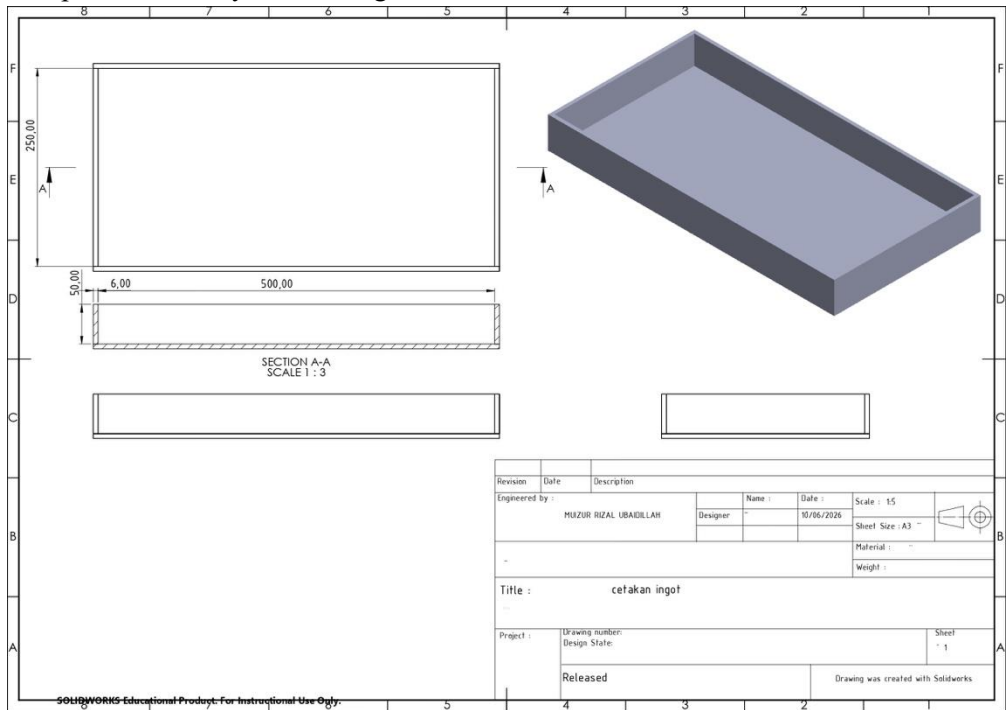
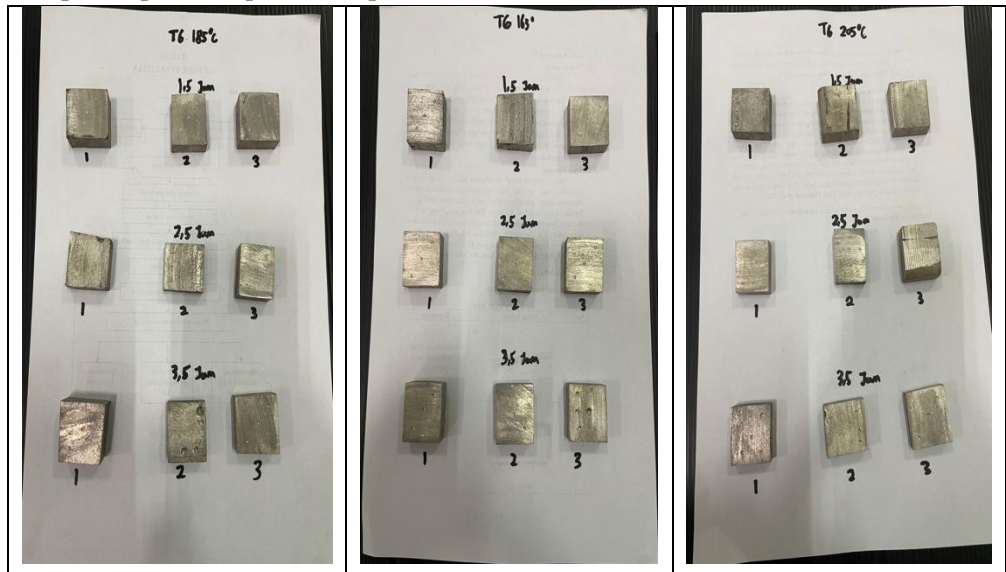


