

LAMPIRAN

Proses remelting	
	
Material AA6061	Tungku peleburan
	
Proses peleburan	Proses penuangan
	
Proses pembongkaran	Proses pendinginan

Proses pengukuran hasil coran



Lebar 245 mm



Panjang 495 mm



Tebal 25 mm

S

Proses Pemotongan Dan *Finising* Untuk Pembuatan Spesimen Uji



Proses pemotongan



Proses bubut *facing* untuk meratakan permukaan



Hasil pemotongan

Proses Pengujian Kekerasan Brinell



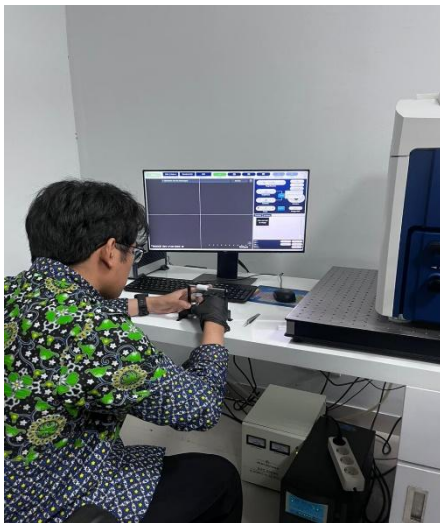
Pengujian

Kekerasan Brinell



Spesimen uji kekerasan

Proses pengujian SEM-EDX



Proses Sterilisasi Spesimen Uji SEM-EDX

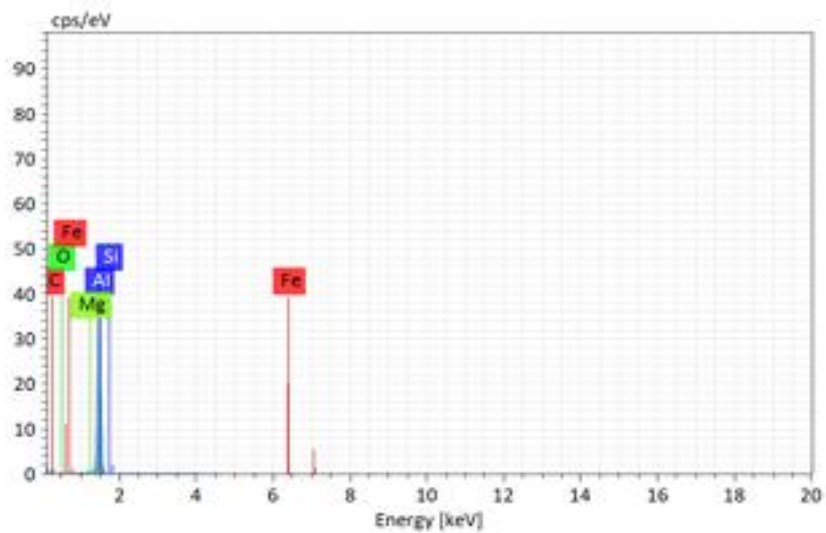
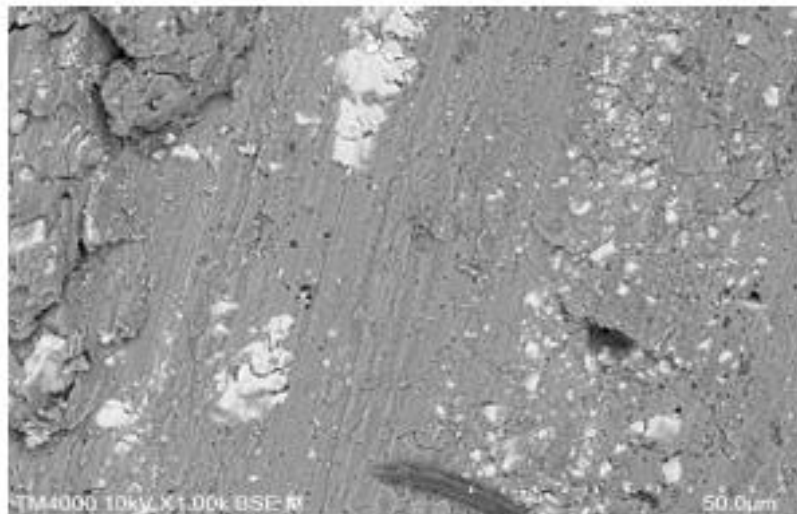


Proses scanning

Pengujian SEM-EDX

- Spesimen raw material

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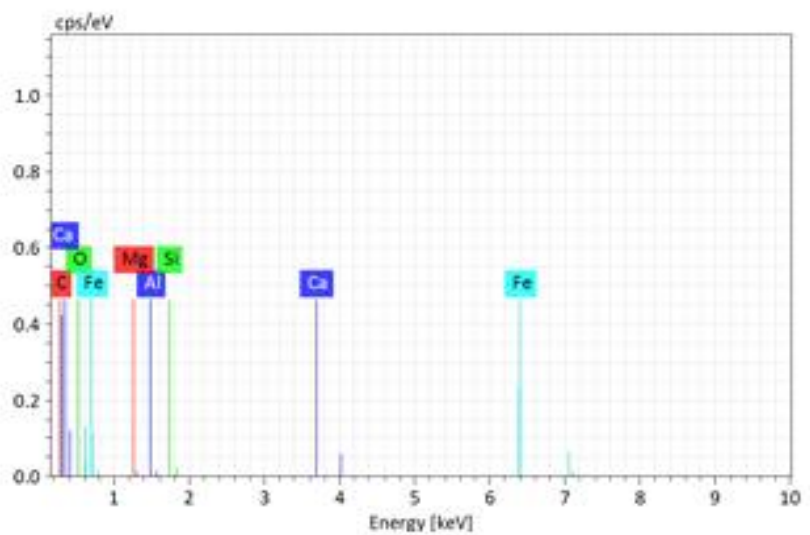
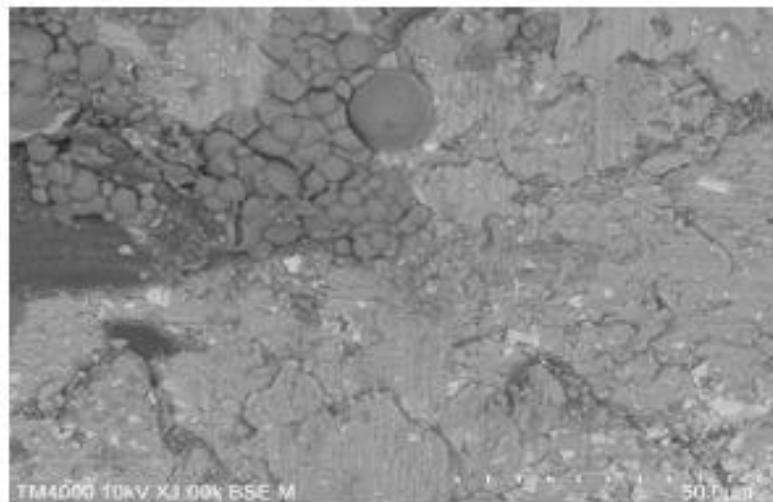




