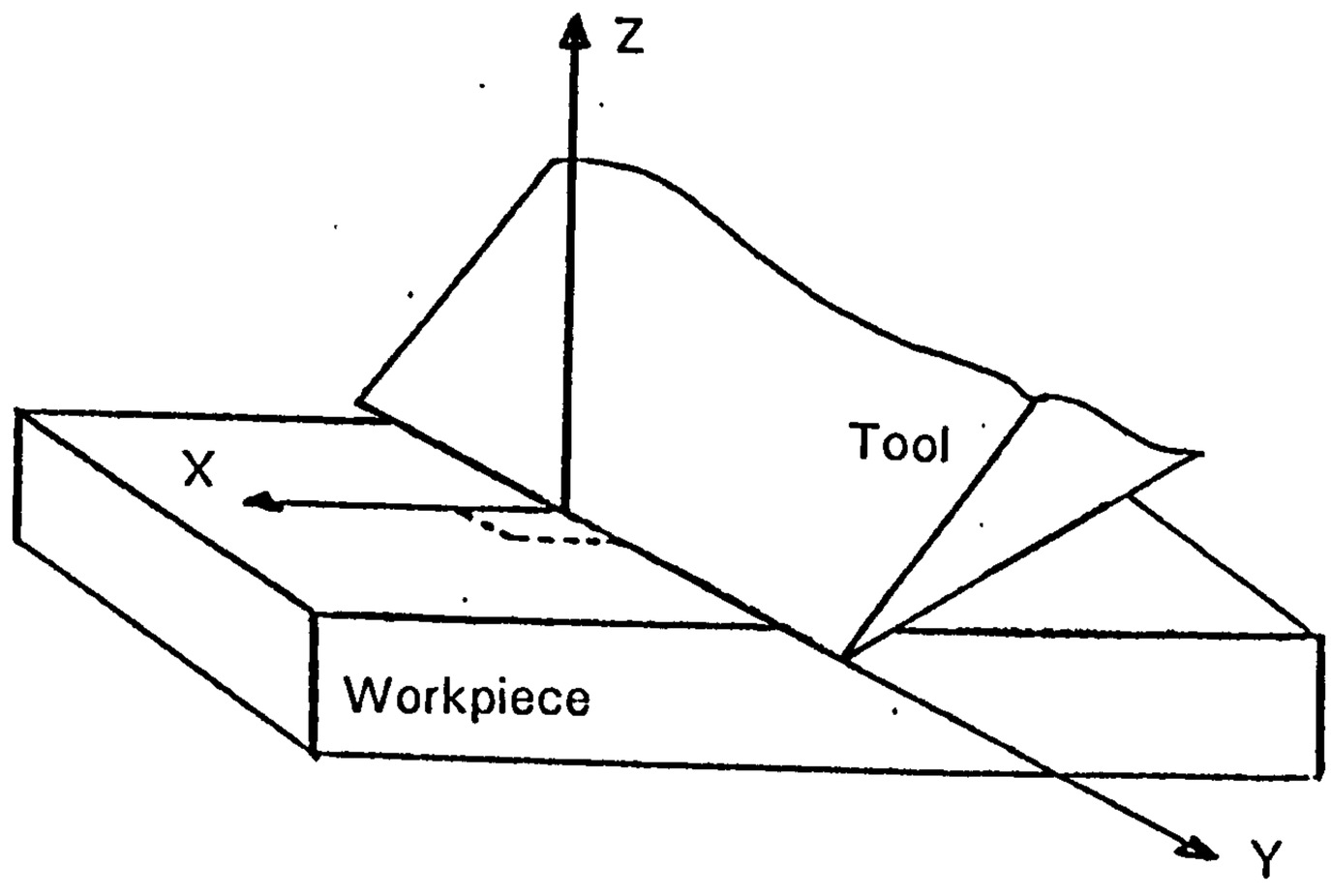
Volume 2


Z
X
Tool
Workpiece
Y

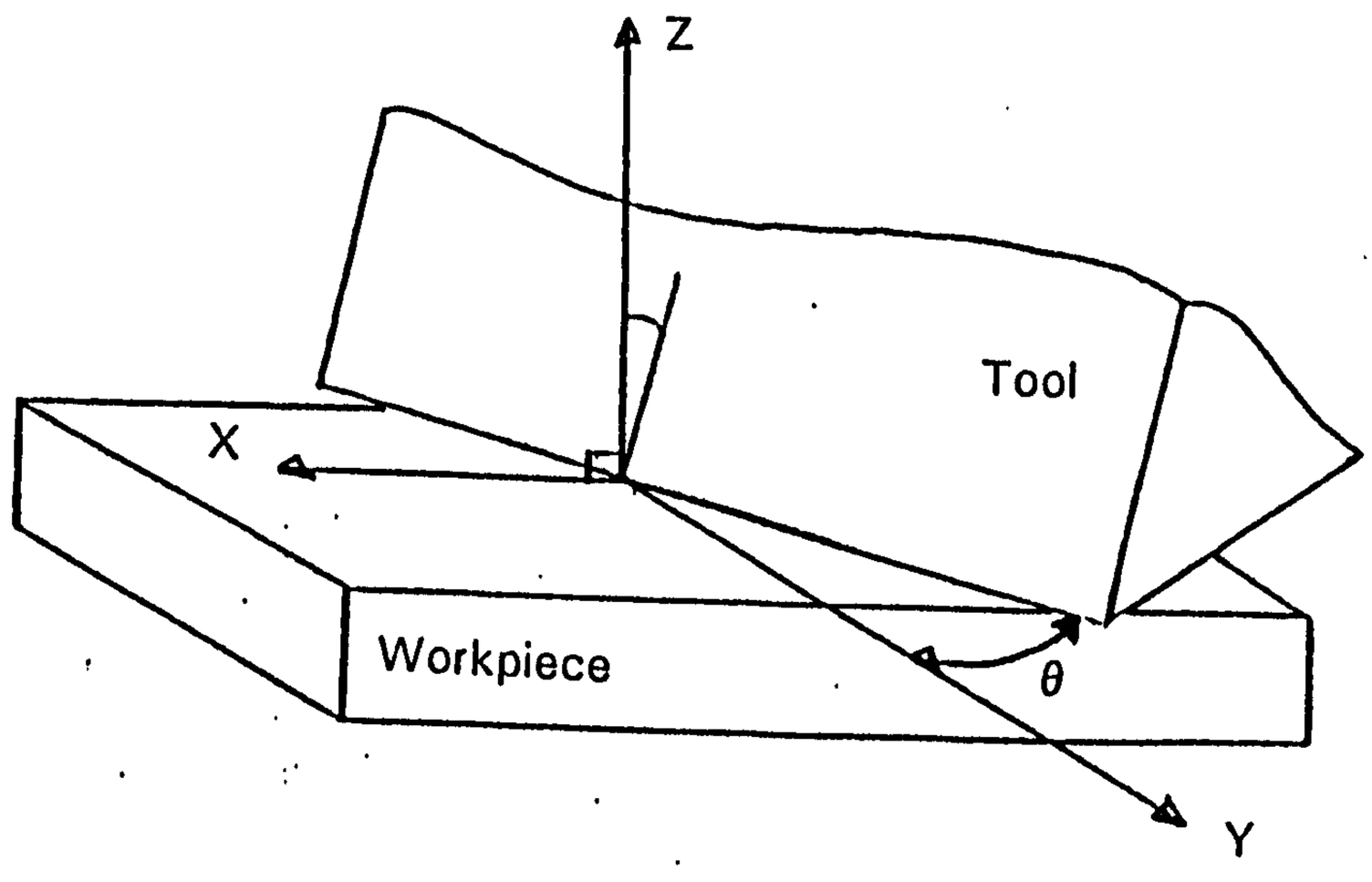

Z
X
Tool
Workpiece
θ
Y

