



DEPARTEMEN PENDIDIKAN NASIONAL
POLITEKNIK MANUFAKTUR NEGERI BANDUNG

JLN. KANAYAKAN 21 - DAGO - BANDUNG 40135, TROMOL POS 851 - BANDUNG 40008
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Lab No. : 453/Sp.Lab/Ex Polman/XII/2008
Order No. : PF-30906

11 Desember 2008

LAPORAN HASIL ANALISA (REPORT OF ANALYSIS)

Customer :
BPPT ENJINIRING
Jl. M.H. Thamrin No.8
Jakarta

Kode Sampel : BPPT 3
Analisa : Spectrometer
Program : CUBRAS
Hasil / Results :

| Unsur | (%) |
|-------|----------|
| Sn | 0,01603 |
| Zn | 30,05447 |
| Pb | 0,00993 |
| Fe | 0,05761 |
| Ni | 0,08965 |
| Al | 0,00685 |
| P | 0,00172 |
| Si | - |
| Mn | - |
| S | 0,00283 |
| Sb | 0,00517 |
| Mg | 0,00033 |
| Cu | 69,75353 |

Ka. Divisi Pengecoran.

ACHMAD SAMBAS, M.T
NIP. 132 144 637

Catatan :

Lampiran 1 : Uji Komposisi Kimia (Lanjutan)



DEPARTEMEN PENDIDIKAN NASIONAL
POLITEKNIK MANUFAKTUR NEGERI BANDUNG

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11 December 2008

LAPORAN HASIL ANALISA (REPORT OF ANALYSIS)

Customer :
BPPT ENJINIRING
Jl. M.H. Thamrin No.8
Jakarta

Kode Sampel : BPPT 5
Analisa : Spectrometer
Program : CUBRAS
Hasil / Results :

| Unsur | (%) |
|-------|----------|
| Sn | 0.01691 |
| Zn | 30.18515 |
| Pb | 0.01063 |
| Fe | 0.10787 |
| Ni | 0.07765 |
| Al | 0.16112 |
| P | 0.00355 |
| Si | |
| Mn | |
| S | 0.0033 |
| Sb | 0.0063 |
| Mg | 0.00033 |
| Cu | 69.42985 |

Ka. Divisi Pengecoran,

ACHMAD SAMBAS, M.T
NIP. 132 144 637

Catatan -

Lampiran 2 : Perhitungan Besar Butir

Data perhitungan besar butir AI $\leq 0,03\%$

| Sampel no. | tampak | M (perbesaran) | f (faktor pengali) | n1 | n2 | n2/2 | NA | G (ASTM) | Akumulasi | Standar deviasi | Diameter Butir |
|------------------|---------|----------------|--------------------|----|----|------|-----|------------|------------|-----------------|----------------|
| 1 No anil | atas | 200 | 8 | 19 | 17 | 8.5 | 220 | 4.83152815 | 5.02720828 | 0.185268261 | 0.065 |
| | samping | 200 | 8 | 26 | 19 | 9.5 | 284 | 5.19992353 | | | |
| | depan | 200 | 8 | 24 | 16 | 8 | 256 | 5.05017316 | | | |
| 2 500,3menit | atas | 200 | 8 | 91 | 33 | 16.5 | 860 | 6.79840386 | 6.76798845 | 0.120524343 | 0.03432 |
| | samping | 200 | 8 | 81 | 30 | 15 | 768 | 6.63516997 | | | |
| | depan | 200 | 8 | 98 | 30 | 15 | 904 | 6.87039153 | | | |
| 3 600,3menit | atas | 200 | 8 | 36 | 18 | 9 | 360 | 5.54203691 | 5.54150227 | 0.048110927 | 0.0539 |
| | samping | 200 | 8 | 34 | 19 | 9.5 | 348 | 5.49312625 | | | |
| | depan | 200 | 8 | 37 | 19 | 9.5 | 372 | 5.58934365 | | | |
| 4 600,3menit | atas | 200 | 8 | 38 | 20 | 10 | 384 | 5.63514833 | 5.56770071 | 0.058964817 | 0.0533 |
| | samping | 200 | 8 | 37 | 16 | 8 | 360 | 5.54203691 | | | |
| | depan | 200 | 8 | 37 | 15 | 7.5 | 356 | 5.52591689 | | | |
| 5 700,3menit | atas | 200 | 8 | 31 | 15 | 7.5 | 308 | 5.31696548 | 5.44886344 | 0.212535897 | 0.05587 |
| | samping | 200 | 8 | 34 | 10 | 5 | 312 | 5.33558156 | | | |
| | depan | 200 | 8 | 39 | 22 | 11 | 400 | 5.69404329 | | | |
| 10 600,4menit | atas | 200 | 8 | 35 | 19 | 9.5 | 356 | 5.52591689 | 5.53571269 | 0.064721827 | 0.0541 |
| | samping | 200 | 8 | 37 | 20 | 10 | 376 | 5.60477402 | | | |
| | depan | 200 | 8 | 34 | 18 | 9 | 344 | 5.47644715 | | | |
| 11 600,2menit | atas | 200 | 8 | 39 | 18 | 9 | 384 | 5.63514833 | 5.67045193 | 0.197360015 | 0.05075 |
| | samping | 200 | 8 | 36 | 15 | 7.5 | 348 | 5.49312625 | | | |
| | depan | 200 | 8 | 48 | 18 | 9 | 456 | 5.88308121 | | | |

Lampiran 2 : Perhitungan Besar Butir (Lanjutan)

Data perhitungan besar butir $AI > 0,03\%$

| Sampel no. | tampak | M (perbesaran) | f (faktor pengali) | n1 | n2 | n2/2 | NA | G (ASTM) | Akumulasi | Standar deviasi | Diameter Butir |
|-------------------|--------------------------|----------------|--------------------|----|----|------|------|-------------|-------------|-----------------|----------------|
| 6 600, 3menit | atas | 200 | 8 | 34 | 16 | 8 | 336 | 5.442499079 | 5.555771403 | 0.098393269 | 0.055 |
| | samping | 200 | 8 | 38 | 18 | 9 | 376 | 5.604774021 | | | |
| | depan | 200 | 8 | 37 | 21 | 10.5 | 380 | 5.620041108 | | | |
| 7 700,3menit | atas | 200 | 8 | 25 | 19 | 9.5 | 276 | 5.158699971 | 5.253299674 | 0.163851492 | 0.05917 |
| | samping | 200 | 8 | 32 | 20 | 10 | 336 | 5.442499079 | | | |
| | depan | 200 | 8 | 24 | 21 | 10.5 | 276 | 5.158699971 | | | |
| 8 600,3menit | atas | 200 | 8 | 36 | 22 | 11 | 376 | 5.604774021 | 5.60986305 | 0.008814457 | 0.0525 |
| | samping | 200 | 8 | 38 | 18 | 9 | 376 | 5.604774021 | | | |
| | depan | 200 | 8 | 36 | 23 | 11.5 | 380 | 5.620041108 | | | |
| 9 600,2menit | atas | 200 | 8 | 48 | 15 | 7.5 | 444 | 5.844606227 | 5.976233896 | 0.142173561 | 0.0454 |
| | samping | 200 | 8 | 51 | 18 | 9 | 480 | 5.957083391 | | | |
| | depan | 200 | 8 | 59 | 17 | 8.5 | 540 | 6.12701207 | | | |
| 12 600,4menit | atas | 200 | 8 | 31 | 15 | 7.5 | 308 | 5.31696548 | 5.340780451 | 0.174452389 | 0.057665 |
| | samping | 200 | 8 | 36 | 17 | 8.5 | 356 | 5.525916893 | | | |
| | depan | 200 | 8 | 26 | 18 | 9 | 280 | 5.17945898 | | | |
| 13 No anil | atas | 200 | 8 | 17 | 15 | 7.5 | 196 | 4.664874669 | 4.652498777 | 0.104844826 | 0.07125 |
| | samping | 200 | 8 | 19 | 14 | 7 | 208 | 4.750606399 | | | |
| | depan | 200 | 8 | 15 | 15 | 7.5 | 180 | 4.542015262 | | | |
| 14 500,3 menit | atas samping depan | 500 | 50 | 56 | 21 | 10.5 | 3325 | 8.74939186 | 8.74939186 | | 0.025 |