sampel standart 635

Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom. [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
C	6	4004	64.97	40.30	58.72	10.63	16.36
O	8	1405	9.53	5.91	6.47	2.00	20.93
Mg	12	2149	1.26	0.78	0.56	0.11	8.39
Al	13	165763	84.42	52.36	33.96	4.06	4.81
Si	14	514	0.44	0.27	0.17	0.06	12.77
Fe	26	443	0.61	0.38	0.12	0.06	9.91
		Sum	161.23	100.00	100.00		

- Spesimen tanpa T6



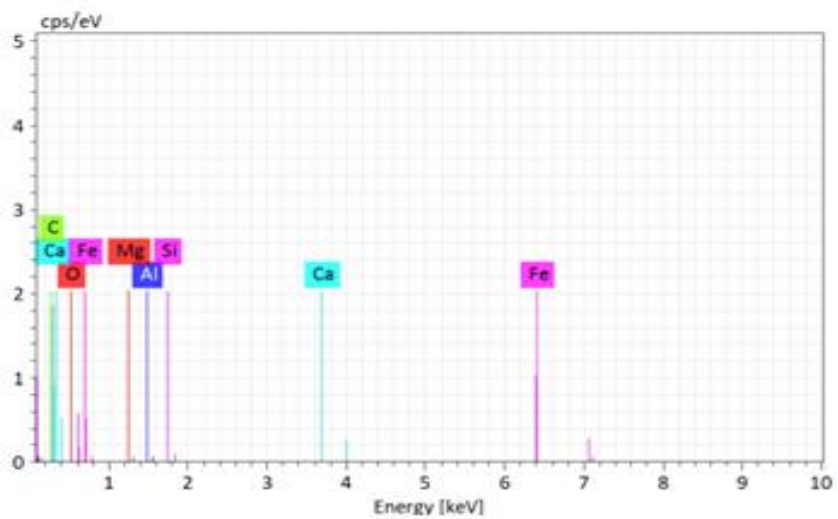
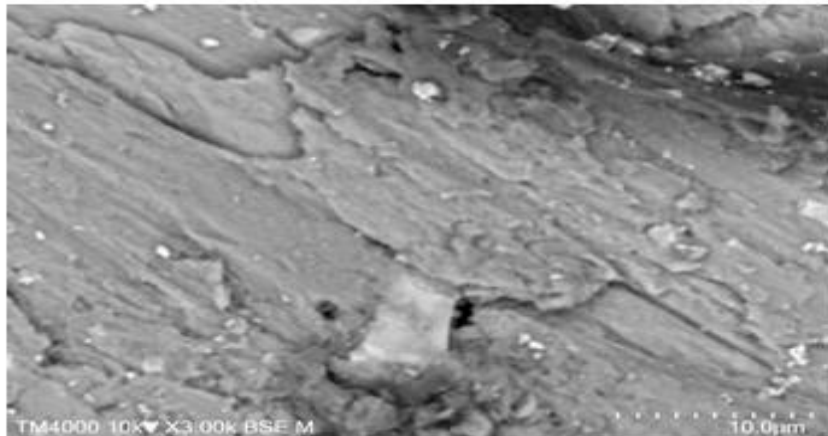


sampel standart 658

Element	At. No.	Netto	Mass [%]	Mass Norm. [%]	Atom [%]	abs. error [%] (1 sigma)	rel. error [%] (1 sigma)
C	6	1474	30.46	22.45	37.23	6.24	20.50
O	8	2529	16.99	12.52	15.59	3.07	18.10
Mg	12	469	0.95	0.70	0.57	0.10	10.72
Al	13	38490	78.87	58.13	42.92	3.60	4.57
Si	14	1422	5.39	3.97	2.82	0.32	5.85
Ca	20	179	0.80	0.59	0.29	0.10	12.15
Fe	26	132	2.22	1.64	0.58	0.28	12.40
		Sum	135.68	100.00	100.00		

