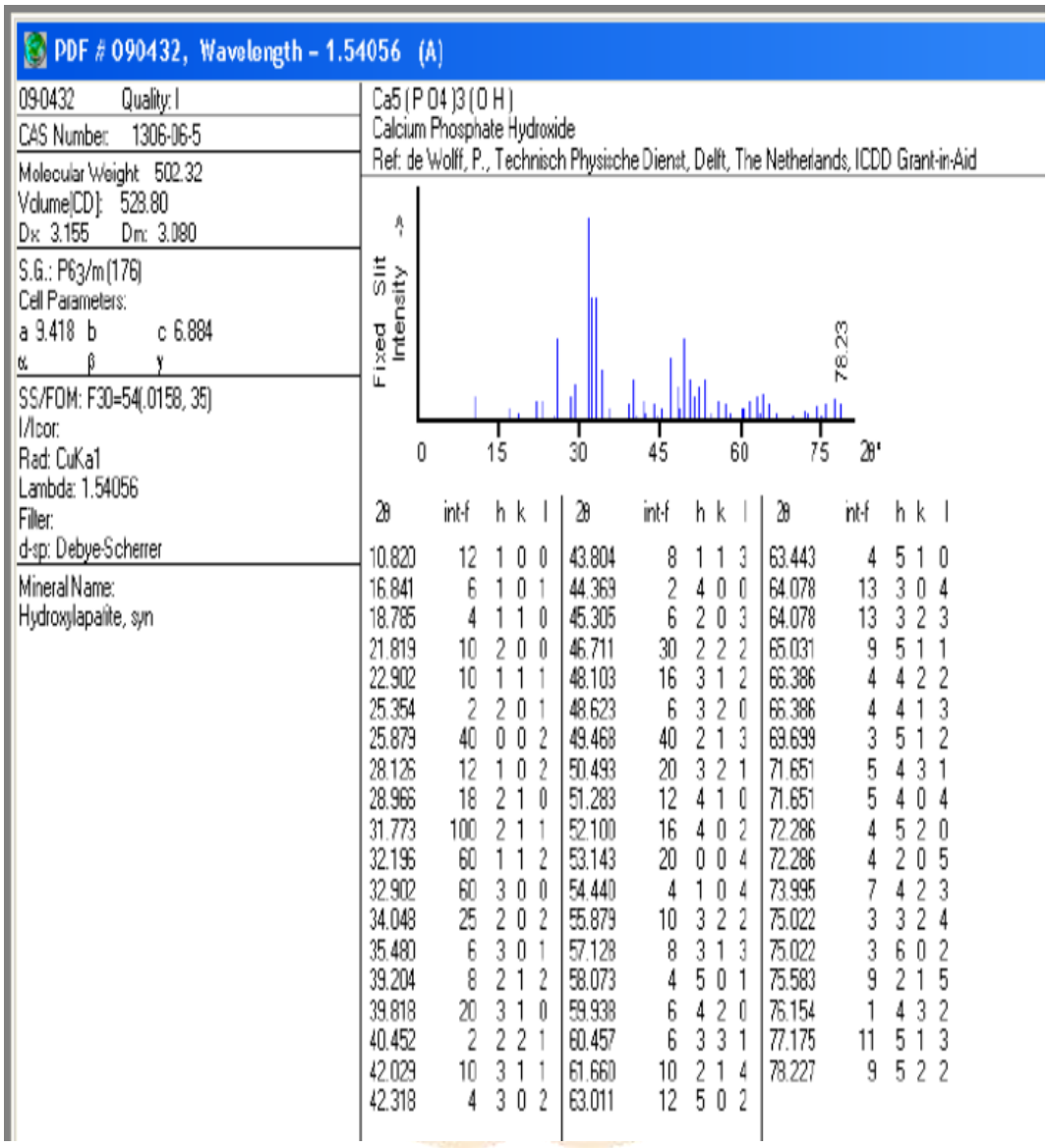
$$c^2 = \frac{2{,}3734\times10^{-20}}{0{,}050536}$$

$$c^2 = 4{,}698\times10^{-19}$$

$$c = \sqrt{4{,}698\times10^{-19}} = 6{,}85\times10^{-10}$$

$$c = 6{,}85\ \text{Å}$$

Lampiran 6. Database JCPDS-090432 *Hidroksiapatit*, JCPDS-050453 $CaCO_3$, dan JCPDS-350108 Apatit Karbonat Type A (Sirait & Aulia, 2021).