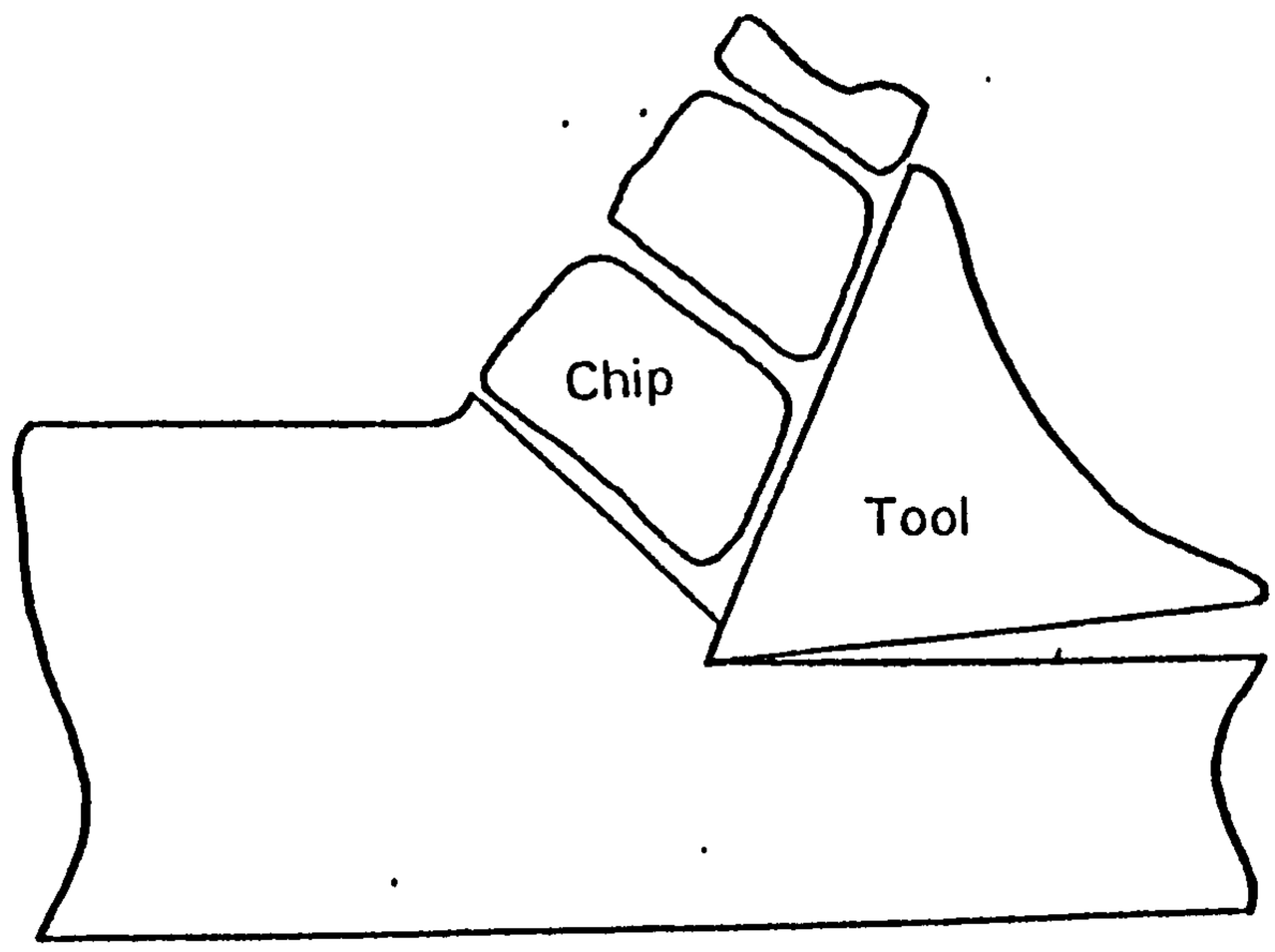
Figure 1(a) : Orthogonal machining (7).

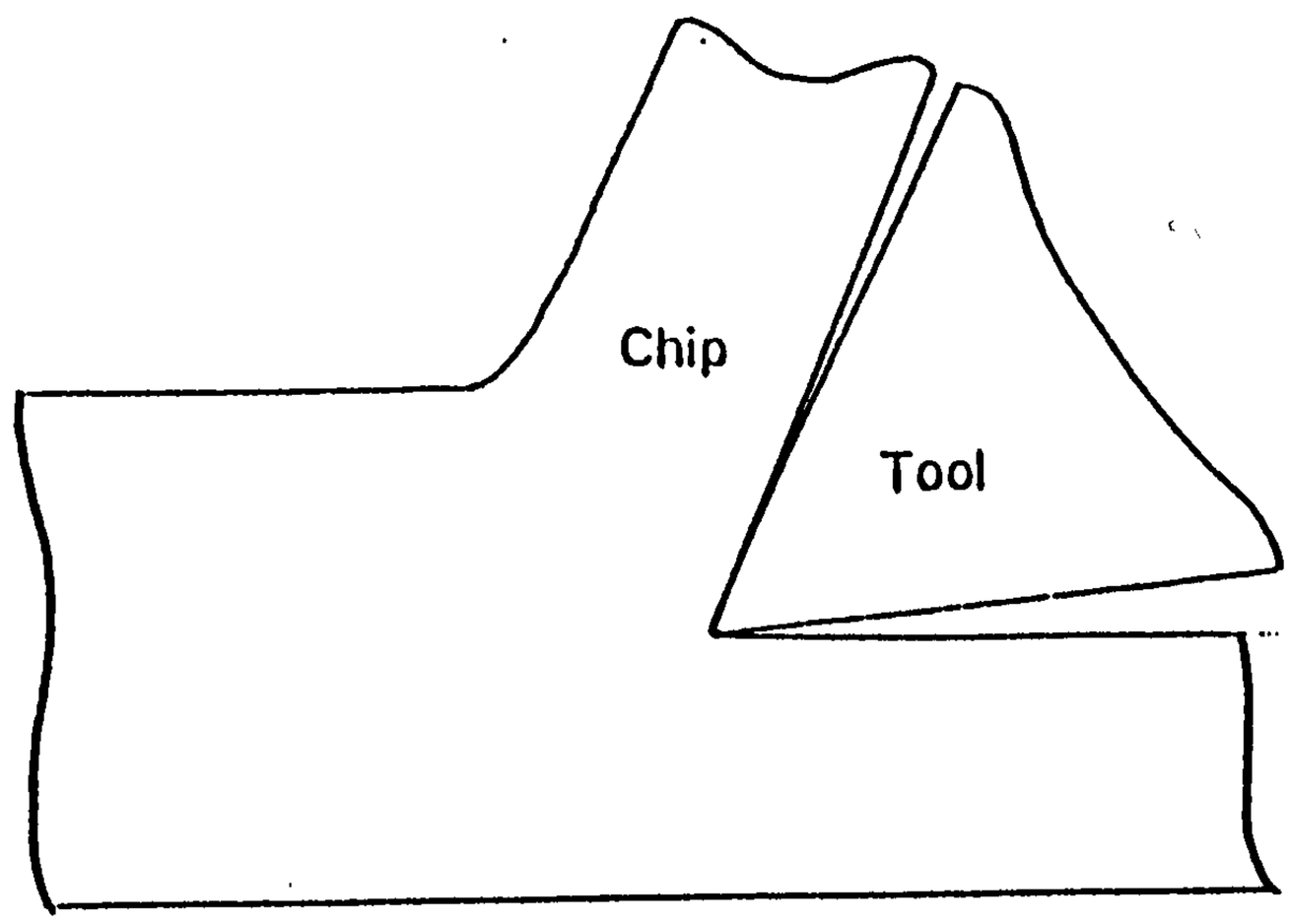
Figure 1(b) : Oblique machining (7).

