

**LAMPIRAN A**  
**CONTOH PERHITUNGAN**

### A.1 Perhitungan Volume Cetakan

$$\begin{aligned}\text{Luas Alas} &= \frac{1}{2} (2 + 2,5) \times 15 \\ &= 33,75 \text{ cm}^2\end{aligned}$$

$$\begin{aligned}\text{Volume Cetakan} &= \text{Luas alas} \times t \\ &= 33,75 \times 2,5 \\ &= 67,5 \text{ cm}^3\end{aligned}$$

### A.2 Perhitungan Kebutuhan Sampel

$$\begin{aligned}\text{Tembaga} &= \text{Volume Cetakan} \times \rho \text{ Tembaga} \\ &= 67,5 \text{ cm}^3 \times 8,96 \text{ g/cm}^3 \\ &= 604,8 \text{ gr} \sim 605 \text{ gr} \\ &= 605 \times \frac{90}{100} \\ &= 545 \text{ gr}\end{aligned}$$

$$\begin{aligned}\text{Aluminium} &= \frac{10}{100} \times 605 \text{ gr} \\ &= 60,5 \text{ gr}\end{aligned}$$

$$\begin{aligned}0,6\% \text{ Mangan} &= \frac{0,6}{100} \times 605 \text{ gr} \\ &= 3,63 \text{ gr}\end{aligned}$$

$$0,8\% \text{ Mangan} = \frac{0,8}{100} \times 605 \text{ gr}$$

$$= 4,84 \text{ gr}$$

$$1,0\% \text{ Mangan} = \frac{1,0}{100} \times 605 \text{ gr}$$

$$= 6,059 \text{ gr}$$

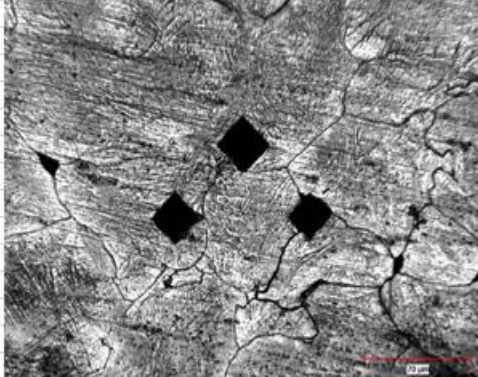
**LAMPIRAN B**

**HASIL PENELITIAN**

## Lampiran B. Hasil Penelitian

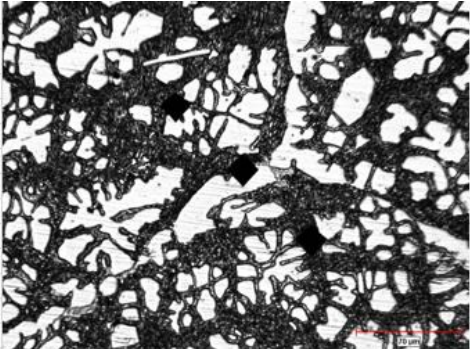
### B.1 Hasil Uji Kekerasan

Sample Name	: A0			
Free Text	:			
Calibration	: 0.465909 $\mu\text{m}/\text{pixel}$			
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	$\mu\text{m}$	$\mu\text{m}$	HV0.1
	1	29.7	29.3	213.57
	2	35.1	36.2	145.67
	3	32.9	33.2	169.83
				176.36




**Gambar B.1** Hasil Uji Kekerasan Data Awal

Sample Name	: A1			
Free Text	:			
Calibration	: 0.465909 $\mu\text{m}/\text{pixel}$			
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	$\mu\text{m}$	$\mu\text{m}$	HV0.1
	1	23.8	23.1	208.12
	2	21.9	23.1	215.55
	3	22.5	23.6	209.90
				211.19



