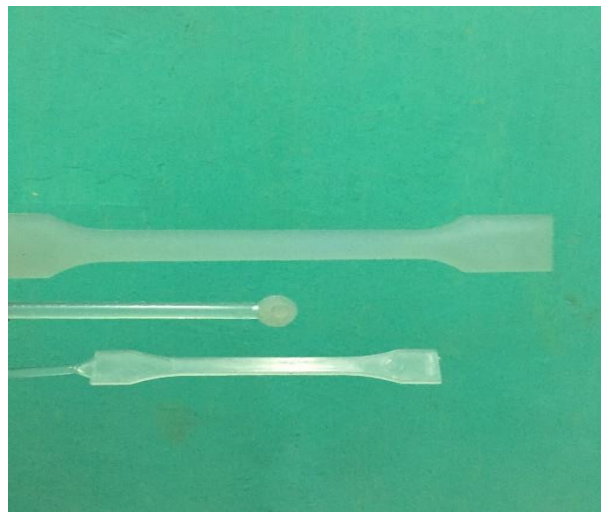


## LAMPIRAN

### Lampiran 1 Hasil spesimen multipurpose

Proses pembuatan spesimen *multipurpose* menggunakan mesin *injection molding* standar ISO 294-1 seperti pada Gambar. Hasil dari pembuatan spesimen PP murni, PP + limbah *coating* 15% dengan variasi mikropartikel (*As- received*, *200 mesh*, *400 mesh*) ditunjukkan pada Gambar.



**Gambar** Spesimen multipurpose polypropylene HI10HO

Keterangan :

Produk : Spesimen *Multipurpose Polypropylene* HI10HO

Mesin : *Injection Molding Machine 70* MEIKI

Proses injeksi : 42 detik/spesimen

Masa : 78,6 gram

Panjang : 150 mm

Lebar : 10 mm

Tebal : 4 mm



**Gambar** Spesimen multipurpose polypropylene HI10HO

Keterangan :

*Polypropylene murni*

*Polypropylene / limbah coating as-received*

*Polypropylene / limbah coating 200 mesh*

*Polypropylene / limbah coating 400 mesh*

## Lampiran 2 tabel perhitungan

### 1. Tabel pengukuran tebal dan lebar

No spesimen	<i>Polypropylene</i>		<i>Limbah coating/polypropylene</i>					
	murni		<i>As-received</i>		200 mesh		400 mesh	
	Tebal	Lebar	Tebal	Lebar	Tebal	Lebar	Tebal	Lebar
	mm	mm	mm	mm	mm	mm	mm	mm
Spesimen 1	4,02	9,96	3,95	9,9	3,96	9,96	3,98	9,98
Spesimen 2	3,96	10,04	3,93	9,94	4,02	9,92	4,03	9,98
Spesimen 3	3,97	9,94	3,94	9,89	3,97	9,92	3,99	9,99
Spesimen 4	3,98	9,91	3,96	9,89	4	9,93	3,96	9,98
Spesimen 5	3,96	9,95	3,91	9,88	4,02	9,94	3,99	10
AVERAGE	3,98	9,96	3,94	9,90	3,99	9,93	3,99	9,99
STDEV	0,02	0,05	0,02	0,02	0,03	0,02	0,03	0,02
MAX	4,02	10,04	3,96	9,94	4,02	9,96	4,03	10
MIN	3,96	9,91	3,91	9,88	3,96	9,92	3,96	9,98

### 2. Tabel pengukuran uji *bending*

Nilai tegangan $\sigma$ (MPa)				
No spesimen	<i>Polypropylene</i>	<i>Polypropylene + Limbah coating</i>		
	Murni	<i>As-received</i>	200 mesh	400 mesh
Spesimen 1	46.3	43.5	43.8	44
Spesimen 2	45.3	44.8	44.8	39.3
Spesimen 3	46.7	44	43.1	44.7
Spesimen 4	45.7	44.5	44.4	43.2
Spesimen 5	45.9	44.2	45.2	44.5
AVERAGE	45.98	44.2	44.26	43.14
STDEV	0.540370243	0.494974747	0.8294577	2.223285857
MAX	46.7	44.8	45.2	44.7
MIN	45.3	43.5	43.1	39.3