PDF # 090432, Wavelength = 1.54056 (A)

09-0432 Quality: I

CAS Number: 1306-06-5

Molecular Weight: 502.32
Volume[CD]: 528.80
Dx: 3.155 Dm: 3.080

S.G.: P63/m(176)
Cell Parameters:
a 9.418 b c 6.884
α β γ

SS/FOM: F30=54(.0158, 35)
I/Icor:
Rad: CuKa1
Lambda: 1.54056
Filter:
d-sp: Debye-Scherrer

Mineral Name:
Hydroxylapatite, syn

Ca5 (P O4)3 (O H)
Calcium Phosphate Hydroxide
Ref: de Wolff, P., Technisch Physische Dienst, Delft, The Netherlands, ICDD Grant-in-Aid

2θ	int-f	h	k	l	2θ	int-f	h	k	l	2θ	int-f	h	k	l
10.820	12	1	0	0	43.804	8	1	1	3	63.443	4	5	1	0
16.841	6	1	0	1	44.369	2	4	0	0	64.078	13	3	0	4
18.785	4	1	1	0	45.305	6	2	0	3	64.078	13	3	2	3
21.819	10	2	0	0	46.711	30	2	2	2	65.031	9	5	1	1
22.902	10	1	1	1	48.103	16	3	1	2	66.386	4	4	2	2
25.354	2	2	0	1	48.623	6	3	2	0	66.386	4	4	1	3
25.879	40	0	0	2	49.468	40	2	1	3	69.699	3	5	1	2
28.126	12	1	0	2	50.493	20	3	2	1	71.651	5	4	3	1
28.966	18	2	1	0	51.283	12	4	1	0	71.651	5	4	0	4
31.773	100	2	1	1	52.100	16	4	0	2	72.286	4	5	2	0
32.196	60	1	1	2	53.143	20	0	0	4	72.286	4	2	0	5
32.902	60	3	0	0	54.440	4	1	0	4	73.995	7	4	2	3
34.048	25	2	0	2	55.879	10	3	2	2	75.022	3	3	2	4
35.480	6	3	0	1	57.128	8	3	1	3	75.022	3	6	0	2
39.204	8	2	1	2	58.073	4	5	0	1	75.583	9	2	1	5
39.818	20	3	1	0	59.938	6	4	2	0	76.154	1	4	3	2
40.452	2	2	2	1	60.457	6	3	3	1	77.175	11	5	1	3
42.029	10	3	1	1	61.660	10	2	1	4	78.227	9	5	2	2
42.318	4	3	0	2	63.011	12	5	0	2					

PCPDFWIN - [PDF # 050453, Wavelength = 1.5405 (A)]

PDFNumber Search Print View Data Conversion Window Clear Help

05-0453 (Deleted)

CAS Number: 14791-73-2

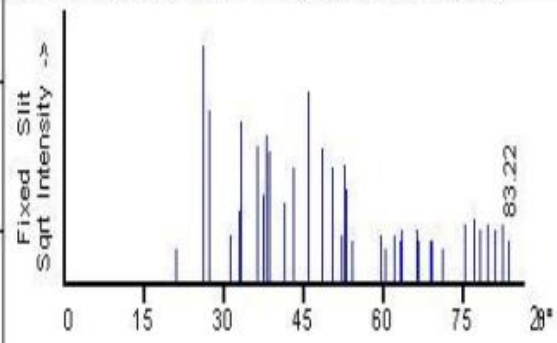
Molecular Weight: 100.09
Volume[CD]: 226.85
Dx: 2.931 Dm: 2.947

S.G.: Pmcn (62)
Cell Parameters:
a 4.959 b 7.968 c 5.741
α β γ

SS/FOM: F30=29(.0181, 58)
I/Icor:
Rad: CuKa1
Lambda: 1.5405
Filter: Ni
d-sp:

Mineral Name:
Aragonite, syn

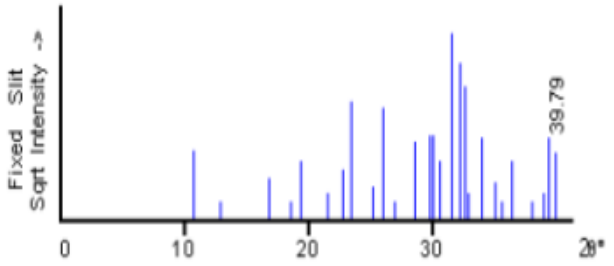
Ca C O3
Calcium Carbonate
Ref: Swanson, Fuyat, Natl. Bur. Stand. (U.S.), Circ. 539, 3, 53 (1954)