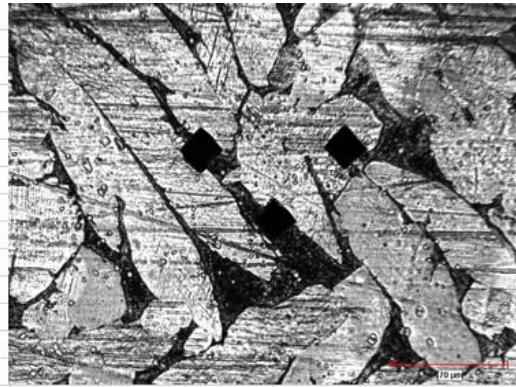
**Gambar B.2** Hasil Uji Kekerasan 0,6% Mangan pada 300°C

Sample Name	A2			
Free Text	:			
Calibration	: 0.465909 $\mu\text{m}/\text{pixel}$			
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	$\mu\text{m}$	$\mu\text{m}$	HV0.1
	1	28.3	27.2	183.85
	2	27.6	28.5	204.54
	3	27.0	26.5	159.36
				182.58



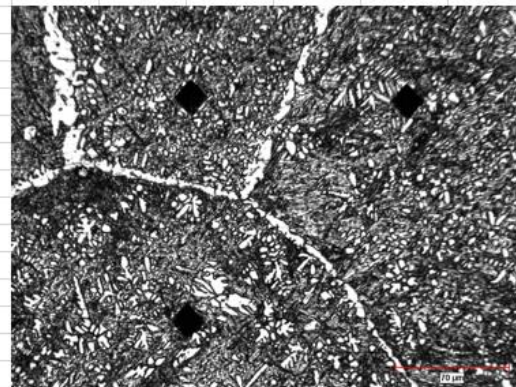
**Gambar B.3** Hasil Uji Kekerasan 0,6% Mangan pada 350°C

Sample Name	: A3			
Free Text	:			
Calibration	: 0.465909	µm/pixel		
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	µm	µm	HV0.1
	1	26.6	28.2	225.37
	2	26.7	28.1	150.83
	3	26.3	26.6	209.86
				195.35



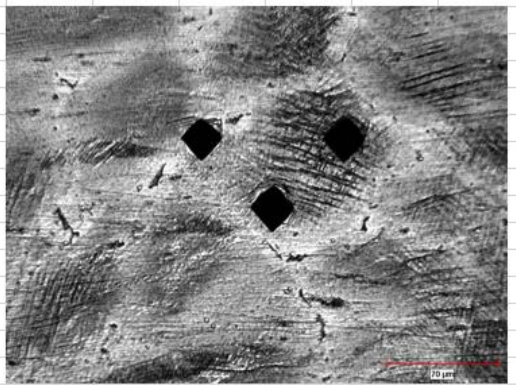
**Gambar B.4** Hasil Uji Kekerasan 0,6% Mangan pada 400°C

Sample Name	: B1			
Free Text	:			
Calibration	: 0.465909	µm/pixel		
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	µm	µm	HV0.1
	1	21.2	22.9	220.99
	2	21.0	22.1	225.56
	3	21.9	22.9	219.04
				221.86



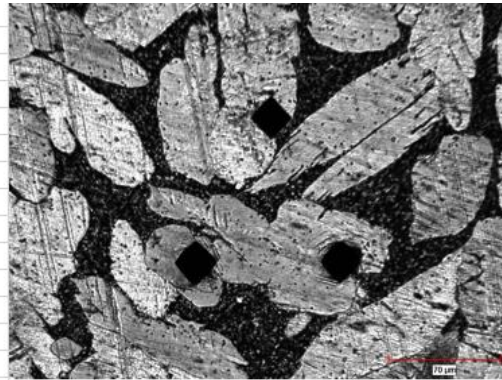
**Gambar B.5** Hasil Uji Kekerasan 0,8% Mangan pada 300°C

Sample Name	: B2			
Free Text	:			
Calibration	: 0.465909	µm/pixel		
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	µm	µm	HV0.1
	1	26.6	27.2	163.53
	2	28.1	29.1	201.04
	3	28.5	29.7	176.99
				180.52



