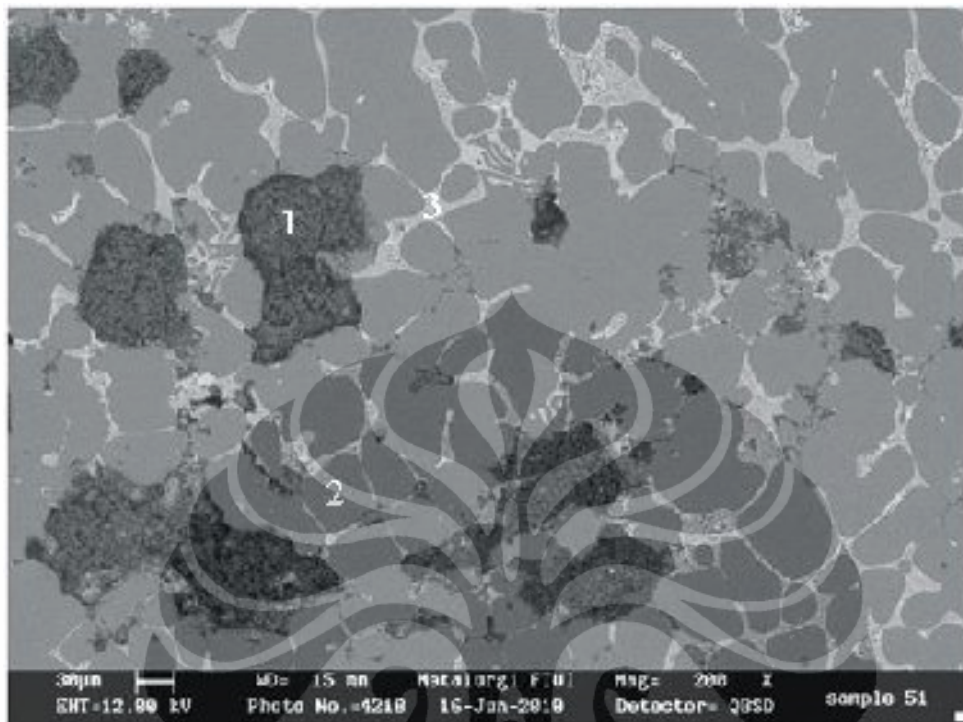
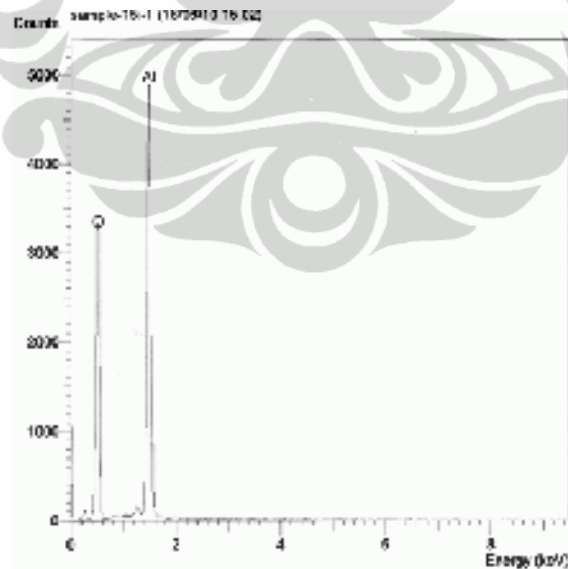


## Lampiran 1

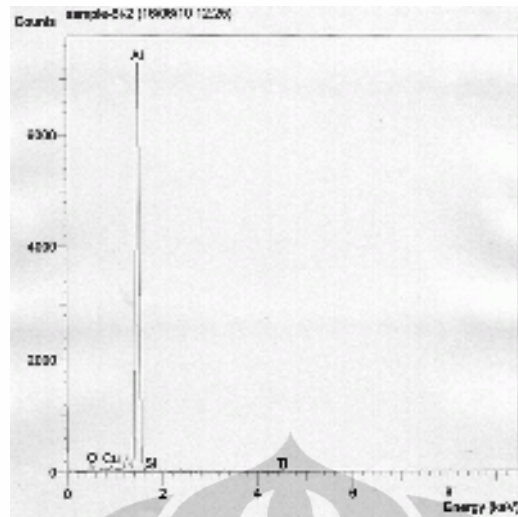
## Hasil Uji SEM/EDS

Gambar 1. Hasil SEM ingot dengan fraksi volume 5 %  $\text{Al}_2\text{O}_3$ 

Quantitative method : ZAF (2 iterations).  
 Analyzed all elements and normalized results.

Elmt	Spect.	Element	Atomic
	Type	%	%
O K	ED	27.84	39.41
Al K	ED	72.16	60.59
Total		100.00	100.00

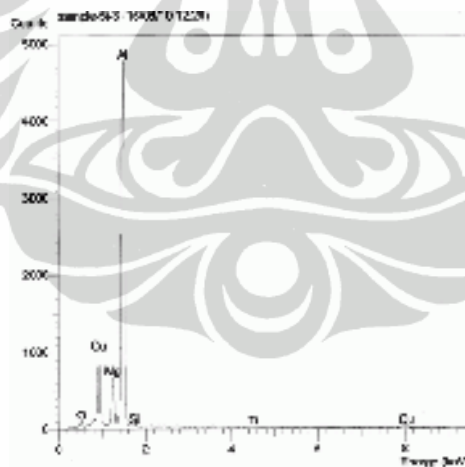
(a)



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	3.51	6.07
Al K	ED	86.66	88.87
Si K	ED	0.92	0.94
Ti K	ED	1.82	1.05
Cu K	ED	7.06	3.07
Total		100.00	100.00

(b)

