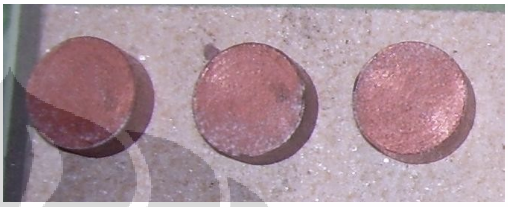
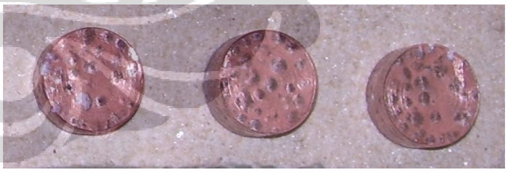
1. Data Geometri & Foto Sampel

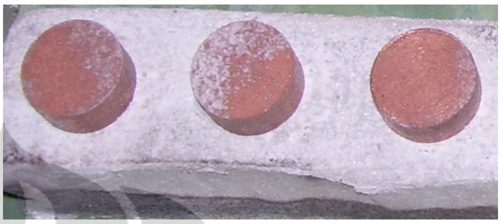
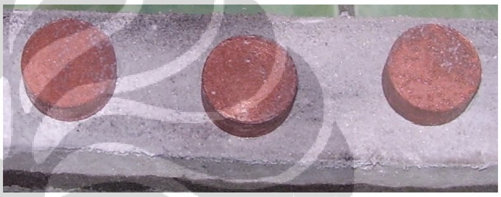
1.1 Hasil Kompaksi 1

Tabel L.1 Hasil kompaksi pertama, untuk sinter skema S1

KODE SAMPEL	m [g]	d [mm]	h [mm]	Foto sampel dari kiri ke kanan; sampel 1, 2, dan 3.
S1201	8,21	20,17	9	
S1202	8,22	20,11	9,07	
S1203	8,18	20,13	8,8	
S1301	8,16	20,14	9,05	
S1302	8,03	20,12	8,72	
S1303	8,19	20,14	9,06	
S1401	8,17	20,15	9,2	
S1402	8,2	20,16	9,27	
S1403	7,99	20,15	9,09	
S1SG1	8,2	20,15	7,88	
S1SG2	8,18	20,17	8,78	
S1SG3	8,36	20,17	9,87	

1.2 Hasil Kompaksi 2

Tabel L.2 Hasil kompaksi 2

KODE SAMPEL	Massa [g]	Diameter [mm]	Tinggi [mm]	Foto sampel dari kiri ke kanan; sampel 1, 2, dan 3.
S2201	Tidak ditimbang	20,12	9,24	
S2202	Tidak ditimbang	20,12	8,63	
S2203	Tidak ditimbang	20,13	9,06	
S2301	Tidak ditimbang	20,12	9,37	
S2302	Tidak ditimbang	20,12	9,32	
S2303	Tidak ditimbang	20,14	9,02	
S2401	Tidak ditimbang	20,14	9,44	
S2402	Tidak ditimbang	20,11	8,82	
S2403	Tidak ditimbang	20,14	9,6	
S2SG1	Tidak ditimbang	20,13	8,5	
S2SG2	Tidak ditimbang	20,16	8,76	
S2SG3	Tidak ditimbang	20,17	9,14	

1.3 Hasil Sintering 1

Tabel L.3 Hasil skema sinter S1

KODE SAMPEL	m [g]	d [mm]	h [mm]	Foto sampel dari kiri ke kanan; sampel 1, 2, dan 3.
S1201	4,01	20,09	9,23	
S1202	3,97	19,73	9,81	
S1203	3,77	19,71	9,45	
S1301	3,68	19,8	9,1	
S1302	3,57	19,35	9,18	
S1303	3,69	19,45	9,07	
S1401	3,55		terbelah	
S1402	3,94	19,6	9,49	
S1403	3,67	19,52	9,15	
S1SG1	7,98	20,51	8,13	
S1SG2	8,17	20,87	9,41	
S1SG3	8,09	20,79	10,71	

1.4 Hasil Sintering 2

Tabel L.4 Hasil skema sinter S2

KODE SAMPEL	m [g]	d [mm]	h [mm]	Foto sampel dari kiri ke kanan; sampel 1, 2, dan 3.
S2201	8,25	21,41	10,43	
S2202	7,82	21,41	10,44	
S2203	8,04	21,13	9,74	
S2301	7,27		terbelah	
S2302	7,45	20,95	11,21	
S2303	6,41	21,14	terbelah	
S2401	7,71	21,05	11,16	
S2402	7,28	21,09	10,99	
S2403	7,56	20,96	11,98	
S2SG1	7,97	20,63	9,25	
S2SG2	8,08	20,73	9,28	
S2SG3	7,97	20,72	9,39	

1.5 Foto Sampel Hasil Pelarutan

Hasil pelarutan tidak diukur, maupun difoto di atas kertas berskala. Pada tahap ini, hampir semua sampel dengan pengisi silica gel rusak.

1.5.1 Pengisi Silica Gel

Gambar L.1 Sampel hasil pelarutan silica gel.

1.5.2 Pengisi Potassium Carbonates

Gambar L.2 Sampel hasil pelarutan potassium.

2. Hasil Pengukuran Manual

2.1 Data Uji Densitas

Hasil penimbangan basah & kering untuk uji densitas & porositas.

massa air, m =	489	g
volume air, V =	500	ml = cm^3
densitas air, ρ =	0,978	g/cm^3

Tabel L.5 Data uji Densitas & Porositas

nomor sampel	Berat di dalam air, *W* [g]			Berat kering, *m* [g]		
	Sampel 1	Sampel 2	Sampel 3	Sampel 1	Sampel 2	Sampel 3
S120n	2,78	2,9	2,8	3,84	3,75	3,64
S130n	2,59	2,83	2,57	3,62	3,51	3,77
S140n	2,66	2,71	2,63	3,81	4,08	3,43
S1SGn	2,28	0,98	1,22	4,61	1,48	2,16
S220n	2,78	2,9	2,8	4,54	3,54	4,03
S230n	2,59	2,83	2,57	3,6	3,95	3,56
S240n	2,66	2,71	2,63	3,8	3,16	3,58
S2SGn	1,38	1,48	1,22	2,31	2,85	2,07

font merah : sampel terbelah

2.2 Data Pengukuran Pori

Berikut adalah hasil pengamatan dengan menggunakan mikroskop makro merk Nikon di Lab Metalografi lantai 4 Departemen Metalurgi & Material UI. Mikroskop ini belum dilengkapi kamera yang menyatu, sehingga untuk pemotretan makro menggunakan mikroskop lain.

Diameter rerata potassium karbonat;

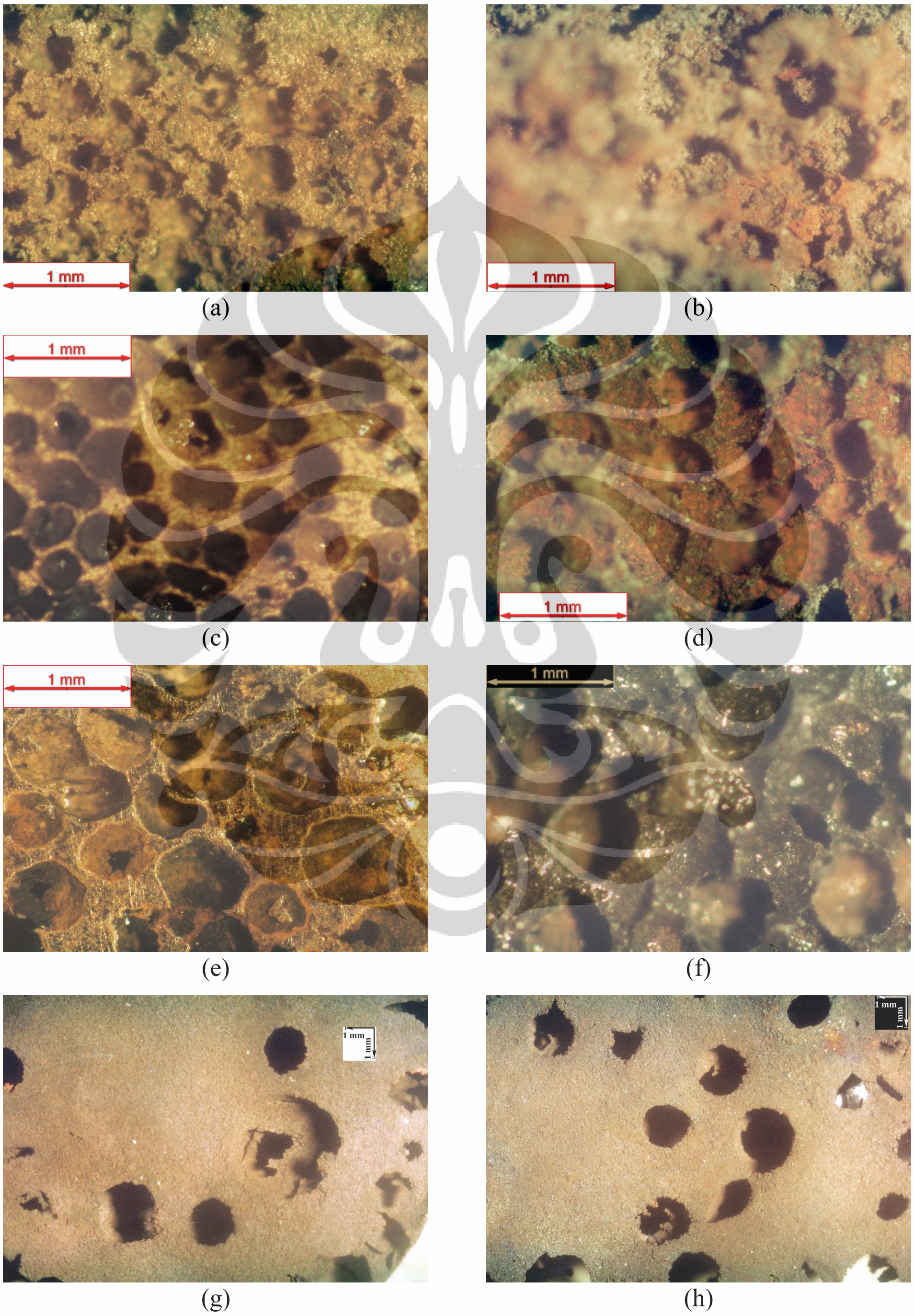
Mesh 20 =	0,841	mm
Mesh 30 =	0,542	
Mesh 40 =	0,420	
Diameter rerata silica gel =	2,650	mm