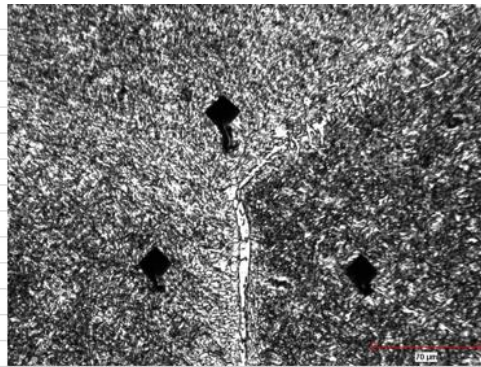
**Gambar B.6** Hasil Uji Kekerasan 0,8% Mangan pada 350°C

Sample Name	: B3			
Free Text	:			
Calibration	: 0.465909	µm/pixel		
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	µm	µm	HV0.1
	1	27.2	28.1	186.56
	2	26.3	27.6	200.82
	3	26.1	27.2	210.59
				199.32



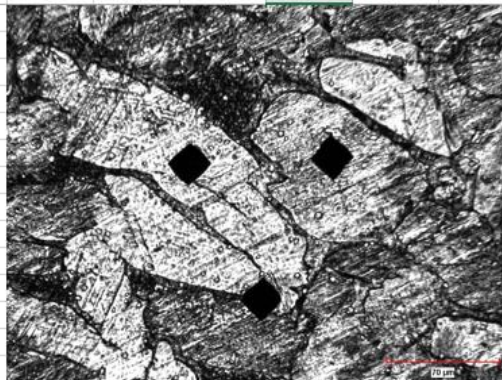
**Gambar B.7** Hasil Uji Kekerasan 0,8% Mangan pada 400°C

Sample Name	: C1			
Free Text	:			
Calibration	: 0.465909	µm/pixel		
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	µm	µm	HV0.1
	1	22.3	20.2	223,54
	2	20.8	22.1	247.19
	3	21.7	22.7	205.72
				226.46



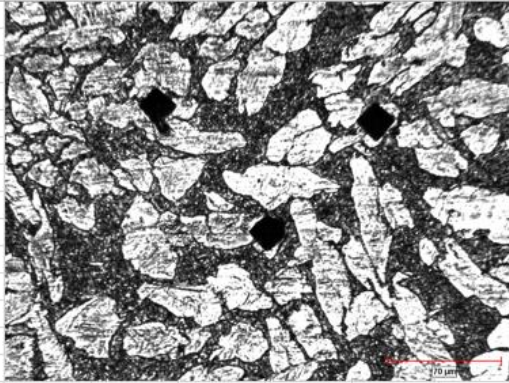
**Gambar B.8** Hasil Uji Kekerasan 1,0% Mangan pada 300°C

	A	B	C	D	E	F	G	H	I	J	K	L
Sample Name		C2										
Free Text		:										
Calibration		: 0.465909	µm/pixel									
Magnification		: 20x										
Force		: 100	gf									
Dwell Time		: 10	sec.									
		Field	H Diag.	V Diag.	Hard.							
		#	µm	µm	HV0.1							
		1	30.4	29.5	150.88							
		2	26.3	28.7	195.63							
		3	27.0	28.7	190.05							
					178.85							




**Gambar B.9** Hasil Uji Kekerasan 1,0% Mangan pada 350°C

Sample Name	: C3			
Free Text	:			
Calibration	: 0.465909	µm/pixel		
Magnification	: 20x			
Force	: 100	gf		
Dwell Time	: 10	sec.		
	Field	H Diag.	V Diag.	Hard.
	#	µm	µm	HV0.1
	1	23.6	24.0	200.61
	2	24.3	24.3	205.84
	3	22.7	22.7	202.76
				203.07