Lampiran 3 : Perhitungan Kekerasan/Hardness

Data pengujian hardness $AI \leq 0,03\%$

| Sampel No | Tampak | 1 | | 2 | | 3 | | VHN1 | VHN2 | VHN3 | V rata2 | V akumulasi | Standar deviasi | Konversi Brinell |
|-------------|---------|-------|-------|-------|-------|-------|-------|-------------|-------------|-------------|-------------|-------------|-----------------|------------------|
| | | A | B | A | B | A | B | | | | | | | |
| 600, 2menit | Atas | 73 | 74 | 72 | 71 | 72.75 | 68.5 | 102.9571012 | 108.7974962 | 111.5100634 | 107.754887 | 111.2505252 | 4.160888997 | 98.25 |
| | Depan | 67.5 | 70 | 73.75 | 70 | 71.5 | 74 | 117.6753719 | 107.6651796 | 105.0908704 | 110.1438073 | | | |
| | Samping | 70.5 | 68.5 | 67.5 | 67.5 | 69.5 | 72.5 | 115.1493194 | 122.0740741 | 110.3352509 | 115.8528815 | | | |
| 600, 3menit | Atas | 78.75 | 78 | 79.5 | 80 | 76.3 | 77.5 | 90.54737758 | 87.45197079 | 94.05422407 | 90.68452415 | 92.43274307 | 2.932001275 | 82.215 |
| | Depan | 81 | 77.5 | 70.5 | 71.5 | 79 | 79.5 | 88.55894675 | 110.3352509 | 88.55894675 | 95.81771481 | | | |
| | Samping | 78.75 | 77.5 | 77.2 | 78 | 80.2 | 78 | 91.127808 | 92.36502285 | 88.89513986 | 90.79599024 | | | |
| 600, 4menit | Atas | 79.4 | 77 | 76 | 78 | 81.25 | 77.2 | 90.95309424 | 93.81008602 | 88.61484635 | 91.12600887 | 91.90005483 | 4.281297373 | 81.9 |
| | Depan | 75 | 76 | 74.5 | 77 | 76 | 77 | 97.57466778 | 96.93167337 | 95.04036909 | 96.51557008 | | | |
| | Samping | 83.5 | 87 | 78 | 77 | 76 | 77 | 76.53184957 | 92.60353798 | 95.04036909 | 88.05858555 | | | |
| 500, 3menit | Atas | 66.5 | 74 | 71 | 77 | 71 | 69 | 112.7037398 | 101.5704894 | 113.5102041 | 109.2614778 | 105.365299 | 3.420712223 | 93.36 |
| | Depan | 70.75 | 75 | 69 | 74.75 | 69.5 | 80 | 104.7306621 | 107.6651796 | 99.54251071 | 103.9794508 | | | |
| | Samping | 74.75 | 74.25 | 73.25 | 81.25 | 66.5 | 72.5 | 100.2117022 | 93.2038835 | 115.1493194 | 102.8549684 | | | |
| 600, 3menit | Atas | 78 | 83.5 | 79 | 75.5 | 80 | 79.75 | 85.29938943 | 93.2038835 | 87.17846988 | 88.56058094 | 85.94752062 | 3.68049132 | 76.975 |
| | Depan | 85.5 | 81.5 | 82.5 | 81 | 81 | 83.5 | 79.77338736 | 83.22531773 | 82.21653532 | 81.73841347 | | | |
| | Samping | 79.5 | 80 | 78.25 | 81 | 79 | 80.5 | 87.45197079 | 87.72676079 | 87.45197079 | 87.54356746 | | | |
| 700, 3menit | Atas | 80 | 87.5 | 78.5 | 81 | 80.5 | 79.25 | 79.29783916 | 87.45197079 | 87.17846988 | 84.64275995 | 84.29280382 | 6.404741347 | 76.145 |
| | Depan | 81 | 80.25 | 76 | 76 | 78.75 | 78.75 | 85.5640887 | 96.29501385 | 89.68707483 | 90.51539246 | | | |
| | Samping | 85.25 | 86.5 | 86.5 | 86 | 79.25 | 84.5 | 75.42190271 | 74.76748582 | 82.97138861 | 77.72025905 | | | |
| No Anil | Atas | 52 | 55.5 | 55 | 55.5 | 52.5 | 57 | 192.5191996 | 182.2075715 | 185.55076 | 186.759177 | 169.9570199 | 15.06623011 | 146.98 |
| | Depan | 55.5 | 56.5 | 57 | 62 | 63.75 | 63 | 177.3596939 | 157.1075489 | 138.4825461 | 157.6499296 | | | |
| | Samping | 61 | 59.5 | 58.25 | 56.25 | 57.25 | 56 | 153.2205024 | 169.6992811 | 173.466076 | 165.4619532 | | | |

Lampiran 3 : Perhitungan Kekerasan/Hardness (Lanjutan)