Nilai modulus elastisitas (Mpa)				
No spesimen	<i>Polypropylene</i>	<i>Polypropylene + Limbah coating</i>		
	Murni	As-received	200 mesh	400 mesh
Spesimen 1	1.39	1.34	1.4	1.58
Spesimen 2	1.36	1.4	1.41	1.22
Spesimen 3	1.26	1.29	1.34	1.5
Spesimen 4	1.31	1.42	1.36	1.54
Spesimen 5	0.992	1.38	1.44	1.55
AVERAGE	1.2624	1.366	1.39	1.478
STDEV	0.159055965	0.05176872	0.04	0.1470374
MAX	1.39	1.42	1.44	1.58
MIN	0.992	1.29	1.34	1.22

Nilai regangan $\epsilon$ (%)				
No spesimen	<i>Polypropylene</i>	<i>Polypropylene + Limbah coating</i>		
	Murni	As-received	200 mesh	400 mesh
Spesimen 1	6.9	6.8	6.8	6.6
Spesimen 2	6.6	6.5	6.8	7
Spesimen 3	7.2	6.8	6.9	6.4
Spesimen 4	7	6.7	6.8	6.3
Spesimen 5	7.2	6.7	6.6	6.5
AVERAGE	6.98	6.7	6.78	6.56
STDEV	0.248997992	0.122474487	0.109545	0.2701851
MAX	7.2	6.8	6.9	7
MIN	6.6	6.5	6.6	6.3

### 3. Tabel perhitungan kekerasan

Nilai kekerasan Shore D				
No spesimen	<i>Polypropylene</i>	Polypropylene + Limbah <i>coating</i>		
	Murni	As-received	200 mesh	400 mesh
Spesimen 1	65,16	59,66	59	66,5
Spesimen 2	65,5	59,66	62	68
Spesimen 3	64,33	61	67,83	62,5
Spesimen 4	65,5	58	67	66,83
Spesimen 5	65,5	58,5	67	65,83
AVERAGE	65,20	59,36	64,57	65,93
STDEV	0,507070015	1,168195189	3,875149029	2,073323419
MAX	65,5	61	67,83	68
MIN	64,33	58	59	62,5

### Lampiran 3 Perhitungan Grafik

Perhitungan modulus uji bending

Tabel spesifikasi perhitungan material limbah coating/polypropylene 200mesh

Spesimen	$\sigma$ (MPa)	$\epsilon$ (%)	$\square$ (MPa)
Spesimen 5	45,2	6,6	1,44

Diketahui dari grafik :  $\sigma_1 = 12,5$  MPa       $\epsilon_1 = 0,7$  %

$\sigma_2 = 18$  MPa       $\epsilon_2 = 1,1$  %

Ditanya : modulus elastisitas ( $\epsilon$ )...?