Gambar B.10 Hasil Uji Kekerasan 1,0% Mangan pada 400°C



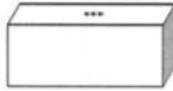
**FAKULTAS TEKNIK – UNIVERSITAS INDONESIA**  
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**DEPARTEMEN TEKNIK METALURGI & MATERIAL**  
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 Telp: 021 – 7863510, 78849045 Fax: 021 – 78888111 E-mail: lum@metal.ui.ac.id

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**LAPORAN PENGUJIAN KEAUSAN**  
**WEAR RESISTANCE TEST REPORT**  
 Hal 1 dari 2

No Laporan	M0109	Tanggal Terima	4 Juli 2022
Report Nr		Receiving Date	
No Kontrak	M0109/PT.02/FT04/P/2022	Tanggal Uji	14 Juli 2022
Contract Nr		Date of Test	
Pemakai Jasa	Irham Murdiansyah	Standar	ASTM G99
Customer		Standard	
Alamat	UNTIRTA	Metode Uji	Aus
Address		Testing method	
Bahan	Cu Based	Mesin Uji	OGOSHI
Material		Testing machine	


**Sketsa Sampel**  
Sample Figure



\* Daerah penjejakan

Kode Sampel	Lebar Jejak Rata-rata (b) [mm]	Tebal Cincin (B) [mm]	Diameter Cincin (d) [mm]	Beban (F) [Kg]	Jarak Luncur (x) [m]	Kecepatan [m/s]	Spesifik Abrasi [mm <sup>3</sup> /mm]
A0	2.43	3	30	3.16	100	1.97	6.550667 × 10 <sup>-6</sup>
A I	3.40	3	30	3.16	100	1.97	0.762383 × 10 <sup>-6</sup>
A II	2.74	3	30	3.16	100	1.97	2.391485 × 10 <sup>-6</sup>
A III	1.52	3	30	3.16	100	1.97	2.246879 × 10 <sup>-6</sup>
B I	2.20	3	30	3.16	100	1.97	0.608711 × 10 <sup>-6</sup>

Depok, 18 Juli 2022  
 Manajer Teknis



(Ahmad Ashari, S.T., M.T.)

Laporan hasil pengujian ini hanya berlaku untuk sample yang diuji di Laboratorium Uji-OTMM, publikasi serta penggunaan dokumen ini atau sebagian dari padanya harus dengan izin dari Laboratorium Uji-OTMM

Gambar B.11 Hasil Uji Keausan A0-B1



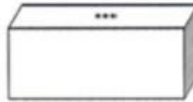


**LAPORAN PENGUJIAN KEAUSAN**  
**WEAR RESISTANCE TEST REPORT**

Hal 2 dari 2

No Laporan <i>Report Nr</i>	M0109	Tanggal Terima <i>Receiving Date</i>	4 Juli 2022
No Kontrak <i>Contract Nr</i>	M0109/PT.02/FT04/P/2022	Tanggal Uji <i>Date of Test</i>	14 Juli 2022
Pemakai Jasa <i>Customer</i>	Irham Murdiansyah	Standar	ASTM G99
Alamat <i>Address</i>	UNTIRTA	Metode Uji <i>Testing method</i>	Aus
Bahan <i>Material</i>	Cu Based	Mesin Uji <i>Testing machine</i>	OGOSHI

