

LAMPIRAN A
PERHITUNGAN

Lampiran A. Contoh Perhitungan

1. Burn Off length (mm)

$$T_1 - T_0 = \text{Burn Off length}$$

Ket:

T_1 = Panjang awal

T_0 = Panjang akhir

$\text{Burn off length} \approx \Delta T$

2. Flash (mm^3) $\approx V$

$$V = \pi r^2 \times \Delta T$$

Ket:

V = volume tabung

π = nilai 3,14

r = jari jari lingkaran

ΔT = burn off length

Contoh perhitungan

$$V = 3,14 \times 6^2 \times 10$$

$$V = 1130,4$$

3. Kekuatan Tarik (MPa)

a.
$$\sigma = \frac{F}{A}$$

b.
$$A = \pi \times (D_0 \div 2)^2$$

Ket:

F = Gaya yang diterima (dapat dilihat pada lampiran B.7)

A = Alas pada sampel (dapat dilihat pada lampiran B.6)

π = nilai 3,14

D_0 = Diameter awal sampel

Contoh perhitungan

$$A = 3,14 \times (12,01/2)^2$$

$$A = 113,2284$$

$$\sigma = \frac{8,7 \times 1000}{113,2284}$$

$$\sigma = 76,8$$

4. Kalibrasi bar ke newton

a. Ekstrapolasi

$$y(n) = n_1 + \frac{(n - n_1)}{(n_2 - n_1)} \times (n_2 - n_1)$$

Contoh perhitungan

$$y(40) = 2116,75 + \frac{(40-30)}{(45-30)} \times (4264 - 2116,75)$$

$$40 \text{ bar} = 3548,25 \text{ N}$$

5. Kalibrasi *newton* ke MPa $\approx$ (P)

$$P = \frac{F}{A}$$

Ket

P = Tekanan yang dihasilkan

F = Gaya hasil ekstrapolasi

A = Diameter batang hidrolik (113,0972 mm²)

Contoh perhitungan

$$P = \frac{3548,25}{113,0972}$$

$$P = 31,373$$

6. Perhitungan efisiensi %

$$e\% = \left(\frac{\sigma_1}{\sigma_0} \right) \times 100\%$$

Ket

σ_1 = Data hasil uji tarik

σ_0 = Data base metal uji tarik

Contoh perhitungan

Efisiensi kekuatan Tarik

$$e\% = \frac{92,6}{227,1} \times 100\%$$

$$= 41\%$$

7. Rata-rata efisiensi kekuatan Kekerasan

$$e\% = \left(\frac{HV_1}{HV_0} \right) \times 100\%$$

Ket

HV₁ = Data hasil uji kekerasan

HV₀ = Data base metal uji kekerasan

Contoh perhitungan

$$e\% = \frac{65,6}{83} \times 100\%$$

$$= 79\%$$

LAMPIRAN B
DATA PENELITIAN

Lampiran B. Data Penelitian

B.1 Kekerasan *Base Material* Aluminium 6063



Frank findlest
HV 3 kgf



NO.	
1.	84,1
2.	82,8
3.	84,1
4.	83,5
5.	80,3
	82,96

B.2 Komposisi Material Tembaga



LABORATORIUM TEKNOLOGI KEKUATAN STRUKTUR
BADAN RISET DAN INOVASI NASIONAL
 Kawasan Puspiptek Gd. 220, Setu, Tangerang Selatan 15314,
 web: www.brin.go.id

Chemical Result

Probe Nr. / sample ID : round bar Cu
 Grundwerkstoff / material :

Kunde / customer : Agus Suhartono
 Abmessung / dimension :

Kom.-Nr. / commission :
 Zusatzwerkstoff / filler metals :

Labor Nr. / lab-no. :
 Wärmebehandlung / heat treatment :

PTQ-Nr. / PTQ-no. :
 Schmelze-Nr. / heat-no. :

Spektralanalyse PMI-MASTER-Pro Werkstoff / grade :

	Cu	Zn	Pb	Sn	Mn	Fe	Ni	Si
1	99.8	0.0527	< 0.200	0.0235	0.0070	0.0089	0.0126	< 0.0040
2	99.7	0.0449	< 0.200	0.0209	0.0067	0.0080	0.0145	0.0057
3	99.7	0.0357	< 0.200	0.0242	0.0064	0.0110	0.0172	0.0051
Ave	99.7	0.0444	< 0.200	0.0229	0.0067	0.0093	0.0147	0.0040