Jawab : Menghitung modulus elastisitas

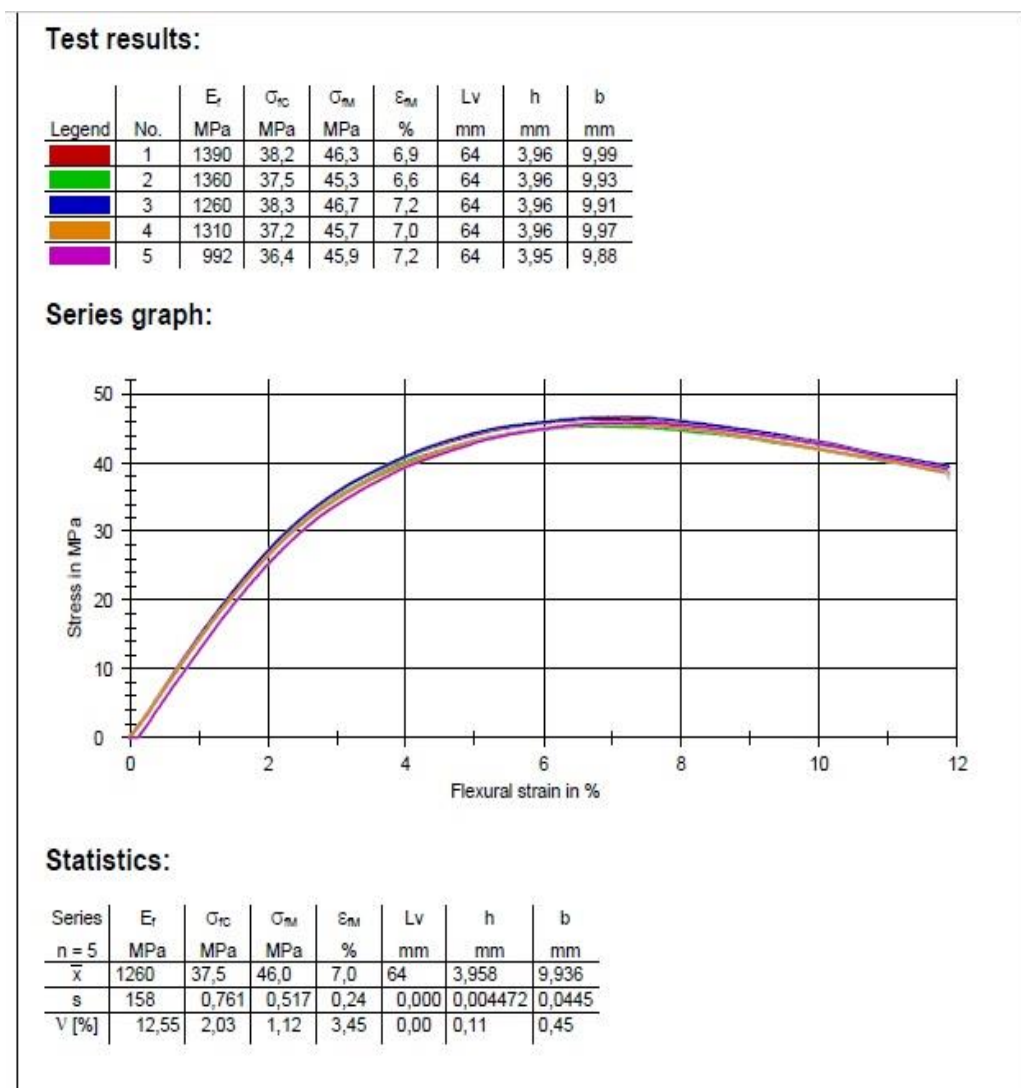
$$\epsilon = \frac{\sigma_2 - \sigma_1}{\epsilon_2 - \epsilon_1} \times 100$$

$$\frac{18-12,5}{1,1-0,7} \times 100 = 1375 \text{ MPa}$$

Jadi perhitungan manual nilai modulus elastisitas mendekati nilai dari tabel perhitungan