LAMPIRAN

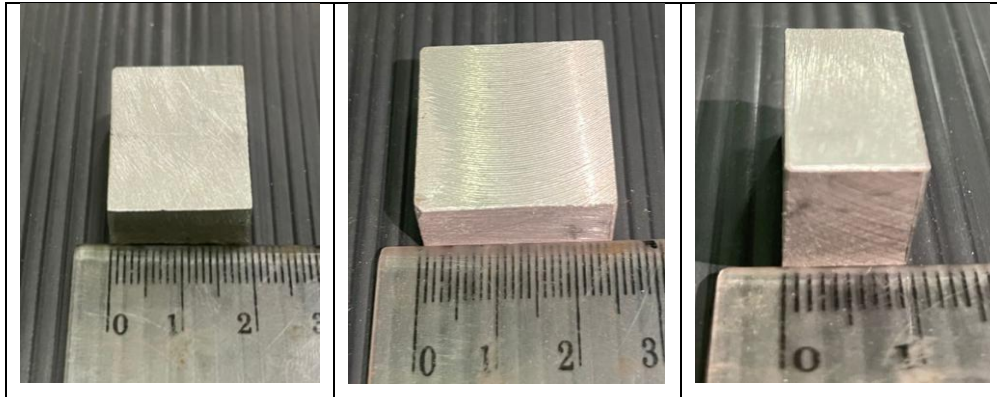
Lampiran Assembly cetakan ingot



Lampiran spesimen perlakuan panas T6



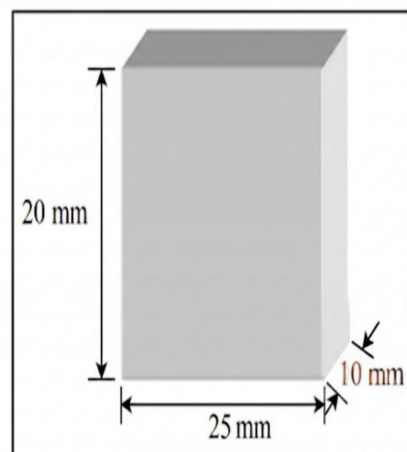
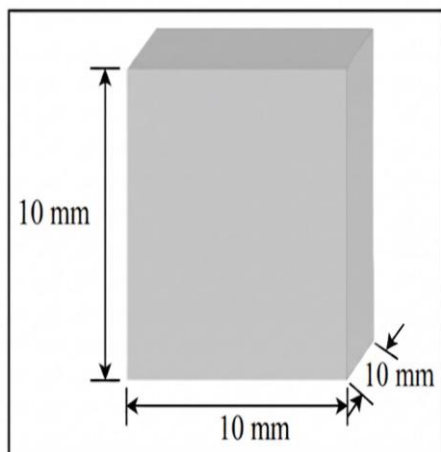
Lampiran ukuran spesimen uji kekerasan brinnel



Lampiran variasi temperatur dan waktu penuaan *aging*

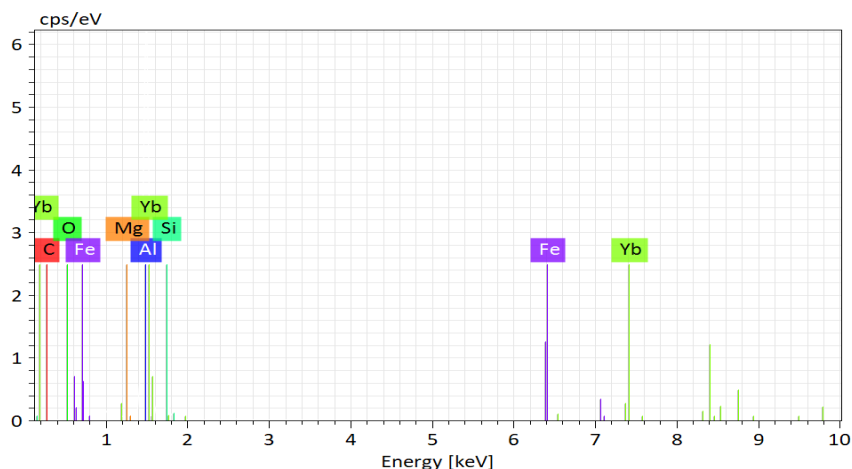
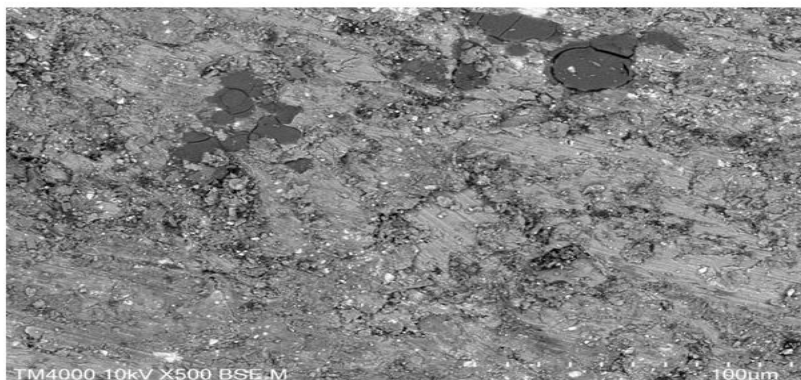






Lampiran SEM-EDX spesimen L1

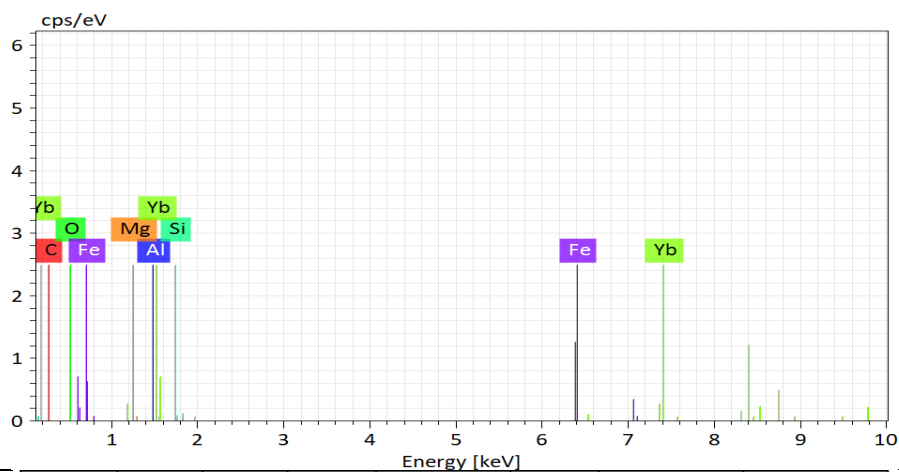
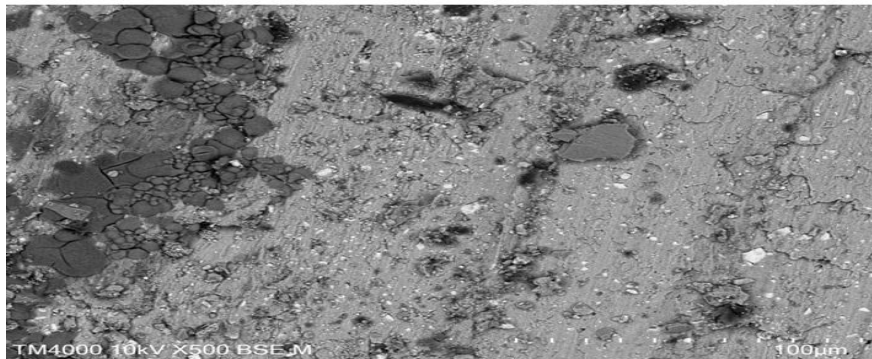
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	2447	20.45	20.45	16.13	3.01	9.60
O	8	30.39	9.71	12.07	13.07	1.01	04.14
Mg	12	722	0.89	0.81	0.70	0.10	17.23
Al	13	87501	79.81	57.54	54.01	5.03	9.14
Si	14	3270	4.19	1.16	1.14	0.17	7.71
Fe	26	400	5.70	1.45	1.42	0.21	6.84
Yb	70	99.41	18.91	13.07	13.53	0.50	9.07
		Sum	139,66	100.00	100.00		