Figure 2(a) : Discontinuous chip (7).

Figure 2(b) : Continuous chip (7).

Figure 2(c) : Built-up edge chip (7).


Chip
Tool


Chip
Tool

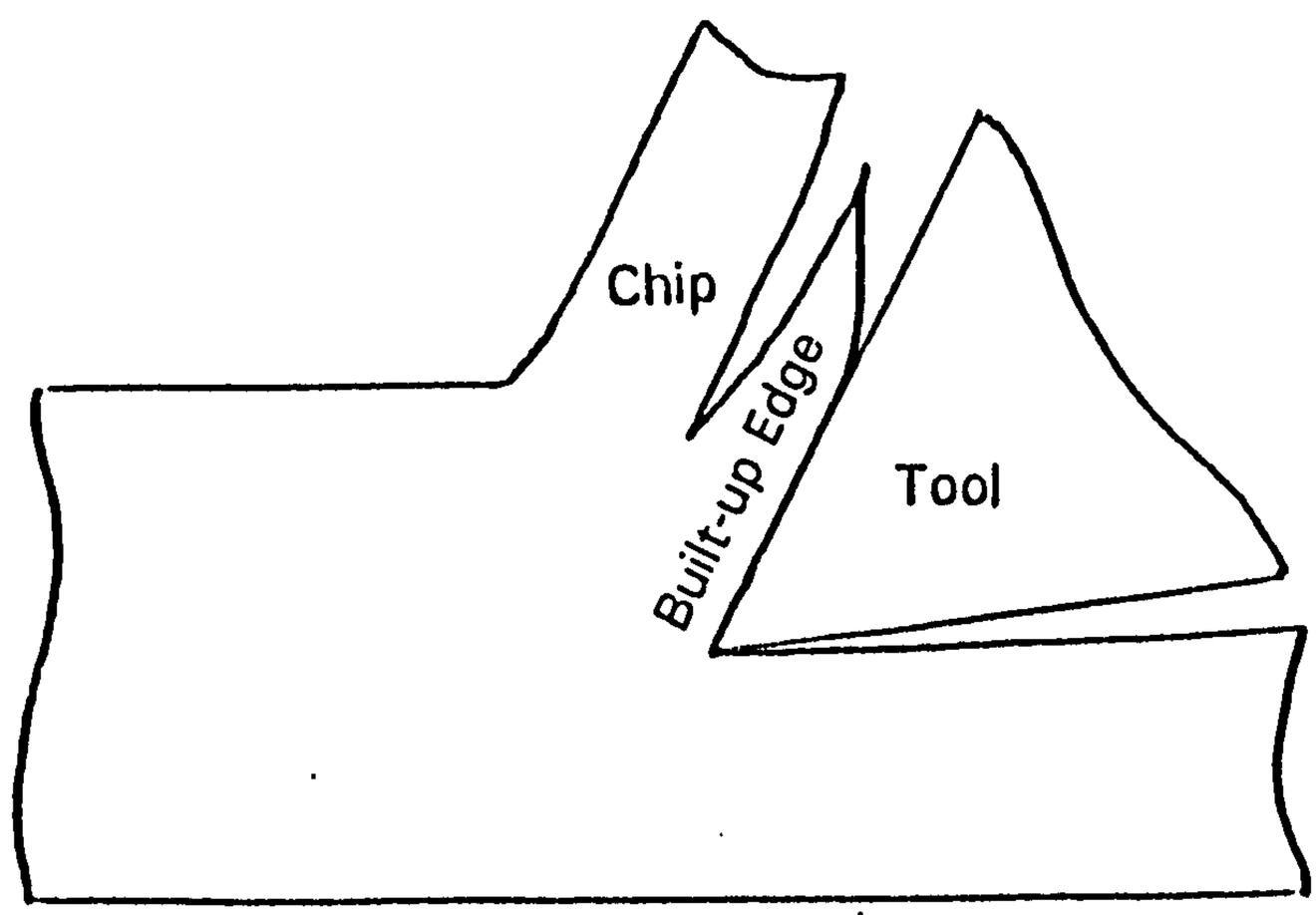

Chip
Built-up Edge
Tool

Figure 3 : A simple model for orthogonal cutting action (7).