Data pengujian hardness AI > 0,03%

| Sampel No | Tampak | 1 | | 2 | | 3 | | VHN1 | VHN2 | VHN3 | V rata2 | V akumulasi | Standar deviasi | Konversi Brinell |
|-------------|---------|-------|-------|-------|-------|-------|-------|------------|-------------|-------------|-------------|-------------|-----------------|------------------|
| | | A | B | A | B | A | B | | | | | | | |
| 600, 2menit | Atas | 75 | 77.5 | 76.5 | 78.5 | 77.75 | 77.75 | 95.6646063 | 92.60353798 | 92.00897427 | 93.42570618 | 102.0151256 | 9.289563774 | 90.015 |
| | Depan | 77 | 76.75 | 73 | 75 | 71.5 | 73 | 94.1154075 | 101.5704894 | 106.5504484 | 100.7454484 | | | |
| | Samping | 70.25 | 74.25 | 75 | 79 | 63 | 65.25 | 106.550448 | 93.81008602 | 135.2621319 | 111.8742221 | | | |
| 600, 3menit | Atas | 76.5 | 75.25 | 78 | 75.5 | 79 | 78.5 | 96.612557 | 94.42222199 | 89.68707483 | 93.57395126 | 95.72749045 | 2.026742718 | 84.73 |
| | Depan | 76.75 | 76 | 74 | 75.5 | 74.25 | 76.5 | 95.3517214 | 99.54251071 | 97.89856687 | 97.59759967 | | | |
| | Samping | 77.75 | 75.5 | 75 | 75 | 76 | 77.5 | 94.7305392 | 98.88 | 94.42222199 | 96.01092041 | | | |
| 600, 4menit | Atas | 77 | 79.5 | 80.5 | 78 | 80 | 78.5 | 90.8368974 | 88.55894675 | 88.55894675 | 89.31826363 | 87.69039559 | 6.593458704 | 78.69 |
| | Depan | 77 | 77.75 | 75.5 | 77.5 | 77.25 | 78.25 | 92.9029833 | 95.04036909 | 92.00897427 | 93.31744223 | | | |
| | Samping | 88.75 | 88 | 82.25 | 80.5 | 80.75 | 80 | 71.215107 | 83.99413876 | 86.09719699 | 80.4354809 | | | |
| 500, 3menit | Atas | 68 | 68 | 68 | 69.5 | 72.5 | 70.25 | 120.285467 | 117.6753719 | 109.1789069 | 115.7132487 | 114.451257 | 9.262465601 | 101.45 |
| | Depan | 73.5 | 74.25 | 71.75 | 70 | 73.25 | 75 | 101.914504 | 110.7247837 | 101.2282134 | 104.6225005 | | | |
| | Samping | 71 | 68.25 | 67.5 | 71.75 | 62.75 | 63.5 | 114.736228 | 114.736228 | 139.5816096 | 123.0180219 | | | |
| 600, 3menit | Atas | 79.5 | 80 | 79.25 | 81 | 86 | 78.5 | 87.4519708 | 86.63530317 | 82.21653532 | 85.43460309 | 88.75072082 | 3.13908244 | 79.375 |
| | Depan | 79.5 | 75.5 | 79.5 | 79.5 | 78.75 | 74.75 | 92.603538 | 88.00284799 | 94.42222199 | 91.67620265 | | | |
| | Samping | 85 | 85.6 | 77.1 | 77.5 | 76.85 | 73.9 | 76.4421551 | 93.08334826 | 97.89856687 | 89.14135673 | | | |
| 700, 3menit | Atas | 89.75 | 93.5 | 92.5 | 89 | 86.5 | 87.4 | 66.2526127 | 67.53637047 | 73.56848486 | 69.11915599 | 69.72001862 | 0.563866924 | 62.86 |
| | Depan | 83 | 93.3 | 88 | 91.6 | 87 | 92.75 | 71.5791194 | 68.97287216 | 68.85780552 | 69.8032657 | | | |
| | Samping | 91 | 90 | 86.85 | 90.5 | 87 | 88.7 | 67.910015 | 70.73406061 | 72.0688269 | 70.23763416 | | | |
| No Anil | Atas | 55.75 | 60.75 | 54.25 | 57.75 | 56.5 | 59.75 | 163.92271 | 177.3596939 | 164.628512 | 168.6369719 | 156.3734869 | 14.08027896 | 136.37 |
| | Depan | 61 | 61.75 | 59.25 | 53.5 | 59.25 | 60.25 | 147.654938 | 175.0079891 | 155.7955918 | 159.4861728 | | | |
| | Samping | 72.5 | 67.5 | 60.25 | 65.25 | 57 | 58 | 113.510204 | 141.2549007 | 168.2268431 | 140.997316 | | | |

Lampiran 4 : Perhitungan Uji Tarik

Data UTS $A_l \leq 0,03\%$

| Kode Sampel | Arah | Dimensi Awal (mm) | | A_0 (mm ²) | l_0 (mm) | Δl sampel (mm) | Δl grafik (mm) | P_{UTS} (Kg) | UTS (Kg/mm ²) | UTS rata-rata (Kg/mm ²) | Standar deviasi |
|-------------|------|-------------------|-------|--------------------------|------------|------------------------|------------------------|----------------|---------------------------|-------------------------------------|-----------------|
| | | t_0 | w_0 | | | | | | | | |
| 1 | 0 | 3.1 | 12.4 | 38.44 | 50 | 21.1 | 23.5 | 1460 | 37.98126951 | 37.73591777 | 0.213532524 |
| 2 | | 3.1 | 12.7 | 39.37 | 50 | 21.55 | 23.75 | 1480 | 37.59207518 | | |
| 3 | | 3.1 | 13.2 | 40.92 | 50 | 21.45 | 24.25 | 1540 | 37.6344086 | | |
| 4 | 45 | 3.1 | 13.3 | 41.23 | 50 | 26.5 | 29.75 | 1500 | 36.38127577 | 36.86735939 | 0.432942327 |
| 5 | | 3.1 | 12.9 | 39.99 | 50 | 25.4 | 27.5 | 1480 | 37.00925231 | | |
| 6 | | 3.1 | 13.35 | 41.385 | 50 | 25.65 | 29.5 | 1540 | 37.21155008 | | |
| 7 | 90 | 3.1 | 12.5 | 38.75 | 50 | 24.65 | 26 | 1510 | 38.96774194 | 38.21377077 | 0.713000011 |
| 8 | | 3.1 | 12.8 | 39.68 | 50 | 25.45 | 27.25 | 1490 | 37.55040323 | | |
| 9 | | 3.1 | 13.2 | 40.92 | 50 | 25.35 | 27.5 | 1560 | 38.12316716 | | |

| | | |
|-------------------|--------------------|-------------|
| UTS ₀ | 37.73591777 | |
| UTS ₄₅ | 36.86735939 | |
| UTS ₉₀ | 38.21377077 | |
| UTS | 37.60568264 | 0.682588306 |

Lampiran 4 : Perhitungan Uji Tarik (Lanjutan)