Tabel L.6 Data Hasil Pengukuran Sel dengan *Measuring Microscope*

nomor sampel, dipilih secara acak	Pori 1		Pori 2		Pori 3		Pori 4		Pori 5	
	dx	dy	dx	dy	dx	dy	dx	dy	dx	dy
S1201	0,581	0,589	0,686	0,538	0,606	0,595	0,712	0,647	0,734	0,551
S1301	0,472	0,434	0,417	0,491	0,502	0,519	0,435	0,462	0,444	0,439
S1402	0,333	0,386	0,417	0,381	0,359	0,338	0,373	0,309	0,323	0,320
S1SG2	2,292	2,353	2,119	1,921	1,697	2,262	2,688	2,789		
S2202	0,613	0,533	0,632	0,686	0,478	0,583	0,530	0,521	0,591	0,503
S2301	0,531	0,455	0,311	0,288	0,312	0,308	0,500	0,563		
S2401	0,643	0,344	0,429	0,401	0,408	0,383	0,409	0,377	0,354	0,325
S2SG1	2,873	2,725	2,853	2,682	1,747	2,010	2,331	2,233		

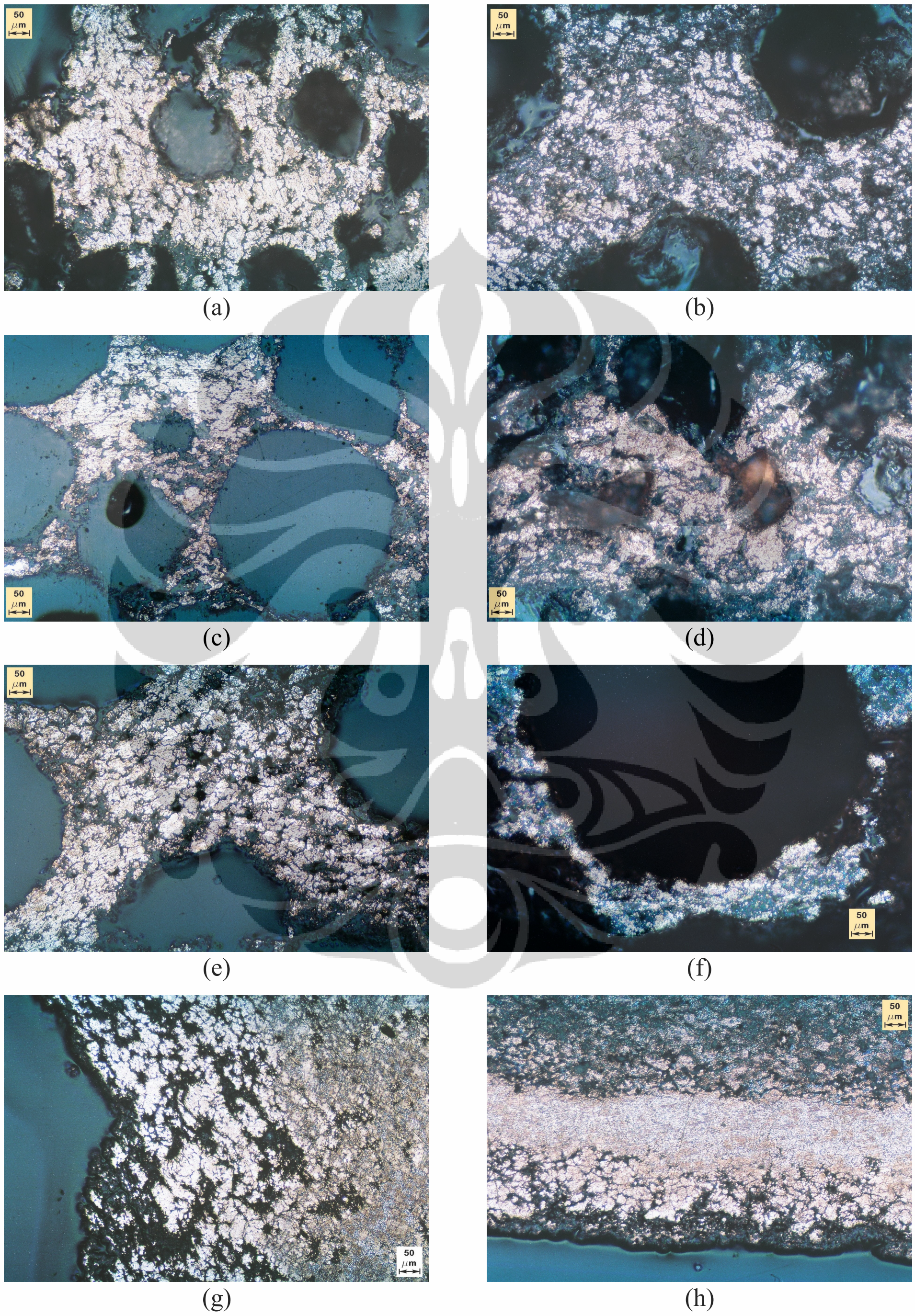
4. Hasil Pengamatan Makro & Mikro

4.1 Struktur Makro



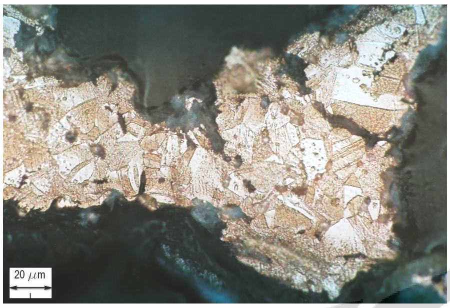
Gambar L.3 Foto-foto Makromikroskop, perbesaran 32x utk pengisisi potassium & 7x utk pengisi silica gel. (a) S1401. (b) S2402. (c) S1301 dimounting. (d) S2302. (e) S1203 dimounting. (f) S2203. (g) S1SG1 (h) S2SG1.

4.2 Struktur Mikro Perbesaran 100x

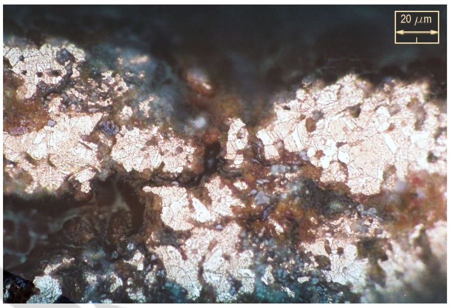


Gambar L.4 Foto-foto Mikromikroskop Perbesaran 100x. (a) S1403. (b) S2402. (c) S1302. (d) S2303. (e) S1203. (f) S2203. (g) S1SG3. (h) S2SG3.

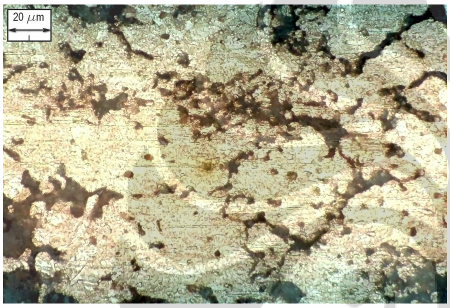
4.3 Struktur Mikro Perbesaran 500x



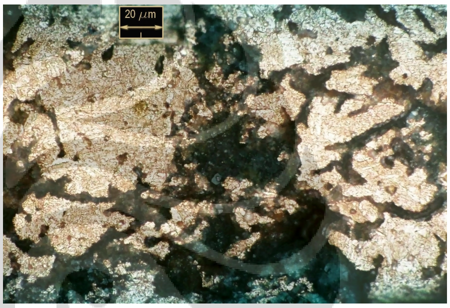
(a)



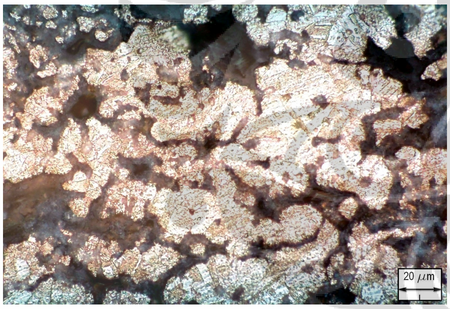
(b)



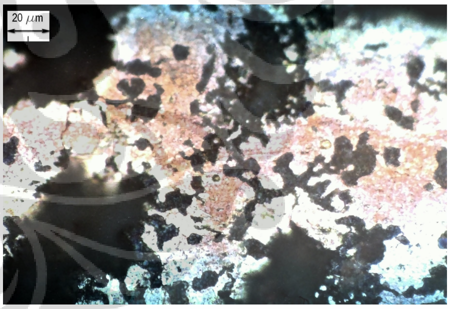
(c)



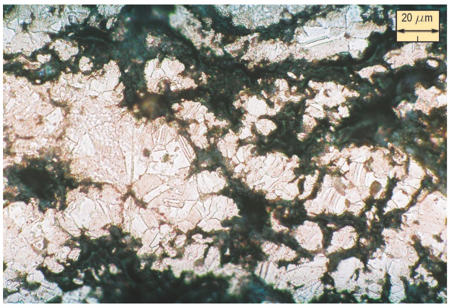
(d)