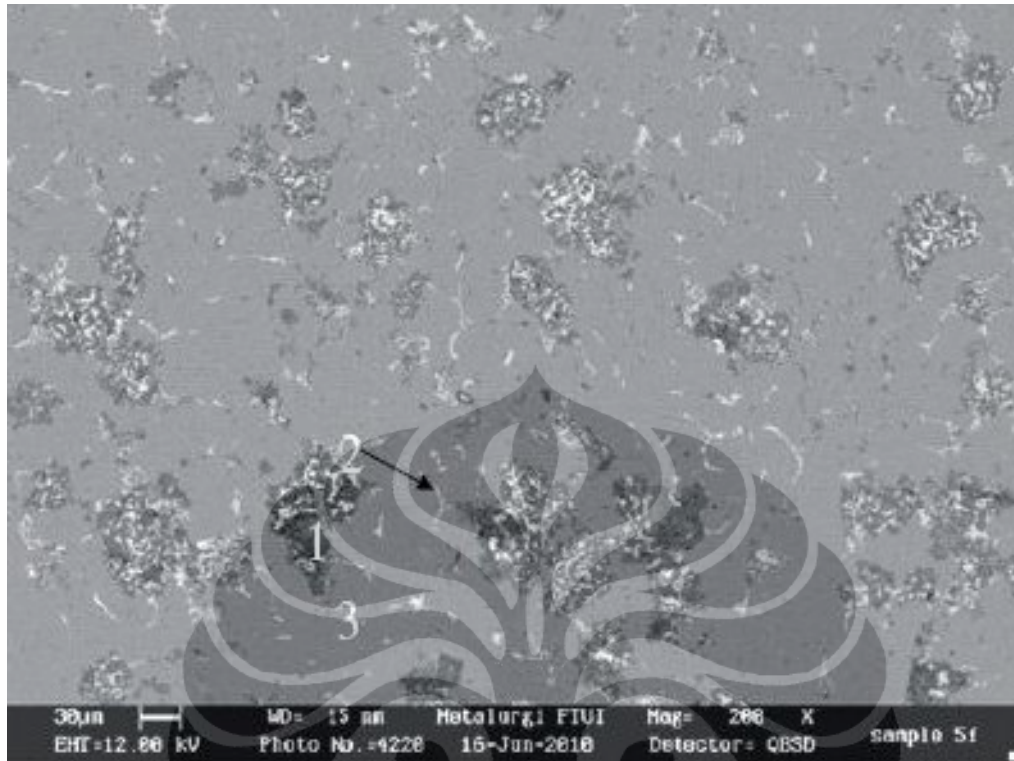


Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

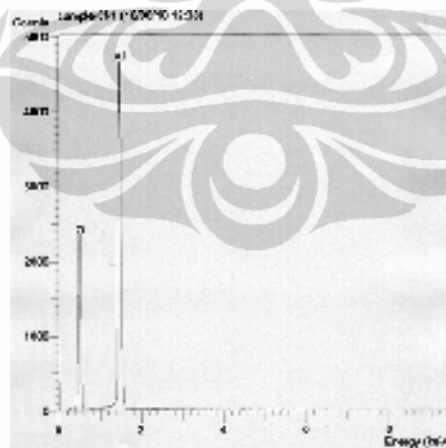
Elmt	Spect. Type	Element %	Atomic %
O K	ED	1.25	2.63
Mg K	ED	5.62	7.79
Al K	ED	55.31	69.05
Si K	ED	0.48	0.58
Ti K	ED	0.88	0.62
Cu K	ED	36.46	19.33
Total		100.00	100.00

(c)

Gambar 1. Hasil EDS ingot dengan fraksi volume 5 %  $\text{Al}_2\text{O}_3$  pada daerah : (a) 1, (b) 2, (c) 3



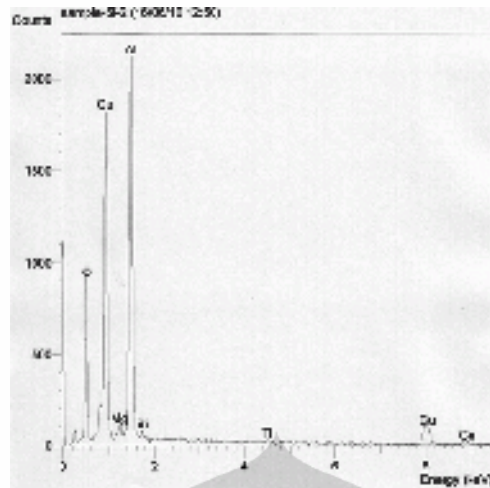
Gambar 2. Hasil EDS komposit *thixoforming* dengan fraksi volume 5 %  $\text{Al}_2\text{O}_3$



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	46.04	58.99
Al K	ED	53.96	41.01
Total		100.00	100.00

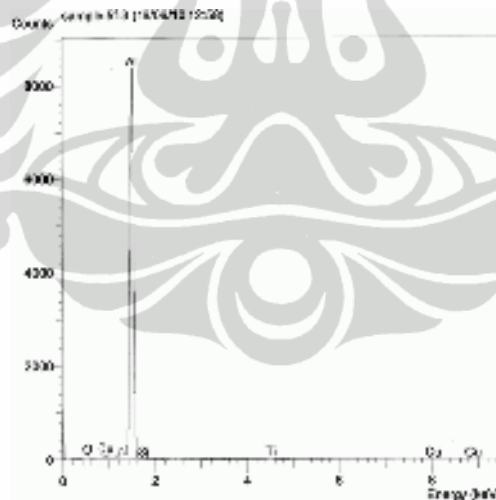
(a)



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	8.98	23.04
Mg K	ED	0.39	0.67
Al K	ED	19.84	30.21
Si K	ED	0.25	0.37
Ti K	ED	0.25	0.51
Cu K	ED	0.60	45.21
Total		100.00	100.00

(b)

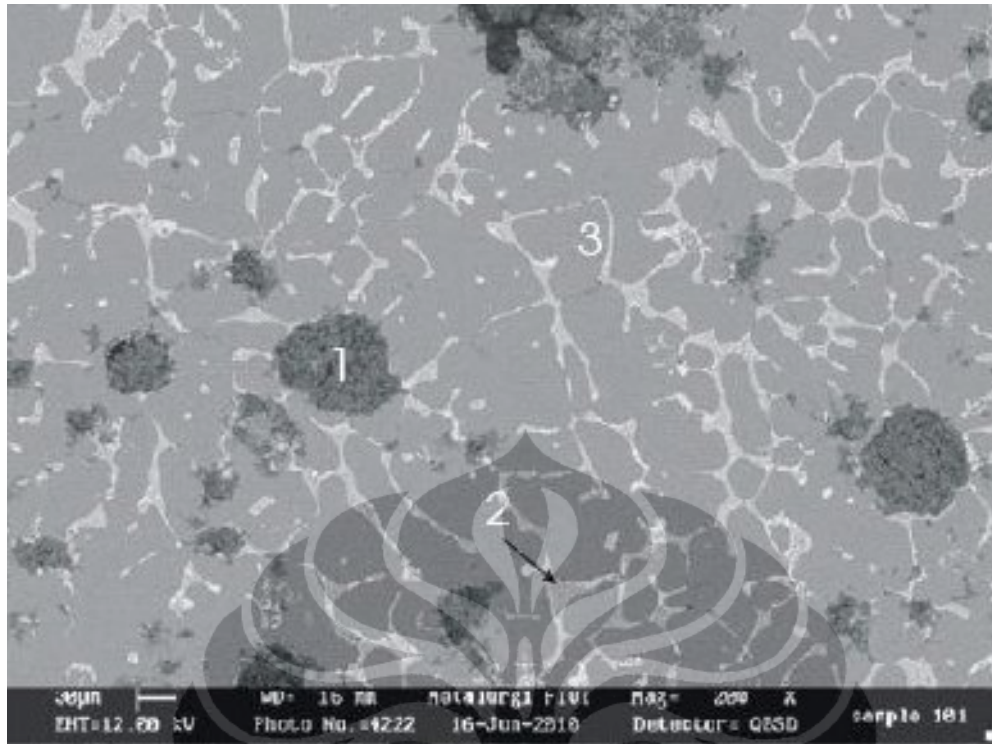


Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

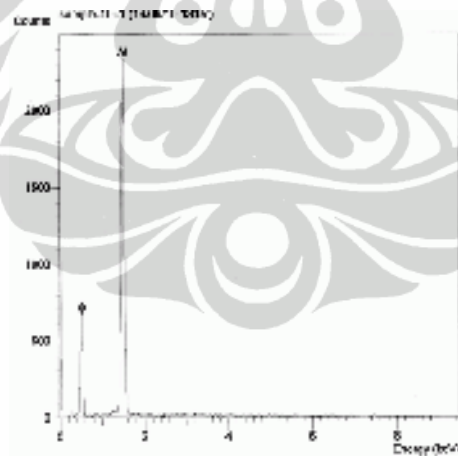
Elmt	Spect. Type	Element %	Atomic %
O K	ED	1.75	3.02
Mg K	ED	91.51	93.78
Ti K	ED	1.88	1.09
Cu K	ED	4.86	2.11
Total		100.00	100.00

(c)

Gambar 2. Hasil EDS komposit *thixoforming* dengan fraksi volume 5 %  $\text{Al}_2\text{O}_3$  pada daerah : (a) 1, (b) 2, (c) 3