➤ Spesimen F1

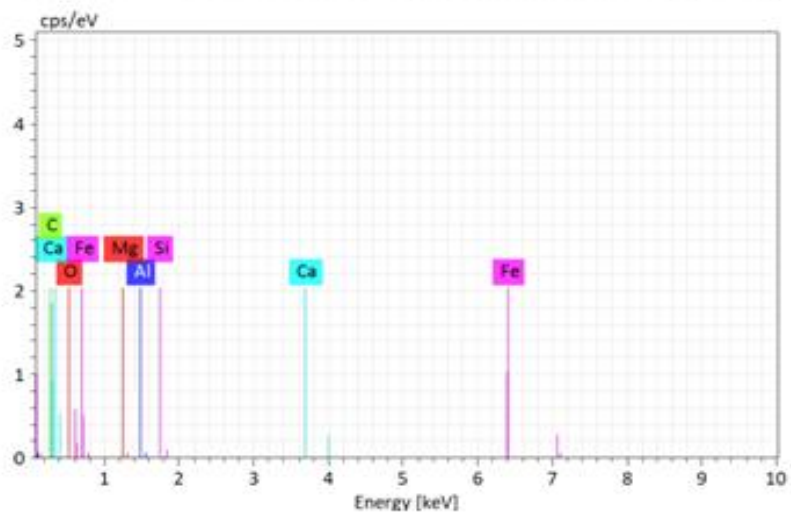
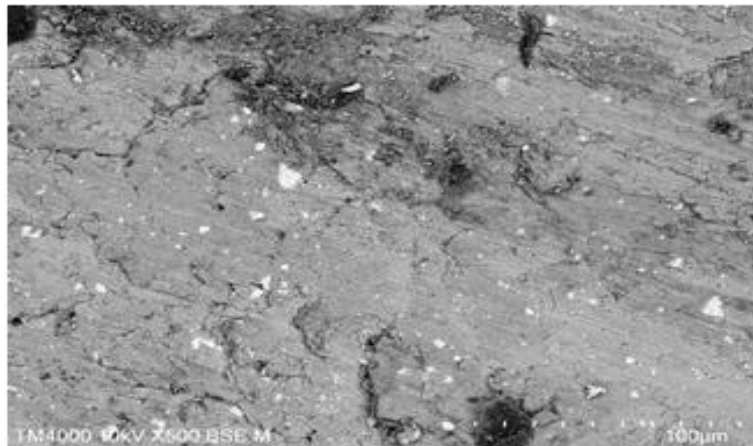
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1200	11.93	14.73	28.13	12.41	13.00
O	8	11313	22.13	26.01	19.12	16.00	17.35
Mg	12	2917	2.47	1.30	1.19	0.07	6.63
Al	13	91633	61.23	53.79	49.50	0.19	2.49
Si	14	1400	2.21	1.67	1.65	6.17	6.03
Ca	20	713	1.42	1.09	0.13	0.11	10.97
Fe	26	111	1.54	1.41	0.28	0.09	12.31
		Sum	102.93	100.00	100.00		

➤ Spesimen F2

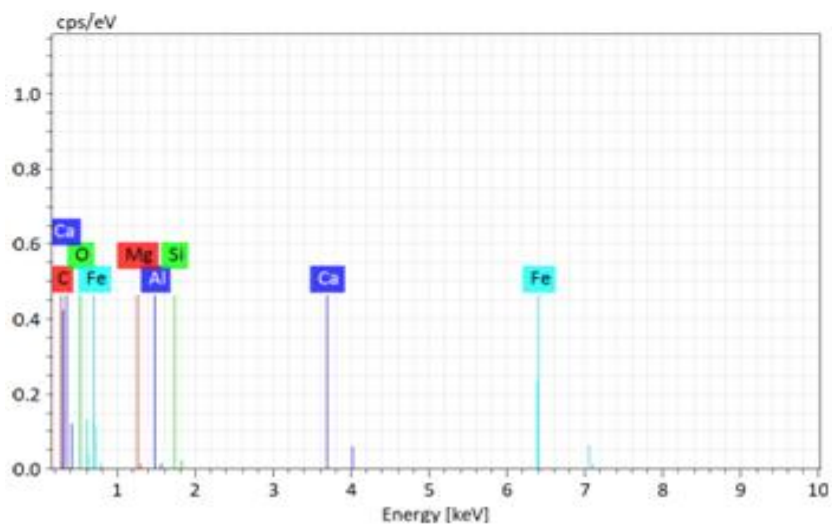
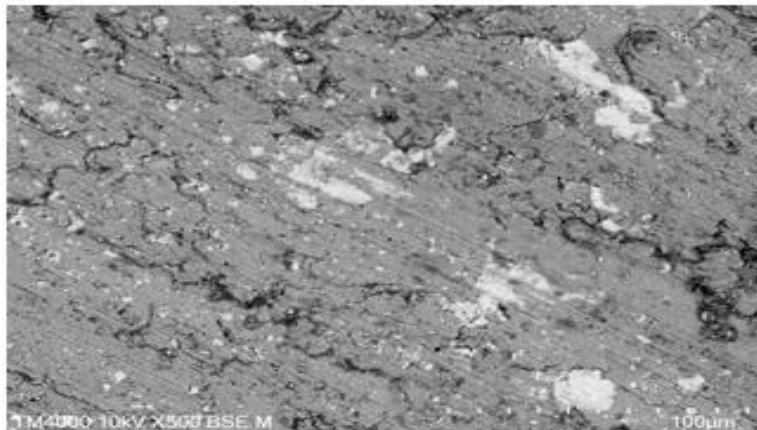
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1236	16.71	17.71	23.11	17.55	13.27
O	8	10132	20.33	22.80	21.81	9.31	15.26
Mg	12	2928	2.41	1.29	1.17	0.19	6.20
Al	13	91639	61.27	54.31	52.03	6.16	2.37
Si	14	1397	2.19	1.55	1.57	1.31	5.59
Ca	20	722	1.45	1.15	0.10	0.8	9.11
Fe	26	107	1.50	1.19	0.21	0.7	11.33
		Sum	105.86	100.00	100.00		