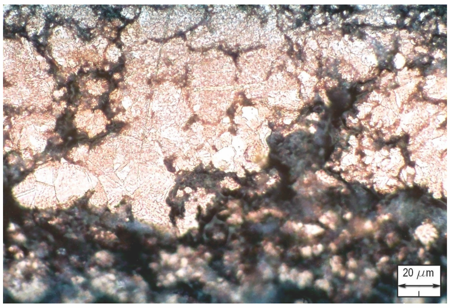
(e)



(f)



(g)

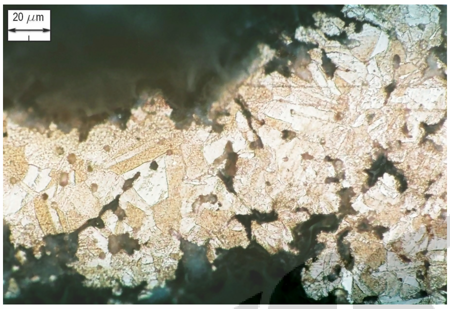


(h)

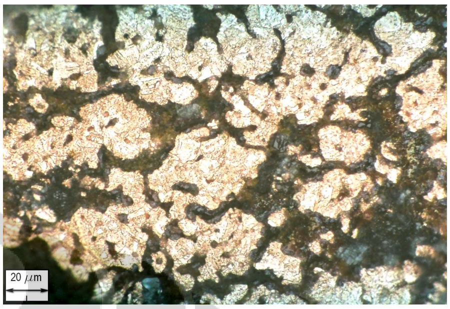
Gambar L.5 Foto mikro sampel pada perbesaran 500x. (a) S1403_2. (b) S2402_1. (c) S1302_1. (d) S2302_1. (e) S1203_2. (f) S2203_2. (g) S1SG3_1. (h) S2SG3_1.

4.4 Foto Struktur Mikro yang Lain

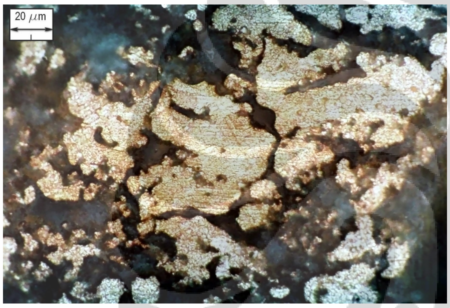
Foto struktur mikro perbesaran 500x lainnya.



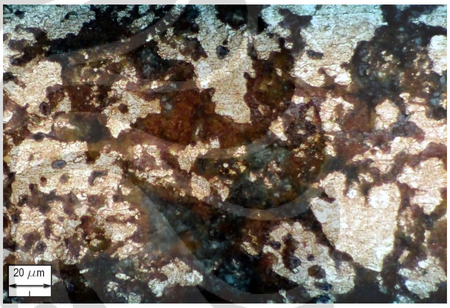
(a)



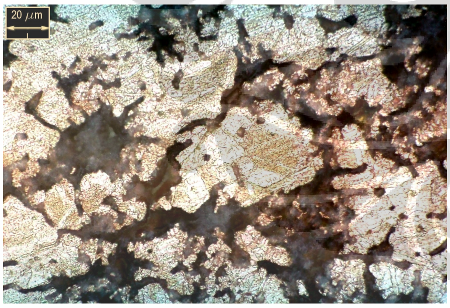
(b)



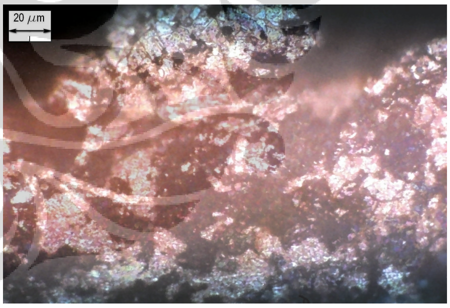
(c)



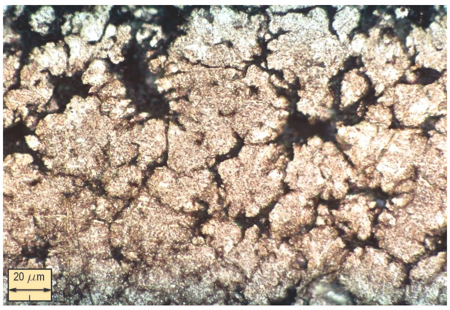
(d)



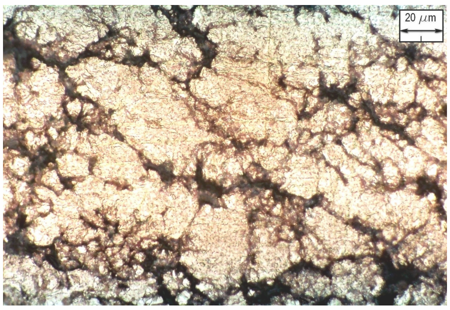
(e)



(f)



(g)



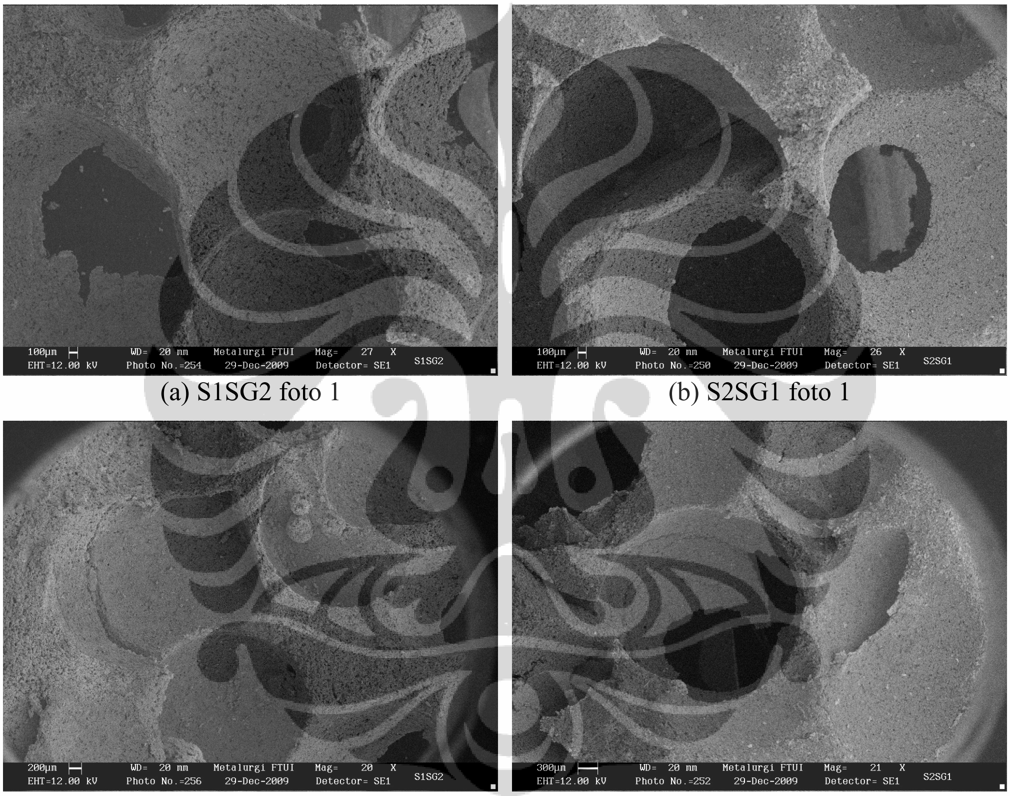
(h)

Gambar L.6 Foto-foto Mikromikroskop Perbesaran 500x lainnya, (a) S1403_1. (b) S2402_2. (c) S1302_2. (d) S2303_2. (e) S1203_1. (f) S2203_1. (g) S1SG3_2. (h) S2SG3_2.

7. Hasil Foto SEM

Lokasi amatan sebagaimana sudah disinggung di bab 3 gambar 3.22. Sampel dengan pengisi potassium yang diuji hanya M30, masing-masing mewakili 2 skema sinter, S1 & S2.

7.1 Sampel M10 (pengisi silica gel)

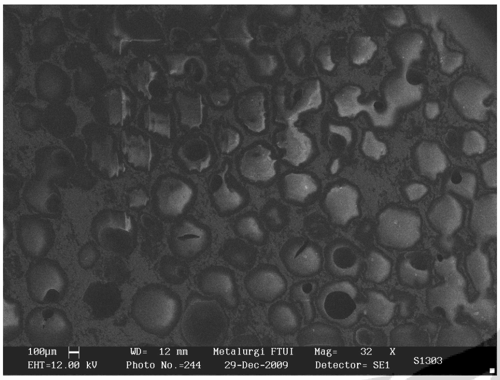


(a) S1SG2 foto 1 (b) S2SG1 foto 1

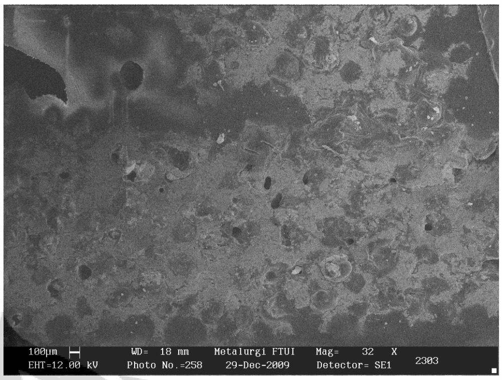
(c) S1SG2 foto 2 (d) S2SG1 foto 2

Gambar L.7 Hasil foto SEM mode *secondary electron* untuk sampel pengisi silica gel.