Lampiran SEM-EDX spesimen L2

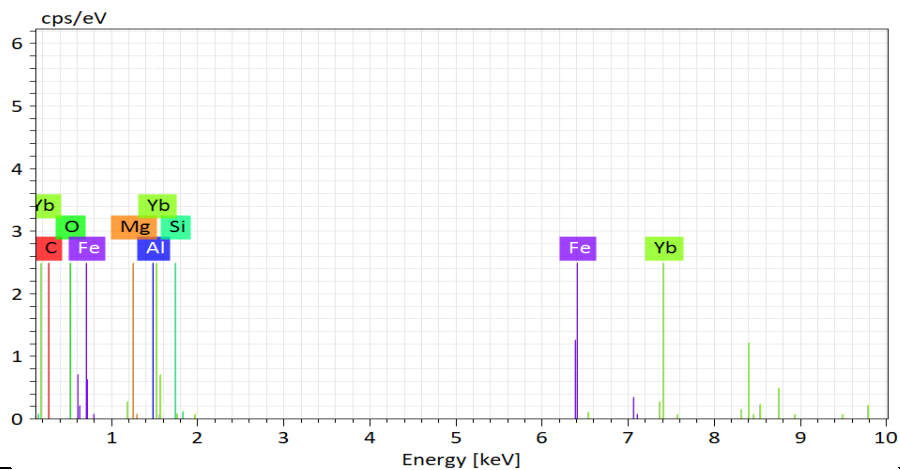
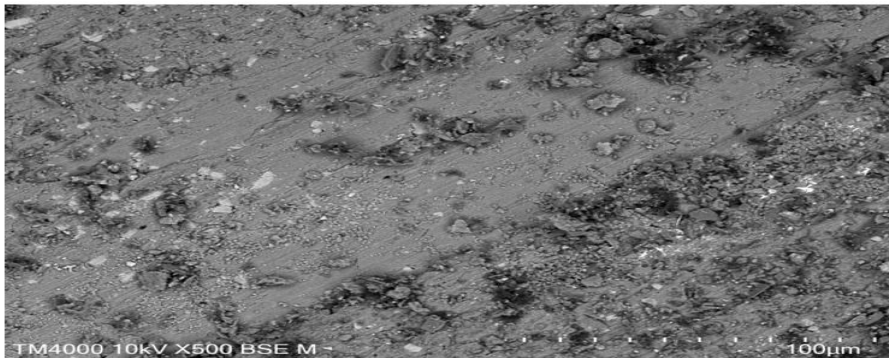
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	2180	19.74	13.94	26.79	4.27	10.14
O	8	27.61	8.89	11.85	5.07	1.17	06.11
Mg	12	597	0.33	0.39	0.35	0.09	11.70
Al	13	87604	80.00	58.29	52.76	2.17	4.12
Si	14	3400	6.01	10.71	9.87	0.11	6.71
Fe	26	189	3.71	3.73	1.26	0.20	8.21
Yb	70	894	2.07	1.09	3.90	0.90	7.20
		Sum	120.75	100.00	100.00		