➤ Spesimen F3

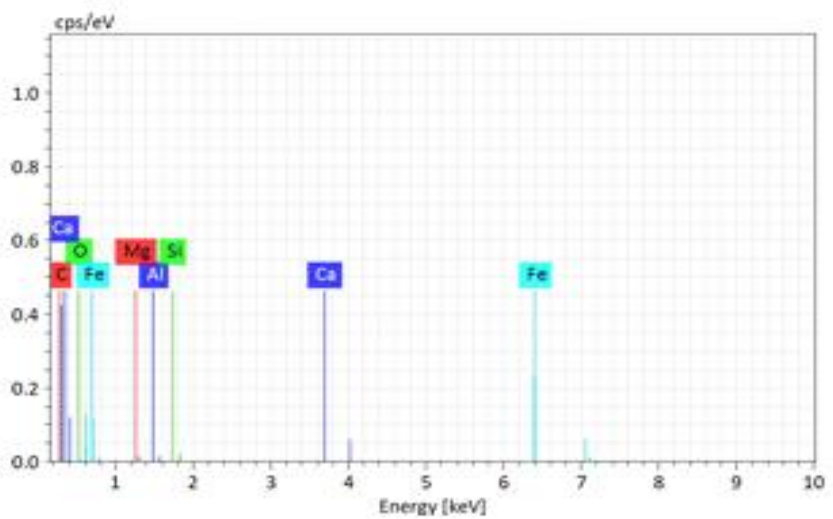
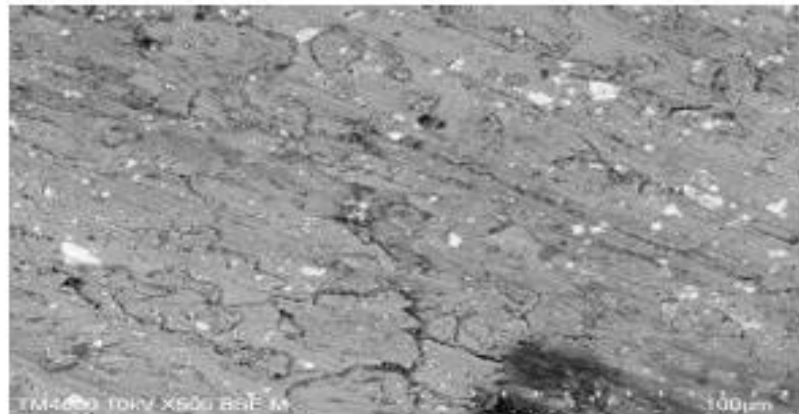
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1434	12.56	16.29	19.33	10.21	13.00
O	8	12103	14.31	25.03	23.89	15.73	16.11
Mg	12	3214	2.50	1.35	1.21	0.01	6.52
Al	13	78614	61.19	53.60	51.30	0.23	2.53
Si	14	1423	2.07	1.61	1.63	6.20	7.19
Ca	20	719	1.45	1.07	1.21	0.13	11.00
Fe	26	127	1.61	1.05	1.43	0.11	12.33
		Sum	95.69	100.00	100.00		

➤ Spesimen G1

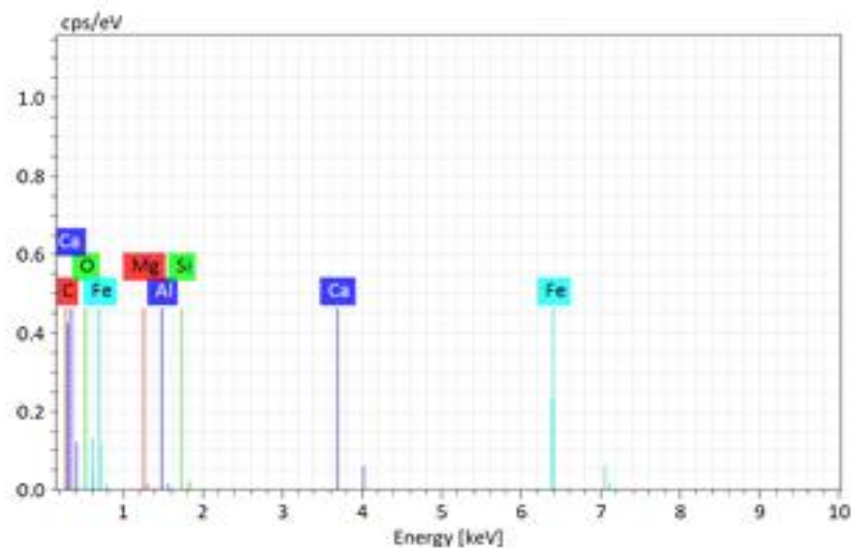
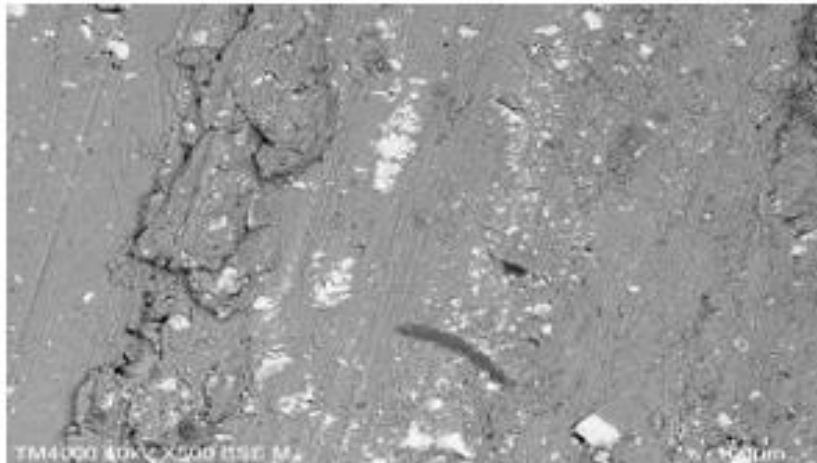
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1379	10.97	17.45	20.44	9.11	19.27
O	8	10410	23.90	26.62	30.23	2.09	10.35
Mg	12	3278	2.53	1.87	2.07	0.13	5.30
Al	13	81513	63.20	51.65	45.10	1.17	4.75
Si	14	1513	2.10	1.77	1.37	0.09	3.65
Ca	20	721	1.47	0.34	0.34	1.07	6.21
Fe	26	137	1.73	0.30	0.45	0.17	11.55
		Sum	105.90	100.00	100.00		