	Mg	Cr	Al	As	Be	Ag	Co	Bi
1	< 0.0005	0.0020	< 0.0010	0.0278	< 0.0010	0.0048	< 0.0020	0.0097
2	< 0.0005	0.0016	0.0013	0.0318	< 0.0010	0.0052	0.0037	0.0087
3	< 0.0005	0.0015	0.0033	0.0317	< 0.0010	0.0052	< 0.0020	0.0103
Ave	< 0.0005	0.0017	0.0018	0.0304	< 0.0010	0.0051	< 0.0020	0.0096

	Cd	Zr	Se	Ti
1	< 0.0020	< 0.0010	0.0092	< 0.0010
2	< 0.0020	< 0.0010	0.0078	< 0.0010
3	< 0.0020	< 0.0010	0.0104	< 0.0010
Ave	< 0.0020	< 0.0010	0.0091	< 0.0010

Ort / town

Datum / date
2/29/2024

Prüfer / tester
Aswandi

Sachverständiger / engineer
Tirta

B.3 Komposisi Material Aluminium 6063



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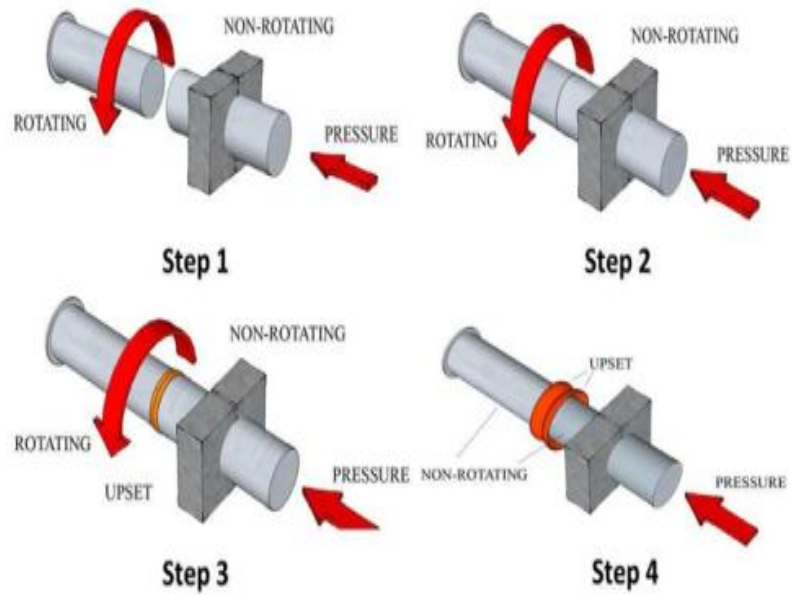
Chemical Result

Probe Nr. / sample ID : patahan Al uji tarik	Grundwerkstoff / material : Al alloy
Kunde / customer : Khotib	Abmessung / dimension :
Kom.-Nr. / commission :	Zusatzwerkstoff / filler metals :
Labor Nr. / lab-no. :	Wärmebehandlung / heat treatment :
PTQ-Nr. / PTQ-no. :	Schmelze-Nr. / heat-no. :