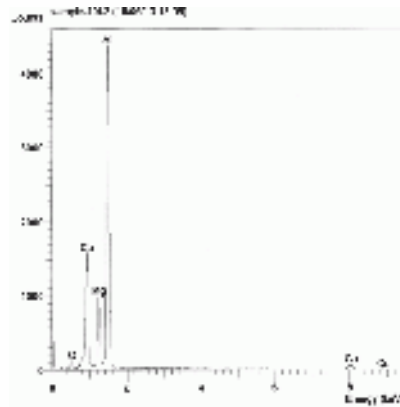
Gambar 3. Hasil SEM ingot komposit dengan fraksi volume 10 %  $\text{Al}_2\text{O}_3$



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	35.42	48.06
Al K	ED	64.58	51.94
Total		100.00	100.00

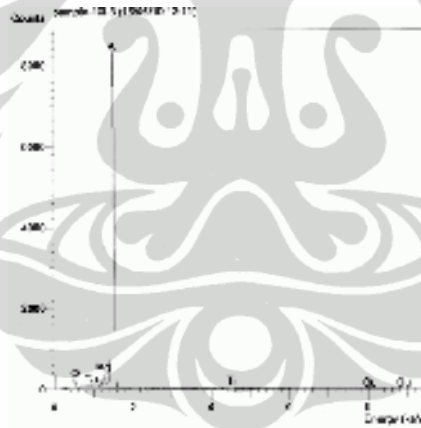
(a)



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	1.32	3.04
Mg K	ED	7.81	11.86
Al K	ED	41.07	56.17
Cu K	ED	49.80	28.93
Total		100.00	100.00

(b)

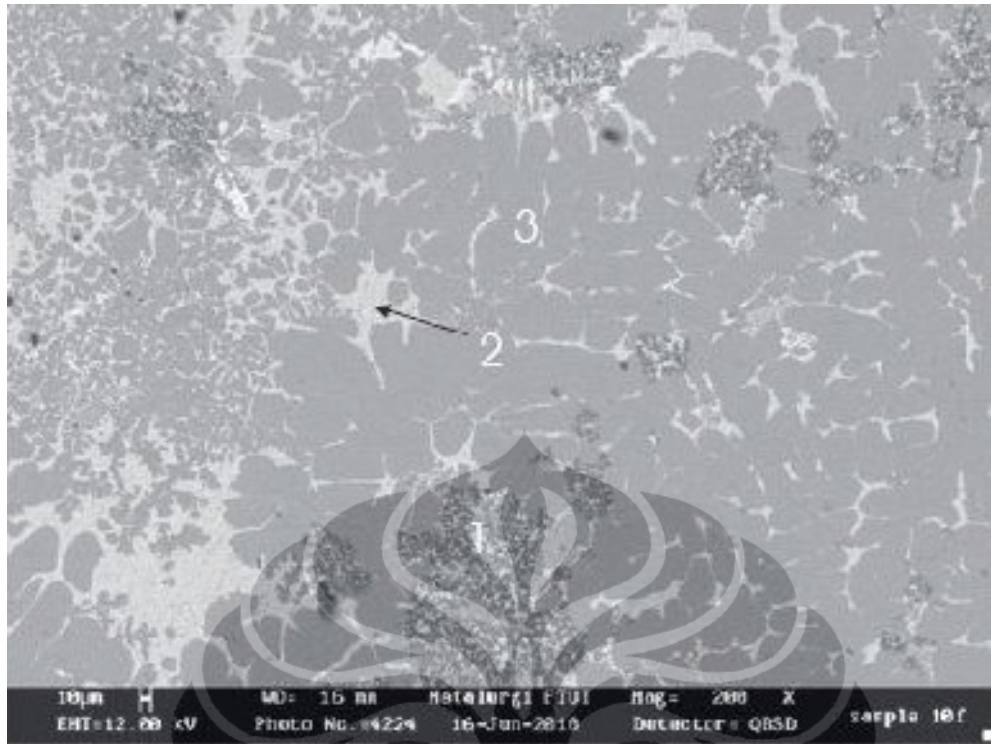


Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

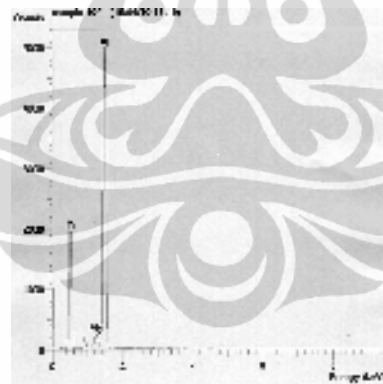
Elmt	Spect. Type	Element %	Atomic %
O K	ED	6.22	10.45
Mg K	ED	0.50	0.55
Al K	ED	85.42	85.03
Ti K	ED	4.68	2.62
Cu K	ED	3.18	1.34
Total		100.00	100.00

(c)

Gambar 3. Hasil EDS ingot komposit dengan fraksi volume 10 %  $\text{Al}_2\text{O}_3$  pada daerah : (a) 1, (b) 2, (c) 3



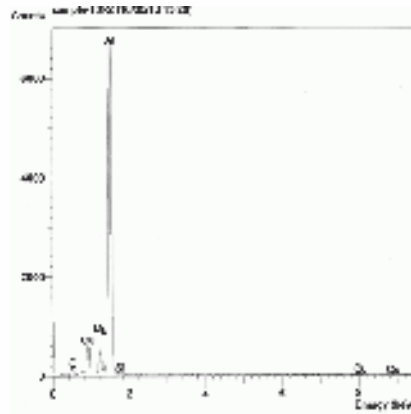
Gambar 4. Hasil SEM komposit *thixoforming* dengan fraksi volume 10 %  $\text{Al}_2\text{O}_3$



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	38.06	51.93
Mg K	ED	1.20	1.07
Al K	ED	56.14	45.42
Cu K	ED	4.60	1.58
Total		100.00	100.00

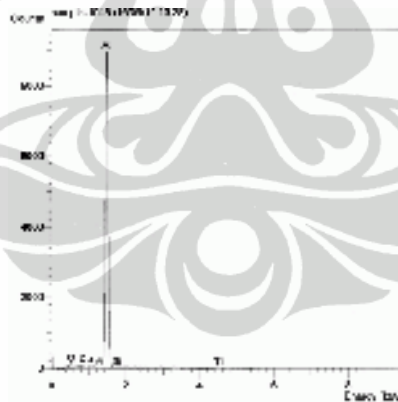
(a)



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	2.72	4.95
Mg K	ED	3.33	3.98
Al K	ED	76.90	82.83
Si K	ED	0.76	0.79
Cu K	ED	16.29	7.45
Total		100.00	100.00

(b)