➤ Spesimen G2

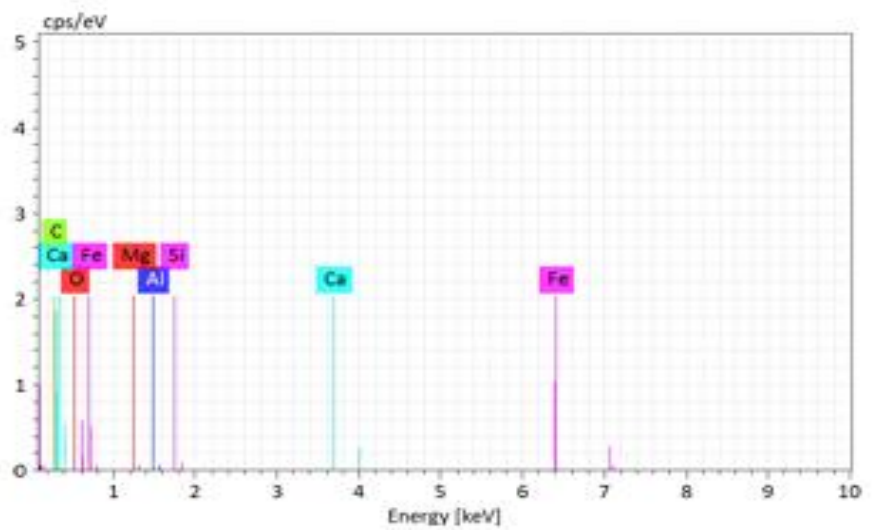
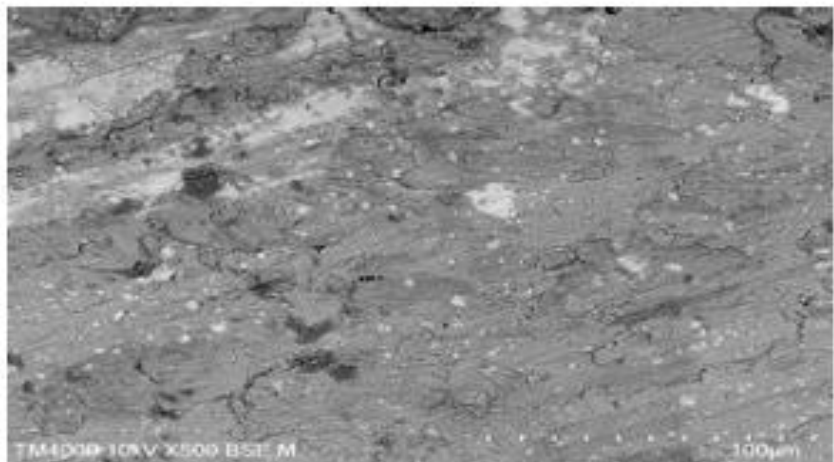
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1203	14.26	15.79	29.57	24.50	10.59
O	8	14776	21.29	41.25	30.22	10.13	13.50
Mg	12	1531	2.07	9.70	8.35	0.10	5.00
Al	13	8016	40.68	30.19	29.33	5.09	2.15
Si	14	1034	1.07	1.21	1.08	1.33	3.59
Ca	20	739	1.31	1.27	1.10	0.03	8.89
Fe	26	101	1.20	0.59	0.35	0.01	9.33
		Sum	81.88	100.00	100.00		

➤ Spesimen G3

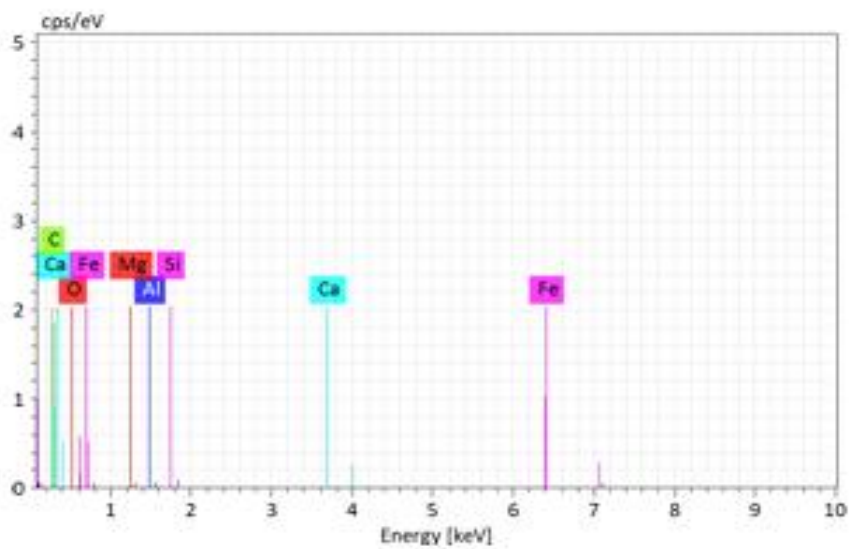
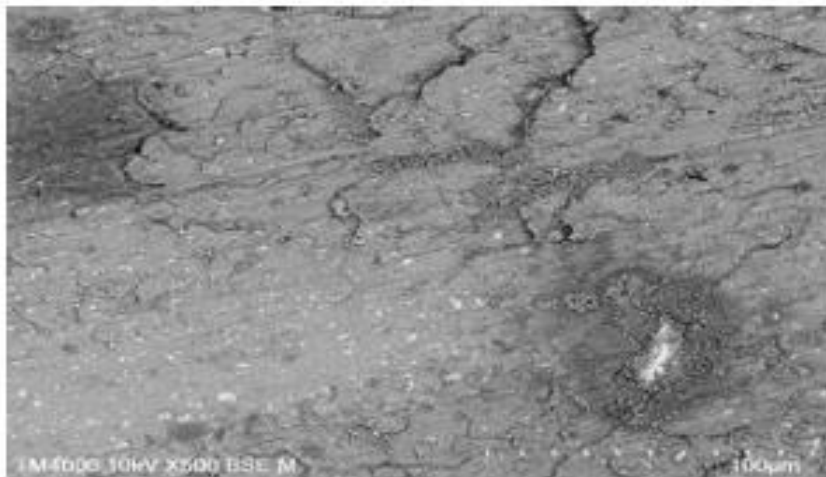
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1380	11.87	10.50	16.85	2.37	20.81
O	8	10520	24.35	25.70	30.25	3.13	13.31
Mg	12	3387	2.63	2.33	2.13	0.15	5.62
Al	13	83600	67.31	57.91	47.21	2.00	3.61
Si	14	1520	2.21	1.98	1.49	0.13	6.33
Ca	20	730	1.50	1.30	1.04	0.09	7.00
Fe	26	140	1.79	0.28	1.03	0.19	12.23
		Sum	111.66	100.00	100.00		