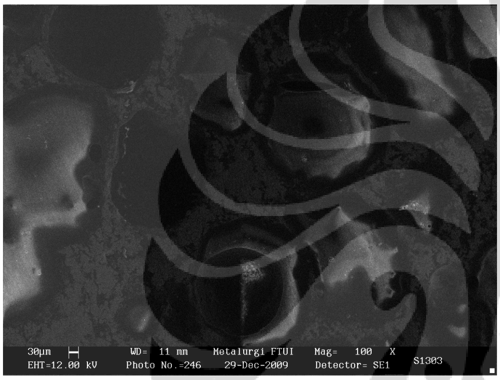
7.2 Sampel M30



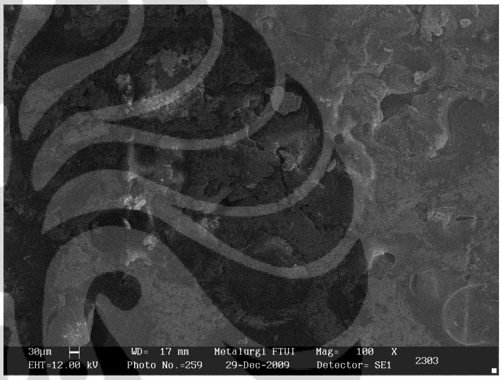
(a) S1303 foto 1



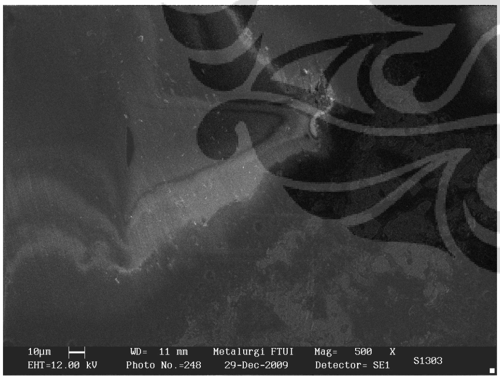
(b) S2303 foto 1



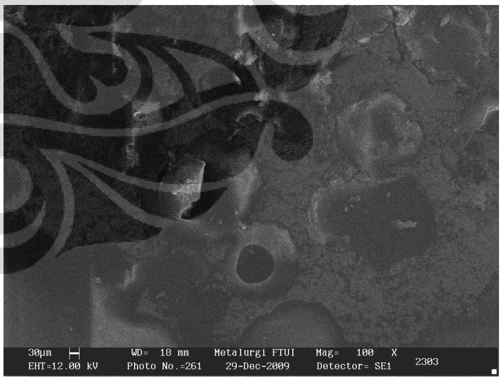
(c) S1303 foto 2



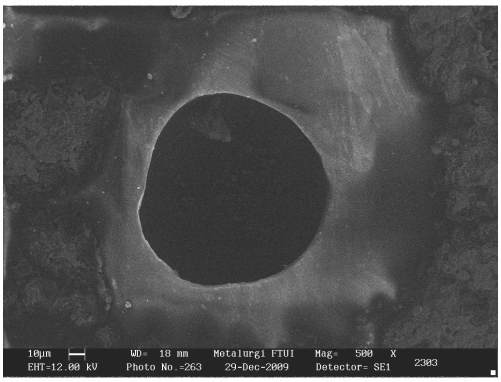
(d) S2303 foto 2



(e) S1303 foto 3



(f) S2303 foto 3

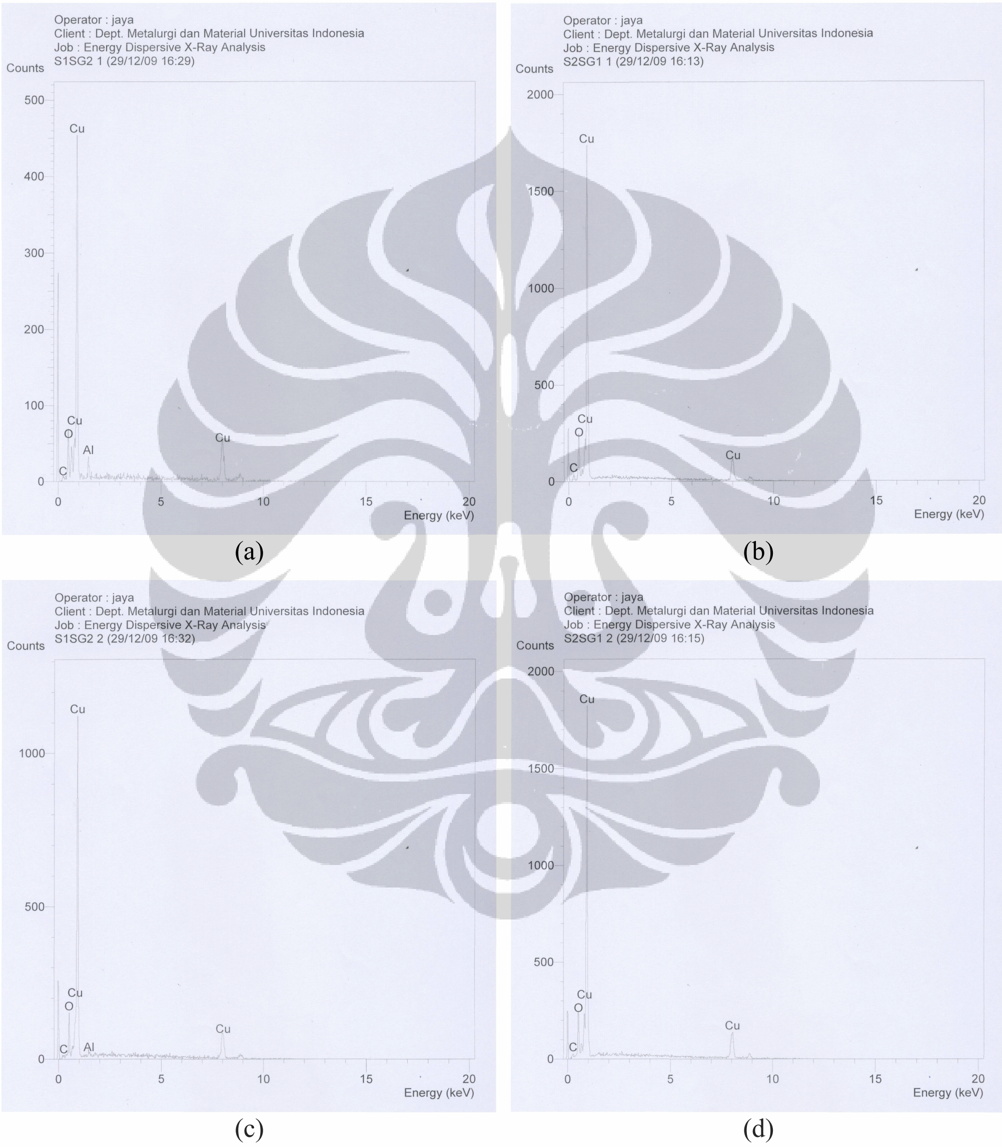


(g) S2303 foto 4

Gambar L.8 Hasil foto SEM mode *secondary electron* untuk sampel pengisi potassium.

8. Hasil EDX

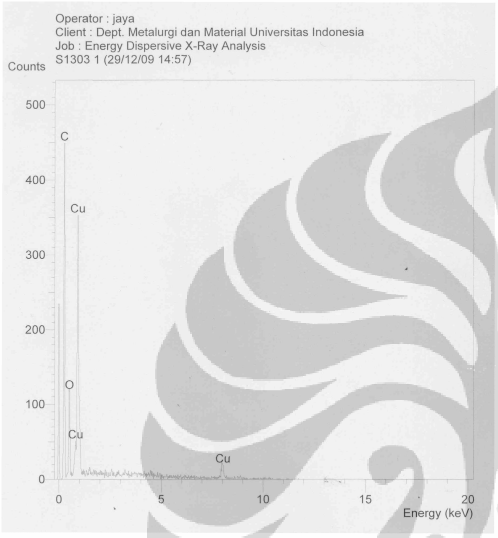
8.1 Sampel M10



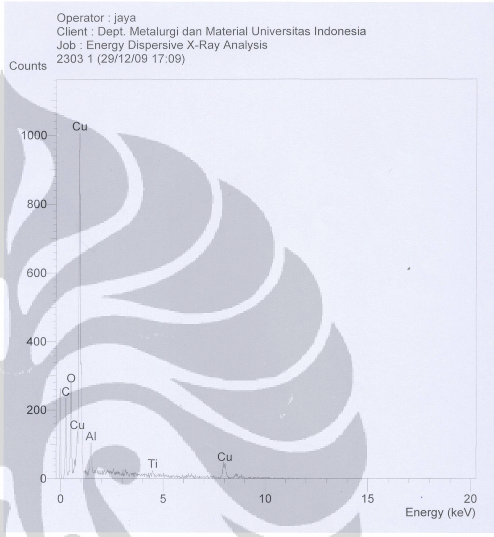
Gambar L.9 Grafik EDAX untuk pori hasil pembentukan silica-gel. (a) & (c) hasil skema sinter S1. (kiri) (b) & (d) hasil skema sinter S2. (kanan)

8.2 Sampel M20

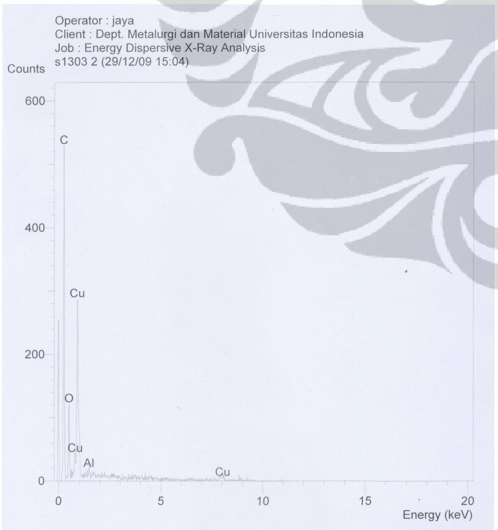
Sampel dengan pengisi potassium yang diuji hanya M20, masing-masing mewakili 2 skema sinter, S1 & S2.