2θ	int-f	h	k	l	2θ	int-f	h	k	l	2θ	int-f	h	k	l
21.074	2	1	1	0	45.860	65	2	2	1	66.171	5	3	1	2
26.219	100	1	1	1	48.318	32	0	4	1	66.544	3	3	3	0
27.223	52	0	2	1	48.455	25	2	0	2	68.705	3	2	4	2
31.125	4	0	0	2	50.252	23	1	3	2	69.110	3	1	1	4
32.776	9	1	2	1	51.939	4	1	4	1	70.902	2	0	6	0
33.151	46	0	1	2	52.484	25	1	1	3	75.298	6	3	3	2
36.174	33	2	0	0	52.942	15	2	3	1	76.803	7	4	0	0
37.294	14	0	3	1	53.953	3	2	2	2	77.995	5	1	3	4
37.898	38	1	1	2	59.300	4	3	1	1	79.466	6	0	6	2
38.419	31	1	3	0	60.237	2	0	5	1	80.738	5	1	5	3
38.642	6	0	2	2	61.840	4	2	4	1	82.243	6	1	6	2
41.224	11	2	1	1	62.960	3	3	2	1	83.221	3	4	2	1
42.906	23	2	2	0	63.392	5	1	5	1					

35-0180 Quality:
CAS Number:
Molecular Weight: 1030.64
Volume[CD]: 1248.62
Dx: Dm:
S.G.: Pa (7)
Cell Parameters:
a 9.529 b 19.10 c 6.860
α β 89.97 γ
SS/FOM: F27=3(0.095,113)
I/Icor:
Rad: CuKa
Lambda: 1.5418
Filter:
d-sp: diffractometer

Ca10 (P O4)6 C O3
Calcium Phosphate Carbonate
Ref: Elliott, J. et al., J. Appl. Crystallogr., 13, 618 (1980)



2θ	int-f	h	k	l	2θ	int-f	h	k	l	2θ	int-f	h	k	l
10.732	14	1	1	0	25.972	35	0	0	2	32.835	2	0	7	0
12.929	1	0	0	1	26.847	<1	$\bar{2}$	3	1	33.917	19	3	4	0
16.814	5	1	3	0	28.535	17	3	1	0	35.016	4	0	5	2
18.598	1	0	4	0	29.682	20	$\bar{3}$	2	0	35.509	1	0	7	1
19.363	10	$\bar{2}$	1	0	29.968	20	2	5	0	36.370	10	2	6	1
21.528	2	$\bar{1}$	3	1	30.510	10	0	6	1	37.963	<1	$\bar{2}$	7	0
22.691	7	0	4	1	31.529	100	3	3	0	38.886	2	$\bar{1}$	8	0
23.376	40	2	$\bar{1}$	1	32.214	70	$\bar{2}$	0	2	39.301	19	0	0	3
25.144	3	1	5	0	32.596	50	$\bar{2}$	1	2	39.793	13	0	1	3

Lampiran 7. Hasil Uji XRF.