### Lampiran 4 uji bending

Polypropylene murni

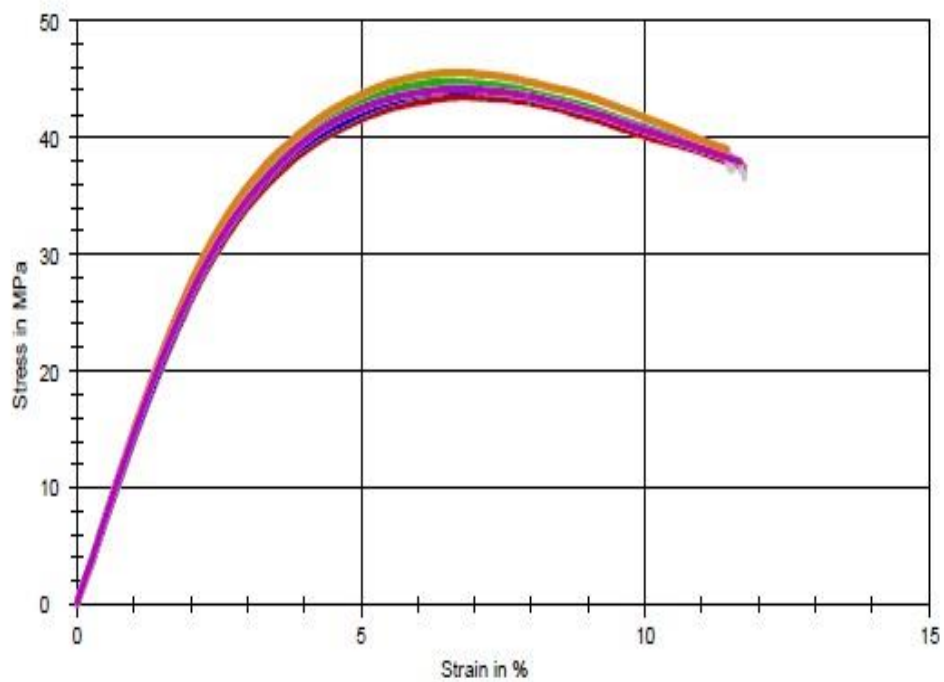


## Polypropylene as-received

### Test results:

Legend	No.	Force N	$E_r$ MPa	$\sigma_{rc}$ MPa	$\sigma_{M}$ MPa	$\varepsilon_M$ %	$L_v$ mm	$h$ mm	$b$ mm
<span style="color: red;">■</span>	1	72,12	1340	36,8	43,5	6,8	64	4,01	9,9
<span style="color: green;">■</span>	2	70,34	1400	37,3	44,8	6,5	64	3,92	9,81
<span style="color: blue;">■</span>	3	70,61	1290	36,8	44,0	6,8	64	3,94	9,92
<span style="color: orange;">■</span>	4	71,66	1420	37,8	45,5	6,7	64	3,91	9,88
<span style="color: magenta;">■</span>	5	72,41	1380	37,4	44,2	6,7	64	3,99	9,88

### Series graph:



### Statistics:

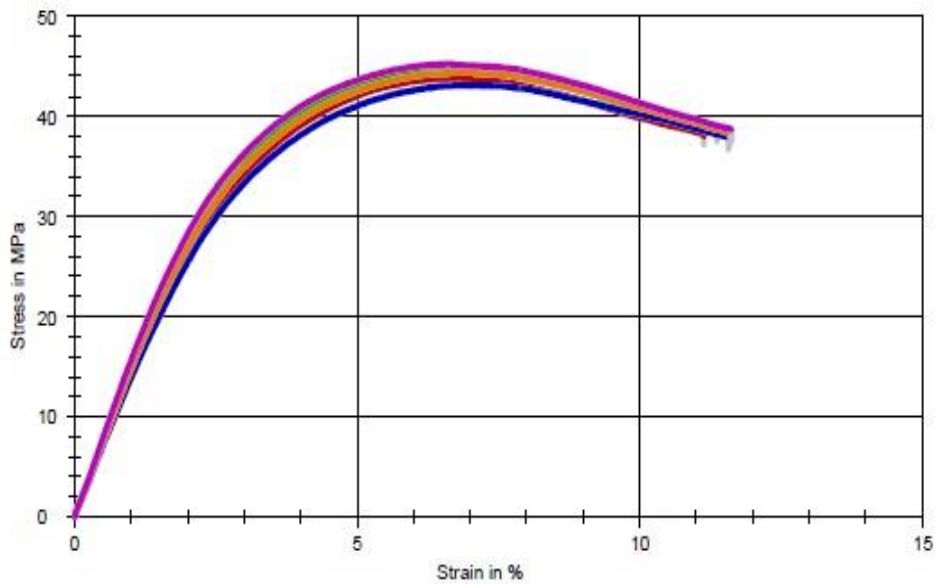
Series	Force N	$E_r$ MPa	$\sigma_M$ MPa	$L_v$ mm	$h$ mm	$b$ mm
$n = 5$						
$\bar{x}$	71,43	1370	44,4	64	3,954	9,878
$s$	0,92	53,2	0,788	0,000	0,04393	0,04147
$v$ [%]	1,28	3,89	1,77	0,00	1,11	0,42