➤ Spesimen H1

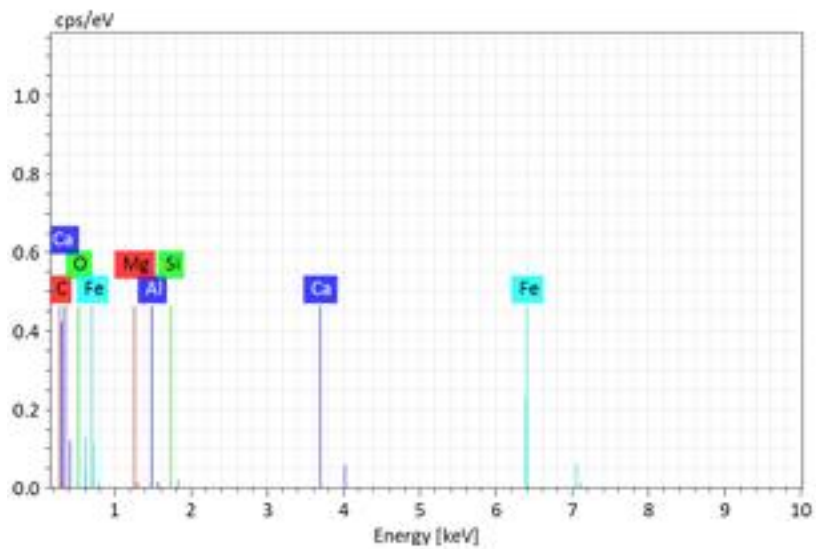
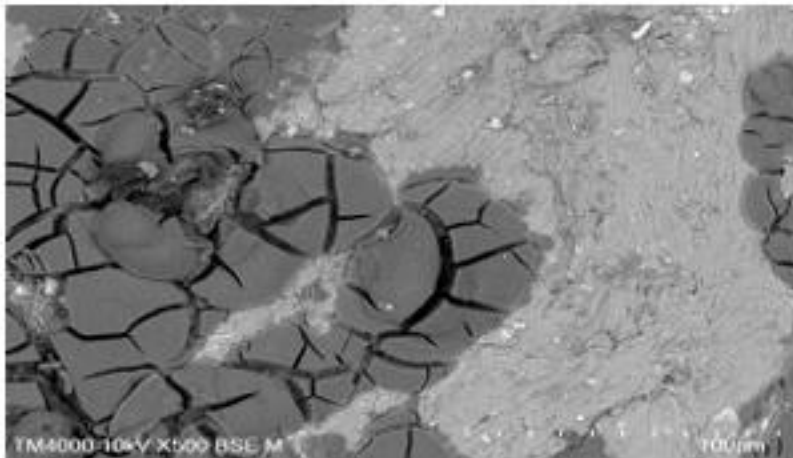
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1383	11.90	10.61	18.75	2.49	20.97
O	8	10529	24.50	21.85	29.00	3.43	14.00
Mg	12	3390	2.68	2.39	2.09	0.18	6.62
Al	13	83604	67.35	60.07	47.27	3.06	4.54
Si	14	1524	2.25	2.01	1.52	0.14	6.42
Ca	20	736	1.57	1.40	0.74	0.11	7.09
Fe	26	142	1.82	1.67	0.63	0.23	12.29
		Sum	112.07	100.00	100.00		

➤ Spesimen H2

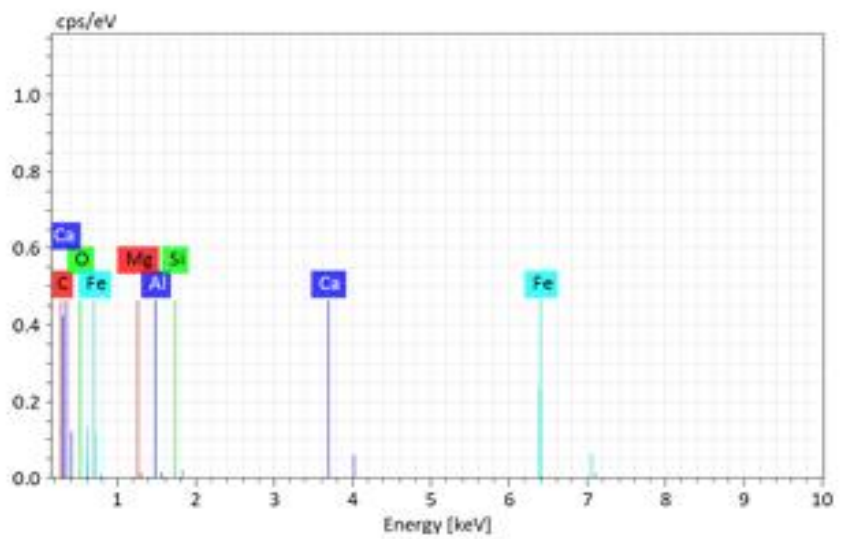
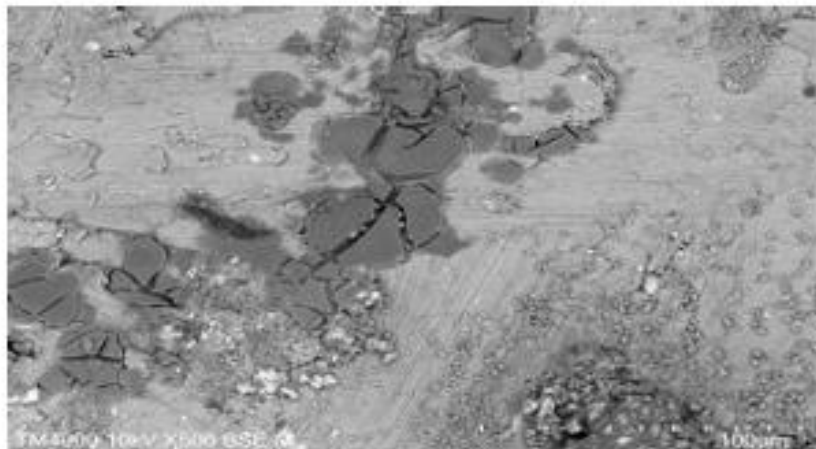
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1371	30.37	18.39	23.11	7.22	17.35
O	8	1039	20.55	19.30	13.19	2.07	9.10
Mg	12	3172	2.49	1.66	1.40	0.07	4.35
Al	13	81516	59.19	55.95	58.10	0.18	3.41
Si	14	1502	2.03	1.70	1.60	6.31	5.11
Ca	20	730	1.40	1.35	1.20	0.10	4.20
Fe	26	130	1.69	1.65	1.40	0.13	13.40
		Sum	117.72	100.00	100.00		