Spektralanalyse PMI-MASTER-Pro	Werkstoff / grade :																																																																																										
<table style="width: 100%; border-collapse: collapse;"> <tr> <th></th> <th>Al</th> <th>Si</th> <th>Fe</th> <th>Cu</th> <th>Mn</th> <th>Mg</th> <th>Zn</th> <th>Cr</th> </tr> <tr> <td>1</td> <td>98.7</td> <td>0.521</td> <td>0.173</td> <td>0.0072</td> <td>0.0024</td> <td>0.524</td> <td>< 0.0150</td> <td>0.0069</td> </tr> <tr> <td>2</td> <td>98.3</td> <td>0.576</td> <td>0.199</td> <td>0.0091</td> <td>0.0093</td> <td>0.517</td> <td>0.0601</td> <td>0.0135</td> </tr> <tr> <td>3</td> <td>98.6</td> <td>0.502</td> <td>0.186</td> <td>0.0051</td> <td>0.0022</td> <td>0.543</td> <td>0.0483</td> <td>0.0012</td> </tr> <tr> <td>Ave</td> <td>98.5</td> <td>0.533</td> <td>0.186</td> <td>0.0071</td> <td>0.0046</td> <td>0.528</td> <td>0.0361</td> <td>0.0072</td> </tr> </table>		Al	Si	Fe	Cu	Mn	Mg	Zn	Cr	1	98.7	0.521	0.173	0.0072	0.0024	0.524	< 0.0150	0.0069	2	98.3	0.576	0.199	0.0091	0.0093	0.517	0.0601	0.0135	3	98.6	0.502	0.186	0.0051	0.0022	0.543	0.0483	0.0012	Ave	98.5	0.533	0.186	0.0071	0.0046	0.528	0.0361	0.0072	<table style="width: 100%; border-collapse: collapse;"> <tr> <th></th> <th>Ni</th> <th>Ti</th> <th>Be</th> <th>Ca</th> <th>Pb</th> <th>Sn</th> <th>Sr</th> <th>V</th> </tr> <tr> <td>1</td> <td>< 0.0050</td> <td>0.0187</td> <td>< 0.0010</td> <td>< 0.0010</td> <td>< 0.0050</td> <td>< 0.0050</td> <td>< 0.0010</td> <td>0.0098</td> </tr> <tr> <td>2</td> <td>0.0211</td> <td>0.0189</td> <td>< 0.0010</td> <td>< 0.0010</td> <td>0.0082</td> <td>0.0700</td> <td>< 0.0010</td> <td>0.0126</td> </tr> <tr> <td>3</td> <td>0.0096</td> <td>0.0144</td> <td>< 0.0010</td> <td>< 0.0010</td> <td>< 0.0050</td> <td>< 0.0050</td> <td>< 0.0010</td> <td>0.0074</td> </tr> <tr> <td>Ave</td> <td>0.0113</td> <td>0.0174</td> <td>< 0.0010</td> <td>< 0.0010</td> <td>< 0.0050</td> <td>0.0244</td> <td>< 0.0010</td> <td>0.0099</td> </tr> </table>		Ni	Ti	Be	Ca	Pb	Sn	Sr	V	1	< 0.0050	0.0187	< 0.0010	< 0.0010	< 0.0050	< 0.0050	< 0.0010	0.0098	2	0.0211	0.0189	< 0.0010	< 0.0010	0.0082	0.0700	< 0.0010	0.0126	3	0.0096	0.0144	< 0.0010	< 0.0010	< 0.0050	< 0.0050	< 0.0010	0.0074	Ave	0.0113	0.0174	< 0.0010	< 0.0010	< 0.0050	0.0244	< 0.0010	0.0099
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Ort / town	Datum / date 8/30/2023	Prüfer / tester Aswandi	Sachverständiger / engineer
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B.4 Skema Penyambungan Sampel