## Polypropylene 200 mesh

### Test results:

Legend	No.	Force N	$E_r$ MPa	$\sigma_{10}$ MPa	$\sigma_M$ MPa	$\varepsilon_M$ %	Lv mm	h mm	b mm
<span style="color: red;">■</span>	1	63,77	1400	35,3	43,8	6,8	64	3,8	9,87
<span style="color: green;">■</span>	2	68,81	1410	37,1	44,8	6,8	64	3,88	9,8
<span style="color: blue;">■</span>	3	69,24	1340	35,7	43,1	6,9	64	3,95	9,88
<span style="color: orange;">■</span>	4	71,75	1360	37,3	44,4	6,8	64	3,96	9,9
<span style="color: magenta;">■</span>	5	73,48	1440	38,7	45,2	6,6	64	3,97	9,9

### Series graph:



### Statistics:

Series	Force N	$E_r$ MPa	$\sigma_M$ MPa	Lv mm	h mm	b mm
n = 5						
x	69,41	1390	44,3	64	3,912	9,83
s	3,68	41,3	0,810	0,000	0,0719	0,09849
v [%]	5,30	2,97	1,83	0,00	1,84	1,00

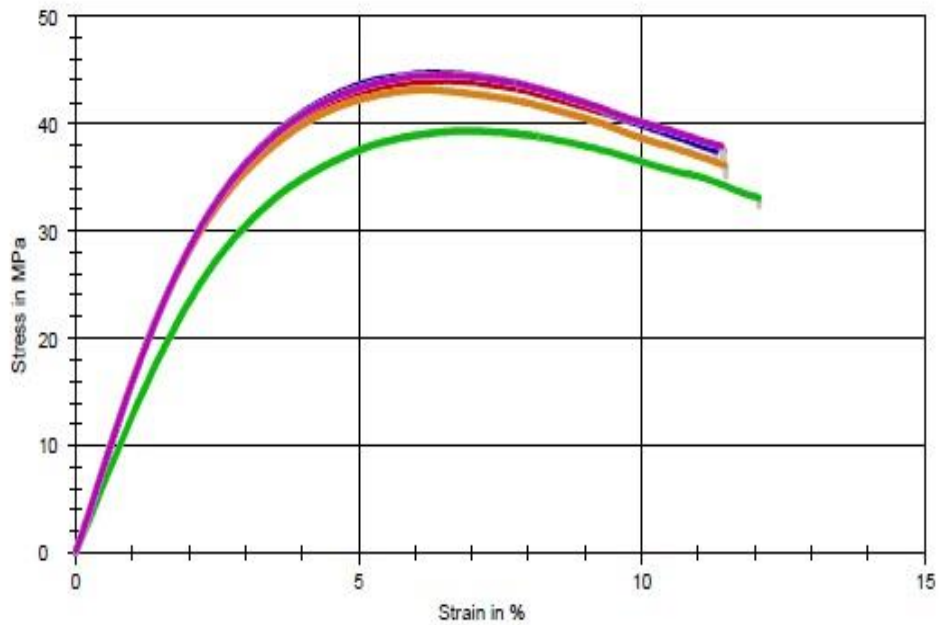


Propylene 400 mesh

**Test results:**

Legend	No.	Force N	$E_r$ MPa	$\sigma_{10}$ MPa	$\sigma_M$ MPa	$\epsilon_M$ %	$L_v$ mm	$h$ mm	$b$ mm
<span style="color: red;">■</span>	1	69,26	1580	37,6	44,0	6,6	64	3,91	9,88
<span style="color: green;">■</span>	2	69,47	1220	33,9	39,3	7,0	64	4,12	9,99
<span style="color: blue;">■</span>	3	67,58	1500	37,8	44,7	6,4	64	3,86	9,74
<span style="color: orange;">■</span>	4	68,33	1540	37,3	43,2	6,3	64	3,92	9,89
<span style="color: magenta;">■</span>	5	69,42	1550	38,0	44,5	6,5	64	3,9	9,84