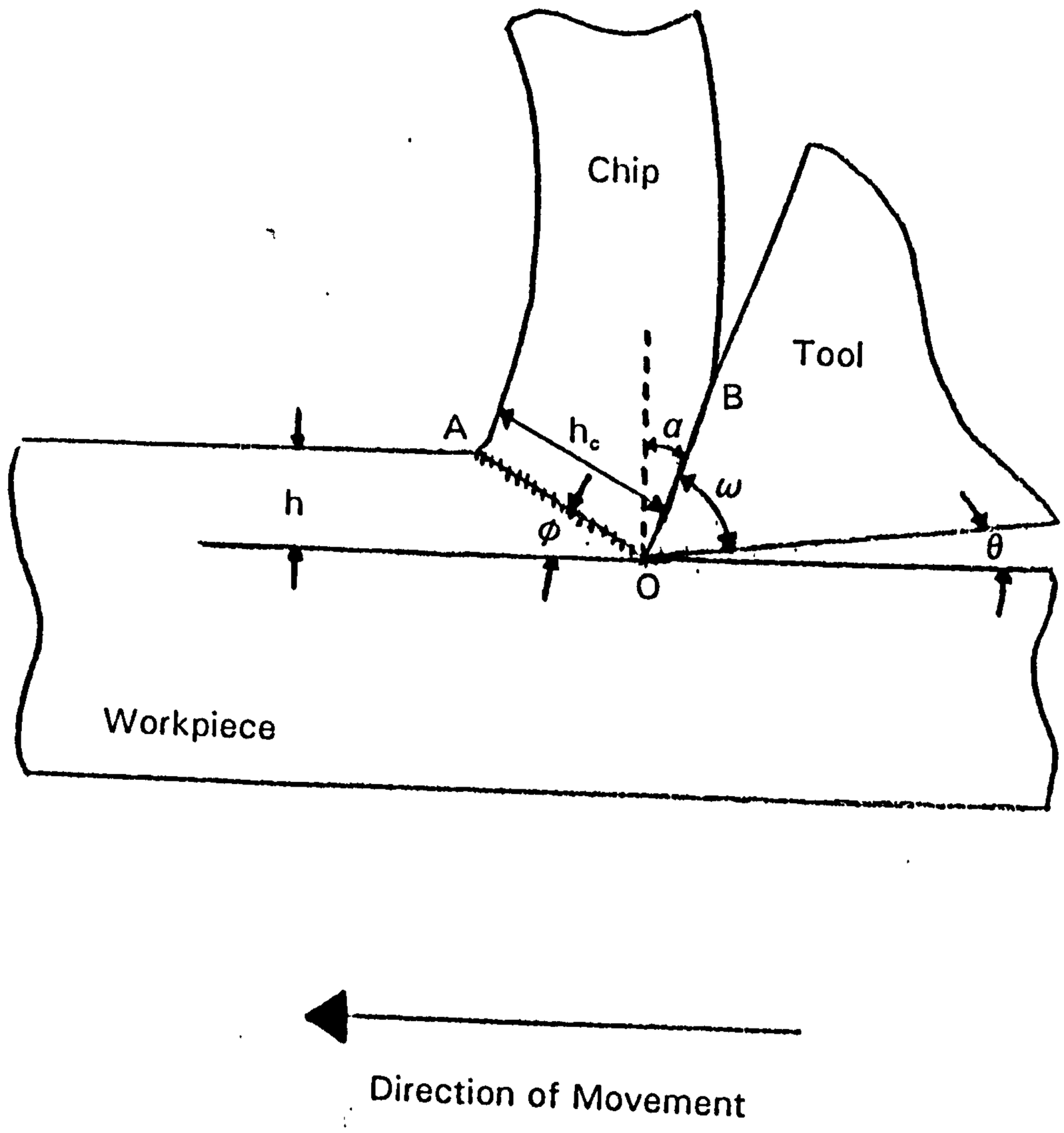
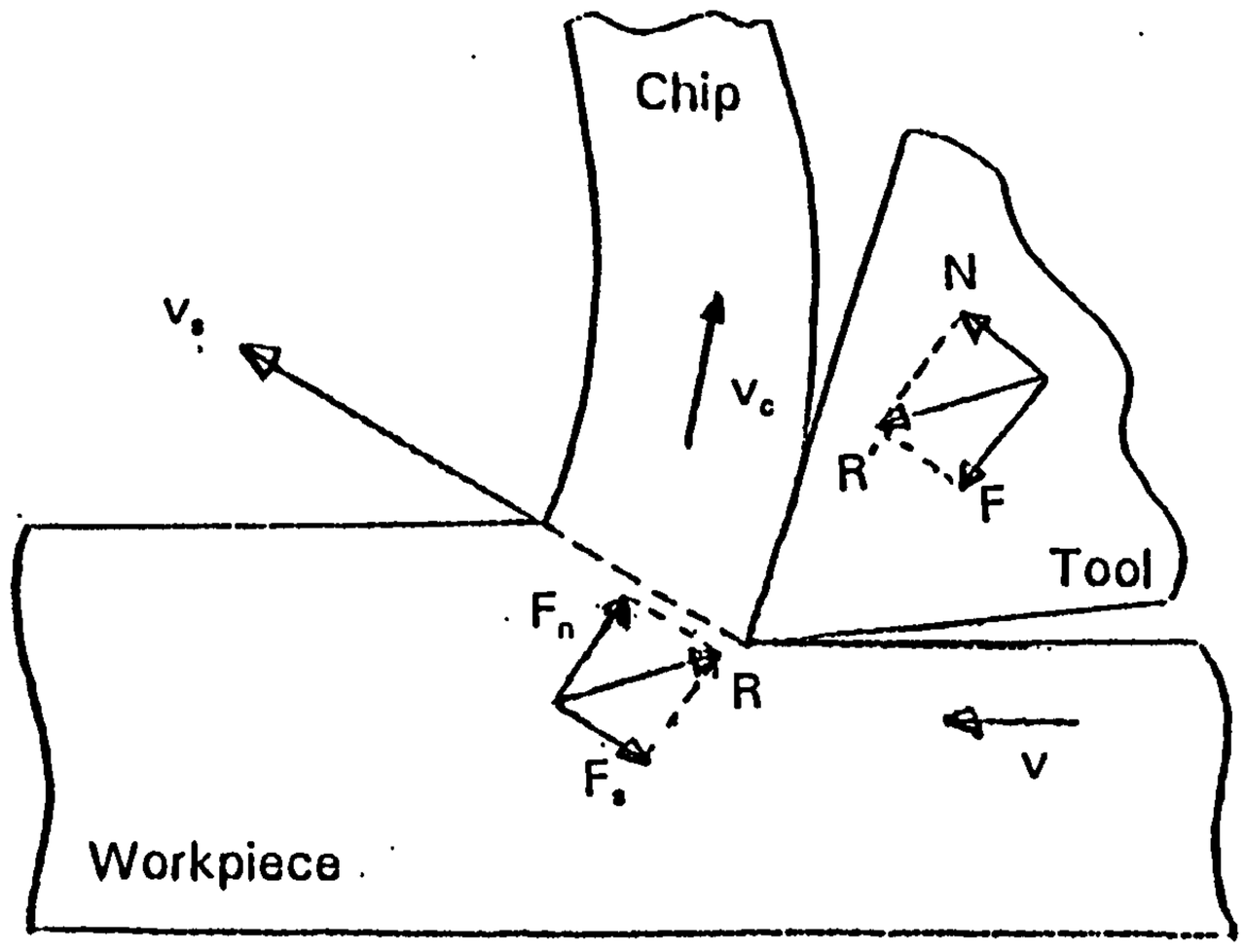

Chip
Tool
A
B
h_c
α
ω
h
ϕ
θ
O
Workpiece
Direction of Movement

Figure 4 : Force and velocity system for orthogonal machining (2).