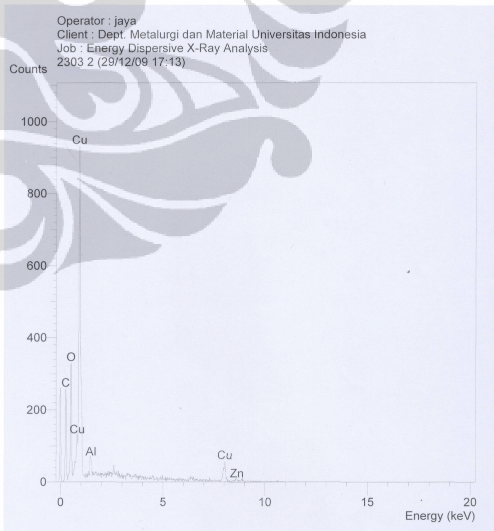
(a)



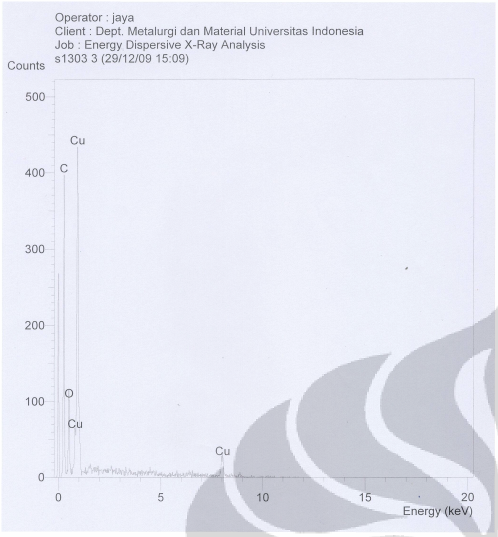
(b)



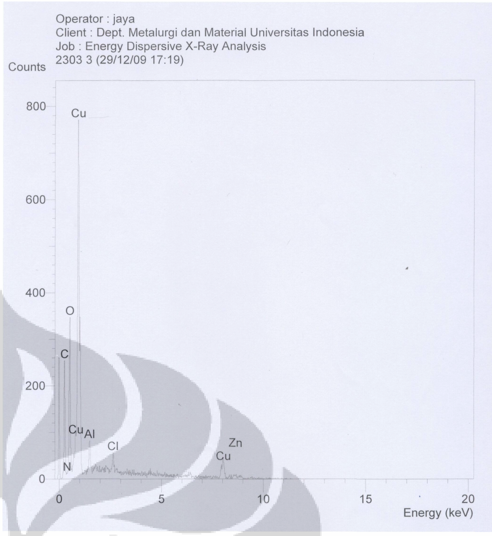
(c)



(d)



(e)



(f)

Gambar L.10 Grafik EDAX untuk pori hasil pembentukan potassium carbonates. Sebelah kiri hasil skema sinter S1, sebelah kanan hasil skema sinter S2.

9. Data Uji Properti Listrik

Tabel L.7 Pengukuran hambatan

KODE SAMPEL	R [mΩ]					
	Nilai 1	Nilai 2	Nilai 3	Nilai 4	Nilai 5	Nilai 6
S1SG1	55,3					
S1201	84,2	83,5	83,3			
S1202	73,5	73,6				
S1301	54,4	52,4	52,3			
S1303	56,7	56,6	56,5	54,4		
S1402	83,3	85	84,3	83,3	65,4	65,3
S2SGn	tidak bisa diuji karena hancur					
S2201	130,1	129,3	129,2			
S2301	134,1	133,6	133,9	135,2		
S2302	149,6	149	148	147,8		
S2401	166,2	172,3	171	168,2	165,6	165,4
S2403	198,2	197	196	195,7		

10.

SEMQuant results. Listed at 15:01:51 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S1303 1
System resolution = 60 eV
Quantitative method: ZAF (2 iterations).
Analysed all elements and normalised results.
Standards :
C K Carbon Low 13/09/06
0 K AL203 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	7,08	24,47
O	K	ED	7,64	19,83
Cu	K	ED	85,28	55,71
Total			100,00	100,01

* = <2 Sigma

SEMQuant results. Listed at 15:06:57 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S1303 2
System resolution = 60 eV
Quantitative method: ZAP (3 iterations).
Analysed all elements and normalised results.
Standards :
C K Carbon Low 13/09/06
0 K AL203 17/11/09
Al K AL203 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	13,52	36,24
O	K	ED	12,72	25,60
Al	K	ED	1,17	1,40
Cu	K	ED	72,58	36,76
Total			99,99	100,00

= <2 Sigma

SEMQuant results. Listed at 15:11:35 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S1303 3
System resolution = 60 eV
Quantitative method: ZAP (2 iterations).
Analysed all elements and normalised results.
Standards :
C K Carbon Low 13/09/06
0 K AL203 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C K		ED	4,92	19,18
O K		ED	4,94	14,46
Cu K		ED	90,13	66,37
Total			99,99	100,01
Sigma				

SEMQuant results. Listed at 15:15:39 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S1303(2) 1
System resolution = 60 eV
Quantitative method: ZAP (2 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :
C K Carbon Low 13/09/06
O K AL2O3 17/11/09
Al K AL2O3 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	2,14	8,58
O	K	ED	6,87	20,73
Al	K	ED	1,55	2,77
Cu	K	ED	89,44	67,92
Total			100,00	100,00

SEMQuant results. Listed at 15:19:44 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S1303(2) 2
System resolution = 60 eV
Quantitative method: ZAF (2 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :
C K Carbon Low 13/09/06
0 K AL2O3 17/11/09
Al K AL2O3 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	2,80	11,35
O	K	ED	5,79	17,62
Al	K	ED	0,90	1,62
Cu	K	ED	90,52	69,41
Total			100,01	100,00

SEMQuant results. Listed at 15:23:42 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S1303(2) 3
System resolution = 60 eV
Quantitative method: ZAP (2 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :
C K Carbon Low 13/09/06
O K AL2O3 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	5,39	20,58
O	K	ED	5,18	14,86
Cu	K	ED	89,43	64,55
Total			100,00	99,99
Sigma				

SEMQuant results. Listed at 16:14:38 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label; S2SG1 1
System resolution = 60 eV
Quantitative method: ZAP (2 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :
C K Carbon Low 13/09/06
O K AL2O3 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	0,23	1,13
O	K	ED	2,57	9,40
Cu	K	ED	97,2	89,47
Total			100,00	100,00

* = <2 Sigma

SEMQuant results. Listed at 16:16:50 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S2SG1 2
System resolution = 60 eV
Quantitative method: ZAP (2 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :
C K Carbon Low 13/09/06
0 K AL2O3 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	0,16	0,81
O	K	ED	1,95	7,27
Cu	K	ED	97,89	91,92
Total			100,00	100,00

* = <2 Sigma

SEMQuant results. Listed at 16:31:11 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S1SG2 1
System resolution 60 eV
Quantitative method: ZAP (2 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :
C K Carbon Low 13/09/06
O K AL203 17/11/09
Al K AL203 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	0,32	1,59
O	K	ED	0,83	3,16
Al	K	ED	0,73	1,64
Cu	K	ED	98,12	93,62
Total			100,00	100,01

SEMQuant results. Listed at 16:33:44 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: S1SG2 2
System resolution 60 eV
Quantitative method: ZAP (2 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :
C K Carbon Low 13/09/06
O K AL203 17/11/09
Al K AL203 17/11/09
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	0,18	0,91
O	K	ED	1,65	6,17
Al	K	ED	0,31	0,68
Cu	K	ED	97,86	92,24
Total			100,00	100,00

SEMQuant results. Listed at 17:11:57 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: 2303 1
System resolution = 60 eV
Quantitative method: ZAP (3 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :
C K Carbon Low 13/09/06
O K AL203 17/11/09
Al K AL203 17/11/09
Ti K Titanium Oxide 19/05/06
Cu K Copper 22/03/06

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	2,05	7,80
O	K	ED	8,5	24,30
Al	K	ED	3,15	5,34
Ti	K	ED	1,81	1,73
Cu	K	ED	84,49	60,83
Total			100,00	100,00

SEMQuant results. Listed at 17:17:34 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: 2303 2
System resolution = 61 eV
Quantitative method: ZAP (3 iterations).
Analysed all elements and normalised results.
Standards :
C K Carbon Low 13/09/06
O K AL203 17/11/09
Al K AL203 17/11/09
Cu K Copper 22/03/06
Zn L Zinc 17/11/09

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	1,77	7,21
O	K	ED	7,12	21,72
Al	K	ED	1,38	2,50
Cu	K	ED	72,70	55,85
Zn	L	ED	17,03	12,72
Total			100,00	100,00

SEMQuant results. Listed at 17:25:31 on 29/12/09
Operator: jaya
Client: Dept. Metalurgi dan Material Universitas Indonesia
Job: Energy Dispersive X-Ray Analysis
Spectrum label: 2303 3
System resolution = 61 eV
Quantitative method: ZAP (3 iterations).
Analysed all elements and normalised results.
1 peak possibly omitted: -0.02 keV
Standards :

C K	Carbon Low 13/09/06
N K	**BN 22/03/06**
O K	Al2O3 17/11/09
Al K	Al203 17/11/09
Cl K	KCl 15/02/94
Cu K	Copper 22/03/06
Zn L	Zinc 17/11/09

Elmt		Spect. Type	Element %	Atomic %
C	K	ED	1,99	6,65
N	K	ED	5,06	14,55
O	K	ED	9,11	22,93
Al	K	ED	1,63	2,43
Cl	K	ED	3,31	3,76
Cu	K	ED	61,39	38,90
Zn	L	ED	17,51	10,78
			100,00	100,00

Lampiran 2

PENGOLAHAN DATA

1. Pelarutan HF

Perhitungan pelarutan HF

Konsentrasi awal	=	55	%
Konsentrasi dikehendaki	=	25	%

Contoh :

100 ml HF 55% akan diencerkan menjadi 25%.

a) Berapa volume setelah diencerkan?

b) Berapa volume pengencer?

$$V_1 . M_1 = V_2 . M_2$$

100 55	=	V_2 25			
V_2	=	100.55/25			
V_2	=	220 ml			→ jawaban a)
V_2	=	V_1	+	$V_{pengencer}$	
220	=	100	+	$V_{pengencer}$	
$V_{pengencer}$	=	120 ml			→ jawaban b)

2. Densitas Teoritis

Densitas teoritis Cu-15Zn

ρ_{Cu} =	8,92	g/cm^3
ρ_{Zn} =	7,14	g/cm^3
χ_{Cu} =	85	%
χ_{Zn} =	15	%

$$\rho_{paduan} = \frac{\chi_A + \chi_B}{\chi_A / \rho_A + \chi_B / \rho_B}$$

ρ_{paduan} ?

$$\rho_{paduan} = \frac{85 + 15}{85 / 8,92 + 15 / 7,14}$$

$$= \frac{100}{9,53 + 2,1}$$

ρ_{paduan} = 8,6 g/cm^3

Misalkan akan membuat 500 g paduan Cu15Zn. Berarti sesuai % terdiri dari 425 g Cu & 75 g Zn. Vol Cu adalah beratnya dibagi Bj-Cu yaitu 8,92 g/cm^3. Volume Cu = 47,65 cm^3.
Sedangkan vol Zn adalah beratnya dibagi Bj-Zn yaitu 7,14 g/cm^3. Volume Zn = 10,5 cm^3.
Jumlah volume menjadi 58,15 cm^3.
Maka BJ paduan adalah berat total dibagi volume total 500 g dibagi 58,15 cm^3 = **8,6** g/cm^3.