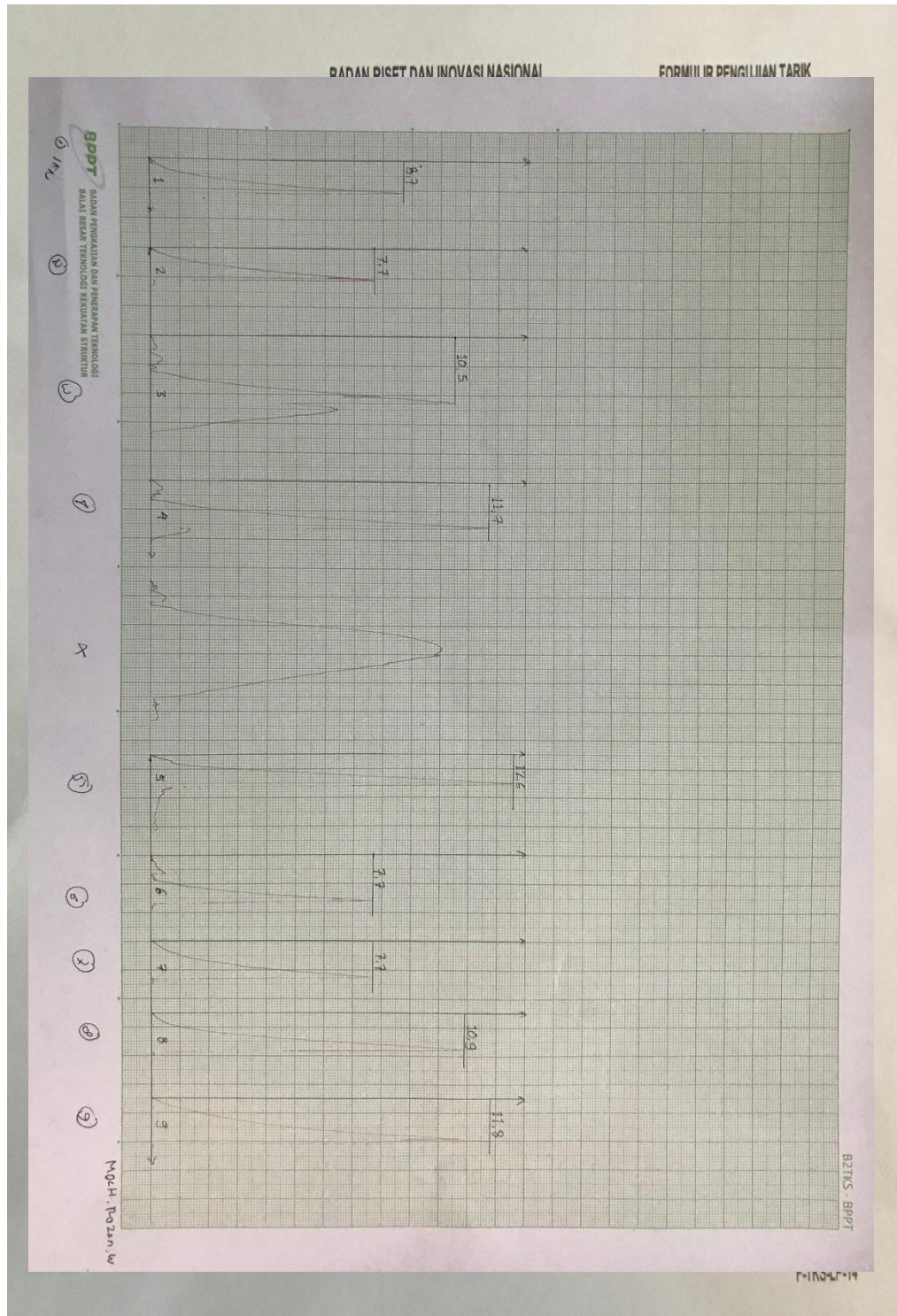


B.5 Data Uji kekerasan (HV)

	1	2	3	4	5	6	7	8	9
1	50	45	46	55	48	50	49	40	50
2	52	48	47	56	51	52	51	45	52
3	58	53	49	59	55	54	52	50	53
4	61	57	53	61	57	56	54	56	59
5	50	60	61	64	67	68	70	70	67
6	84	75	86	85	87	86	84	88	80

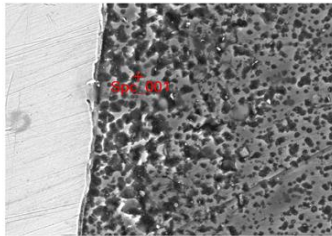
7	87	83	91	88	90	88	90	90	84
8	90	87	96	92	95	92	92	92	93
9	95	94	99	93	97	99	96	95	96

B.6 Data Sebelum Uji Tarik

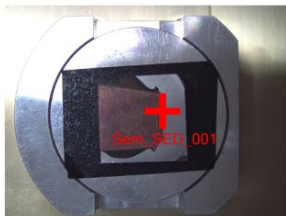
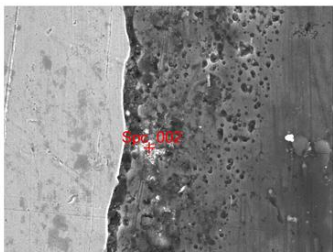
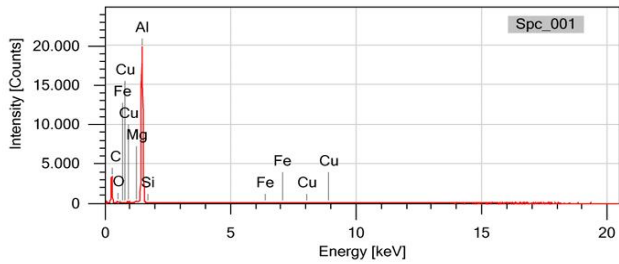