Chip
V_s
V_c
N
R
F
Tool
F_n
R
F_s
V
Workpiece

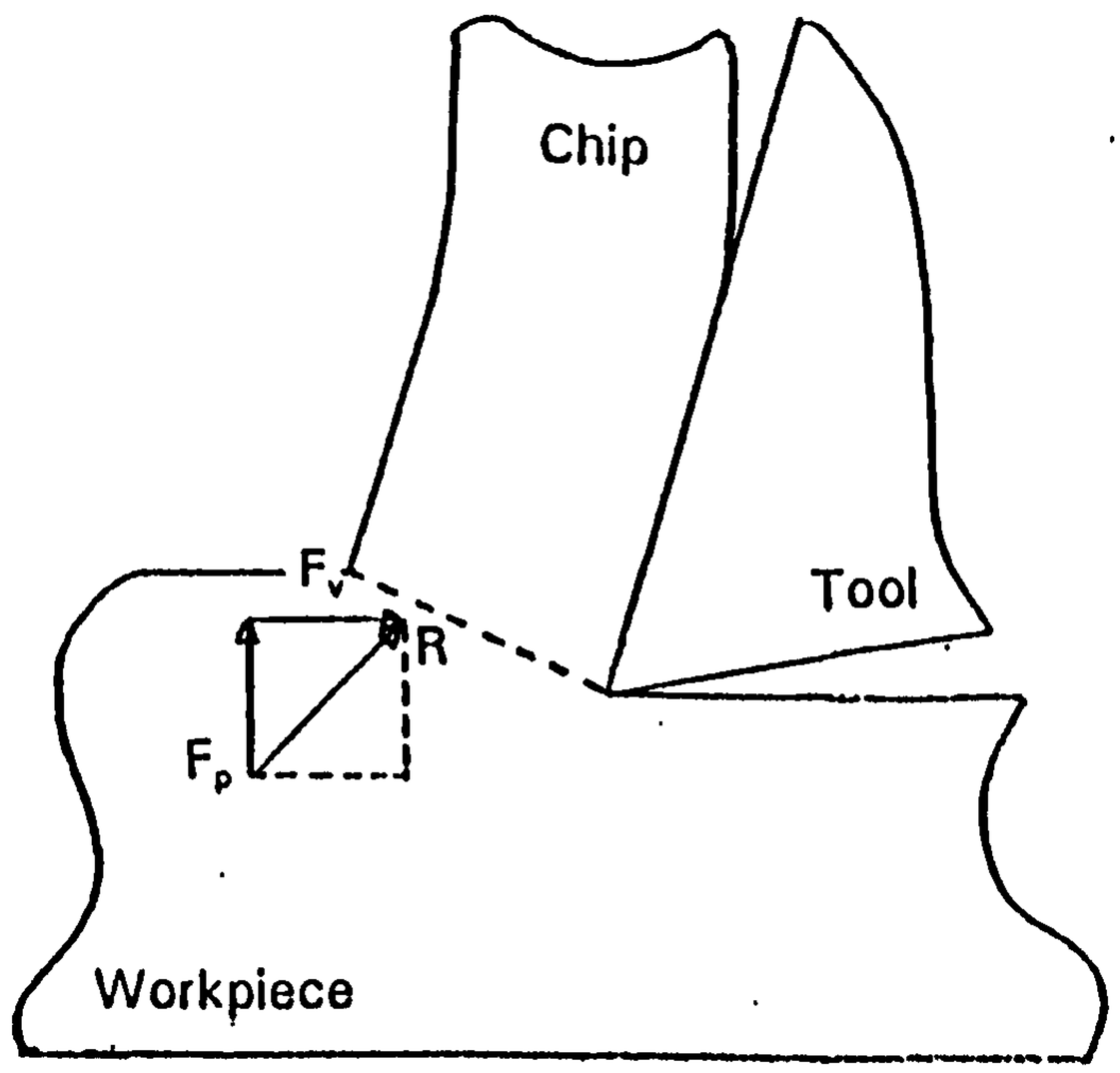

Chip
F_v
R
Tool
F_p
Workpiece

Figure 5 : Elements of surface feature (106).