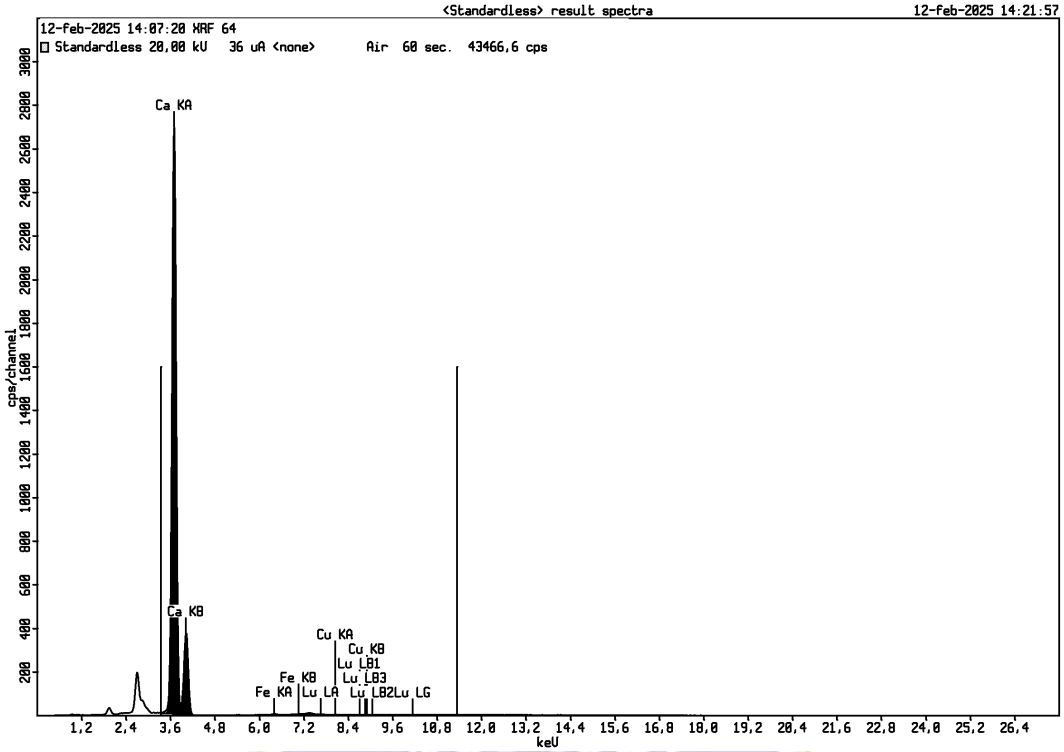
12-feb-2025 14:25:35 **Sample results** Page 1

Sample ident
XRF 64

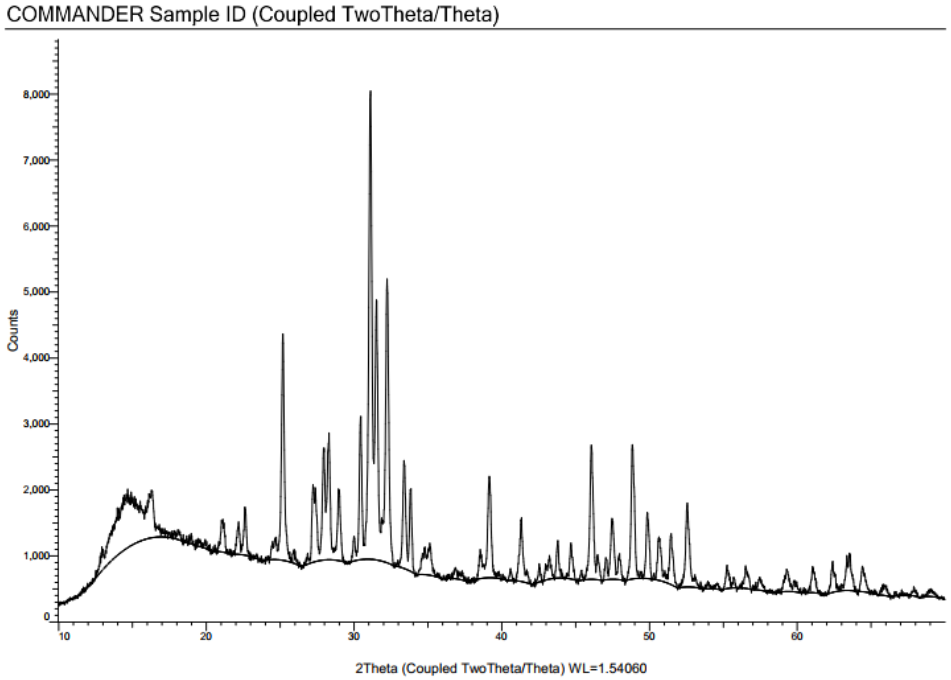
Application	<Standardless>
Sequence	1 of 1
Measurement time	12-feb-2025 14:07:20
Position	2

Compound	CaO	Fe2O3	CuO	Lu2O3
Conc	99,62	0,16	0,036	0,18
Unit	%	%	%	%

<Standardless> result spectra 12-feb-2025 14:21:57



Lampiran 8. Hasil Uji XRD.