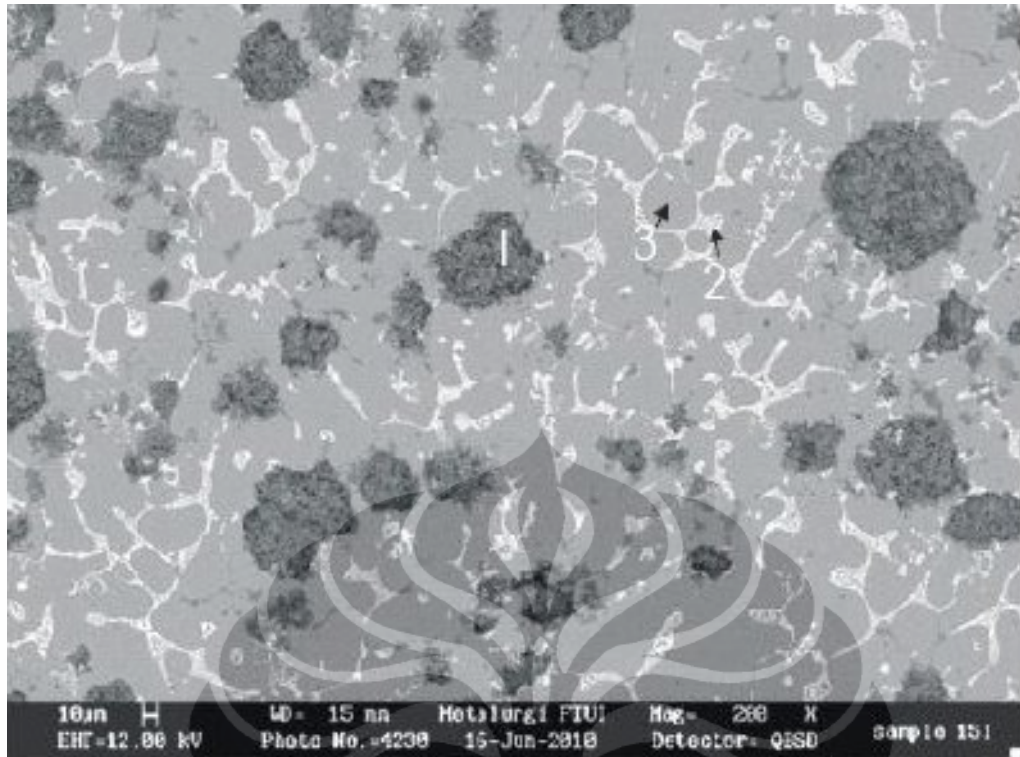
Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	3.34	5.71
Al K	ED	88.92	90.13
Si K	ED	1.03	1.00
Ti K	ED	1.92	1.10
Cu K	ED	4.78	2.06
Total		100.00	100.00

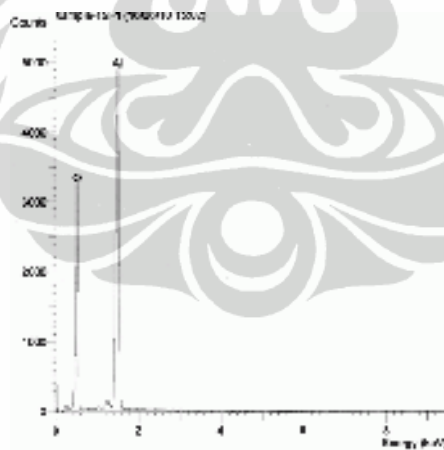
(c)

Gambar 4 Hasil EDS komposit *thixoforming* dengan fraksi volume 10 %  $\text{Al}_2\text{O}_3$  pada daerah : (a) 1, (b) 2, (c) 3





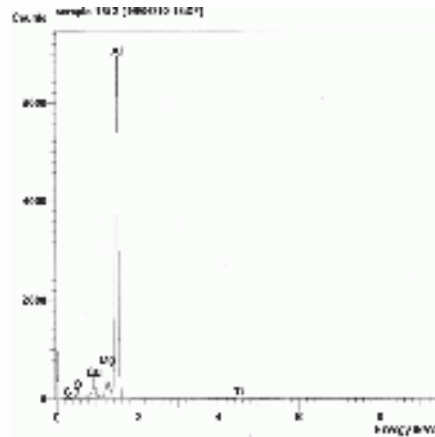
Gambar 5. Hasil SEM ingot komposit dengan fraksi volume 15 %  $\text{Al}_2\text{O}_3$



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	51.19	63.88
Al K	ED	48.81	36.12
Total		100.00	100.00

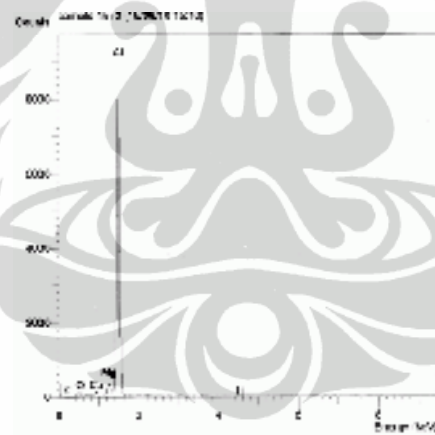
(a)



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
C K	ED	1.33	2.94
O K	ED	2.69	4.49
Mg K	ED	0.27	0.29
Al K	ED	91.39	90.33
Ti K	ED	0.98	0.54
Cu K	ED	3.35	1.41
Total		100.00	100.00

(b)

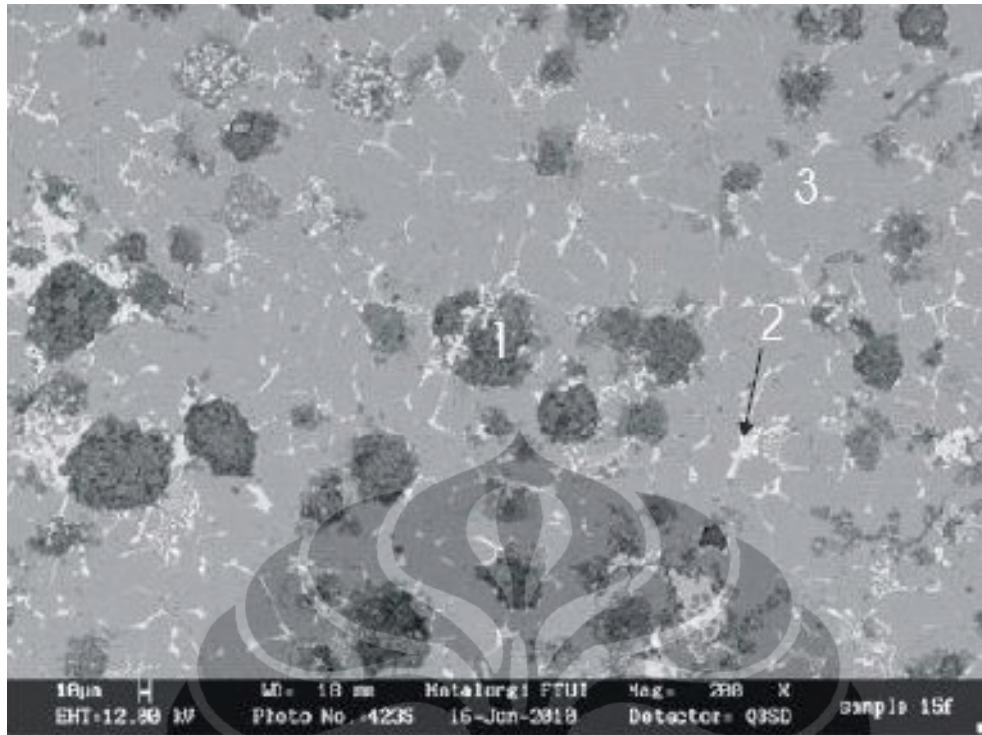


Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

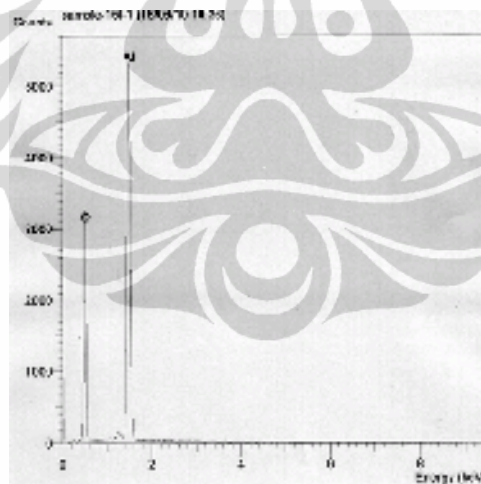
Elmt	Spect. Type	Element %	Atomic %
C K	ED	1.83	4.02
O K	ED	3.65	6.02
Mg K	ED	1.65	1.80
Al K	ED	87.66	85.79
Ti K	ED	1.53	0.85
Cu K	ED	3.67	1.53
Total		100.00	100.00