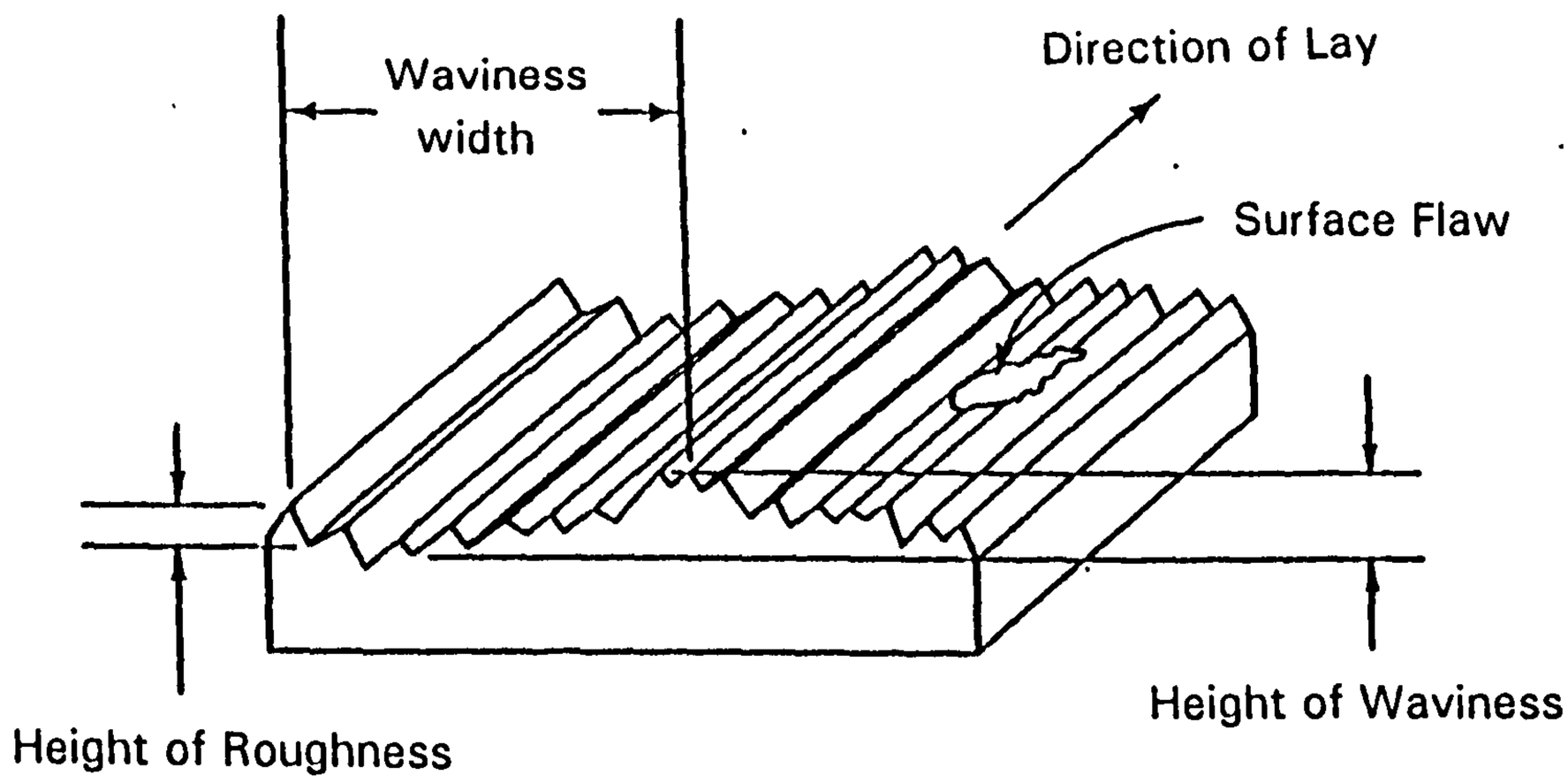

Waviness
width
Direction of Lay
Surface Flaw
Height of Roughness
Height of Waviness

Figure 6 : Diagram to show the parameters used to calculate Newtonian fluid motion (35).

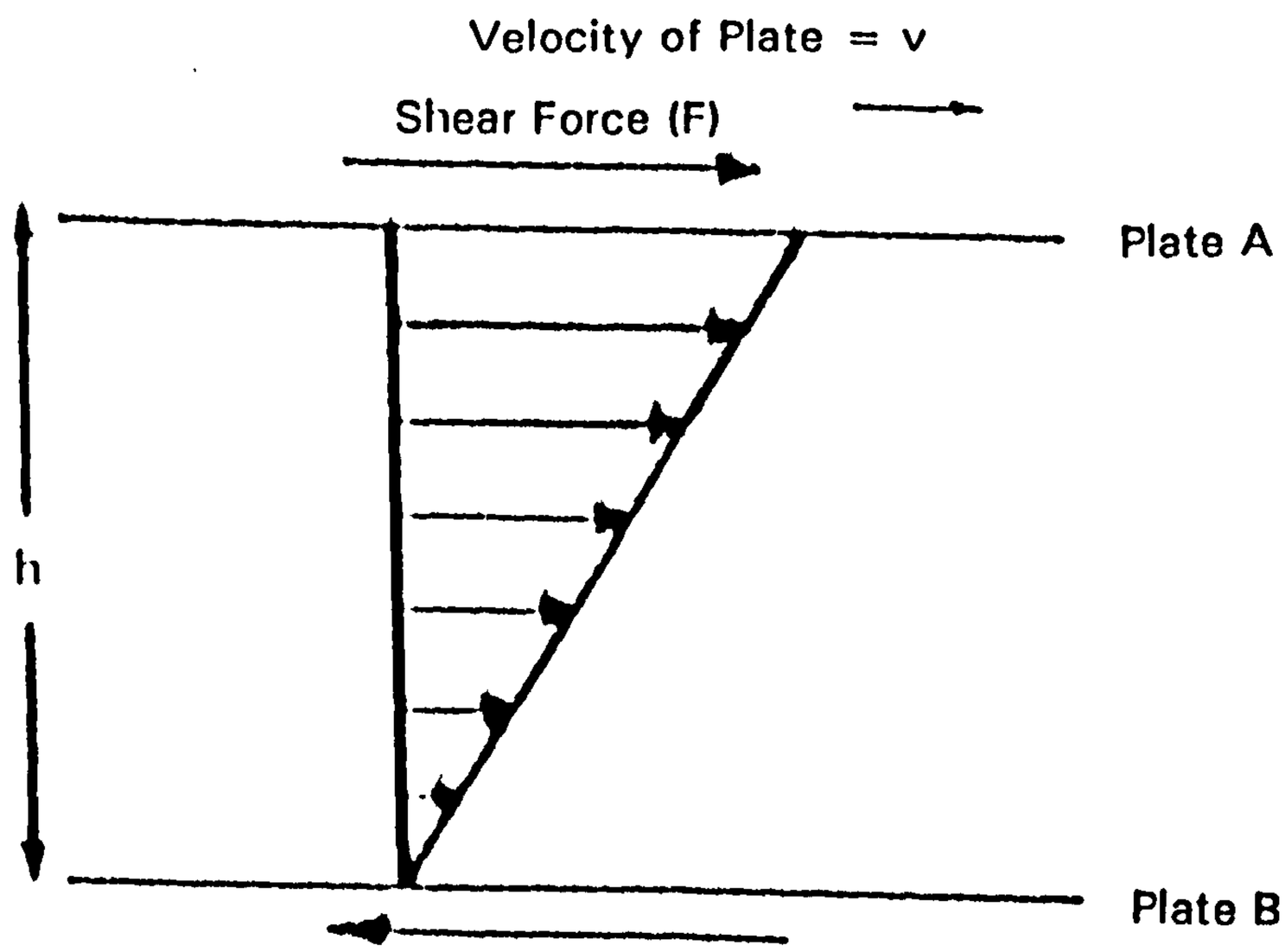

Velocity of Plate = v
Shear Force (F)
Plate A
h
Plate B

Figure 7 : Graph illustrating the behaviour of the four types of time-independent fluid (39).