**Series graph:**



**Statistics:**

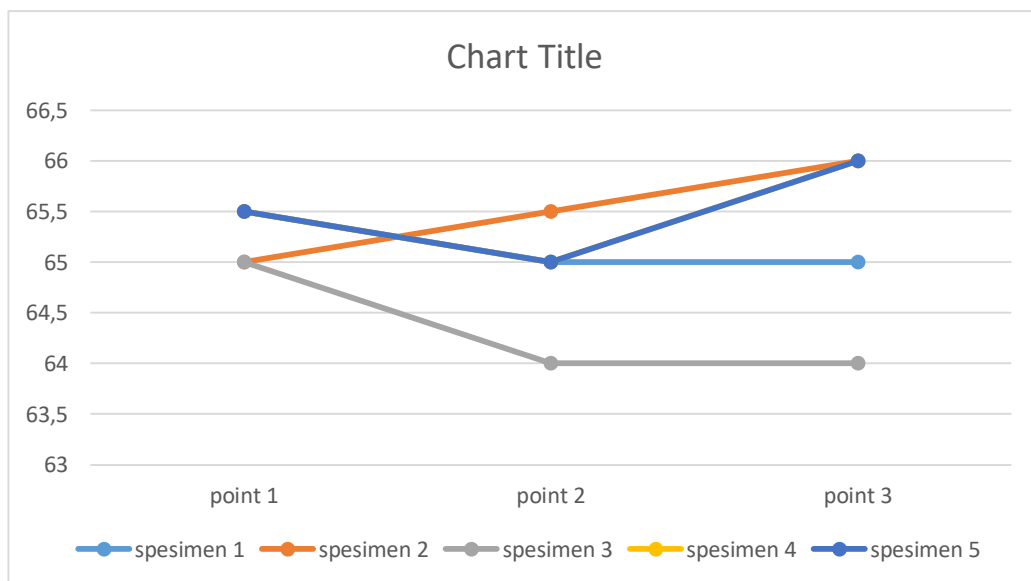
Series	Force N	$E_r$ MPa	$\sigma_M$ MPa	$L_v$ mm	$h$ mm	$b$ mm
$n = 5$						
$\bar{x}$	68,81	1480	43,1	64	3,942	9,868
$s$	0,83	148	2,22	0,000	0,1021	0,09039
$v$ [%]	1,20	10,02	5,14	0,00	2,59	0,92