(c)

Gambar 5. Hasil EDS ingot komposit dengan fraksi volume 15 %  $\text{Al}_2\text{O}_3$  pada daerah : (a) 1, (b) 2, (c) 3



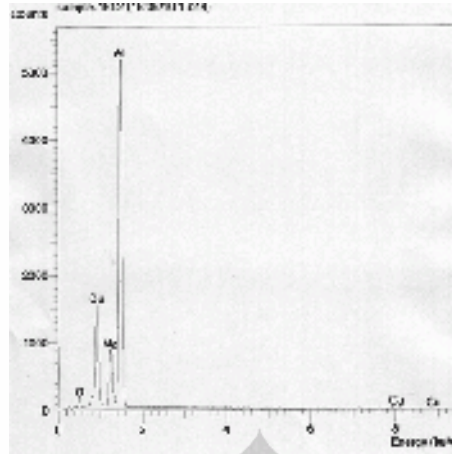
Gambar 6. Hasil SEM komposit *thixoforming* dengan fraksi volume 15 %  $\text{Al}_2\text{O}_3$



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	48.39	61.26
Al K	ED	51.61	38.74
Total		100.00	100.00

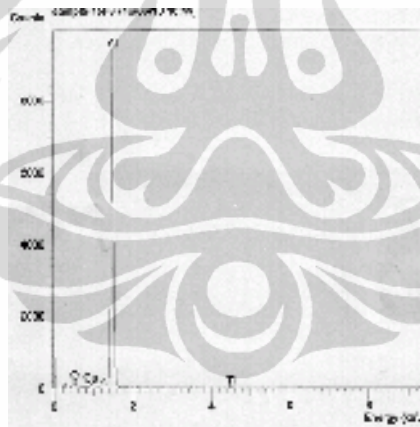
(a)



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	2.20	4.61
Mg K	ED	7.07	9.74
Al K	ED	52.98	65.76
Cu K	ED	37.75	19.89
Total		100.00	100.00

(b)

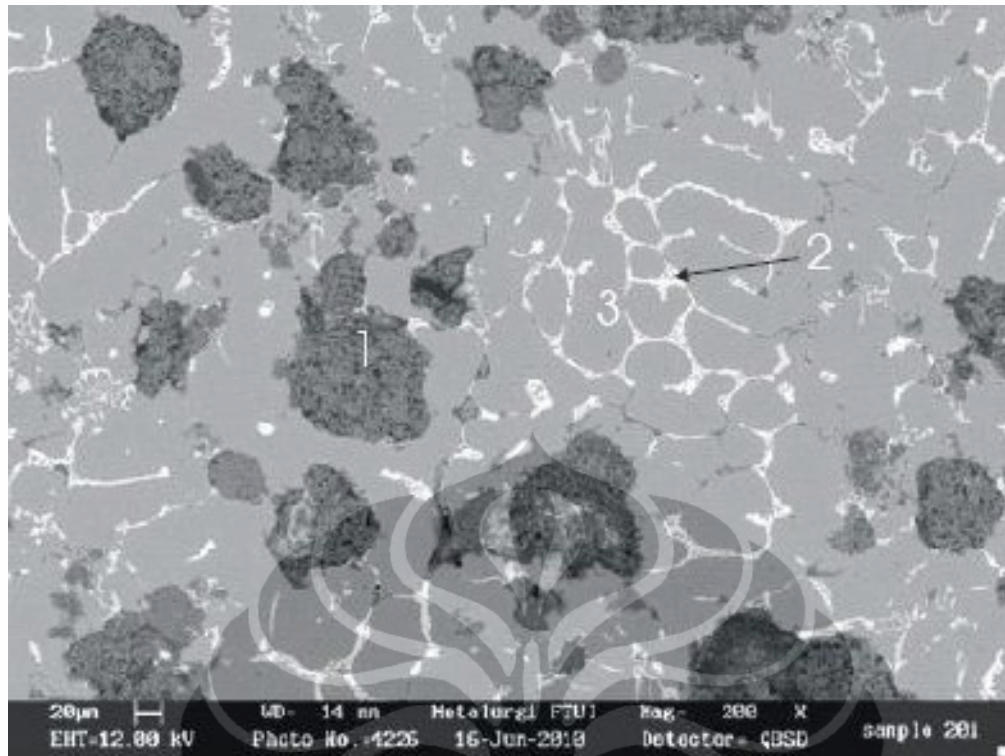


Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

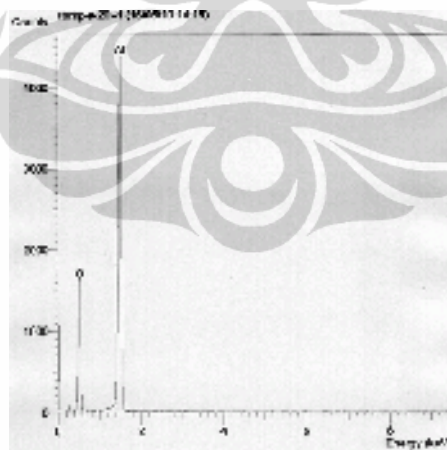
Elmt	Spect. Type	Element %	Atomic %
O K	ED	4.88	8.17
Al K	ED	90.04	89.42
Ti K	ED	1.90	1.06
Cu K	ED	3.18	1.34
Total		100.00	100.00

(c)

Gambar 6. Hasil EDS komposit *thixoforming* dengan fraksi volume 15 %  $\text{Al}_2\text{O}_3$  pada daerah : (a) 1, (b) 2, (c) 3



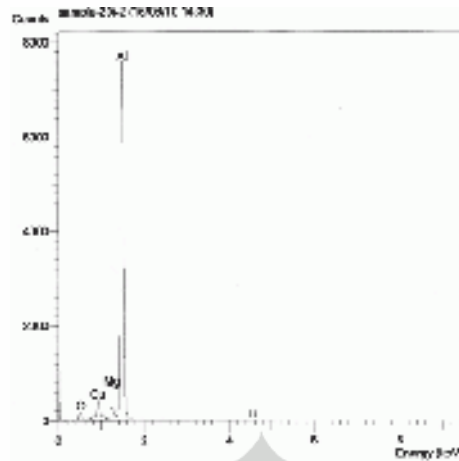
Gambar 7. Hasil SEM ingot komposit dengan fraksi volume 20 %  $\text{Al}_2\text{O}_3$



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	40.32	53.26
Al K	ED	59.68	46.74
Total		100.00	100.00

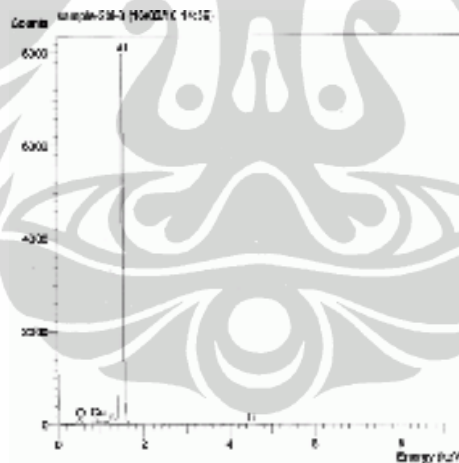
(a)