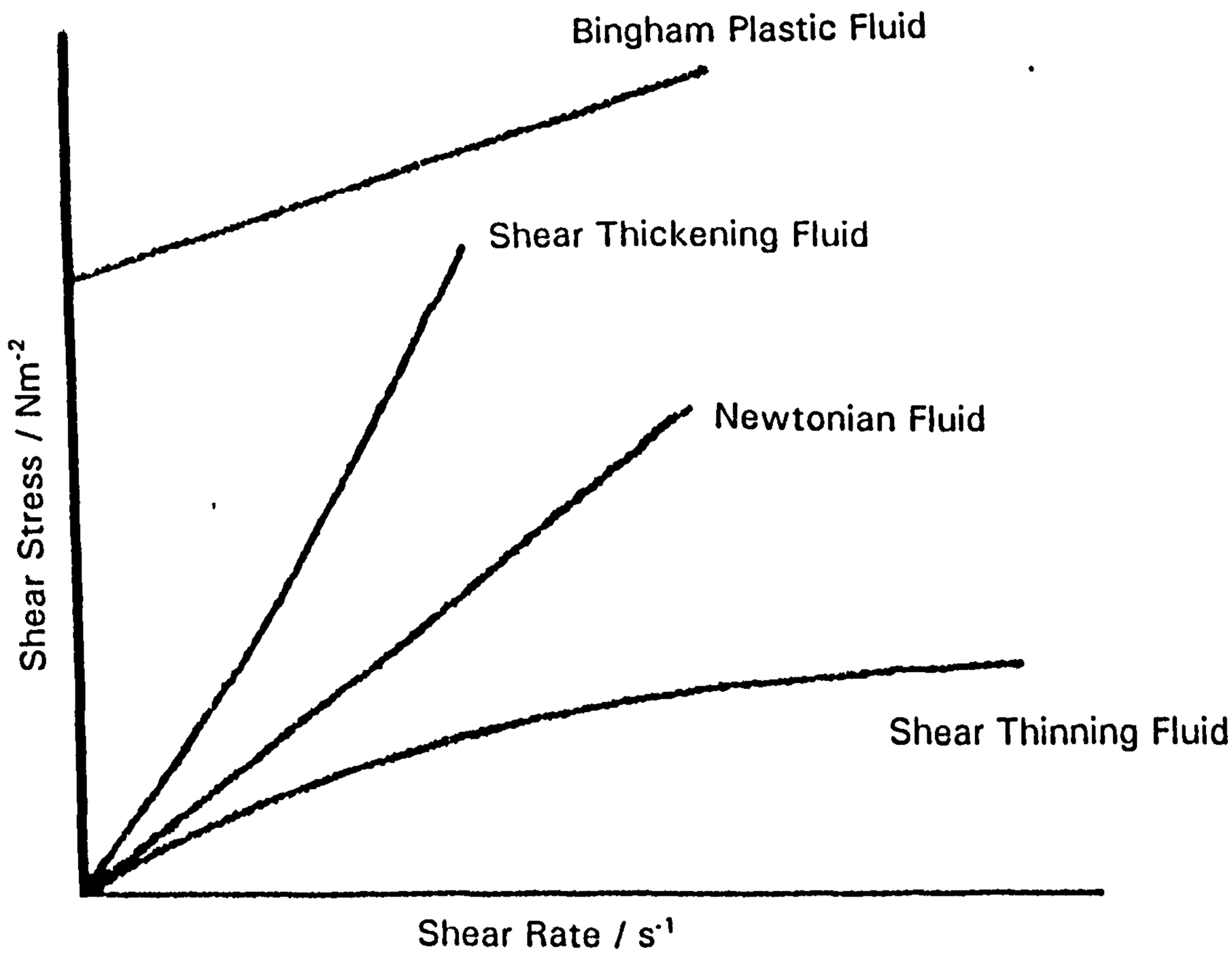

Bingham Plastic Fluid
Shear Thickening Fluid
Newtonian Fluid
Shear Thinning Fluid
Shear Stress / Nm-2
Shear Rate / s-1

Figure 8 : Diagram showing the Normal stress components in a shear system (41).

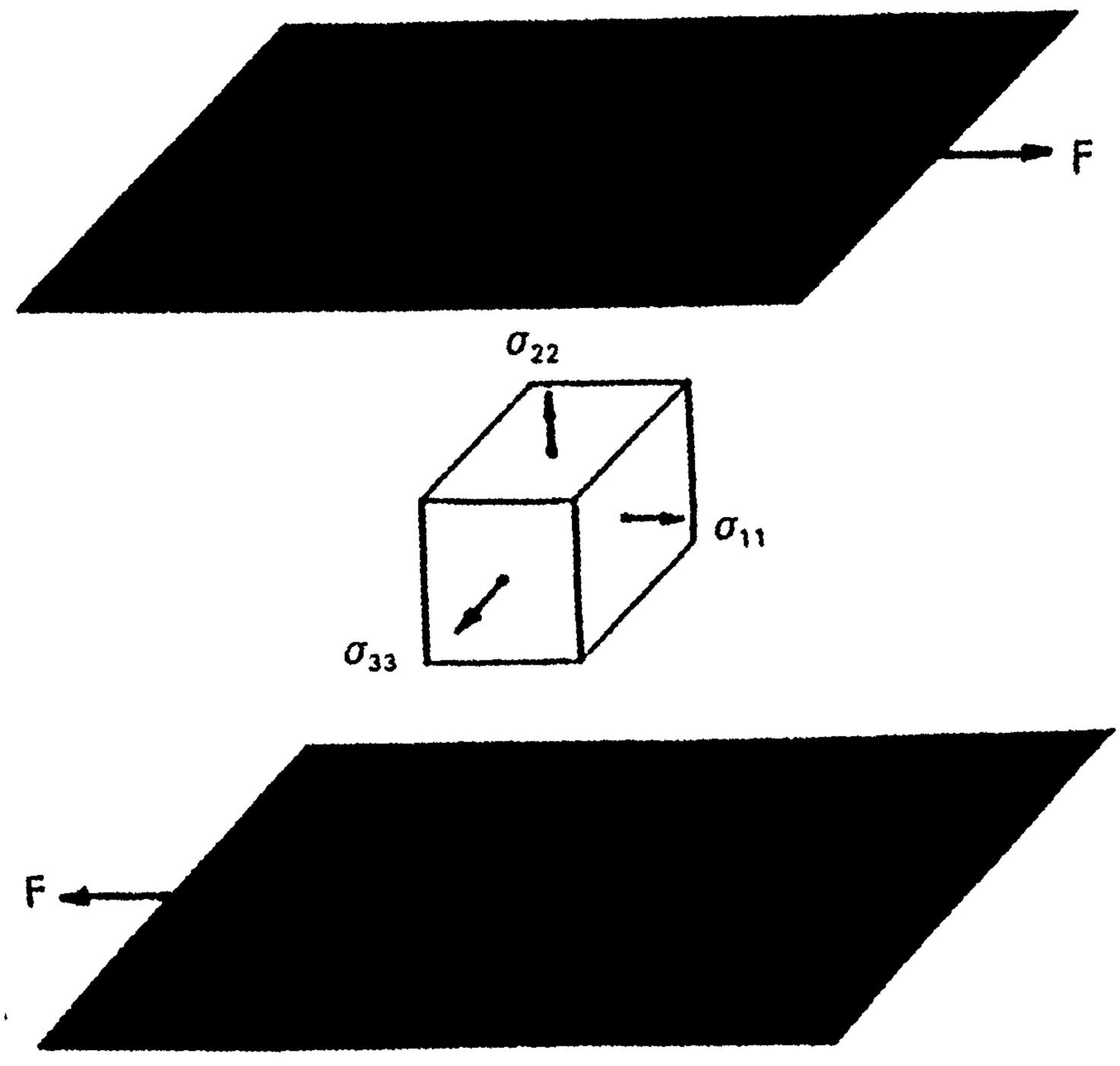

F
σ_{22}
σ_{11}
σ_{33}
F

Figure 9 : Graph illustrating the relationship between the viscosity and the molecular weight average (41).