Lampiran SEM-EDX spesimen L3

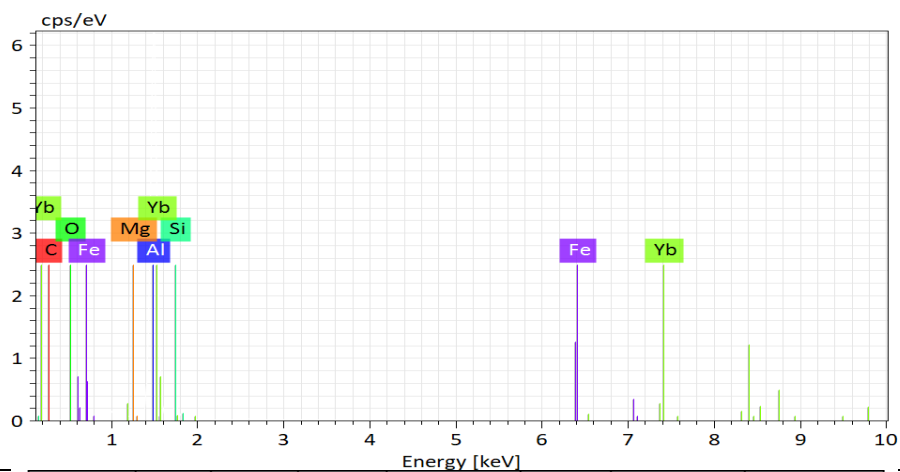
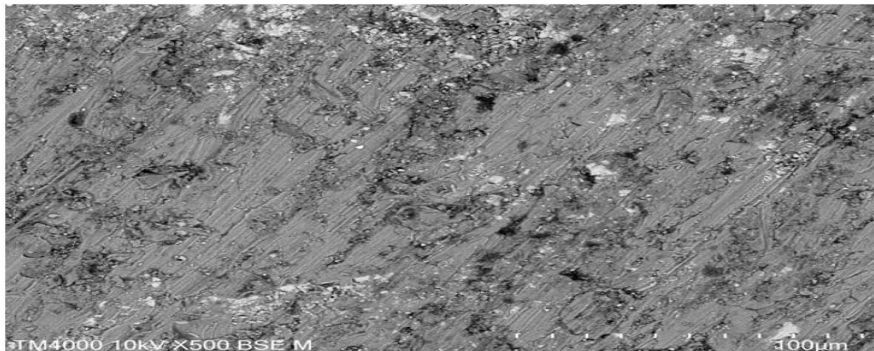
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	2991	30.40	16.03	17.08	3.07	15.45
O	8	4713	22.75	23.68	22.23	2.04	7.08
Mg	12	737	0.82	0.79	0.75	0.15	11.95
Al	13	80012	69.57	50.37	50.12	6.60	8.53
Si	14	3475	4.53	1.59	1.48	0.17	6.51
Fe	26	390	5.09	2.77	2.59	0.30	9.71
Yb	70	9018	16.79	4.77	5.75	0.70	5.43
		Sum	139.95	100.00	100.00		

Lampiran SEM-EDX spesimen M1

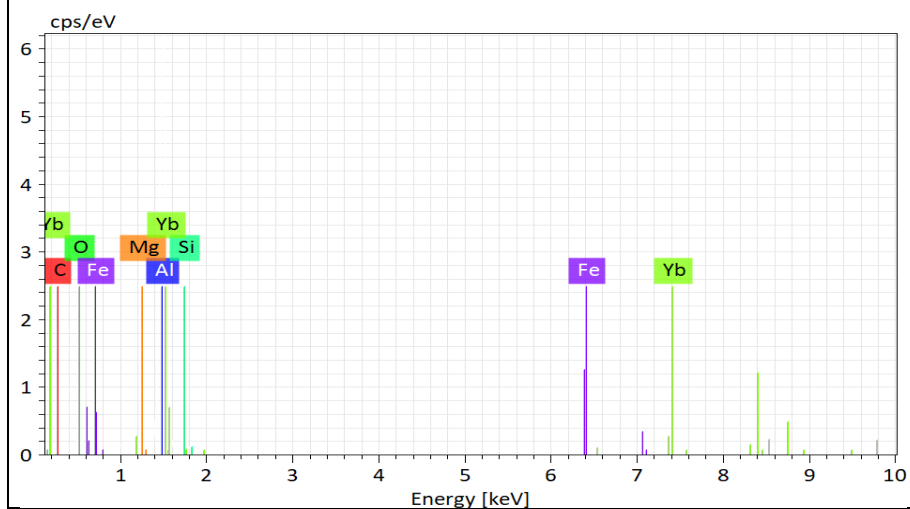
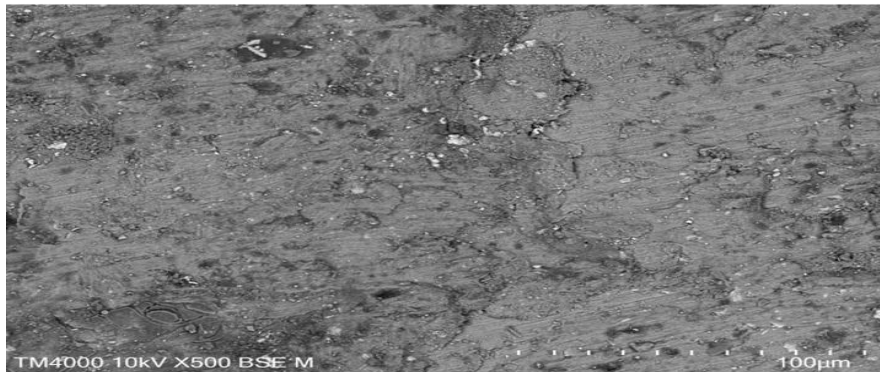
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Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	2150	17.11	13.42	27.20	4.30	10.12
O	8	3581	9.83	9.10	5.01	1.69	06.49
Mg	12	602	0.48	0.41	0.38	0.12	12.11
Al	13	90514	80.12	58.79	53.99	3.95	3.01
Si	14	3660	7.90	11.75	9.71	0.19	6.70
Fe	26	172	3.69	3.14	1.22	0.13	7.41
Yb	70	730	2.49	3.39	2.49	0.50	7.11
Sum			121.62	100.00	100.00		