Bila menggunakan fraksi volume, maka rumus "rule of mixture" dapat dipakai.

$$\rho_{campuran} = \rho_1 . V_1 + \rho_2 . V_2 + ... + \rho_n . V_n$$

ρ_{paduan} = 8,6 g/cm^3 58,15

3. Densitas Percobaan

$$V_{sampel} = \frac{W}{\rho_{air}} \qquad \rho_{sampel} = \frac{m}{V_{sampel}}$$

Tabel L.8 Perhitungan Uji Densitas

	Volume sampel, V_{sampel} [cm^3]			Densitas sampel, ρ_{sampel} [g/cm^3]		
n	Sampel 1	Sampel 2	Sampel 3	Sampel 1	Sampel 2	Sampel 3
S1SGn	2,33	1	1,25	1,98	1,48	1,73
S120n	2,84	2,97	2,86	1,35	1,26	1,27
S130n	2,65	2,89	2,63	1,37	1,21	1,43
S140n	2,72	2,77	2,69	1,4	1,47	1,28
S2SGn	1,41	1,51	1,25	1,64	1,88	1,66
S220n	2,84	2,97	2,86	1,6	1,19	1,41
S230n	2,65	2,89	2,63	1,36	1,37	1,35
S240n	2,72	2,77	2,69	1,4	1,14	1,33

4. Porositas (fraksi massa)

$$\epsilon[\%] = 1 - \frac{\rho_{percobaan}}{\rho_{teoritis}}$$ dengan ϵ: porositas

Tabel L.9 Perhitungan Porositas

	Densitas sampel, ρ_{sampel} [g/cm^3]			Densitas rerata, ρ_{sampel} [g/cm^3]	Porositas rerata [%]
n	Sampel 1	Sampel 2	Sampel 3		
S1SGn	1,98	1,48	1,73	1,73	79,9
S120n	1,35	1,26	1,27	1,3	84,93
S130n	1,37	1,21	1,43	1,34	84,44
S140n	1,4	1,47	1,28	1,38	83,92
S2SGn	1,64	1,88	1,66	1,73	79,92
S220n	1,6	1,19	1,41	1,4	83,72
S230n	1,36	1,37	1,35	1,36	84,19
S240n	1,4	1,14	1,33	1,29	85

5. Konversi ke Fraksi Volume

Tabel L.10 (a) Konversi fraksi berat ke fraksi volume untuk pengisi potassium carbonates

1 sampel	Massa Zat[g]			ρ [g/cm^3]	Volume [cm^3]	fraksi volume, V_n	$\rho_n . V_n$
% massa	60%						
	40 mesh	30 mesh	20 mesh				
Massa K_2CO_3	4,8	4,8	4,8	2,29	2,10	0,81	1,85
Massa ZnO	0,16	0,16	0,16	5,61	0,03	0,01	0,06
Massa C_2H_5-OH	0,08	0,08	0,08	0,79	0,10	0,04	0,03
Massa Cu	2,72	2,72	2,72	8,92	0,30	0,12	1,05
Massa 15%Zn	0,48	0,48	0,48	7,14	0,07	0,03	0,18
TOTAL	8,24	8,24	8,24		2,60	1,00	3,17

Tabel L.10 (b) Konversi fraksi berat ke fraksi volume untuk pengisi silica gel

1 sampel	Massa Zat[g]	ρ [g/cm^3]	Volume [cm^3]	fraksi volume, V_n	$\rho_n . V_n$
% massa zat	30%				
	10 mesh				
Massa SiO_2	2,4	2,63	0,91	0,54	1,42
Massa ZnO	0,16	5,61	0,03	0,02	0,09
Massa C_2H_5-OH	0,08	0,79	0,10	0,06	0,05
Massa Cu	4,76	8,92	0,53	0,32	2,81
Massa 15%Zn	0,84	7,14	0,12	0,07	0,5
TOTAL	8,24		1,69	1,00	4,86

$$\rho_{campuran} = \rho_1 . V_1 + \rho_2 . V_2 + \ldots + \rho_n . V_n$$

$$V_n = \frac{Volume_n}{Volume_{campuran}}$$

6. Porositas (fraksi volume)

Tabel L.12 Perhitungan porositas dengan fraksi volume

	Densitas sampel, ρ_{sampel} [g/cm^3]			Densitas rerata, ρ_{sampel} [g/cm^3]	Porositas rerata [%]
n	Sampel 1	Sampel 2	Sampel 3		
S1SGn	1,98	1,48	1,73	1,73	64,47
S120n	1,35	1,26	1,27	1,3	59,15
S130n	1,37	1,21	1,43	1,34	57,81
S140n	1,4	1,47	1,28	1,38	56,40
S2SGn	1,64	1,88	1,66	1,73	64,51
S220n	1,6	1,19	1,41	1,4	55,87
S230n	1,36	1,37	1,35	1,36	57,13
S240n	1,4	1,14	1,33	1,29	59,34

7. Perbandingan Properti Fraksi Massa & Fraksi Volume

Tabel L.13 Perbandingan perhitungan fraksi berat & fraksi volume

Sampel n	$\rho_{relatif}$ [g/cm³], fV	$\rho_{relatif}$ [g/cm³], fm	ϵ [%], fV	ϵ [%], fm
S1SGn	0,36	0,20	64,47	79,9
S120n	0,41	0,15	59,15	84,93
S130n	0,42	0,16	57,81	84,44
S140n	0,44	0,16	56,40	83,92
S2SGn	0,35	0,20	64,51	79,92
S220n	0,44	0,16	55,87	83,72
S230n	0,43	0,16	57,13	84,19
S240n	0,41	0,15	59,34	85

8. Morfologi Sel & Pori

Tabel L.14 Ukuran Sel & Pori

sampel dipilih secara acak	Pori 1	Pori 2	Pori 3	Pori 4	Pori 5	Diameter pori rata2 [mm]	Diameter filler [mm]		
			S1						
S1SG2	tdk bulat	tdk bulat	tdk bulat	tdk bulat		2,265	2,650	menyusut	-14,52%
S1201	tdk bulat	tdk bulat	tdk bulat	tdk bulat	tdk bulat	0,624	0,841	menyusut	-25,81%
S1301	tdk bulat	tdk bulat	tdk bulat	tdk bulat	tdk bulat	0,462	0,542	menyusut	-14,85%
S1402	tdk bulat	tdk bulat	tdk bulat	tdk bulat	tdk bulat	0,354	0,420	menyusut	-15,74%
			S2						
S2SG1	tdk bulat	tdk bulat	tdk bulat	tdk bulat		2,432	2,650	menyusut	-8,24%
S2202	tdk bulat	tdk bulat	tdk bulat	tdk bulat	tdk bulat	0,567	0,841	menyusut	-32,58%
S2301	tdk bulat	tdk bulat	tdk bulat	tdk bulat		0,409	0,542	menyusut	-24,63%
S2401	tdk bulat	tdk bulat	tdk bulat	tdk bulat	tdk bulat	0,407	0,420	menyusut	-3,02%

Tabel L.15 Hubungan Ukuran Pengisi dengan Ukuran Pori

	D_{pori}(S1) [mm]	D_{pori}(S2) [mm]	D(pengisi) [mm]	P(S1) [%]	P(S2) [%]
2,650	2,27	2,43	2,65	-14,52	-8,24
0,841	0,62	0,57	0,84	-25,81	-32,58
0,542	0,46	0,41	0,54	-14,85	-24,63
0,420	0,35	0,41	0,42	-15,74	-3,02

9. Properti Listrik

Tabel L.15 Pengukuran hambatan

KODE SAMPEL	Rrerata [mΩ]	L [mm]	A [mm²]	koreksi A [mm²]	ρ [mΩ mm]	ρ [mΩm]	λ [mΩm]⁻¹
S1SG1	55,30	15	195,26	142,48	525,27	0,53	1,9
S1201	78,61	15	188,41	142,48	746,66	0,75	1,34
S1301	54,54	15	178,07	142,48	518,07	0,52	1,93
S1402	77,77	15	182,31	142,48	738,67	0,74	1,35
S2SGn		15	192,59	142,48	0,00	0	
S2201	129,53	15	217,54	142,48	1230,38	1,23	0,81
S2301	141,40	15	234,85	142,48	1343,09	1,34	0,74
S2401	182,42	15	239,27	142,48	1732,73	1,73	0,58
			203,54				

$$\frac{\lambda}{\lambda_s} = \frac{1}{3}\left(\frac{\rho}{\rho_s}\right)$$

Tabel L.16 Perhitungan konduktifitas listrik

				referensi	
KODE SAMPEL	λ [1/mΩm] (S2)	ρ_{rel}, fm (S1)	ρ_{rel}, fm (S2)	λ [1/mΩm] (S1)	λ [1/mΩm] (S2)
2,650		0,2	0,2	0,58	0,58
0,841	0,81	0,15	0,16	0,43	0,47
0,542	0,74	0,16	0,16	0,45	0,45
0,420	0,58	0,16	0,15	0,46	0,43

10.