Sketsa Sampel  
*Sample Figure*



\* Daerah penjejakan

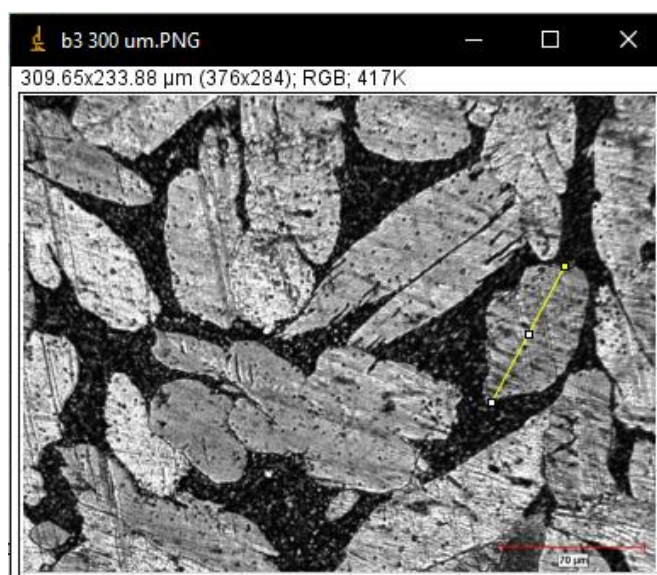
Kode Sampel	Lebar Jejak Rata-rata (b) [mm]	Tebal Cincin (B) [mm]	Diameter Cincin (d) [mm]	Beban (P) [Kg]	Jarak Luncur (x) [m]	Kecapatan [m/s]	Spesifik Abrasi [mm <sup>3</sup> /mm]
B II	2.47	3	30	3.16	100	1.97	$2.511537 \times 10^{-6}$
B III	1.54	3	30	3.16	100	1.97	$2.108223 \times 10^{-6}$
C I	2.33	3	30	3.16	100	1.97	$0.585301 \times 10^{-6}$
C II	2.38	3	30	3.16	100	1.97	$3.428471 \times 10^{-6}$
C III	1.66	3	30	3.16	100	1.97	$1.774667 \times 10^{-6}$

Depok, 18 Juli 2022  
Manajer Teknis  
  
(Ahmad Ashari, S.T., M.T.)

Gambar B.12 Hasil Uji Keausan B2-C3

A	B	C	D	E	F	G
	Area	Mean	Min	Max	Angle	Length
1	17.782	213.84	22	255	-90	20.241
2	12.895	233.329	90.353	255	-119.54	29.081
3	14.937	245.965	225.4	255	-120.47	16.634
4	8.008	238.558	130	253.795	-78.179	37.051
5	16.74	238.663	105.108	255	37.476	31.881
6	6.183	225.142	31.788	255	-93.468	27.882
7	12.803	250.222	230.824	254.824	-76.759	14.729
8	5.008	194.681	14.397	253.397	-152.85	36.964
9	10.874	240.747	173	255	-30.964	34.424
10	19.916	205.087	61	249.148	-66.251	23.035
11	12.627	231.655	59.5	255	175.914	23.675
12	5.606	239.908	142.84	253.96	-143.13	29.518
13	8.874	230.775	73.914	254.475	67.166	34.773
14	18.451	238.959	179	255	-39.806	32.935
15	12.05	242.863	93	253.396	103.57	25.16
16	14.226	229.3	59	255	180	16.024
17	12.768	230.083	24.947	255	-83.991	64.451
18	8.05	237.992	85	254.658	-50.44	25.16
19	14.183	215.319	59.592	254.405	-64.983	27.921
20	17.071	221.466	11.503	255	-124.38	19.416
21	16.029	198.896	25.305	255	-38.418	31.216
22	13.514	230.868	105	255	-80.538	15.39
23	9.338	203.851	52.61	253.39	-133.6	24.458
24	18.451	233.941	105.026	254.738	-142.25	33.064
25	10.916	217.208	58.551	253	-61.557	23.02
26	12.782	235.809	74	252.292	145.008	20.589
27	7.338	239.664	42	254.491	-30.964	24.588
28	17.071	243.344	90	254.584	-77.196	19.027
29	12.916	250.61	221	255	23.749	23.035
30	18.606	171.615	41.89	254.056	-76.759	29.458
ukuran butir Fasa $\alpha$		12.8671				