Data UTS Al > 0,03%

| Kode Sampel | Arah | Dimensi Awal (mm) | | A ₀ (mm ²) | l ₀ (mm) | Δl sampel (mm) | Δl grafik (mm) | P _{UTS} (Kg) | UTS (Kg/mm ²) | UTS rata-rata (Kg/mm ²) | Standar deviasi |
|-------------|------|-------------------|----------------|-----------------------------------|---------------------|----------------|----------------|-----------------------|---------------------------|-------------------------------------|-----------------|
| | | t ₀ | w ₀ | | | | | | | | |
| 1 | 0 | 3.1 | 13.2 | 40.92 | 50 | 22.65 | 25.5 | 1540 | 37.6344086 | 37.35201477 | 0.253093955 |
| 2 | | 3.1 | 13.5 | 41.85 | 50 | 22.55 | 25 | 1560 | 37.27598566 | | |
| 3 | | 3.1 | 13.2 | 40.92 | 50 | 22.7 | 26.25 | 1520 | 37.14565005 | | |
| 4 | 45 | 3.1 | 13 | 40.3 | 50 | 23.7 | 26.25 | 1510 | 37.46898263 | 36.61635922 | 0.804386047 |
| 5 | | 3.1 | 12.9 | 39.99 | 50 | 22.8 | 26.75 | 1460 | 36.50912728 | | |
| 6 | | 3.1 | 12.5 | 38.75 | 50 | 24.4 | 27.5 | 1390 | 35.87096774 | | |
| 7 | 90 | 3.1 | 12.3 | 38.13 | 50 | 26.1 | 29.25 | 1380 | 36.19197482 | 36.95398334 | 1.082875509 |
| 8 | | 3.1 | 13 | 40.3 | 50 | 25.25 | 28.5 | 1470 | 36.4764268 | | |
| 9 | | 3.1 | 12.5 | 38.75 | 50 | 24.35 | 27.25 | 1480 | 38.19354839 | | |

| | | |
|-------------------|--------------------|-----------|
| UTS ₀ | 37.35201477 | |
| UTS ₄₅ | 36.61635922 | |
| UTS ₉₀ | 36.95398334 | |
| UTS | 36.97411911 | 0.3682409 |

Lampiran 4 : Perhitungan Uji Tarik (Lanjutan)

Uji tarik n Al ≤ 0,03%

| Kode Sampel | Arah | Dimensi Awal (mm) | | A ₀ (mm ²) | dL (mm) | P (Kg) | ε | σ (Mpa) | ε _t | σ _t (Mpa) | n | n rata-rata | Standar deviasi |
|-------------|------|-------------------|----------------|-----------------------------------|---------|--------|-----|-------------|----------------|----------------------|-------------|-------------|-----------------|
| | | t ₀ | w ₀ | | | | | | | | | | |
| 1 | 0 | 3.1 | 12.4 | 38.44 | 10 | 1260 | 0.2 | 321.4245578 | 0.182321557 | 385.7094693 | 0.46986915 | 0.495425691 | 0.027425005 |
| | | | | | 15 | 1380 | 0.3 | 352.0364204 | 0.262364264 | 457.6473465 | 0.524398971 | | |
| | | | | | 20 | 1460 | 0.4 | 372.4443288 | 0.336472237 | 521.4220604 | 0.492008954 | | |
| 2 | | 3.1 | 12.7 | 39.37 | 10 | 1260 | 0.2 | 313.8318517 | 0.182321557 | 376.598222 | 0.48970707 | 0.50522338 | 0.016650722 |
| | | | | | 15 | 1390 | 0.3 | 346.2113284 | 0.262364264 | 450.0747269 | 0.522814116 | | |
| | | | | | 20 | 1470 | 0.4 | 366.1371603 | 0.336472237 | 512.5920244 | 0.503148954 | | |
| 3 | | 3.1 | 13.2 | 40.92 | 10 | 1340 | 0.2 | 321.115347 | 0.182321557 | 385.3384164 | 0.417670619 | 0.463385118 | 0.049056731 |
| | | | | | 15 | 1440 | 0.3 | 345.0791789 | 0.262364264 | 448.6029326 | 0.515211339 | | |
| | | | | | 20 | 1520 | 0.4 | 364.2502444 | 0.336472237 | 509.9503421 | 0.457273398 | | |
| 4 | 45 | 3.1 | 13.3 | 41.23 | 10 | 1220 | 0.2 | 290.1605627 | 0.182321557 | 348.1926752 | 0.518396375 | 0.522727026 | 0.00464727 |
| | | | | | 15 | 1360 | 0.3 | 323.4576764 | 0.262364264 | 420.4949794 | 0.527636657 | | |
| | | | | | 20 | 1440 | 0.4 | 342.4845986 | 0.336472237 | 479.478438 | 0.522148047 | | |
| 5 | | 3.1 | 12.9 | 39.99 | 10 | 1240 | 0.2 | 304.0620155 | 0.182321557 | 364.8744186 | 0.473719943 | 0.498989139 | 0.027116652 |
| | | | | | 15 | 1360 | 0.3 | 333.4873718 | 0.262364264 | 433.5335834 | 0.527636657 | | |
| | | | | | 20 | 1440 | 0.4 | 353.1042761 | 0.336472237 | 494.3459865 | 0.495610817 | | |
| 6 | | 3.1 | 13.35 | 41.385 | 10 | 1260 | 0.2 | 298.5516491 | 0.182321557 | 358.261979 | 0.46986915 | 0.521056884 | 0.054930119 |
| | | | | | 15 | 1380 | 0.3 | 326.9851395 | 0.262364264 | 425.0806814 | 0.579088073 | | |
| | | | | | 20 | 1480 | 0.4 | 350.6797149 | 0.336472237 | 490.9516008 | 0.514213428 | | |
| 7 | 90 | 3.1 | 12.5 | 38.75 | 10 | 1280 | 0.2 | 323.9143226 | 0.182321557 | 388.6971871 | 0.505106394 | 0.498637118 | 0.00694225 |
| | | | | | 15 | 1420 | 0.3 | 359.3424516 | 0.262364264 | 467.1451871 | 0.491302945 | | |
| | | | | | 20 | 1490 | 0.4 | 377.0565161 | 0.336472237 | 527.8791226 | 0.499502017 | | |
| 8 | | 3.1 | 12.8 | 39.68 | 10 | 1240 | 0.2 | 306.4375 | 0.182321557 | 367.725 | 0.473719943 | 0.498989139 | 0.027116652 |
| | | | | | 15 | 1360 | 0.3 | 336.0927419 | 0.262364264 | 436.9205645 | 0.527636657 | | |
| | | | | | 20 | 1440 | 0.4 | 355.8629032 | 0.336472237 | 498.2080645 | 0.495610817 | | |
| 9 | | 3.1 | 13.2 | 40.92 | 10 | 1300 | 0.2 | 311.5298143 | 0.182321557 | 373.8357771 | 0.50093578 | 0.50762632 | 0.007179691 |
| | | | | | 15 | 1440 | 0.3 | 345.0791789 | 0.262364264 | 448.6029326 | 0.515211339 | | |
| | | | | | 20 | 1520 | 0.4 | 364.2502444 | 0.336472237 | 509.9503421 | 0.50673184 | | |

Rata2 SD

| | | | |
|-----------------|-------------|-------------|-------------|
| n ₀ | 0.495425691 | | |
| | 0.50522338 | 0.488011397 | 0.021882387 |
| | 0.463385118 | | |
| n ₄₅ | 0.522727026 | | |
| | 0.498989139 | 0.514257683 | 0.013249289 |
| | 0.521056884 | | |
| n ₉₀ | 0.498637118 | | |
| | 0.498989139 | 0.501750859 | 0.005091341 |
| | 0.50762632 | | |

nilai n 0.504569405 0.013127966

Lampiran 4 : Perhitungan Uji Tarik (Lanjutan)