B.7 Data Sesudah Uji Tarik

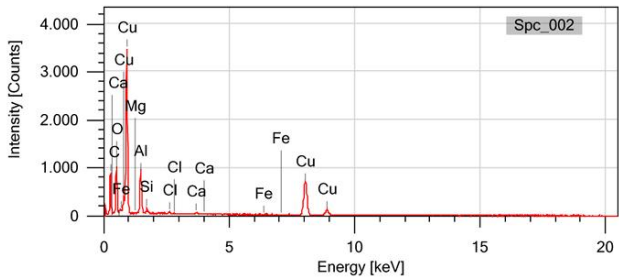
B.8 Data SEM (scanning electron microscopy)

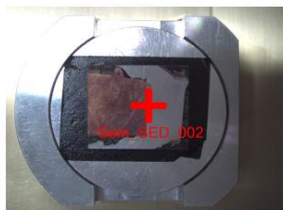
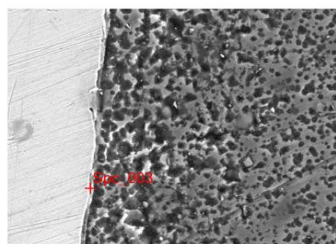


ElementLine	Mass%	Atom%
C K	63,59±0,25	79,30±0,31
O K	1,90±0,06	1,78±0,06
Mg K	0,16±0,01	0,10±0,01
Al K	33,38±0,12	18,53±0,06
Si K	0,19±0,01	0,10±0,01
Fe K	0,19±0,02	0,05±0,00
Cu K	0,59±0,04	0,14±0,01
Total	100,00	100,00
Spc_001	Fitting ratio 0,0178	

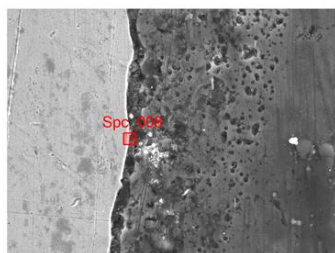
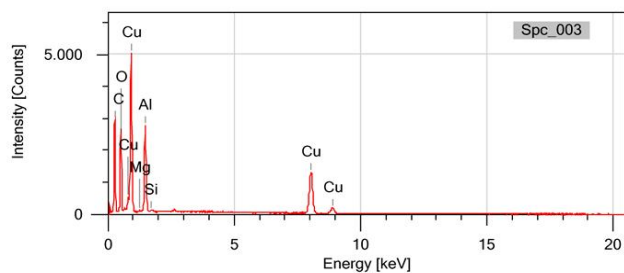


ElementLine	Mass%	Atom%
C K	35,42±0,27	58,70±0,46
O K	18,27±0,26	22,72±0,33
Mg K	0,11±0,04	0,09±0,03
Al K	8,52±0,14	6,28±0,11
Si K	0,63±0,05	0,45±0,03
Cl K	0,30±0,03	0,17±0,02
Ca K	0,34±0,03	0,17±0,02
Fe K	0,18±0,03	0,06±0,01
Cu K	36,23±0,47	11,35±0,15
Total	100,00	100,00
Spc_002	Fitting ratio 0,0635	

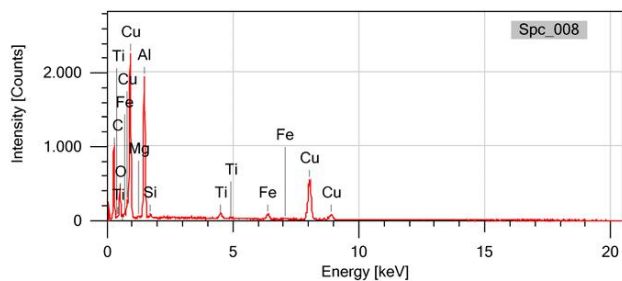


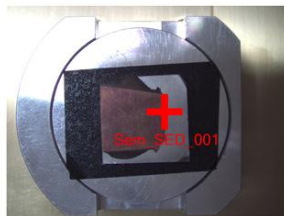
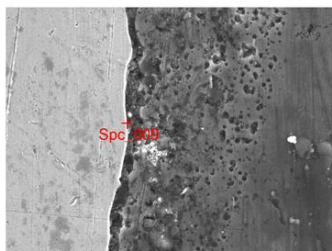