## Lampiran 5 uji kekerasan

Polypropylene murni

### Result

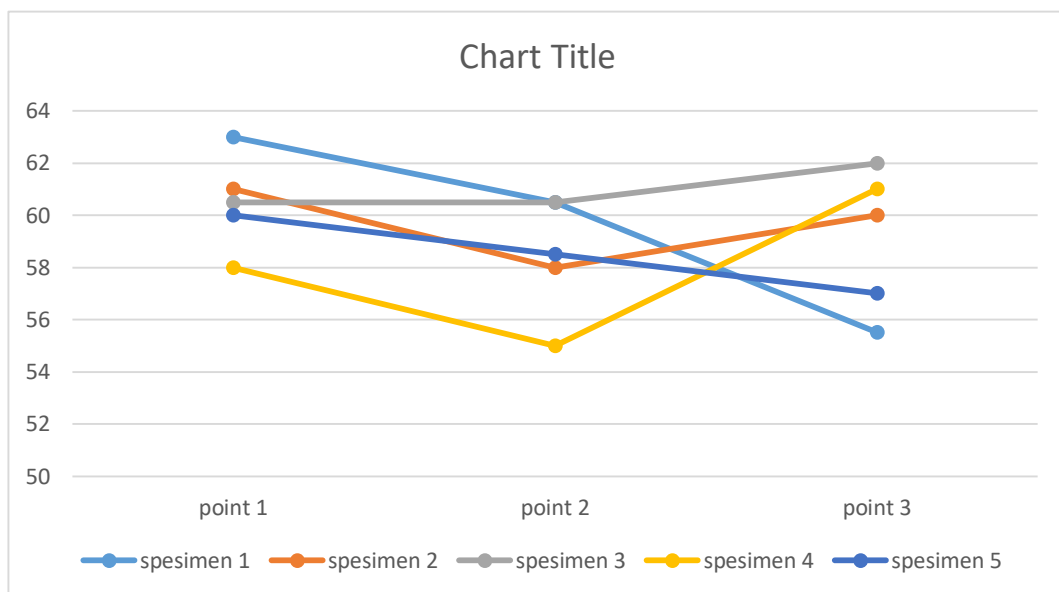
	Point 1	Point 2	Point 3
Spesimen 1	65,5	65	65
Spesimen 2	65	65,5	66
Spesimen 3	65	64	64
Spesimen 4	65,5	65	66
Spesimen 5	65,5	65	66



Polypropylene as-received

## Result

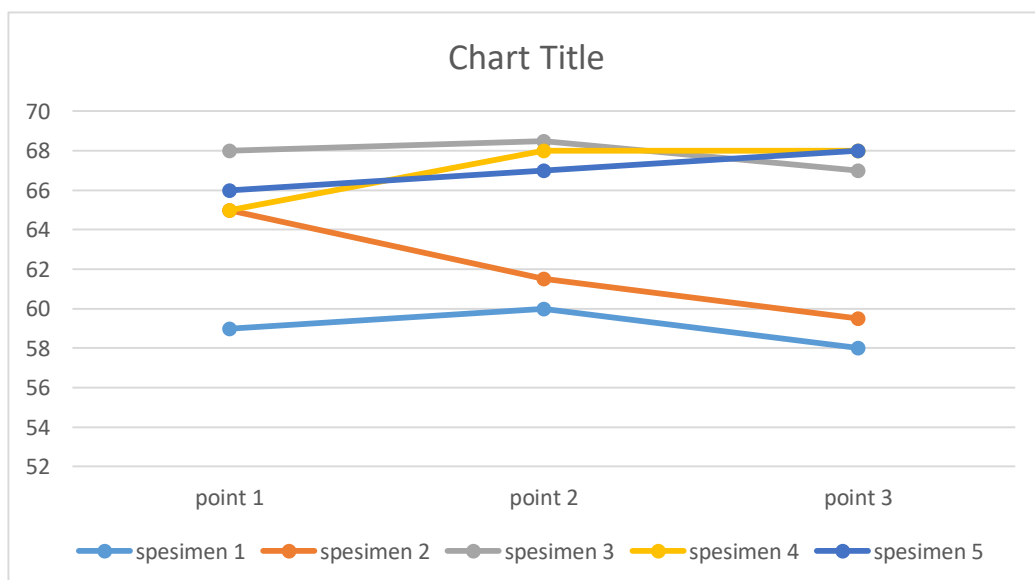
	Point 1	Point 2	Point 3
Spesimen 1	63	60,5	55,5
Spesimen 2	61	58	60
Spesimen 3	60,5	60,5	62
Spesimen 4	58	55	61
Spesimen 5	60	58,5	57



Propylene 200 mesh

## Result

	Point 1	Point 2	Point 3
Spesimen 1	59	60	58
Spesimen 2	65	61,5	59,5
Spesimen 3	68	68,5	67
Spesimen 4	65	68	68
Spesimen 5	66	67	68



Propylene 400 mesh

## Result

	Point 1	Point 2	Point 3
Spesimen 1	67,5	65	67
Spesimen 2	68	68	68
Spesimen 3	62	62	63,5
Spesimen 4	66,5	67	67
Spesimen 5	68	66	63,5