Uji tarik n AI > 0,03%

| Kode Sampel | Arah | Dimensi Awal (mm) | | A ₀ (mm ²) | dL (mm) | P (Kg) | ε | σ (Mpa) | ε _t | σ _t (Mpa) | n | n rata-rata | Standar deviasi | | |
|-------------|------|-------------------|----------------|-----------------------------------|---------|--------|-----|-------------|----------------|----------------------|-------------|-------------|-----------------|-------------|-------------|
| | | t ₀ | w ₀ | | | | | | | | | | | | |
| 1 | 0 | 3.1 | 13.2 | 40.92 | 10 | 1280 | 0.2 | 306.7370479 | 0.182321557 | 368.0844575 | 0.505106394 | 0.523755671 | 0.020012744 | | |
| | | | | | 15 | 1420 | 0.3 | 340.2864125 | 0.262364264 | 442.3723363 | 0.544898232 | | | | |
| | | | | | 20 | 1510 | 0.4 | 361.8538612 | 0.336472237 | 506.5954057 | 0.521262388 | | | | |
| 2 | | 3.1 | 13.5 | 41.85 | 10 | 1300 | 0.2 | 304.6069295 | 0.182321557 | 365.5283154 | 0.50093578 | | | 0.532252338 | 0.033606141 |
| | | | | | 15 | 1440 | 0.3 | 337.4107527 | 0.262364264 | 438.6339785 | 0.567755708 | | | | |
| | | | | | 20 | 1540 | 0.4 | 360.842055 | 0.336472237 | 505.1788769 | 0.528065525 | | | | |
| 3 | | 3.1 | 13.2 | 40.92 | 10 | 1240 | 0.2 | 297.1515152 | 0.182321557 | 356.5818182 | 0.513830729 | | | 0.531642943 | 0.019114483 |
| | | | | | 15 | 1380 | 0.3 | 330.7008798 | 0.262364264 | 429.9111437 | 0.551836531 | | | | |
| | | | | | 20 | 1470 | 0.4 | 352.2683284 | 0.336472237 | 493.1756598 | 0.52926157 | | | | |
| 4 | 45 | 3.1 | 13 | 40.3 | 10 | 1290 | 0.2 | 313.88933 | 0.182321557 | 376.667196 | 0.503005713 | 0.471614819 | 0.033685913 | | |
| | | | | | 15 | 1430 | 0.3 | 347.9548387 | 0.262364264 | 452.3412903 | 0.436027173 | | | | |
| | | | | | 20 | 1480 | 0.4 | 360.1210918 | 0.336472237 | 504.1695285 | 0.47581157 | | | | |
| 5 | | 3.1 | 12.9 | 39.99 | 10 | 1220 | 0.2 | 299.1577894 | 0.182321557 | 358.9893473 | 0.477691333 | | | 0.502660683 | 0.026794883 |
| | | | | | 15 | 1340 | 0.3 | 328.5831458 | 0.262364264 | 427.1580895 | 0.530968266 | | | | |
| | | | | | 20 | 1420 | 0.4 | 348.20005 | 0.336472237 | 487.48007 | 0.499322449 | | | | |
| 6 | | 3.1 | 12.5 | 38.75 | 10 | 1150 | 0.2 | 291.0167742 | 0.182321557 | 349.220129 | 0.492627518 | | | 0.516437508 | 0.025550761 |
| | | | | | 15 | 1270 | 0.3 | 321.3837419 | 0.262364264 | 417.7988645 | 0.543430732 | | | | |
| | | | | | 20 | 1350 | 0.4 | 341.6283871 | 0.336472237 | 478.2797419 | 0.513254272 | | | | |
| 7 | 90 | 3.1 | 12.3 | 38.13 | 10 | 1110 | 0.2 | 285.4618411 | 0.182321557 | 342.5542093 | 0.546283068 | 0.546731597 | 0.000481321 | | |
| | | | | | 15 | 1250 | 0.3 | 321.4660372 | 0.262364264 | 417.9058484 | 0.54724009 | | | | |
| | | | | | 20 | 1330 | 0.4 | 342.0398636 | 0.336472237 | 478.8558091 | 0.546671632 | | | | |
| 8 | | 3.1 | 13 | 40.3 | 10 | 1210 | 0.2 | 294.4233251 | 0.182321557 | 353.3079901 | 0.500304959 | 0.51467596 | 0.015421678 | | |
| | | | | | 15 | 1340 | 0.3 | 326.0555831 | 0.262364264 | 423.8722581 | 0.530968266 | | | | |
| | | | | | 20 | 1420 | 0.4 | 345.5215881 | 0.336472237 | 483.7302233 | 0.512754654 | | | | |
| 9 | | 3.1 | 12.5 | 38.75 | 10 | 1260 | 0.2 | 318.8531613 | 0.182321557 | 382.6237935 | 0.449886952 | 0.485561888 | 0.038283165 | | |
| | | | | | 15 | 1370 | 0.3 | 346.6895484 | 0.262364264 | 450.6964129 | 0.526006323 | | | | |
| | | | | | 20 | 1450 | 0.4 | 366.9341935 | 0.336472237 | 513.707871 | 0.48079239 | | | | |

| | Rata2 | SD |
|-----------------|--------------------|-------------|
| n ₀ | 0.523755671 | |
| | 0.532252338 | 0.529216984 |
| | 0.531642943 | 0.00473944 |
| n ₄₅ | 0.471614819 | |
| | 0.502660683 | 0.496904336 |
| | 0.516437508 | 0.022959094 |
| n ₉₀ | 0.546731597 | |
| | 0.51467596 | 0.515656482 |
| | 0.485561888 | 0.03059664 |
| nilai n | 0.509670535 | 0.016225686 |

Lampiran 4 : Perhitungan Uji Tarik (Lanjutan)