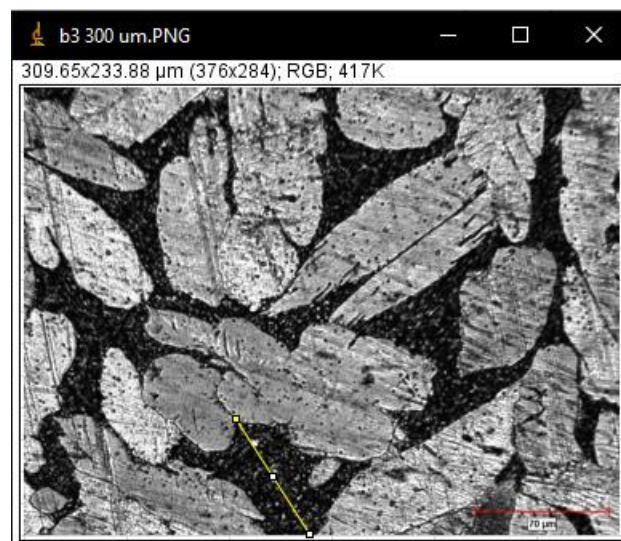
**Gambar B.13** Contoh Ukuran Butir Fasa  $\alpha$



**Gambar 4.14** Contoh Diameter Ukuran Butir Fasa  $\alpha$

J	K	L	M	N	O	P
	Area	Mean	Min	Max	Angle	Length
1	18.451	73.446	12.923	255	-85.601	32.989
2	12.05	44.511	13.98	158.92	13.57	25.16
3	10.071	83.018	13.261	255	2.49	19.416
4	8.409	41.67	8.925	148.887	-95.389	44.897
5	12.803	36.232	17.235	155	-100.01	14.559
6	11.937	46.472	7.76	118.16	-156.04	16.613
7	8.359	51.561	26	104	10.305	18.858
8	5.648	72.71	16.286	251	-95.44	17.791
9	10.359	73.603	25	253	-158.2	18.167
10	11.226	87.467	17.997	251	-47.121	16.113
11	7.782	78.201	17.812	254.547	-152.35	19.993
12	9.071	91.665	24.919	248.448	-30.964	19.671
13	11.493	52.262	13.362	255	163.74	21.084
14	5.648	93.434	10.673	254.306	-135	17.891
15	10.669	103.948	27.857	254.714	-102.1	12.075
16	5.937	78.469	15	252.08	-53.13	16.867
17	7.472	42.944	17.578	209	-10.954	26.63
18	11.205	72.976	17	252	162.255	22.138
19	8.338	90.314	29.856	250	29.249	24.165
20	9.761	58.508	15.419	255	-14.931	26.185
21	7.782	38.4	11	105	0	20.241
22	10.916	46.665	6.296	190	156.251	23.035
23	9.916	55.846	9.481	255	-17.103	22.942
24	17.782	50.014	10	255	152.354	19.993
25	14.937	37.738	11.2	137	-87.138	16.889
26	12.05	53.341	20	204	-47.726	25.075
27	14.183	57.091	14.455	229	5.194	27.946
28	9.183	76.005	17.912	254.486	-37.569	27.665
29	11.451	70.598	16.923	245	-171.25	33.279
30	14.937	57.109	17	204	162.474	16.804
ukuran butir Fasa $\gamma_2$	10.6609					

**Gambar B.15** Contoh Ukuran Butir Fasa  $\gamma_2$



**Gambar 4.16** Contoh Diameter Ukuran Butir Fasa  $\gamma_2$

**LAMPIRAN C**  
**ALAT DAN BAHAN**

**Lampiran C. Alat dan Bahan**



**Gambar C.1 Burner**



**Gambar C.2 Cetakan Besi**



**Gambar C.3 Crucible**



**Gambar C.4 Mangan**



**Gambar C.5 Tabung Gas**



**Gambar C.6 Tembaga**



**Gambar C.7** Timbangan Digital



**Gambar C.8** Tungku Pelebur



**Gambar C.9** Alat Uji Kekerasan



**Gambar C.10** Alat Uji Keausan



**Gambar C.11** Alat Uji Mikroskop Optik