Lampiran SEM-EDX spesimen M2

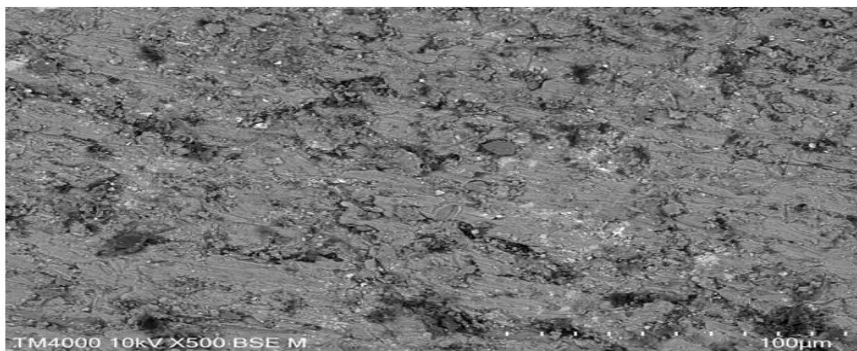
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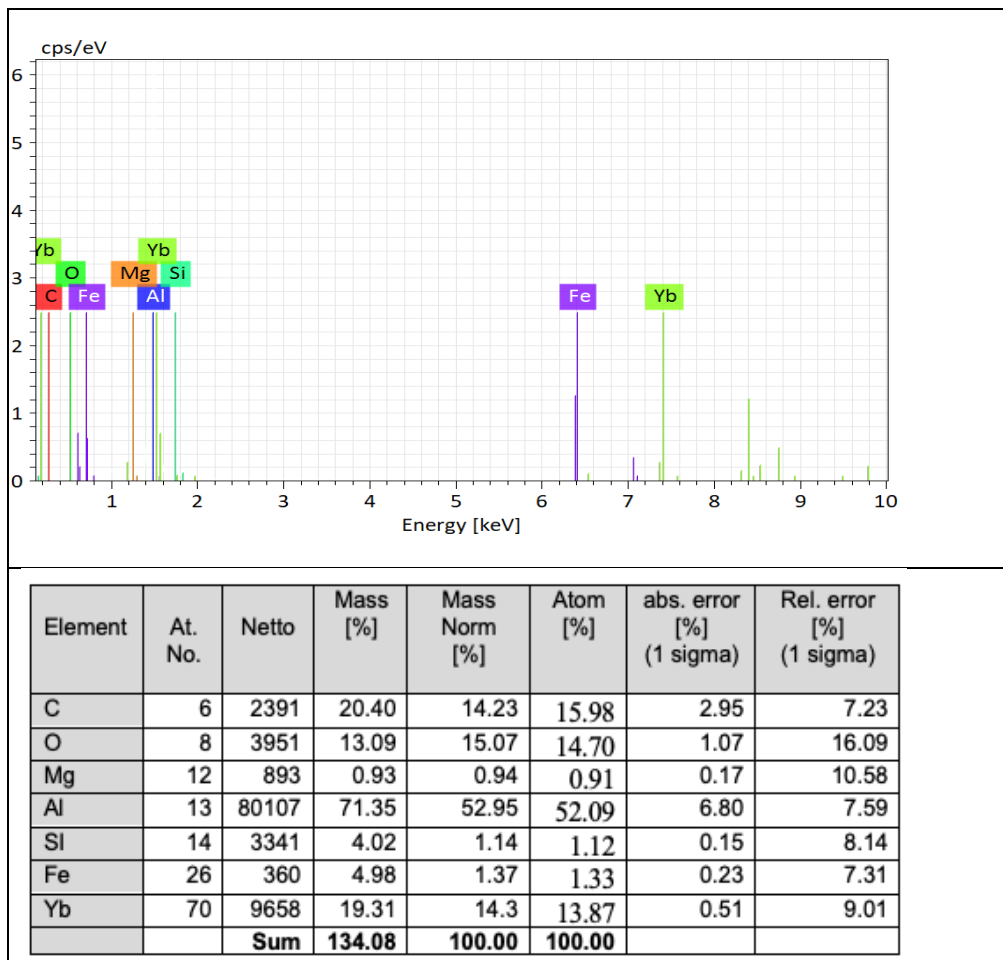


Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	2173	18.91	13.59	27.66	3.54	18.71
O	8	3586	9.84	7.08	10.81	1.67	16.93
Mg	12	622	0.55	0.40	0.40	0.07	12.03
Al	13	91513	83.32	59.88	54.25	3.77	4.53
Si	14	3475	6.26	4.50	3.92	0.32	5.08
Fe	26	222	4.27	3.07	1.34	0.42	9.93
Yb	70	9662	15.99	11.49	1.62	0.79	4.93
		Sum	139.15	100.00	100.00		

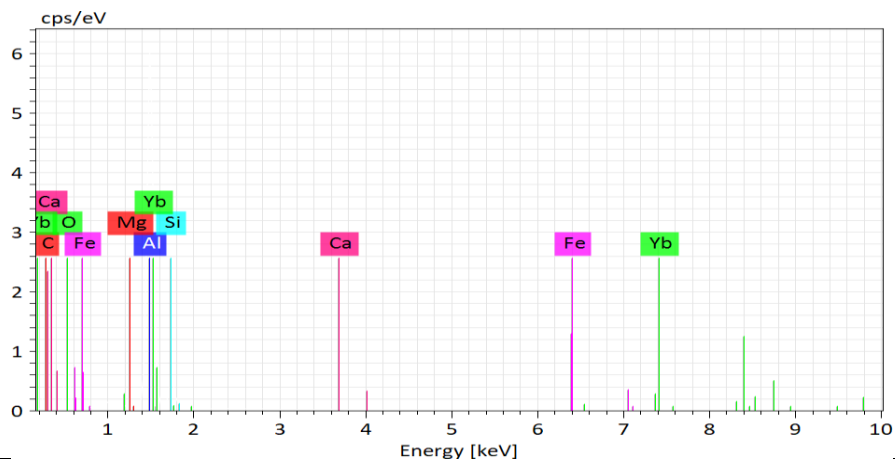
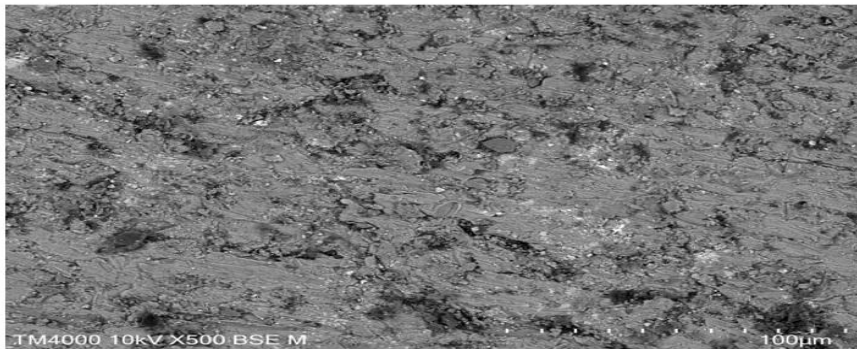
Lampiran SEM-EDX spesimen M3