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	3.80	6.63
Mg K	ED	0.40	0.46
Al K	ED	85.10	88.08
Ti K	ED	0.93	0.54
Cu K	ED	9.77	4.29
Total		100.00	100.00

(b)

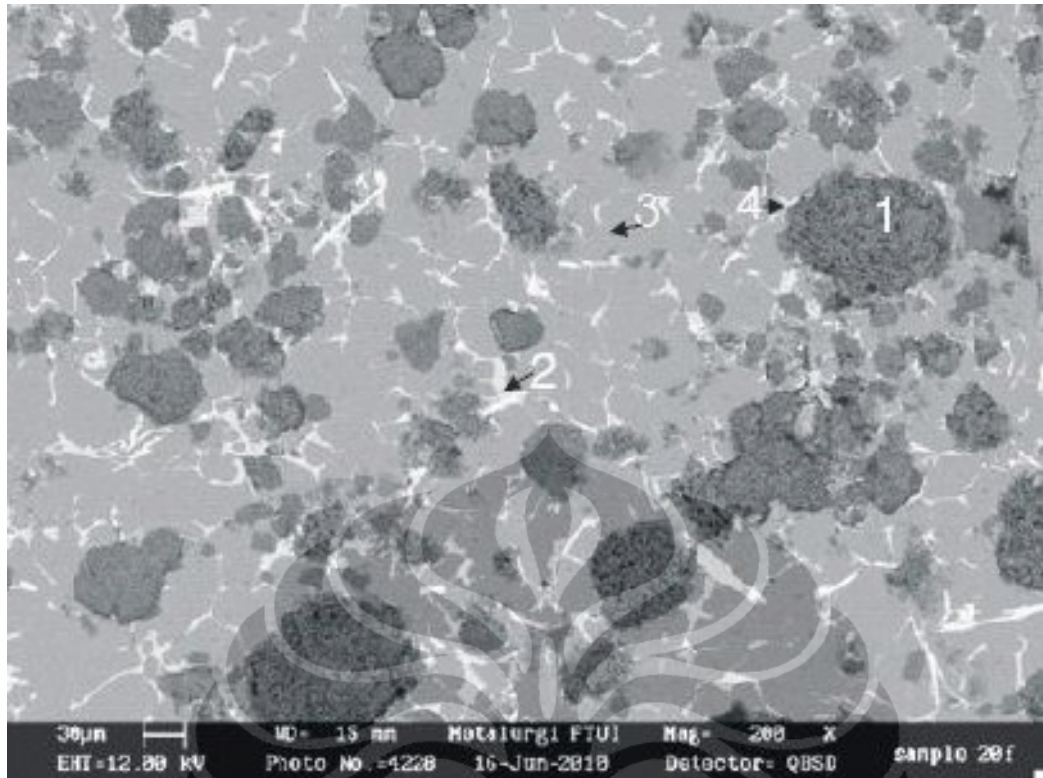


Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

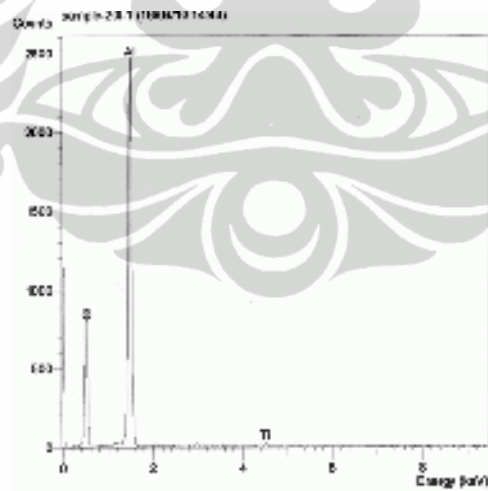
Elmt	Spect. Type	Element %	Atomic %
O K	ED	3.07	5.25
Al K	ED	90.28	91.66
Ti K	ED	1.60	0.92
Cu K	ED	5.05	2.18
Total	ED	100.00	100.00

(c)

Gambar 7. Hasil EDS ingot komposit dengan fraksi volume 20 %  $\text{Al}_2\text{O}_3$  pada daerah : (a) 1, (b) 2, (c) 3



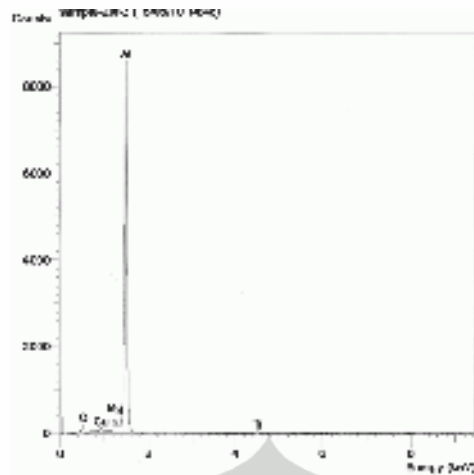
Gambar 8. Hasil SEM komposit *thixoforming* dengan fraksi volume 20 %  $\text{Al}_2\text{O}_3$



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	38.16	51.35
Al K	ED	59.88	47.78
Ti K	ED	1.98	0.88
Total		100.00	100.00

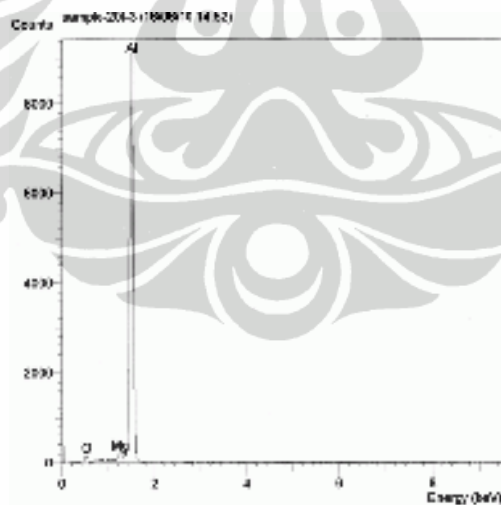
(a)



Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	4.82	8.13
Mg K	ED	0.11	0.12
Al K	ED	88.33	88.40
Ti K	ED	3.45	1.95
Cu K	ED	3.29	1.40
Total		100.00	100.00

(b)

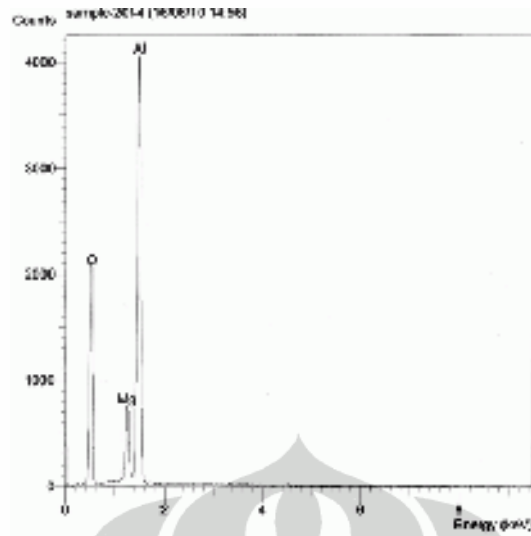


Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	3.95	6.49
Mg K	ED	0.75	0.81
Al K	ED	95.29	92.70
Total		100.00	100.00

(c)





Quantitative method : ZAF (2 iterations).  
Analyzed all elements and normalized results.