Uji tarik nilai r dan $\Delta r \leq 0,03\%$

| Kode Sampel | Arah | Dimensi Awal (mm) | | A_0 (mm ²) | Dimensi Akhir (mm) | | $\ln(w_f/w_0)$ | $\ln(t_f/t_0)$ | $\ln(w_f/w_0) : \ln(t_f/t_0)$ | r rata-rata | Standar deviasi |
|-------------|------|-------------------|-------|--------------------------|--------------------|-------|----------------|----------------|-------------------------------|-------------|-----------------|
| | | t_0 | w_0 | | t_f | w_f | | | | | |
| 1 | 0 | 3.1 | 12.85 | 39.835 | 3 | 12.2 | -0.05190786 | -0.032789823 | 1.583047883 | 1.754864235 | 0.186069493 |
| 2 | | 3.1 | 12.9 | 39.99 | 3 | 12.1 | -0.064021859 | -0.032789823 | 1.952491757 | | |
| 3 | | 3.1 | 12.7 | 39.37 | 3 | 12 | -0.056695344 | -0.032789823 | 1.729053066 | | |
| 4 | 45 | 3.1 | 13.1 | 40.61 | 3 | 12.5 | -0.046883586 | -0.032789823 | 1.429821264 | 1.456771103 | 0.029304308 |
| 5 | | 3.1 | 12.6 | 39.06 | 3 | 12 | -0.048790164 | -0.032789823 | 1.487966691 | | |
| 6 | | 3.1 | 12.9 | 39.99 | 3 | 12.3 | -0.047628049 | -0.032789823 | 1.452525354 | | |
| 7 | 90 | 3.1 | 13.35 | 41.385 | 3 | 12.5 | -0.065787741 | -0.032789823 | 2.006346326 | 1.652806713 | 0.309642663 |
| 8 | | 3.1 | 13.1 | 40.61 | 3 | 12.5 | -0.046883586 | -0.032789823 | 1.429821264 | | |
| 9 | | 3.1 | 13.35 | 41.385 | 3 | 12.7 | -0.049914391 | -0.032789823 | 1.522252549 | | |

| | |
|----------|-------------|
| r_0 | 1.754864235 |
| r_{45} | 1.456771103 |
| r_{90} | 1.652806713 |

| | | |
|------------|--------------------|-------------|
| nilai r | 1.580303288 | 0.151495442 |
| Δr | 0.247064371 | |

Lampiran 4 : Perhitungan Uji Tarik (Lanjutan)

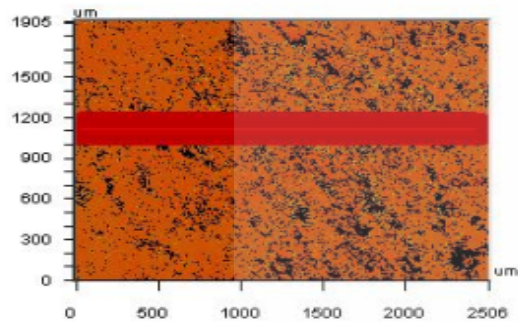
Uji tarik nilai r dan Δr $> 0,03\%$

| Kode Sampel | Arah | Dimensi Awal (mm) | | A_0 (mm ²) | Dimensi Akhir (mm) | | $\ln (w_f/w_0)$ | $\ln (t_f/t_0)$ | $\ln (w_f/w_0) : \ln (t_f/t_0)$ | r rata-rata | Standar deviasi |
|-------------|------|-------------------|-------|--------------------------|--------------------|-------|-----------------|-----------------|---------------------------------|-------------|-----------------|
| | | t_0 | w_0 | | t_f | w_f | | | | | |
| 1 | 0 | 3.1 | 12.85 | 39.835 | 3 | 12.1 | -0.060138359 | -0.032789823 | 1.834055617 | 1.824326535 | 0.008425633 |
| 2 | | 3.1 | 12.95 | 40.145 | 3 | 12.2 | -0.059659836 | -0.032789823 | 1.819461994 | | |
| 3 | | 3.1 | 12.95 | 40.145 | 3 | 12.2 | -0.059659836 | -0.032789823 | 1.819461994 | | |
| 4 | 45 | 3.1 | 12.3 | 38.13 | 3 | 11.6 | -0.058594164 | -0.032789823 | 1.786961905 | 1.698993259 | 0.194580513 |
| 5 | | 3.1 | 12.85 | 39.835 | 3 | 12.1 | -0.060138359 | -0.032789823 | 1.834055617 | | |
| 6 | | 3.1 | 12.7 | 39.37 | 3 | 12.1 | -0.048396541 | -0.032789823 | 1.475962256 | | |
| 7 | 90 | 3.1 | 12.8 | 39.68 | 3 | 12 | -0.064538521 | -0.032789823 | 1.968248547 | 1.669577241 | 0.267374083 |
| 8 | | 3.1 | 12.9 | 39.99 | 3 | 12.3 | -0.047628049 | -0.032789823 | 1.452525354 | | |
| 9 | | 3.1 | 12.22 | 37.882 | 3 | 11.6 | -0.052068856 | -0.032789823 | 1.587957822 | | |

| | |
|----------|-------------|
| r_0 | 1.824326535 |
| r_{45} | 1.698993259 |
| r_{90} | 1.669577241 |

nilai r **1.722972574** 0.082179758
 Δr 0.047958628

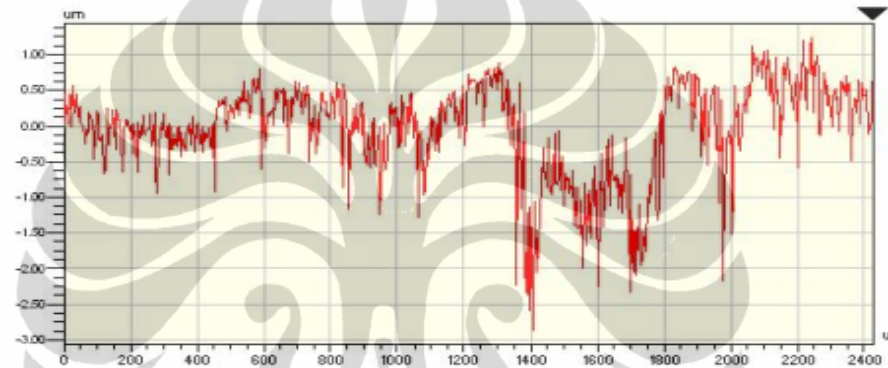
Sampel setelah pengerolan dingin $AI \leq 0,03\%$



| | Delta | | | |
|-------|---------|---------|---------|----|
| X | 20.46 | 2444.80 | 2424.34 | um |
| Y | 1113.86 | 1113.86 | 0.00 | um |
| Ht | 0.39 | 1.12 | 0.73 | um |
| Dist | | | 2424.34 | um |
| Angle | | | 0.00 | ° |

Title:

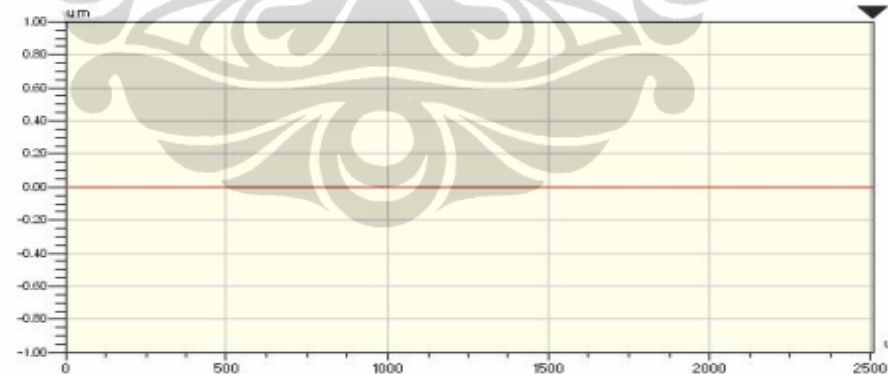
2 Point Profile



| | |
|----|----------|
| Rq | 0.67 um |
| Ra | 0.50 um |
| Rt | 4.09 um |
| Rp | 1.23 um |
| Rv | -2.86 um |

| | |
|--------|-------------------------|
| Angle | -10.03 urad |
| Curve | - |
| Terms | None |
| Avg Ht | -0.04 um |
| Area | -106.14 um ² |