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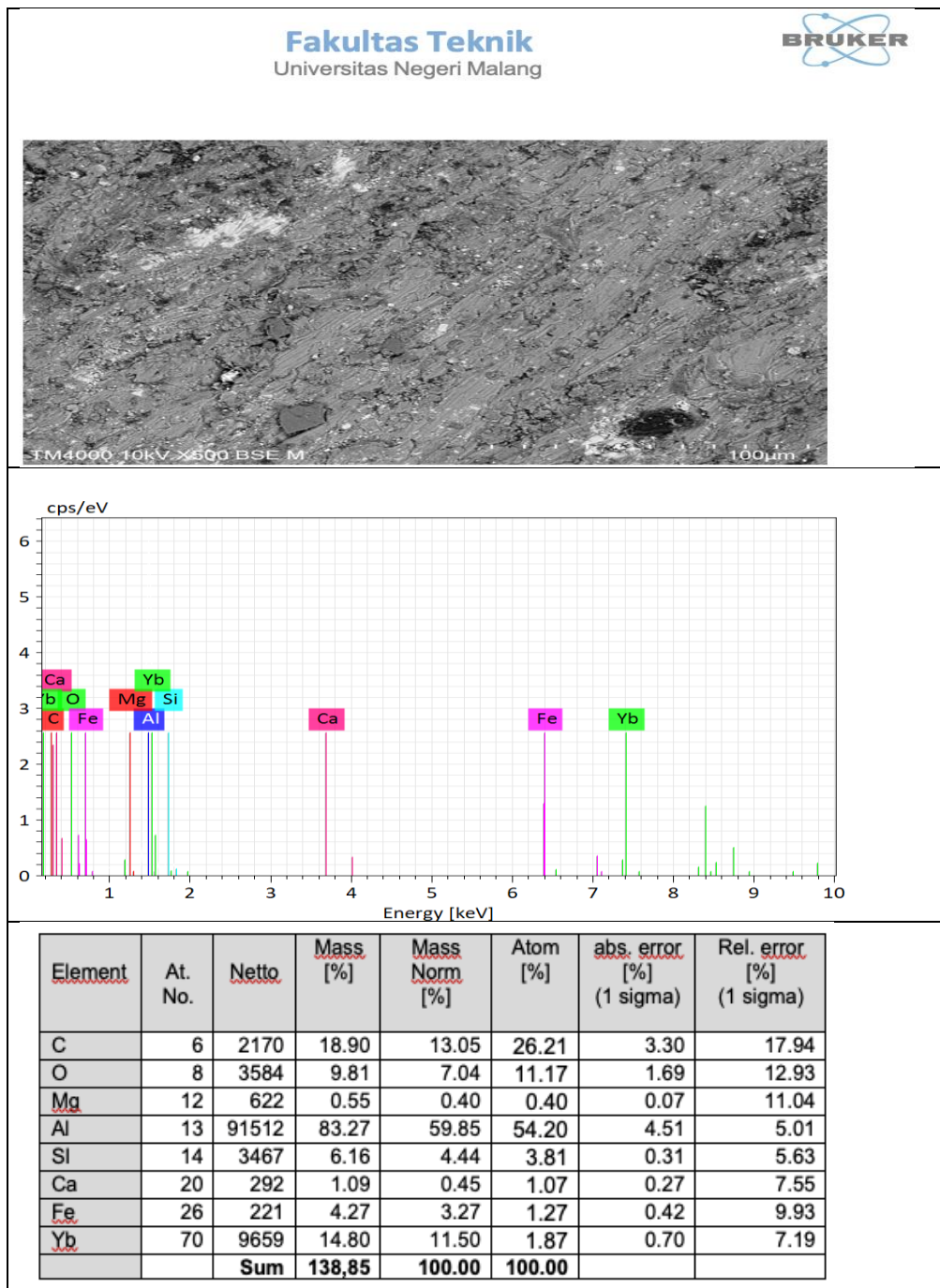