➤ Spesimen H3

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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1332	15.35	16.50	18.41	17.41	12.01
O	8	15017	21.31	29.36	29.40	9.27	13.61
Mg	12	2357	2.19	10.13	9.80	0.16	5.40
Al	13	87314	56.70	40.20	38.71	6.10	2.30
Si	14	1165	2.00	1.41	1.30	1.27	4.47
Ca	20	727	1.46	1.25	1.21	0.07	9.01
Fe	26	105	1.30	1.15	1.17	0.08	10.27
		Sum	100.31	100.00	100.00		

➤ Hasil uji kekerasan

	LABORATORIUM UJI BAHAN		No. Dokumen	:	
	POLITEKNIK PERKAPALAN NEGERI SURABAYA		Tanggal	:	
	HARDNESS TEST - BRINELL		Revisi	:	

SPK No. : 10-V/PL19/BJP/2026
 Customer : Sdr Akmal Taufiqulhakim
 Project : -
 Specimen : RAW Material
 Material : Aluminium 6061
 Dimension : as received
 Test Method : ASTM E10

Weld. Process : -
 Position : -
 Welder : -
 Ref. Code : -

Equipment

Name : Digital Brinell Tester
 Brand/Type : TIME / TBH-3000D

Manufacturer : TIME - China
 Serial Number : 15SSHBW22406

Test Result:

Test Load : 125kgf		Indentor : Ball Ø5mm		Dwell time : 15 s		
No.	Sample Stamp	Position	Location	Hardness Value (BHN)	Average (BHN)	Remark
1	RAW	-	1	82,88	81,04	
2		-	2	78,87		
3		-	3	81,38		

Surabaya, May 29, 2026


 (.....)

	LABORATORIUM UJI BAHAN	No. Dokumen	:
	POLITEKNIK PERKAPALAN NEGERI SURABAYA	Tanggal	:
	HARDNESS TEST - BRINELL	Revisi	:

No	D(mm)	HB						
01	1.373	082.88						
02	1.407	078.87						
03	1.385	081.38						
MIN= 078.87			RU= 081.04		MAX= 082.88		P= 00	
HV		No. 03		2026/05/29_15:36:37				
Loading	Indenter	Dwell		Light	Change	Time		
125	5.0 mm	15S		10 %	HV	MIN		

	LABORATORIUM UJI BAHAN		No. Dokumen	:	
	POLITEKNIK PERKAPALAN NEGERI SURABAYA		Tanggal	:	
	HARDNESS TEST - BRINELL		Revisi	:	

SPK No. : 73-V/PL19/BJP/2026
 Customer : Sdr. Akmal Taufiqul Hakim
 Project : -
 Specimen : Cast
 Material : Aluminium 6061
 Dimension : as received
 Test Method : ASTM E10
Equipment
 Name : Digital Brinell Tester
 Brand/Type : TIME / TBH-3000D
 Weld. Process : -
 Position : -
 Welder : -
 Ref. Code : -
 Manufacturer : TIME - China
 Serial Number : 15SSHBW22406

Test Result:

Test Load : 125kgf		Indenter : Ball Ø5mm		Dwell time : 15 s		
No.	Sample Stamp	Position	Location	Hardness Value (BHN)	Average (BHN)	Remark
1	Tanpa T6	-	1	54,04	54,54	
2		-	2	57,93		
3		-	3	51,65		
4	T6-16S-1.5 (kode F1)	1	1	49,47	52,44	52,07
5			2	51,95		
6			3	55,89		
7		2	1	56,06	52,89	
8			2	50,35		
9			3	52,25		
10		3	1	51,65	50,88	
11			2	52,18		
12			3	48,82		
13	T6-16S-2.5 (kode F2)	1	1	56,40	49,93	48,47
14			2	51,40		
15			3	41,99		
16		2	1	41,55	38,00	
17			2	39,96		
18			3	32,50		
19		3	1	59,79	57,49	
20			2	60,17		
21			3	52,50		

	LABORATORIUM UJI BAHAN		No. Dokumen	:
	POLITEKNIK PERKAPALAN NEGERI SURABAYA		Tanggal	:
	HARDNESS TEST - BRINELL		Revisi	:

No.	Sample Stamp	Position	Location	Hardness Value (BHN)	Average (BHN)	Remark
22	T6-165-3.5 (kode F3)	1	1	52,1	50,87	54,82
23			2	53,29		
24			3	47,23		
25		2	1	59,41	56,78	
26			2	54,52		
27			3	56,40		
28		3	1	59,71	56,81	
29			2	57,02		
30			3	53,71		
31	T6-185-1.5 (kode G1)	1	1	62,15	53,94	57,63
32			2	47,10		
33			3	52,58		
34		2	1	55,28	55,38	
35			2	52,02		
36			3	58,84		
37		3	1	65,29	63,58	
38			2	64,20		
39			3	61,25		
40	T6-185-2.5 (kode G2)	1	1	69,88	66,06	39,88
41			2	73,70		
42			3	54,61		
43		2	1	23,44	23,57	
44			2	23,80		
45			3	23,47		
46		3	1	24,80	30,01	
47			2	31,56		
48			3	33,68		
49	T6-185-3.5 (kode G3)	1	1	61,05	54,27	59,34
50			2	51,26		
51			3	50,49		
52		2	1	61,36	61,96	
53			2	66,94		
54			3	57,57		
55		3	1	55,73	62,07	
56			2	68,34		
57			3	62,15		

	LABORATORIUM UJI BAHAN		No. Dokumen	:	
	POLITEKNIK PERKAPALAN NEGERI SURABAYA		Tanggal	:	
	HARDNESS TEST - BRINELL		Revisi	:	