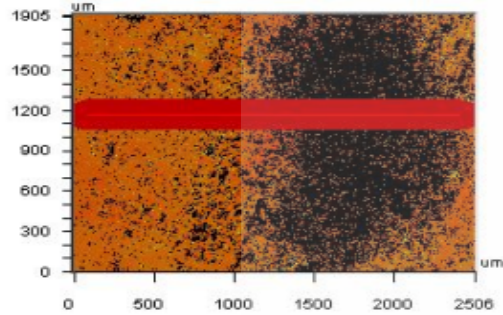
(Inactive)



| | |
|----|---------|
| Rq | 0.00 um |
| Ra | 0.00 um |
| Rt | 0.00 um |
| Rp | 0.00 um |
| Rv | 0.00 um |

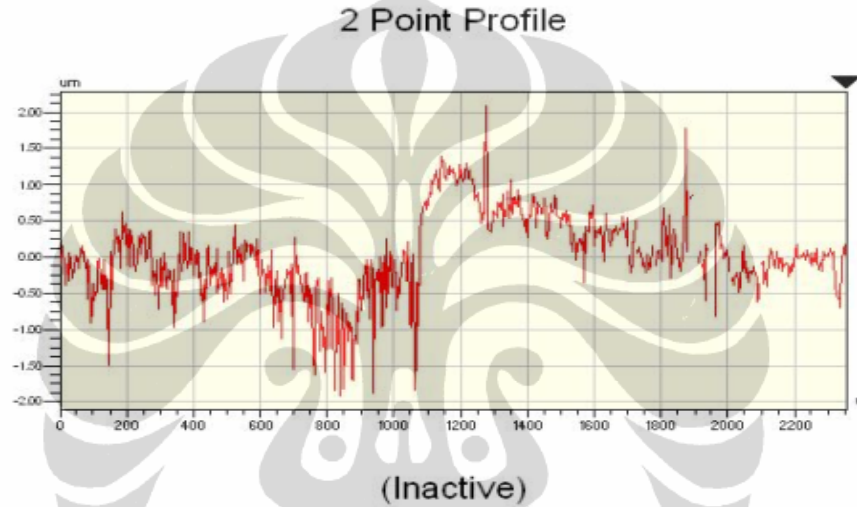
| | |
|--------|----------------------|
| Angle | 0.00 mrad |
| Curve | 0.00 um |
| Terms | None |
| Avg Ht | 0.00 um |
| Area | 0.00 um ² |

Sampel setelah pengerolan dingin Al > 0,03%



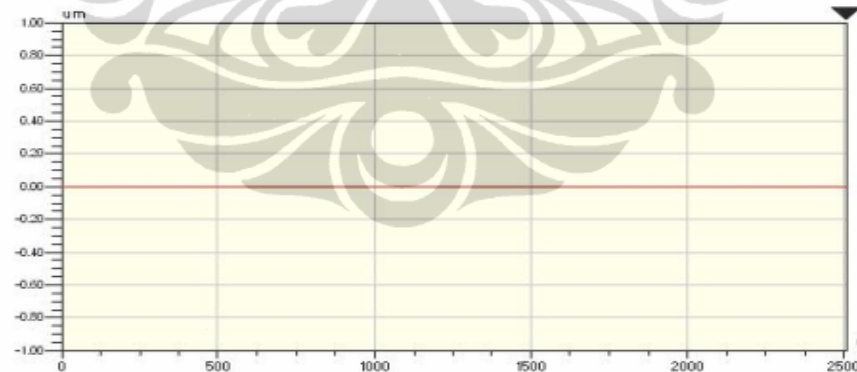
| | Delta | | | |
|-------|---------|---------|---------|----|
| X | 71.61 | 2420.93 | 2349.33 | um |
| Y | 1165.57 | 1165.57 | 0.00 | um |
| Ht | 1.51 | - | - | um |
| Dist | | | 2349.33 | um |
| Angle | | | 0.00 | ° |

Title:



| | |
|----|----------|
| Rq | 0.57 um |
| Ra | 0.42 um |
| Rt | 3.99 um |
| Rp | 2.08 um |
| Rv | -1.91 um |

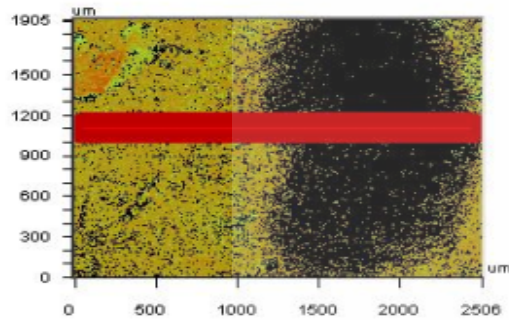
| | |
|--------|-----------------------|
| Angle | 107.56 urad |
| Curve | - |
| Terms | None |
| Avg Ht | 0.03 um |
| Area | 61.78 um ² |



| | |
|----|---------|
| Rq | 0.00 um |
| Ra | 0.00 um |
| Rt | 0.00 um |
| Rp | 0.00 um |
| Rv | 0.00 um |

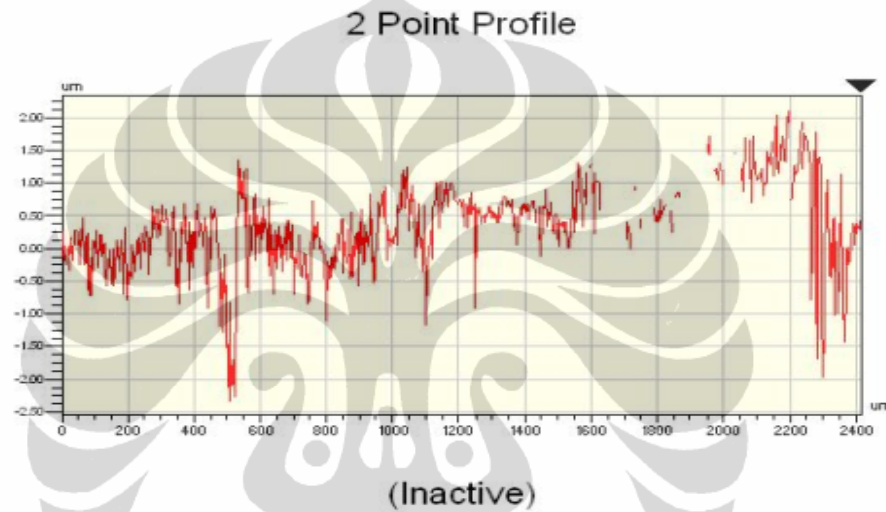
| | |
|--------|----------------------|
| Angle | 0.00 mrad |
| Curve | 0.00 um |
| Terms | None |
| Avg Ht | 0.00 um |
| Area | 0.00 um ² |