Lampiran SEM-EDX spesimen N1

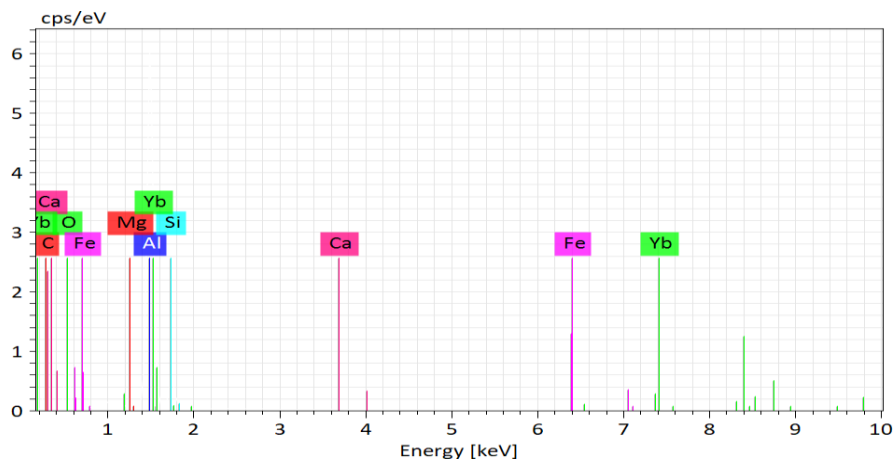
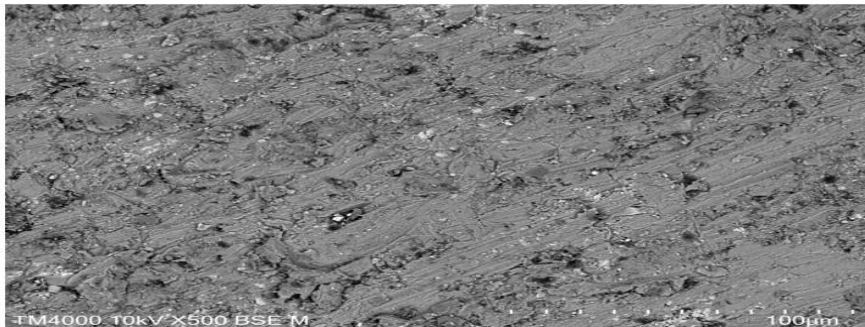


Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	1933	14.11	12.69	24.01	5.11	13.12
O	8	2854	8.81	1.98	4.90	2.05	17.92
Mg	12	600	0.40	0.40	0.37	0.19	11.79
Al	13	90670	90.12	60.41	58.76	2.12	4.00
Si	14	3940	8.99	13.95	10.01	0.17	6.57
Ca	20	302	1.25	1.01	0.09	0.19	9.67
Fe	26	195	4.17	5.19	1.03	0.11	7.40
Yb	70	910	2.50	5.07	0.83	0.58	8.42
		Sum	130.35	100.00	100.00		

Lampiran SEM-EDX spesimen N2



SEM-EDX spesimen N3



Element	At. No.	Netto	Mass [%]	Mass Norm [%]	Atom [%]	abs. error [%] (1 sigma)	Rel. error [%] (1 sigma)
C	6	2170	18.90	13.50	26.89	3.30	16.11
O	8	3579	9.80	2.01	12.01	1.68	07.90
Mg	12	619	0.51	0.38	0.39	0.09	12.90
Al	13	91481	81.23	59.80	54.11	3.90	3.07
Si	14	3459	6.07	4.40	3.76	0.32	5.90
Ca	20	289	1.06	0.70	0.39	0.12	8.92
Fe	26	200	2.93	3.19	1.25	0.67	9.90
Yb	70	9650	15.80	11.02	1.20	0.40	3.50
		Sum	136,3	100.00	100.00		

Hasil uji kekerasan brinell

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

SPK No. : 71-V/PL19/BJP/2026
 Customer : Sdr. M. Luqman 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 : 155SHBW22406

Test Result:

Test Load : 125kgf		Indentor : Ball Ø5mm			Dwell time : 15 s	
No.	Sample Stamp	Position	Location	Hardness Value (BHN)	Average (BHN)	Remark
1	Tanpa T6	-	1	48,90	50,42	
2		-	2	53,53		
3		-	3	48,82		
4	T6-165-1.5	L1	1	54,61	49,22	
5			2	44,07		
6			3	48,97		
7		L2	1	57,29	54,95	
8			2	48,61		
9			3	58,95		
10		L3	1	53,05	50,21	
11			2	48,75		
12			3	48,82		
13		L1	1	47,03	52,85	
14			2	55,28		
15			3	56,23		
16	T6-165-2.5	L2	1	56,06	54,01	
17			2	53,80		
18			3	52,18		
19		L3	1	57,75	57,48	
20			2	57,47		
21			3	57,22		

	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	L1	1	55,89	56,62	
23			2	55,02		
24			3	58,95		
25		L2	1	49,62	50,27	
26			2	49,17		
27			3	52,02		
28		L3	1	41,48	38,87	
29			2	43,04		
30			3	32,10		
31	T6-185-1.5	L1	1	66,73	62,30	
32			2	57,29		
33			3	62,87		
34		L2	1	59,98	59,92	
35			2	60,17		
36			3	59,60		
37		L3	1	61,16	55,14	
38			2	47,03		
39			3	57,22		
40	T6-185-2.5	L1	1	75,67	75,61	
41			2	74,25		
42			3	76,92		
43		L2	1	67,73	63,89	
44			2	65,82		
45			3	58,11		
46		L3	1	66,83	64,25	
47			2	71,96		
48			3	53,95		
49	T6-185-3.5	L1	1	67,42	70,73	
50			2	71,96		
51			3	72,80		
52		L2	1	12,35	16,75	
53			2	18,08		
54			3	19,81		
55		L3	1	66,26	66,76	
56			2	67,63		
57			3	66,39		