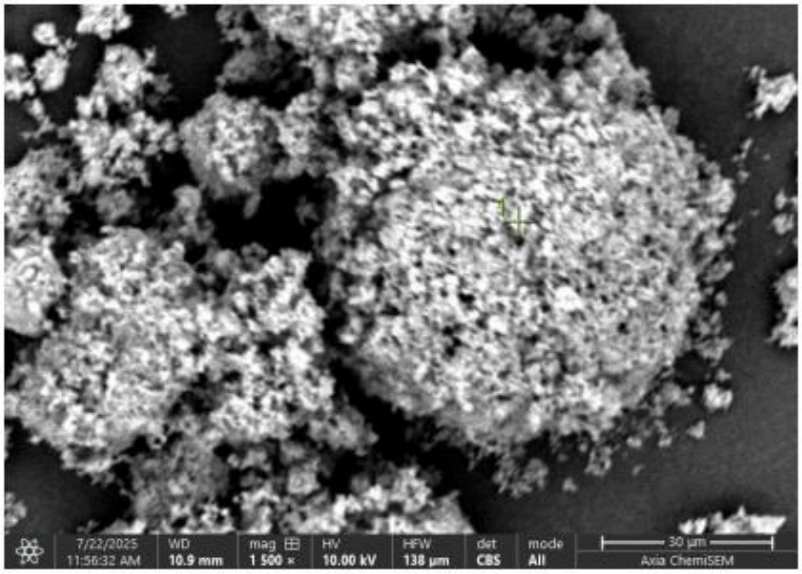
hap batu kapur 70.brml #1

X	d (Å)	Y (counts)	σY (counts)	Index	CPS (cps)	σCPS (cps)	σY/Y (%)	Time (s)
10.000	8.83855	253.000	15.9060	1	7.27012	0.457068	6.28695	34.80
10.020	8.82047	278.000	16.6733	2	7.98851	0.479119	5.99760	34.80
10.041	8.80246	244.000	15.6205	3	7.01149	0.448865	6.40184	34.80
10.061	8.78453	278.000	16.6733	4	7.98851	0.479119	5.99760	34.80
10.082	8.76667	292.000	17.0880	5	8.39080	0.491035	5.85206	34.80
10.102	8.74888	301.000	17.3494	6	8.64943	0.498545	5.76390	34.80
10.123	8.73116	304.000	17.4356	7	8.73563	0.501023	5.73539	34.80
10.143	8.71352	297.000	17.2337	8	8.53448	0.495221	5.80259	34.80
10.164	8.69595	269.000	16.4012	9	7.72989	0.471299	6.09711	34.80
10.185	8.67844	294.000	17.1464	10	8.44828	0.492713	5.83212	34.80
10.205	8.66101	279.000	16.7033	11	8.01724	0.47998	5.98684	34.80
10.226	8.64365	292.000	17.0880	12	8.39080	0.491035	5.85206	34.80
10.246	8.62636	294.000	17.1464	13	8.44828	0.492713	5.83212	34.80
10.267	8.60914	280.000	16.7332	14	8.04598	0.480839	5.97614	34.80
10.287	8.59199	273.000	16.5227	15	7.84483	0.474791	6.05228	34.80
10.308	8.57490	271.000	16.4621	16	7.78736	0.473048	6.07457	34.80
10.328	8.55788	286.000	16.9115	17	8.21839	0.485964	5.91312	34.80
10.349	8.54094	290.000	17.0294	18	8.33333	0.48935	5.87220	34.80
10.370	8.52405	307.000	17.5214	19	8.82184	0.503489	5.70730	34.80
10.390	8.50724	273.000	16.5227	20	7.84483	0.474791	6.05228	34.80
10.411	8.49049	298.000	17.2627	21	8.56322	0.496054	5.79284	34.80
10.431	8.47381	261.000	16.1555	22	7.50000	0.464238	6.18984	34.80
10.452	8.45719	294.000	17.1464	23	8.44828	0.492713	5.83212	34.80
10.472	8.44064	292.000	17.0880	24	8.39080	0.491035	5.85206	34.80
10.493	8.42416	310.000	17.6068	25	8.90805	0.505943	5.67962	34.80