No.	Sample Stamp	Position	Location	Hardness Value (BHN)	Average (BHN)	Remark
58	T6-205-1.5 (kode H1)	1	1	64,42	63,83	60,11
59			2	65,62		
60			3	61,45		
61		2	1	58,01	50,37	
62			2	51,26		
63			3	41,83		
64		3	1	62,87	66,13	
65			2	67,07		
66			3	68,45		
67	T6-205-2.5 (kode H2)	1	1	58,21	52,61	57,37
68			2	45,25		
69			3	54,36		
70		2	1	65,29	64,62	
71			2	61,05		
72			3	67,52		
73		3	1	60,37	54,89	
74			2	57,47		
75			3	46,83		
76	T6-205-3.5 (kode H3)	1	1	69,13	64,23	44,43
77			2	60,48		
78			3	63,08		
79		2	1	19,61	15,98	
80			2	10,69		
81			3	17,63		
82		3	1	56,94	53,10	
83			2	56,40		
84			3	45,97		

Surabaya, May 19, 2026


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	LABORATORIUM UJI BAHAN		No. Dokumen	:
	POLITEKNIK PERKAPALAN NEGERI SURABAYA		Tanggal	:
	HARDNESS TEST - BRINELL		Revisi	:

No. Draw	HB	07	1.447	055.73		
01	1.594	061.05	08	1.589	060.54	
02	1.734	051.26	09	1.580	062.15	
03	1.740	050.43				
04	1.591	061.36				
05	1.523	066.94				
06	1.448	057.57				
R1Hn 070.43		R2Hn 070.43		R3Hn 060.54		Fu 00
Hf		No. 09		2024-05-29 09:15:15		
Loadline	Indenter	Swell	Light	Change	Time	
125	5.0 mm	150	10 %	Hf	R1Hn	

T6-185-3.5

No Draw	HB	07	1,514	061,93		
01	1,552	064,42	08	1,572	062,07	
02	1,539	065,62	09	1,523	067,07	
03	1,500	061,45	10	1,500	060,45	
04	1,624	050,01				
05	1,725	051,26				
06						
R1Hn 051,15		R2Hn 057,11		R3Hn 060,45		Fu 00
Hf		Hb, 10		2024-05-29 09:15:15		
Loadline	Indenter	Swell	Light	Change	Time	
125	5,0 mm	150	10 %	Hf	R1Hn	

T6-205-1.5

No. Draw	HB	07	1.683	060.37		
01	1.432	050.23	08	1.442	057.47	
02	1.045	040.25	09	1.013	046.93	
03	1.486	054.36				
04	1.543	065.29				
05	1.594	061.05				
06	1.517	067.52				
R1Hn 045.25		R2Hn 057.27		R3Hn 067.52		Fu 00
Hf		No. 09		2024-05-29 10:03:57		
Loadline	Indenter	Swell	Light	Change	Time	
125	5.0 mm	150	10 %	Hf	R1Hn	

T6-205-2.5

No. Draw	HB	07	1.649	056.94		
01	1.580	049.17	08	1.637	056.40	
02	1.681	060.40	09	1.829	045.97	
03	1.563	063.00				
04	2.732	019.61				
05	3.562	010.63				
06	2.044	017.67				
R1Hn 010.65		R2Hn 044.44		R3Hn 045.12		Fu 00
Hf		No. 09		2024-05-29 10:22:50		
Loadline	Indenter	Swell	Light	Change	Time	
125	5.0 mm	150	10 %	Hf	R1Hn	

T6-205-3.5

Proses perlakuan panas T6



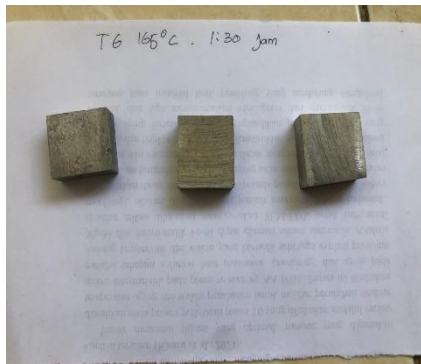
Persiapan spesimen



Temperatur *solution heat treatment*
540°C selama 1 jam



Proses *quenching* spesimen dengan media air



Tiga spesimen untuk dilakukan *artificial aging*



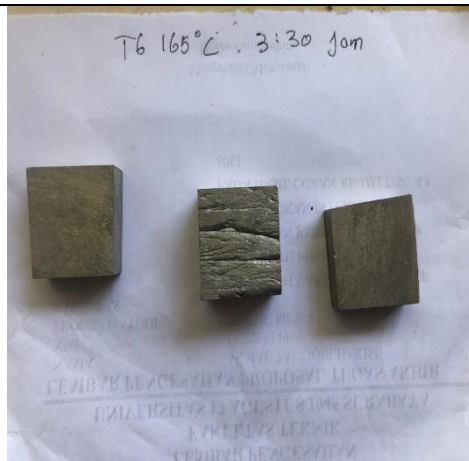
Temperatur 165°C selama 1:30 jam



Tiga spesimen untuk dilakukan *artificial aging*



Temperatur 165°C selama 2:30 jam



Tiga spesimen untuk dilakukan
artificial aging



Temperatur 165°C selama 3:30 jam



Tiga spesimen untuk dilakukan
artificial aging



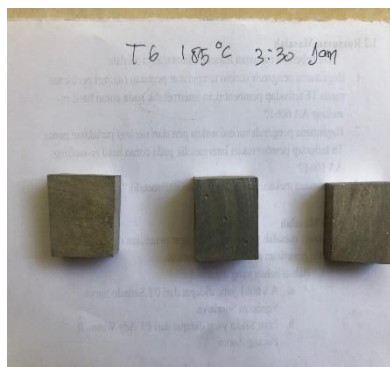
Temperatur 185°C selama 1:30 jam



Tiga spesimen untuk dilakukan *artificial aging*



Temperatur 185°C selama 2:30 jam



Tiga spesimen untuk dilakukan *artificial aging*



Temperatur 185°C selama 3:30 jam



Tiga spesimen untuk dilakukan
artificial aging



Temperatur 205°C selama 1:30 jam



Tiga spesimen untuk dilakukan
artificial aging



Temperatur 205°C selama 2:30 jam



Tiga spesimen untuk dilakukan
artificial aging



Temperatur 205°C selama 3:30 jam