Elmt	Spect. Type	Element %	Atomic %
O K	ED	41.41	54.05
Mg K	ED	7.12	6.12
Al K	ED	51.47	39.83
Total		100.00	100.00

(d)

Gambar 8. Hasil EDS komposit *thixoforming* dengan fraksi volume 20 pada daerah : (a) 1, (b) 2, (c) 3, (d) 4

## Lampiran 2

## Data Uji Kekerasan

Tabel Kekerasan ingot komposit as cast

Pengulangan HRB	Fraksi Volume Alumina				
	0	5	10	15	20
1	48.76	62.72	75.70	67.39	78.10
2	48.54	59.09	65.81	59.46	74.86
3	57.64	61.60	63.94	57.78	68.85
Jumlah( $\Sigma$ )	154.94	183.41	205.45	184.64	221.81
Rata -rata	51.65	61.14	68.48	61.55	73.94
Standart deviasi	5.19	1.86	6.32	5.13	4.69

Tabel Kekerasan hasil thixoforming tanpa perlakuan panas

Pengulangan HRB	Fraksi Volume Alumina				
	0	5	10	15	20
1	59.46	69.50	76.78	73.01	80.49
2	56.59	72.30	74.44	72.60	84.86
3	61.14	69.97	78.21	68.39	79.91
Jumlah( $\Sigma$ )	177.19	211.78	229.42	214.00	245.26
Rata -rata	59.06	70.59	76.47	71.33	81.75
Standart deviasi	2.30	1.50	1.90	2.56	2.70

Tabel Kekerasan hasil thixoforming setelah T6 dan Aging 16 jam

Pengulangan HRB	Fraksi Volume Alumina				
	0	5	10	15	20
1	66.51	78.66	82.51	73.62	86.39
2	69.50	75.91	80.61	74.75	101.58
3	70.93	86.65	91.52	71.32	99.32
Jumlah( $\Sigma$ )	206.94	241.22	254.64	219.69	287.29
Rata -rata	68.98	80.41	84.88	73.23	95.76
Standart deviasi	2.26	5.58	5.83	1.75	8.20

Tabel Kekerasan hasil thixoforming setelah T6 dan Aging 28 jam

Pengulangan HRB	Fraksi Volume Alumina				
	0	5	10	15	20
1	89.44	87.04	86.39	77.65	89.72
2	83.12	86.91	90.96	68.76	95.75
3	79.68	94.26	99.64	78.10	90.54
Jumlah( $\Sigma$ )	252.24	268.21	276.99	224.51	276.02
Rata -rata	84.08	89.40	92.33	74.84	92.01
Standart deviasi	4.95	4.21	6.73	5.27	3.27



## Lampiran 3

## Data Uji Keausan

Tabel 3.A Data Pengujian Aus Komposit As Cast

Pengulangan Lebar celah	Fraksi Volume Alumina				
	0	5	10	15	20
1	5.355	3.895	3.516	3.519	3.684
2	5.174	4.082	3.516	3.217	3.699
3	5.253	3.927	3.544	3.299	3.78
Jumlah( $\Sigma$ )	15.782	11.904	10.576	10.035	11.163
Rata -rata	5.260667	3.968	3.525333	3.345	3.721
Standart deviasi	0.090743	0.100015	0.016166	0.156167	0.051643

Pengulangan Volume Abrasiv	Fraksi Volume Alumina				
	0	5	10	15	20
1	2.560	0.985	0.725	0.727	0.834
2	2.309	1.134	0.725	0.555	0.844
3	2.417	1.010	0.742	0.599	0.900
Jumlah( $\Sigma$ )	7.286	3.129	2.191	1.880	2.578
Rata -rata	2.429	1.043	0.730	0.627	0.859
Standart deviasi	0.126	0.080	0.010	0.089	0.036

Pengulangan Laju Aus	Fraksi Volume Alumina				
	0	5	10	15	20
1	1.28E-02	4.93E-03	3.62E-03	3.63E-03	4.17E-03
2	1.15E-02	5.67E-03	3.62E-03	2.78E-03	4.22E-03
3	1.21E-02	5.05E-03	3.71E-03	2.99E-03	4.50E-03
Jumlah( $\Sigma$ )	3.64E-02	1.56E-02	1.10E-02	9.40E-03	1.29E-02
Rata -rata	1.21E-02	5.21E-03	3.65E-03	3.13E-03	4.30E-03
Standart deviasi	6.29E-04	3.99E-04	5.04E-05	4.46E-04	1.80E-04

Tabel 3.B Data Pengujian Aus Komposisi Hasil Thixoforming Tanpa Perlakuan Panas

Pengulangan Lebar celah	Fraksi Volume Alumina				
	0	5	10	15	20
1	4.842	3.791	3.449	3.246	2.654
2	4.377	3.774	3.398	3.031	2.83
3	4.766	3.609	3.44	3.271	2.51
Jumlah( $\Sigma$ )	13.985	11.174	10.287	9.548	7.994
Rata -rata	4.661667	3.724667	3.429	3.182667	2.664667
Standart deviasi	0.24944	0.10053	0.027221	0.131941	0.160266

Pengulangan Volume Abrasiv	Fraksi Volume Alumina				
	0	5	10	15	20
1	1.893	0.908	0.684	0.570	0.312
2	1.398	0.896	0.654	0.464	0.378
3	1.805	0.784	0.679	0.583	0.264
Jumlah( $\Sigma$ )	5.096	2.588	2.017	1.618	0.953
Rata -rata	1.699	0.863	0.672	0.539	0.318
Standart deviasi	0.264	0.069	0.016	0.065	0.057

Pengulangan Laju Aus	Fraksi Volume Alumina				
	0	5	10	15	20
1	9.46E-03	4.54E-03	3.42E-03	2.85E-03	1.56E-03
2	6.99E-03	4.48E-03	3.27E-03	2.32E-03	1.89E-03
3	9.02E-03	3.92E-03	3.39E-03	2.92E-03	1.32E-03
Jumlah( $\Sigma$ )	2.55E-02	1.29E-02	1.01E-02	8.09E-03	4.77E-03
Rata -rata	8.49E-03	4.31E-03	3.36E-03	2.70E-03	1.59E-03
Standart deviasi	1.32E-03	3.44E-04	7.97E-05	3.27E-04	2.87E-04

Tabel 3.C Data Pengujian Aus Komposit Hasil Thixoforming dan T6 Aging 16 jam

Pengulangan Lebar celah	Fraksi Volume Alumina				
	0	5	10	15	20
1	4.285	3.647	3.089	3.173	2.338
2	4.179	3.637	3.1	2.88	2.673
3	4.503	3.728	3.238	3.191	2.563
Jumlah( $\Sigma$ )	12.967	11.012	9.427	9.244	7.574
Rata -rata	4.322333	3.670667	3.142333	3.081333	2.524667
Standart deviasi	0.165195	0.049903	0.083032	0.174592	0.170758

Pengulangan Volume Abrasiv	Fraksi Volume Alumina				
	0	5	10	15	20
1	1.312	0.809	0.491	0.533	0.213
2	1.217	0.802	0.497	0.398	0.318
3	1.522	0.864	0.566	0.542	0.281
Jumlah( $\Sigma$ )	4.051	2.475	1.554	1.473	0.812
Rata -rata	1.350	0.825	0.518	0.491	0.271
Standart deviasi	0.156	0.034	0.042	0.080	0.053