Lampiran 3

LAIN-LAIN

14 General physical properties

14.1 The physical properties of pure metals

Many physical properties depend on the purity and physical state (annealed, hard drawn, cast, etc.) of the metal. The data in Tables 14.1 and 14.2 refer to metals in the highest state of purity available, and are sufficiently accurate for most purposes. The reader should, however, consult the references before accepting the values quoted as applying to a particular sample.

Table 14.1 THE PHYSICAL PROPERTIES OF PURE METALS AT NORMAL TEMPERATURES

Metal	*Melting point* °C	*Boiling point* °C	*Density at* 20°C $g\,cm^{-3}$‡	*Thermal conductivity* 0–100°C $W\,m^{-1}\,K^{-1}$	*Mean specific heat* 0–100°C $J\,kg^{-1}\,K^{-1}$	*Resistivity at* 20°C $\mu\Omega cm$	*Temp. coeff. of resistivity* 0–100°C $10^{-3}\,K^{-1}$	*Coefficient of expansion* 0–100°C $10^{-6}\,K^{-1}$
Aluminium	660.323†	2520	2.70	238	917	2.67	4.5	23.5
Antimony	630.63†	1590	6.68	23.8	209	40.1	5.1	8–11
Arsenic	(817)	616	5.727	—	331	33.3	—	5.6
Barium	729	2130	3.5	—	285	60 (0°C)	—	18
Beryllium	1287	2470	1.848	194	2052	3.3	9.0	12
Bismuth	217.403	1564	9.80	9	124.8	117	4.6	13.4
Cadmium	321.069†	767	8.64	103	233.2	7.3	4.3	31
Caesium	28.5	670	1.87	36.1(s)	234	20	4.8	97
Calcium	839	1484	1.54	125	624	3.7	4.57	22
Cerium	798	3430	6.75	11.9	188	85.4	8.7	8
Chromium	1860	2680	7.1	91.3	461	13.2	2.14	6.5
Cobalt	1495†	2930	8.9	96	427	6.34	6.6	12.5
Copper	1084.62†	2560	8.96	397	386.0	1.694	4.3	17.0
Dysprosium	1500	(2630)	8.536	10.0	173	91	1.19	8.6
Erbium	1530	(2600)	9.051	9.6	166	86	2.01	9.2
Gadolinium	1350	(3000)	α7.895 β7.80	8.8	298	134	0.9/1.76	6.4
Gallium	29.7646†	2205	5.91	41.0(s)	377	*	—	18.3
Germanium	937	2830	5.32	56.4	310	$\sim 89 \times 10^3$	—	5.75
Gold	1064.18†	2860	19.3[2]	315.5	130	2.20	4.0	14.1
Hafnium	2227	4600	13.1	22.9	147	32.2	4.4	6.0
Holmium	1461	2600	8.803	—	164	94	1.71	9.5**
Indium	156.5985†	2070	7.3	80.0	243	8.8	5.2	24.8
Iridium	2446†	4390	22.4	146.9	130.6	5.1	4.5	6.8
Iron	1536	2860	7.87	78.2	456	10.1	6.5	12.1
Lanthanum	920	(3420)	α6.174 β6.186 γ5.97	13.8	200	57	2.18	4.9
Lead	327.462†	1750	11.68	34.9	129.8	20.6	4.2	29.0
Lithium	181	1342	0.534	76.1	3517	9.29	4.35	56
Lutetium	1652	3327	9.842	—	154	68	—	125**
Magnesium	649	1090	1.74	155.5	1038	4.2	4.25	26.0
Manganese	1244	2060	7.4	7.8	486	160(α)	—	23

* *See* 'Electrical properties'.
** at 400°C.
‡ Densities of higher allotropes not at 20°C.
† Defined fixed point at ITS-90—see Chapter 16.

Table 14.5 THE PHYSICAL PROPERTIES OF COPPER AND COPPER ALLOYS AT NORMAL TEMPERATURES—*continued*

Material	*Composition* %	*Density* g cm^{-3}	*Melting point of liquidus* °C	*Coefficient of expansion* 25–300°C 10^{-6} K^{-1}	*Electrical conductivity* 20°C %IACS*	*Thermal conductivity* W m^{-1} K^{-1}	*Refs.*
Tellurium copper	Cu 99.5 Te 0.5	8.94	1 082	17.7	98	382	2
Chromium copper	Cu 99.4 Cr 0.6	8.89	1 081	17	45(1) 82(2)	167 188	6
Beryllium copper	Be 1.85 Co 0.25	8.25	1 000	17	17(1) 23(2)	84 105	7
	Be 0.5 Co 2.5	8.75	1 060	17	23(1) 47(2)	126 210	7
Cadmium copper	Cu 99.2 Cd 0.8	8.94	1 080	17	85	376	6
Sulphur copper	Cu 99.65 S 0.35	8.92	10.75	17	95	373	5
Cap copper	Cu 95 Zn 5	8.85	1 065	18.1	56	234	5
Gilding metals CuZn10	Cu 90 Zn 10	8.80	1 040	18.2	44	188	5
CuZn15	Cu 85 Zn 15	8.75	1 020	18.7	37	159	5
CuZn20	Cu 80 Zn 20	8.65	1 000	19.1	32	138	5
Brass CuZn30	Cu 70 Zn 30	8.55	965	19.9	28	121	5
CuZn33	Cu 67 Zn 33	8.50	940	20.2	27	121	5
CuZn37	Cu 63 Zn 37	8.45	920	20.5	26	125	5
CuZn40	Cu 60 Zn 40	8.40	900	20.8	28	126	5
Aluminium brass CuZn22Al2	Cu 76 Zn 22 Al 2	8.35	1 010	18.5	23	101	5
Naval brass CuZn36Sn	Cu 62 Zn 37 Sn 1	8.40	915	21.2	26	117	5
Free cutting brass CuZn39Pb3	Cu 58 Zn 39 Pb 3	850	900	20.9	26	109	3, 5
Hot stamping brass CuZn40Pb2	Cu 58 Zn 40 Pb 2	8.45	910	20.9	26	109	3, 5
High tensile brass	Cu 54–62 Others 7 max. Zinc—balance	8.3–8.4	990 approx.	21 approx.	20–25	88–109	5
Nickel silver 10%	Cu 62 Ni 10 Zn 28	8.60	1 010	16.4	8.31	37	8, 9
12%	Cu 62 Ni 12 Zn 26	8.64	1 025	16.2	7.71	30	8, 9
15%	Cu 62 Ni 15 Zn 23	8.69	1 060	16.2	7.01	27	8, 9
18%	Cu 62 Ni 18 Zn 20	8.72	1 100	16.0	6.3	28	8, 9
25%	Cu 62 Ni 25 Zn 13	8.82	1 160	17.0	5.1	21	8, 9

Table 14.1 THE PHYSICAL PROPERTIES OF PURE METALS AT NORMAL TEMPERATURES—*continued*

Metal	*Melting point* °C	*Boiling point* °C	*Density at 20°C* $g cm^{-3}$‡	*Thermal conductivity* 0–100°C $W m^{-1} K^{-1}$	*Mean specific heat* 0–100°C $J kg^{-1} K^{-1}$	*Resistivity at 20°C* μΩcm	*Temp. coeff. of resistivity* 0–100°C $10^{-3} K^{-1}$	*Coefficient of expansion* 0–100°C $10^{-6} K^{-1}$
Mercury	−38.87	357	13.546	8.65	138	95.9	1.0	61
Molybdenum	2615	4610	10.2	137	251	5.7	4.35	5.1
Neodymium	1024	(3060)	α7.004 β6.80	13.0	209	64	1.64	6.7
Nickel	1455†	2915	8.9	88.5	452	6.9	6.8	13.3
Niobium	2467	4740	8.6	54.1	268	16.0	2.6	7.2
Osmium	3030	5000	22.5	86.9	130	8.8	4.1	4.57
Palladium	1554†	2960	12.0	75.2	247	10.8	4.2	11.0
Platinum	1768†	3830	21.45	73.4	134.4	10.58	3.92	9.0
Plutonium	640	3235	19.84	8.4	142	146.5	—	55
Polonium	246	965	—	—	—	—	—	—
Potassium	63.2	759	0.86	104(s)	754	6.8	5.7	83
Praeseodymium	932	(3020)	α6.782 β6.64	11.7	192	68	1.71	4.8
Radium	700	1500	5	—	—	—	—	—
Rhenium	3180	5690	21.0	47.6	138	18.7	4.5	6.6
Rhodium	1962†	3700	12.4	148	243	4.7	4.4	8.5
Rubidium	38.8	688	1.53	58.3(s)	356	12.1	4.8	9.0
Ruthenium	2310	4120	12.2	116.3	234	7.7	4.1	9.6
Samarium	1072	1803	7.536 7.40	—	181	92	1.48	—
Scandium	1538	(2870)	2.99	—	558	66	—	12
Selenium	220.5	685	4.79	—	339	12	—	37
Silicon	1412	3270	2.34	138.5	729	10^3–10^6	—	7.6
Silver	961.78†	2163	10.5	425	234	1.63	4.1	19.1
Sodium	97.8	883	0.97	128	1227	4.7	5.5	71
Strontium	770	1375	2.6	—	737	23 (0°C)	—	100
Tantalum	2980	5370	16.6	57.55	142	13.5	3.5	6.5
Terbium	1356	(2500)	8.272	—	172	116	—	7.0
Tellurium	450	988	6.24	3.8	134	1.6×10^5 (0°C)	— —	1.7 ∥c axis 27.5 ⊥c axis
Thallium	304	1473	11.85	45.5	130	16.6	5.2	30
Thorium	1755	4290	11.5	49.2	100	14	4.0	11.2
Thulium	1543	1727	9.322	—	160	90	1.95	11.6**
Tin	231.928†	2270	7.3	73.2	226	12.6	4.6	23.5
Titanium	1667	3285	4.5	21.6	528	54	3.8	8.9
Tungsten	3420†	5555	19.3	174	138	5.4	4.8	4.5
Uranium	1132	4400	19.05(α) 18.89(β)	28	117	27	3.4	‡
Vanadium	1902	3410	6.1	31.6	498	19.6	3.9	8.3
Ytterbium	824	1427	6.977 6.54	—	145	28	1.30	25.0
Yttrium	1520	3300	4.478 4.25	10.2	309	53	2.71	10.8**
Zinc	419.527†	911	7.14	119.5	394	5.96	4.2	31
Zirconium	1852	4400	6.49	22.6	289	44	4.4	5.9