Sampel setelah anil cepat optimal 600°C, 3 menit Al ≤ 0,03%



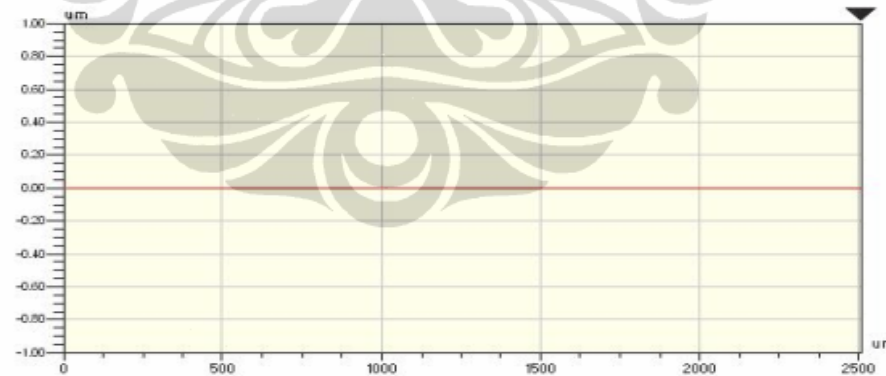
| | Delta | | | |
|-------|---------|---------|---------|----|
| X | 40.92 | 2455.03 | 2414.11 | um |
| Y | 1101.92 | 1101.92 | 0.00 | um |
| Ht | -1.55 | 0.78 | 2.33 | um |
| Dist | | | 2414.11 | um |
| Angle | | | 0.00 | ° |

Title:



| | |
|----|----------|
| Rq | 0.65 um |
| Ra | 0.49 um |
| Rt | 4.44 um |
| Rp | 2.12 um |
| Rv | -2.32 um |

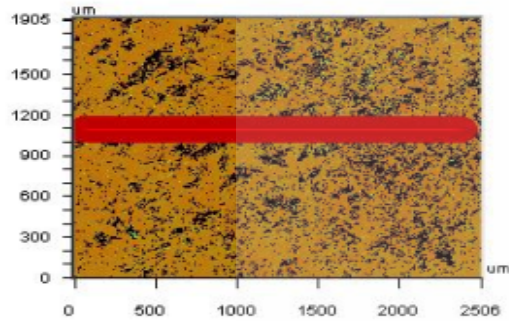
| | |
|--------|------------------------|
| Angle | 131.83 urad |
| Curve | - |
| Terms | None |
| Avg Ht | 0.34 um |
| Area | 821.88 um ² |



| | |
|----|---------|
| Rq | 0.00 um |
| Ra | 0.00 um |
| Rt | 0.00 um |
| Rp | 0.00 um |
| Rv | 0.00 um |

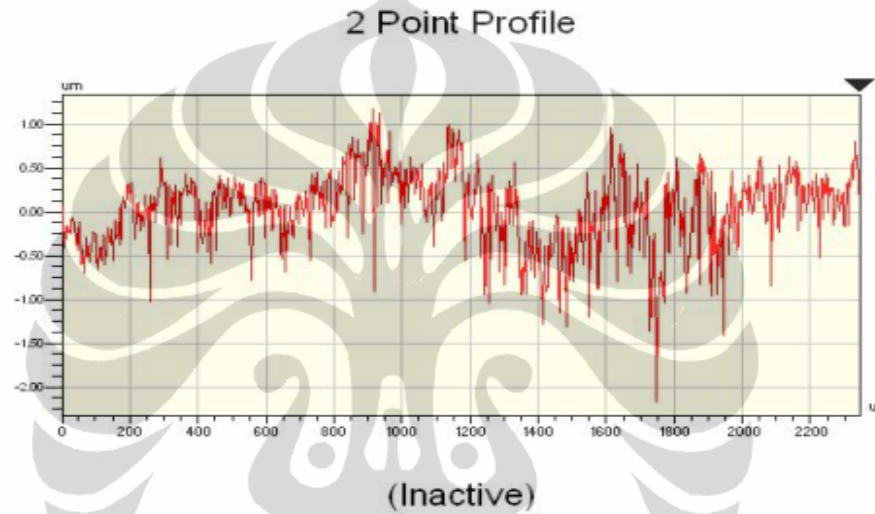
| | |
|--------|----------------------|
| Angle | 0.00 mrad |
| Curve | 0.00 um |
| Terms | None |
| Avg Ht | 0.00 um |
| Area | 0.00 um ² |

Sampel setelah anil cepat optimal 600°C, 3 menit Al > 0,03%



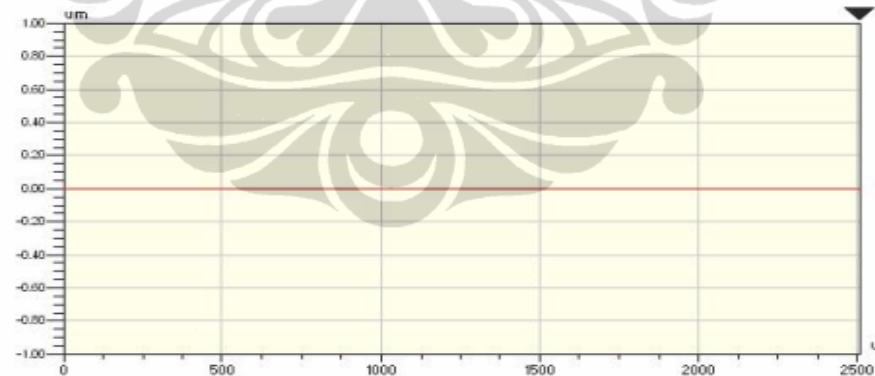
| | Delta | | | |
|-------|---------|---------|---------|----|
| X | 51.15 | 2390.25 | 2339.10 | um |
| Y | 1093.97 | 1093.97 | 0.00 | um |
| Ht | -0.09 | 0.02 | 0.11 | um |
| Dist | | | 2339.10 | um |
| Angle | | | 0.00 | ° |

Title:



| | |
|----|----------|
| Rq | 0.44 um |
| Ra | 0.34 um |
| Rt | 3.33 um |
| Rp | 1.17 um |
| Rv | -2.17 um |

| | |
|--------|-----------------------|
| Angle | 127.69 urad |
| Curve | - |
| Terms | None |
| Avg Ht | 0.03 um |
| Area | 81.82 um ² |



| | |
|----|---------|
| Rq | 0.00 um |
| Ra | 0.00 um |
| Rt | 0.00 um |
| Rp | 0.00 um |
| Rv | 0.00 um |

| | |
|--------|----------------------|
| Angle | 0.00 mrad |
| Curve | 0.00 um |
| Terms | None |
| Avg Ht | 0.00 um |
| Area | 0.00 um ² |