	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	L1	1	19,51	21,63	
59			2	25,83		
60			3	19,54		
61		L2	1	76,51	79,78	
62			2	86,05		
63			3	76,78		
64		L3	1	61,74	65,19	
65			2	68,45		
66			3	65,39		
67	T6-205-2.5	L1	1	54,45	62,67	
68			2	69,13		
69			3	64,42		
70		L2	1	66,39	64,61	
71			2	67,07		
72			3	60,37		
73		L3	1	62,45	61,89	
74			2	64,20		
75			3	59,03		
76	T6-205-3.5	L1	1	50,27	52,90	
77			2	52,02		
78			3	56,40		
79		L2	1	60,09	60,28	
80			2	62,54		
81			3	58,21		
82		L3	1	73,21	68,96	
83			2	64,65		
84			3	69,03		

Surabaya, May 26, 2026

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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

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

No. Data :		HB			
01	1,751	040,70			
02	1,639	051,52			
03	1,777	048,82			
HB= 040,82		HV= 050,42		HV= 052,52	
HB		No. 03		2020-05-25 14:05:11	
Loadline	Indenter	Dwell	Light	Change	Time
125	5,0 mm	150	10 %	00	010

Tanpa T6

No. Data :		HB			
01	1,612	054,61	051,72	048,75	
02	1,706	044,07	051,72	048,82	
03	1,754	040,97			
04	1,648	057,23			
05	1,780	040,61			
06	1,621	058,95			
HB= 044,07		HV= 051,46		HV= 052,52	
HB		No. 09		2020-05-25 14:10:00	
Loadline	Indenter	Dwell	Light	Change	Time
125	5,0 mm	150	10 %	00	010

T6-165-1.5

No. Data :		HB			
01	1,809	047,01	051,84	057,47	
02	1,671	055,13	051,84	057,47	
03	1,658	056,23			
04	1,662	056,06			
05	1,695	055,50			
06	1,720	055,18			
HB= 047,07		HV= 054,79		HV= 057,75	
HB		No. 09		2020-05-25 14:15:16	
Loadline	Indenter	Dwell	Light	Change	Time
125	5,0 mm	150	10 %	00	010

T6-165-2.5

No. Data :		HB			
01	1,664	055,09	00		
02	1,676	055,02	051,88	043,04	
03	1,622	050,95	10	1,172	032,10
04	1,762	043,62			
05	1,774	048,17			
06	1,712	052,02			
HB= 005,71		HV= 044,30		HV= 050,95	
HB		No. 10		2020-05-25 14:17:07	
Loadline	Indenter	Dwell	Light	Change	Time
125	5,0 mm	150	10 %	00	010

T6-165-3.5

No. Data :		HB			
01	1,576	066,73	00	1,000	047,03
02	1,644	057,29	051,84	057,47	
03	1,572	062,90			
04	1,600	058,90			
05	1,606	060,17			
06	1,612	059,60			
HB= 047,03		HV= 059,12		HV= 066,73	
HB		No. 09		2020-05-25 14:21:00	
Loadline	Indenter	Dwell	Light	Change	Time
125	5,0 mm	150	10 %	00	010

T6-185-1.5

No. Data :		HB			
01	1,435	075,67	00	1,472	071,94
02	1,449	074,75	051,84	057,47	
03	1,423	079,26			
04	1,515	067,73			
05	1,536	065,82			
06	1,633	050,11			
HB= 057,95		HV= 067,92		HV= 076,72	
HB		No. 09		2020-05-25 14:25:07	
Loadline	Indenter	Dwell	Light	Change	Time
125	5,0 mm	150	10 %	00	010

T6-185-2.5

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

No. Data	HD	07						
01	1.519	067,40	08	1.719	019,01			
02	1.471	071,36	09	1.532	066,78			
03	1.462	072,08	10	1.517	067,40			
04	1.552	012,35	11	1.538	066,79			
05	2.833	018,88						
06								
HHR		000,00	HR	042,10	HRH	072,20	HR	00
		HR		HR	11	2028-05-26,09130102		
Loadline	Indenter	Doell	Limit	Grade	Time			
125	5,0 mm	15	10 %	HR	HRH			

T6-185-3.5

01	0,88	00	07	1,505	061,74			
01	1,505	061,74	08	1,506	061,45			
02	2,808	075,03	09	1,541	065,79			
03	2,731	059,54						
04	1,428	076,51						
05	1,547	066,05						
06	1,425	076,75						
HHR		019,51	HR	055,53	HRH	086,00	HR	00
		HR		HR	09	2028-05-26,09130102		
Loadline	Indenter	Doell	Limit	Grade	Time			
125	5,0 mm	15	10 %	HR	HRH			

T6-205-1.5

No. Data	HD	07	1,576	062,45				
01	1,605	054,45	08	1,555	064,20			
02	1,500	069,17	09	1,620	059,92			
03	1,552	064,42						
04	1,531	066,39						
05	1,522	067,07						
06	1,605	060,37						
HHR		054,45	HR	067,06	HRH	069,17	HR	00
		HR		HR	09	2028-05-26,09130102		
Loadline	Indenter	Doell	Limit	Grade	Time			
125	5,0 mm	15	10 %	HR	HRH			

T6-205-2.5

No. Data	HD	07	1,632	056,21			
01	1,752	050,27	08	1,459	075,21		
02	1,721	052,02	09	1,550	064,65		
03		10	1,502	069,03			
04	1,657	056,40					
05	1,607	060,09					
06	1,575	062,54					
HHR		057,92	HR	057,44	HRH	075,21	HR
		HR		HR	10	2028-05-26,09130102	
Loadline	Indenter	Doell	Limit	Grade	Time		
125	5,0 mm	15	10 %	HR	HRH		

T6-205-3.5