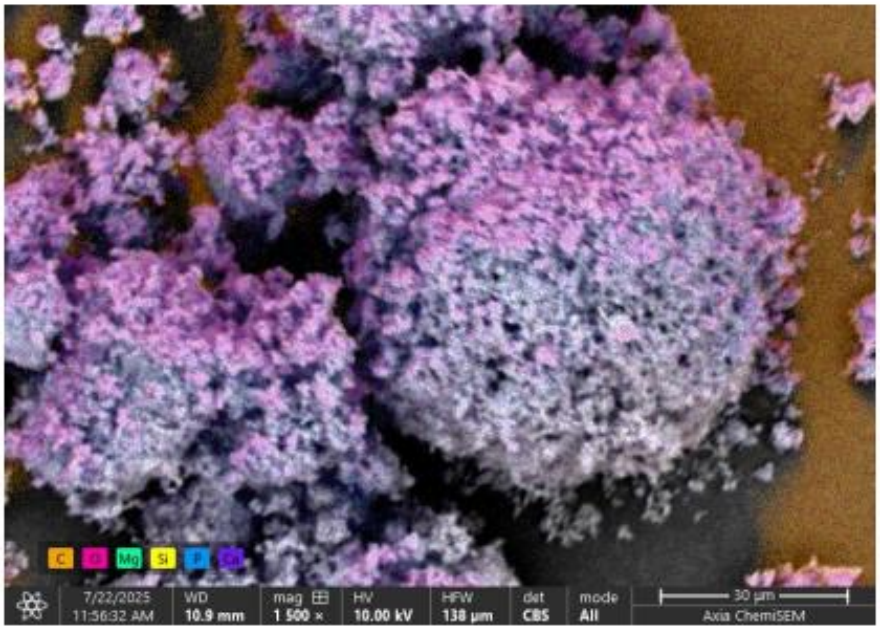
Lampiran 9. Hasil Uji SEM.