Pengulangan Laju Aus	Fraksi Volume Alumina				
	0	5	10	15	20
1	6.56E-03	4.04E-03	2.46E-03	2.66E-03	1.07E-03
2	6.08E-03	4.01E-03	2.48E-03	1.99E-03	1.59E-03
3	7.61E-03	4.32E-03	2.83E-03	2.71E-03	1.40E-03
Jumlah( $\Sigma$ )	2.03E-02	1.24E-02	7.77E-03	7.36E-03	4.06E-03
Rata -rata	6.75E-03	4.12E-03	2.59E-03	2.45E-03	1.35E-03
Standart deviasi	7.82E-04	1.69E-04	2.08E-04	4.02E-04	2.67E-04

Tabel 3.D Data Pengujian Aus Komposit Hasil Thixoforming dan T6 Aging 28 jam

Pengulangan Lebar celah	Fraksi Volume Alumina				
	0	5	10	15	20
1	3.676	3.504	3.063	3.139	3.170
2	4.257	3.259	2.938	3.032	3.270
3	4.686	3.058	3.089	3.092	3.195
Jumlah( $\Sigma$ )	12.619	9.821	9.090	9.263	9.635
Rata -rata	4.206	3.274	3.030	3.088	3.212
Standart deviasi	0.507	0.223	0.081	0.054	0.052

Pengulangan Volume Abrasiv	Fraksi Volume Alumina				
	0	5	10	15	20
1	0.828	0.717	0.479	0.516	0.531
2	1.286	0.577	0.423	0.465	0.583
3	1.716	0.477	0.491	0.493	0.544
Jumlah( $\Sigma$ )	3.830	1.771	1.393	1.473	1.658
Rata -rata	1.277	0.590	0.464	0.491	0.553
Standart deviasi	0.444	0.121	0.037	0.026	0.027

Pengulangan Laju Aus	Fraksi Volume Alumina				
	0	5	10	15	20
1	4.14E-03	3.59E-03	2.40E-03	2.58E-03	2.66E-03
2	6.43E-03	2.89E-03	2.11E-03	2.32E-03	2.91E-03
3	8.58E-03	2.38E-03	2.46E-03	2.46E-03	2.72E-03
Jumlah( $\Sigma$ )	1.91E-02	8.86E-03	6.97E-03	7.37E-03	8.29E-03
Rata -rata	6.38E-03	2.95E-03	2.32E-03	2.46E-03	2.76E-03
Standart deviasi	2.22E-03	6.04E-04	1.83E-04	1.28E-04	1.35E-04

## Lampiran 4

## Data Perhitungan Densitas dan Porositas

Tabel 4.A perhitungan densitas dan porositas pada ingot komposit as cast

no	kode ingot	berat (gram)		V sampel	Densitas		% porositas
		kering	basah		Dp	Dteori	
1	Ingot-0	13.7	5	5.016	2.731	3.01	9.258
2	Ingot-5	29.1	10.4	10.433	2.789	3.06	8.849
3	Ingot-10	24.4	9	9.029	2.703	3.1	12.822
4	Ingot-15	34	12.8	12.841	2.648	3.15	15.941
5	Ingot-20	24.2	8.8	8.828	2.741	3.2	14.334

Tabel 4.B Perhitungan densitas dan porositas pada komposit hasil thixoforming tanpa perlakuan panas

no	kode SSF	berat (gram)		V sampel	Densitas		% porositas
		kering	basah		Dp	Dteori	
1	SSF-0	14	4.8	4.815	2.907	3.01	3.407
2	SSF-10	16.4	5.6	5.618	2.919	3.06	4.598
3	SSF-15	12.2	4.2	4.213	2.896	3.1	6.594
4	SSF-15	15	5.4	5.417	2.769	3.15	12.096
5	SSF-20	12.6	4.4	4.414	2.855	3.2	10.795



## Lampiran 5

## Data Perhitungan Uji Tarik

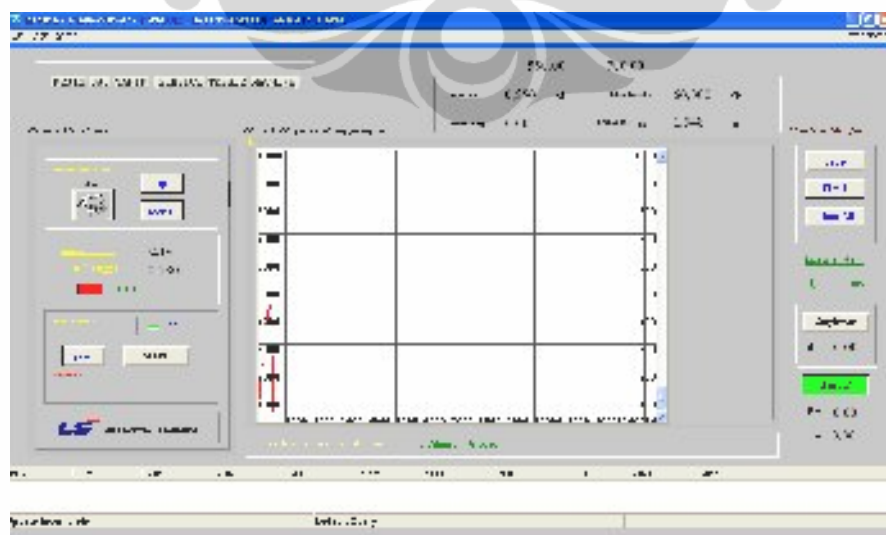
Tabel 5.A Data dimensi spesimen uji tarik

% Vf alumina	spesimen							Gl	w	d	A
		w1	w2	w3	d1	d2	d3				
0	A1	6.5	6.5	6.8	4	4	4	36	6.60	4.00	26.40
	A2	6.6	6.5	6.3	3.7	3.7	3.7	36	6.47	3.70	23.93
5	B1	5.9	6.3	6.5	4.3	4.2	4.3	36	6.23	4.27	26.60
	B2	6.1	6.4	6.5	4.7	4.7	4.6	36	6.33	4.67	29.56
10	C1	6.1	6.1	6.1	4.1	4.1	4.1	36	6.10	4.10	25.01
	C2	6.1	6.4	6.5	3.8	3.8	3.9	36	6.33	3.83	24.28
15	D1	6.6	6.6	6.6	3.7	3.8	3.8	36	6.60	3.77	24.86
	D2	6.9	6.5	6.6	4.2	4.4	4.1	36	6.67	4.23	28.22
20	E1	6.1	6.3	6.4	3.9	4	3.9	36	6.27	3.93	24.65
	E2	6.6	6.3	6.6	4.9	4.8	4.9	36	6.50	4.87	31.63

Tabel 5.B Data tegangan hasil uji tarik

Tegangan (N)				
A	B	C	D	E
0	0			
11	14			
25	28		0	
25	28	4	2	
25	50	18	14	
62	64	18	14	
76	78	41	35	
76	78	53	50	
98	100	69	64	
112	114	69	64	
126	128	91	85	
126	128	104	100	
148	151	119	114	
162	165	119	114	
177	180	141	135	
177	194	154	151	
177	194			
213	215			

227	229			
227	229			
249	252			
263	266			
277	280			
277	280			
300	302			
314	316			
328	330			
328	330			
350	352			
364	366			
378	381			
378	381			
400	403			
415	417			
429	431			
429	431			
451				
465				
479				
479				
500				
515				
529				
529				



Gambar 5.C Tampilan pada layar komputer saat pengujian tarik.