(s) = solid * *See* 'Electrical properties.' ‡ α-Uranium 23 ∥ *a* axis, −3.5 ∥ *b* axis, 17 ∥ *c* axis } 25–300°C β-Uranium 4.6 ∥ *c* axis, 23 ⊥ *c* axis } 20–720°C

** At 400°C. ‡ Densities of higher allotropes not at 20°C.

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Melting and boiling points (1) *see also* 'Thermochemical data' p. 8–1. Electrical resistivity (2, 3) *see also* 'Electrical properties, p. 19–1. Specific heat (4, 5) Thermal conductivity (6).

† Defined fixed point of ITS-90—see Chapter 16.

Table 14.2 THE PHYSICAL PROPERTIES OF PURE METALS AT ELEVATED TEMPERATURES

Metal	*Temperature* t °C	*Coefficient of expansion* 20–t °C 10^{-6} K^{-1}	*Resistivity at* t °C μΩcm	*Thermal conductivity at* t °C W m^{-1} K^{-1}	*Specific heat at* t °C J kg^{-1} K^{-1}	*References*
Aluminium	20	—	2.67		900	7, 8, 9
	100	23.9	3.55		938	
	200	24.3	4.78	238	984	
	300	25.3	5.99		1 030	
	400	26.49	7.30		1 076	
Antimony	20	—	40.1	18.0	205	7, 10, 6
	100	8.4–11.0	59	16.7	214	
	500	9.7–11.6	154	19.7	239	
Beryllium	20	—	3.3	180	1 976	11
	100	12	5.3	152	2 081	
	200	13	10.5	130.2	(2 215)	
	300	14.5	11.1	117.7	(2 353)	
	500	16	21.8	103.0	(2 621)	
	700	17	26	85.8	(2 889)	
Bismuth	20	—	117	8.0	121	7, 12
	100	13.4	156	7.5	130	
	250	—	260	7.5	147	
Cadmium	20	—	7.3	84	230	7, 13, 14
	100	31.8	9.6	87.9	239	
	300	(38)	18.0	104.7	260	
Chromium	20	—	13.2	91.3	444	7, 15, 16
	100	6.6	18 (152 °C)	—	490	
	400	8.4	31 (407 °C)	76.2 (426 °C)	582	
	700	9.4	47 (652 °C)	67.4 (760 °C)	649	
Cobalt	20	—	5.68	—	434	42, 45
	100	12.3	9.30	—	453	
	200	13.1	13.88	—	478	
	300	13.6	19.78	—	502	
	400	14.0	26.56	—	527	
	600	—	40.2	—	575	
	800	—	58.6	—	716	
	1 000	—	77.4	—	800	
	1 200	—	91.9	—	883	
Copper	20	—	1.694	394	385	7, 17, 16, 18
	100	17.1	—	394	389	
	200	17.2	2.93	389	402	
	500	18.3	4.6(497 °C)	341(538 °C)	(427)	
	1 000	20.3	8.1(977 °C)	244(1 037 °C)	(473)	
Gold	20	—	2.2	293	126	7
	100	14.2	2.8	293	130	
	500	15.2	6.8	—	142	
	900	16.7	11.8	—	151	
Hafnium	20	—	35.5	(22.2)	144	43, 44, 48
	100	—	46.5	22.0	148	
	200	—	60.3	21.5	152	
	400	6.3	84.4	20.7	160	
	1 000	6.1	—	—	185	
	1 400	6.0	—	—	—	
	1 800	5.9	—	—	—	
Iridium	20	—	5.1	148(0 °C)	130	19
	100	6.8	6.8	143	134	
	500	7.2	15.1	—	142	
	1 000	7.8	—	—	159	

Table 14.2 THE PHYSICAL PROPERTIES OF PURE METALS AT ELEVATED TEMPERATURES—*continued*

Metal	*Temperature* t °C	*Coefficient of expansion* 20–t °C 10^{-6} K^{-1}	*Resistivity at* t °C μΩ cm	*Thermal conductivity at* t °C $W m^{-1} K^{-1}$	*Specific heat at* t °C $J kg^{-1} K^{-1}$	*References*
Iron	20	—	10.1	73.3	444	7, 20
	100	12.2	14.7	68.2	477	
	200	12.9	22.6	61.5	523	
	400	13.8	43.1	48.6	611	
	600	14.5	69.8	38.9	699	
	800	14.6	105.5	29.7	791	
Lead	20	—	20.6	34.8	130	7, 6, 11
	100	29.1	27.0	33.5	134	
	200	30.0	36.0	31.4	134	
	300	31.3	50	29.7	138	
Magnesium	20	—	4.2	167	1 022	7
	100	26.1	5.6	167	1 063	
	200	27.0	7.2	163	1 110	
	400	28.9	12.1	130	1 197	
Molybdenum	20	—	5.7	142	247	7, 21, 22, 23
	100	5.2	7.6	138	260	
	500	5.7	17.6	121	285	
	1 000	5.75	31	105	310	
	1 500	6.51	46	84	339 (mean)	
	2 500	—	77	—	—	
Nickel	20	—	6.9	88	435	24
	100	13.3	10.3	82.9	477	
	200	13.9	15.8	73.3	528	
	300	14.4	22.5	63.6	578	
	400	14.8	30.6	59.5	519	
	500	15.2	34.2	62.0	535	
	900	16.3	45.5	—	595	
Niobium	20	—	14.6	—	268	42, 45
	200	7.19	25.0	56.5	271	
	400	7.39	36.6	60.7	284	
	600	7.56	48.1	65.3	292	
	800	7.72	59.7	—	301	
	1 000	7.88	71.3	—	310	
Palladium	20	—	10.8	75	243	19
	100	11.1	13.8	74	247	
	500	12.4	27.5	—	268	
	1 000	13.6	40	—	297	
Platinum	20	—	10.58	72	134	7, 19, 23, 25
	100	9.1	13.6	72	134	
	500	9.6	27.9	—	147	
	1 000	10.2	43.1	67	159	
	1 500	11.31	55.4	63	176	
Plutonium	20 $\alpha \rightarrow \alpha$	47	145.8	(8.4)	131	42, 45
	100 $\alpha \rightarrow \alpha$	203	141.6	—	138	
	200 $\alpha \rightarrow \beta$	173	107.8	—	145	
	300 $\alpha \rightarrow \gamma$	181	107.4	—	153	
	400 $\alpha \rightarrow \delta$	109	100.7	—	154	
	500 $\alpha \rightarrow \varepsilon$	101	110.6	—	144	
Rhenium	20	12.4 ‖-axis	18.7	48	134	26, 16, 27
	100	4.7 ⊥-axis	25		138	
	2 500	7.29 (2 000 °C)	132	—	209 (2 527 °C)	
Rhodium	20	—	4.7	149	243	19
	100	8.5	6.2	147	255	
	500	9.8	14.6	—	289	
	1 000	10.8	—	—	331	

Table 14.2 THE PHYSICAL PROPERTIES OF PURE METALS AT ELEVATED TEMPERATURES—*continued*

Metal	*Temperature* t°C	*Coefficient of expansion* 20–t°C $10^{-6}K^{-1}$	*Resistivity at* t°C μΩcm	*Thermal conductivity at* t°C $Wm^{-1}K^{-1}$	*Specific heat at* t°C $Jkg^{-1}K^{-1}$	*References*
Silver	20	—	1.63	419	234	7, 28
	100	19.6	2.1	419	222	
	500	20.6	4.7	(377)	(230)	
	900	22.4	7.6	—	(243)	
Tantalum	20	—	13.5	57	138	7, 29, 30, 31, 32
	100	6.5	17.2	54	142	
	500	6.6	35	—	151	
	1 500	—	71	—	167	
	2 500	—	102	—	234(2 727°C)	
Thallium	20	—	16.6	46	134	33, 6
	100	30	—	45	138	
	200	—	—	45	142	
Tin	20	—	12.6	65	222	7, 34
	100	23.8	15.8	63	239	
	200	24.2	23.0	60	260	
Titanium	20	—	54	16	519	35, 36
	100	8.8	70	15	540	
	200	9.1	88	15	569	
	400	9.4	119	14	619	
	600	9.7	152	13	636	
	800	9.9	165	(13)	682	
Tungsten	20	—	5.4	167	134	37, 33 38
	100	4.5	7.3	159	138	
	500	4.6	18	121	142	
	1 000	4.6	33	111	151	
	2 000	5.4	65	93	—	
	3 000	6.6	100	—	—	
Uranium	20 α	—	30	27	116	Expansion anisotropic 42, 45
	600 α	—	59	38	186	
	700 β	—	55.5	40	176	
	800 γ	—	54	42.3	160	
Vanadium	20	—	24.8	—	492	42, 45
	100	8.3	31.5	31	505	
	500	9.6	—	36.8	570	
	700	—	—	35.2	603	
	900	10.4	—	—	636	
Zinc	20	—	5.96	113	389	39, 13, 40, 41, 6
	100	31	7.8	109	402	
	200	33	11.0	105	414	
	300	34	13.0	101	431	
	400	—	16.5	96	444	

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