Session 25-05-05 10:43

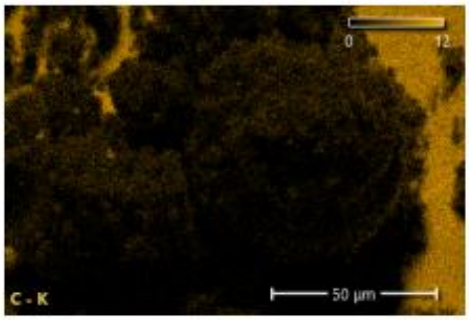
Site 6

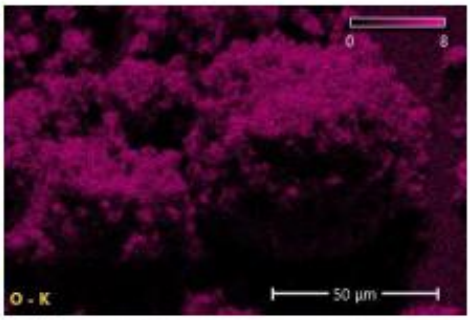


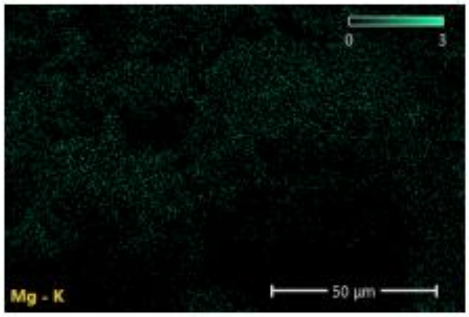
Session 25-05-05 10:43

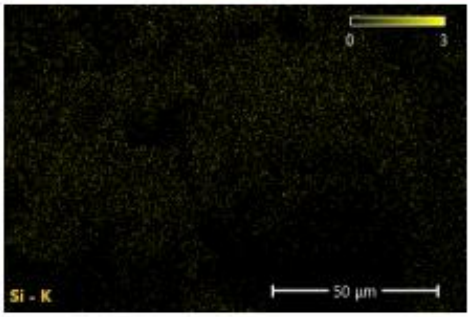


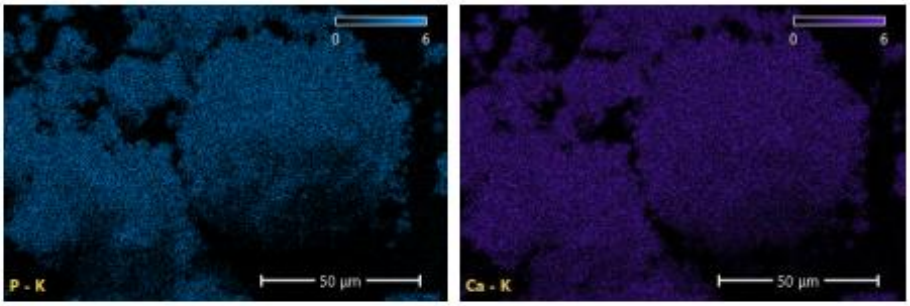
Maps Resolution: 768 x 512







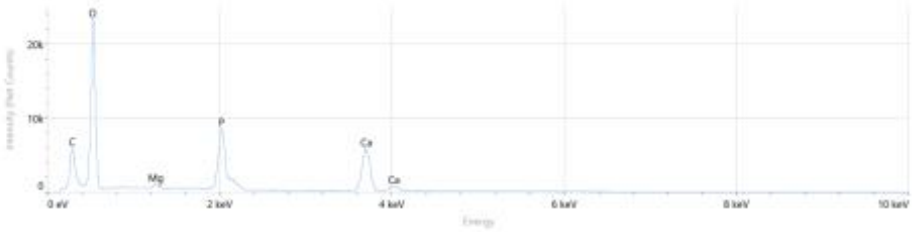




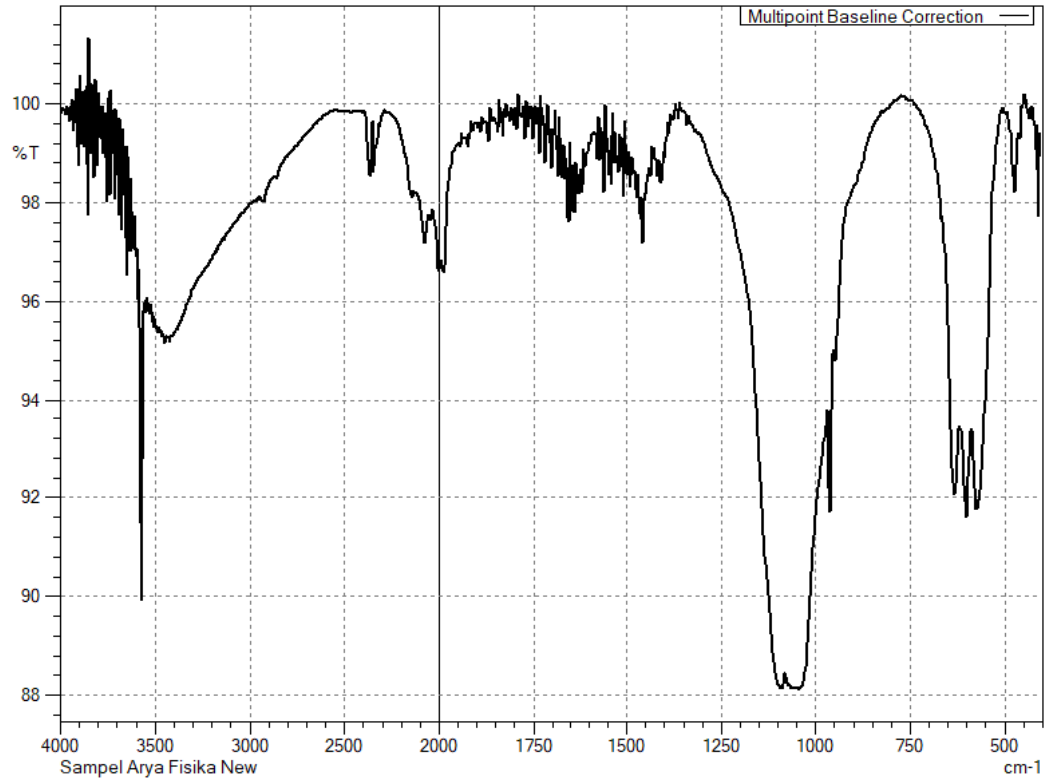
Point 1

Total Number of Counts: 520 975
Average Count Rate: 10 485 cps
Acceleration Voltage: 10 kV
Total Acquisition Time: 52 seconds

Element	Line	At. %	Wt. %	Net Counts	At. % Error	Wt. % Error
C	K	13.4	7.7	38 457	0.1	0.1
O	K	59.9	45.6	132 420	0.3	0.2
Mg	K	0.4	0.5	3 202	0.0	0.0
Si	K	0.1	0.2	1 108	0.0	0.0
P	K	9.5	14.0	77 487	0.1	0.1
Ca	K	16.7	32.0	71 879	0.1	0.2



Lampiran 10. Hasil Uji FTIR.



Lampiran 11. Publikasi Artikel Jurnal *Indonesia Physical Review* (IPR)

Indonesian Physical Review
Volume 09 Issue 01, January 2026
P-ISSN: 2615-1278, E-ISSN: 2614-7904

Synthesis of Nanohydroxyapatite from Bukit Jimbaran Limestone

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DOI:
https://doi.org/10.29303/ipr.v9i1.548.