ElementLine	Mass%	Atom%
C K	42,61±0,18	62,84±0,26
O K	21,28±0,19	23,56±0,21
Mg K	0,07±0,02	0,05±0,01
Al K	9,09±0,09	5,96±0,06
Si K	0,18±0,02	0,11±0,01
Cu K	26,76±0,26	7,46±0,07
Total	100,00	100,00
Spc_003	Fitting ratio 0,0487	

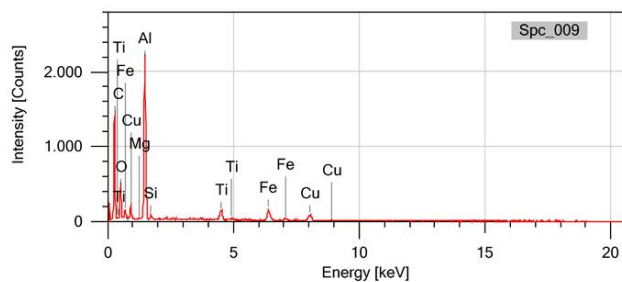


ElementLine	Mass%	Atom%
C K	44,81±0,32	69,44±0,50
O K	8,77±0,20	10,21±0,24
Mg K	0,22±0,03	0,17±0,02
Al K	15,94±0,18	11,00±0,12
Si K	0,45±0,04	0,30±0,03
Ti K	0,96±0,05	0,37±0,02
Fe K	1,67±0,08	0,56±0,03
Cu K	27,17±0,41	7,96±0,12
Total	100,00	100,00
Spc_008	Fitting ratio 0,0555	



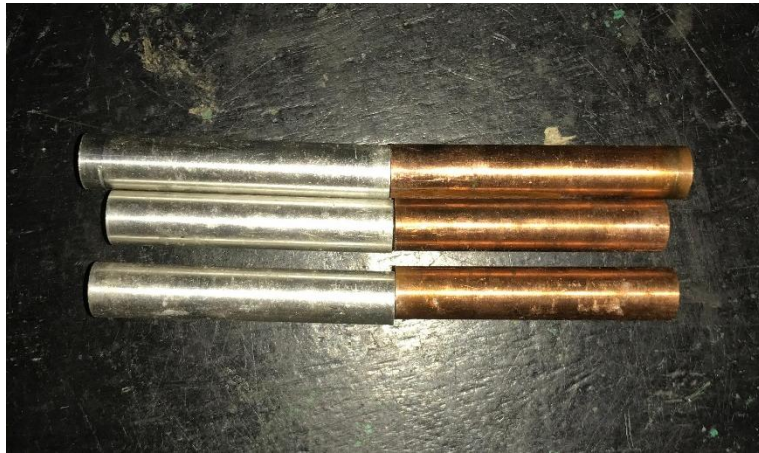


Element	Line	Mass%	Atom%
C	K	57,18±0,34	72,77±0,44
O	K	15,86±0,32	15,16±0,31
Mg	K	0,01±0,02	0,00±0,01
Al	K	15,86±0,17	8,99±0,10
Si	K	0,34±0,03	0,19±0,02
Ti	K	2,16±0,08	0,69±0,02
Fe	K	4,12±0,13	1,13±0,04
Cu	K	4,46±0,18	1,07±0,04
Total		100,00	100,00
Spc_009		Fitting ratio 0,0789	



LAMPIRAN C
GAMBAR ALAT DAN BAHAN

Lampiran C. Gambar Alat dan Bahan



Gambar C.1 Bahan Aluminium dan Tembaga



Gambar C.2 Ampelas



Gambar C.3 Aquades



Gambar C.4 Etanol



Gambar C.5 gelas beker



Gambar C.6 Gelas ukur



Gambar C.7 Gerinda



Gambar C.8 Kain *Polish*



Gambar C.9 Mesin *Grinding*



Gambar C.10 mesin bubut



Gambar C.11 Mesin Uji Kekerasan



Gambar C.12 Mikroskop Optik



Gambar C.13 Pasta *Polish*



Gambar C.14 Pipet



Gambar C.15 Tisu



Gambar C.16 Alat *Friction welding*



Gambar C.17 Alat uji tarik