Abstract

The global demand for biocompatible biomimetic materials drives the development of nanohydroxyapatite (HAp) for biomedical applications. This study aims to synthesize nanohydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$) from Bukit Jimbaran limestone, Bali, through a precipitation method. XRF analysis shows that the limestone contains 99.62% CaO, which is the main source of calcium. FTIR results detect the presence of phosphate (PO_4^{3-}), carbonate (CO_3^{2-}), calcium oxide (CaO), and hydroxyl (OH^-) groups, confirming the formation of the typical HAp structure. The XRD diffraction pattern showed good agreement with JCPDS 09-0432, with major peaks on the (211), (112), and (300) planes, lattice parameters a = b = 9.45 Å and c = 6.85 Å, an average crystallite size of 8.70 nm, and a crystallinity of 92.88%. SEM-EDX analysis revealed agglomerated particle morphology, with a Ca content of 32.0 wt.% and a P content of 14.0 wt.%. The high crystallinity and very small crystallite size confirm the potential of this synthesized HAp to enhance bioactivity and accelerate bone integration, making Jimbaran limestone HP a strong candidate in the biomedical sector.

Introduction

Nanohydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$) has received special attention in the fields of materials and medicine due to its superior bioactive, biocompatible, and osteoconductive properties that resemble the hard tissues of the human body [1,2,3]. The synthesis of HAp from limestone into a relevant topic for development, considering its very abundant availability, very low cost, and environmentally friendly characteristics [4,5]. Nanohydroxyapatite has superior biological properties because its chemical composition is very close to that of body tissues [6,7], and its functionality can be enhanced through doping processes with various elements [8,9,10]. In the medical field, HAp is widely used applied in the manufacture of bone and dental

Lampiran 12. Dokumentasi Pelaksanaan Penelitian.


Batu Kapur Bukit Jimbaran


Pembersihan Batu Kapur


Batu Kapur Dipotong Kecil


Penggerusan Batu Kapur

Pencucian Serbuk Kapur


Pengeringan Serbuk


Pengayakan Serbuk


Sampel Siap Uji Awal


Kalsinasi Serbuk $CaCO_3$


Massa Serbuk CaO

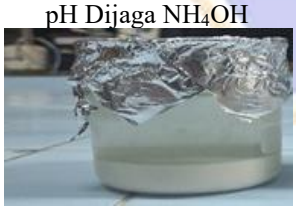

Campuran H_2O dan CaO


$Ca(OH)_2$ ditambah H_3PO_4


pH Dijaga NH_4OH


Suhu Dijaga 60°C


pH Campuram Tepat 10


Pengendapan Campuran


Pencucian HAp


Penyaringan HAp


Pengeringan HAp


Sintering HAp

Karakterisasi HAp

RIWAYAT HIDUP

Gede Arya Amerta lahir di desa Jinengdalem, Buleleng-Bali pada tanggal 12 April 2003. Penulis adalah anak pertama yang lahir dari pasangan suami istri Bapak Wayan Sutarsa dan Ibu Ketut Sudiani. Penulis berkebangsaan Indonesia dan beragama Hindu. Sekarang penulis beralamat di Banjar Dinas Gambang, desa Jinengdalem, kecamatan Buleleng, kabupaten Buleleng, provinsi Bali. Penulis telah menyelesaikan pendidikan di TK Dharma Kumara Jinengdalem dan lulus pada tahun 2009. Kemudian penulis melanjutkan pendidikan dasar di SD Negeri 3 Jinengdalem dan lulus pada tahun 2015. Lalu penulis melanjutkan pendidikan menengah pertama di SMP Negeri 5 Singaraja dan lulus pada tahun 2018. Pada tahun 2021 penulis lulus di SMA Negeri 2 Singaraja mengambil jurusan MIPA dan melanjutkan pendidikan di Progam Studi S1 Pendidikan Fisika Universitas Pendidikan Ganesha melalui jalur SBMPTN dan mendapatkan beasiswa KIP-K. Pada semester akhir tahun 2025 penulis telah menyelesaikan skripsi yang berjudul **"Sintesis dan Karakterisasi *Nanomaterial Hidroksiapatit* (HAp) Berbahan Batu Kapur Bukit Jimbaran dengan Metode Presipitasi"**. Selanjutnya, mulai tahun 2025 sampai dengan penulisan skripsi ini, penulis masih terdaftar sebagai mahasiswa Progam Studi S1 Pendidikan Fisika Jurusan Fisika dan Pengajaran IPA Fakultas Matematika dan Ilmu Pengetahuan Alam di Universitas Pendidikan Ganesha.