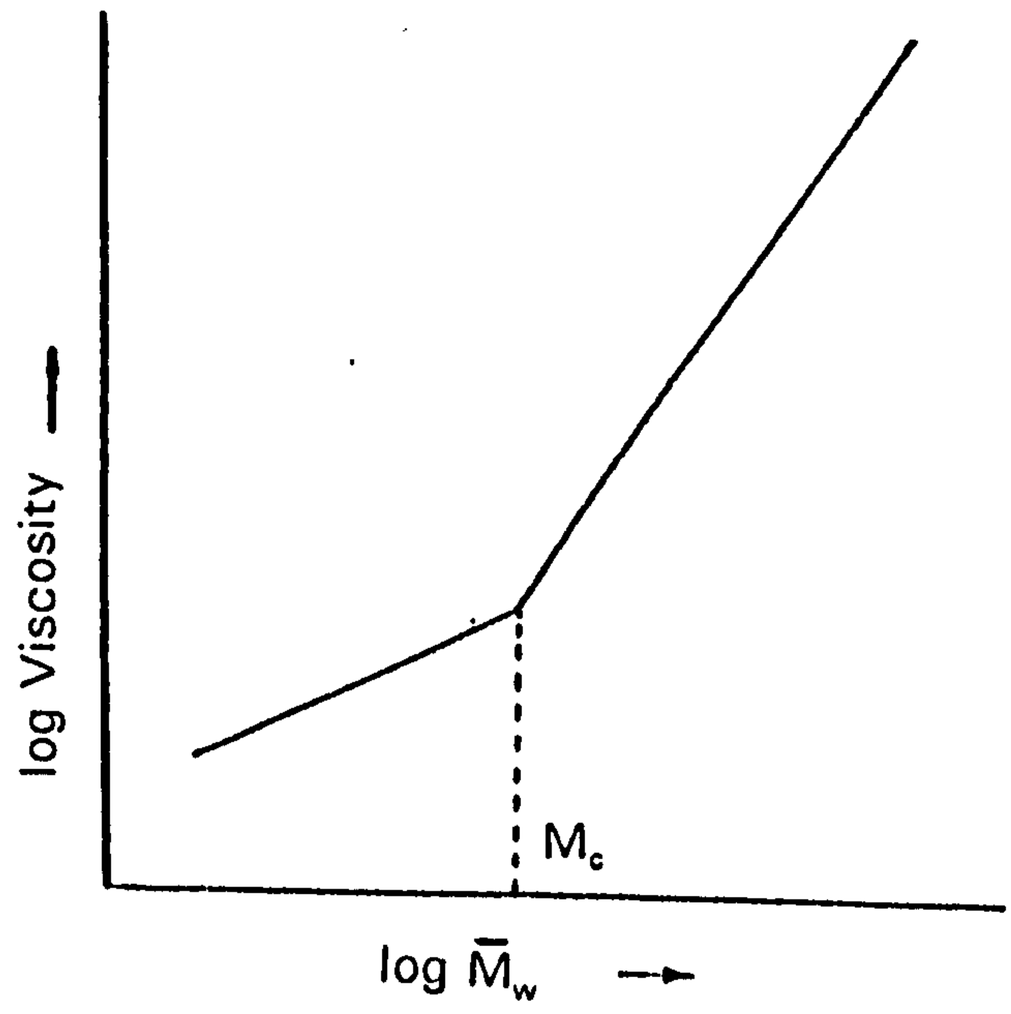
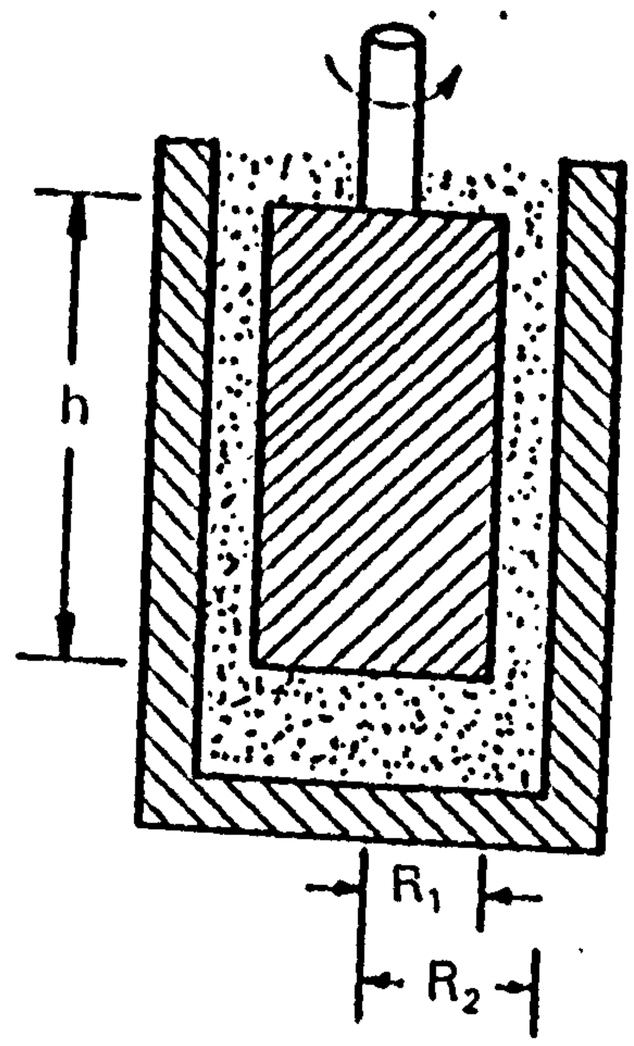
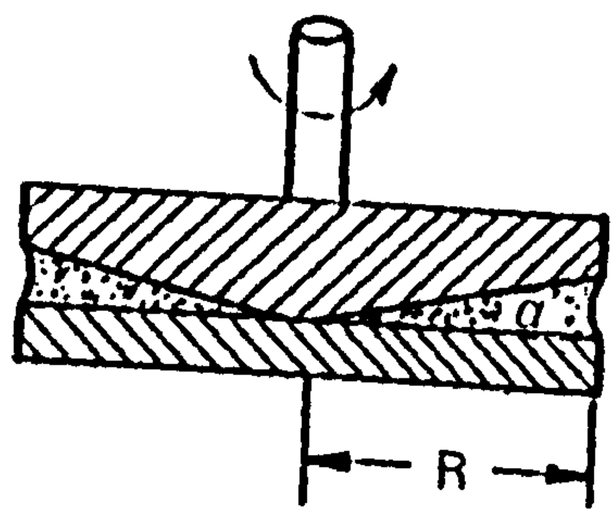

log Viscosity
M_c
log $\bar{M}_w$

Figure 10(a) : Schematic diagram of a coaxial (concentric-cylinder) rotational viscometer (41).

Figure 10(b) : Schematic diagram of a rotational viscometer (41).

Figure 10(c) : Schematic diagram of a capillary viscometer (41).


h
R1
R2


a
R

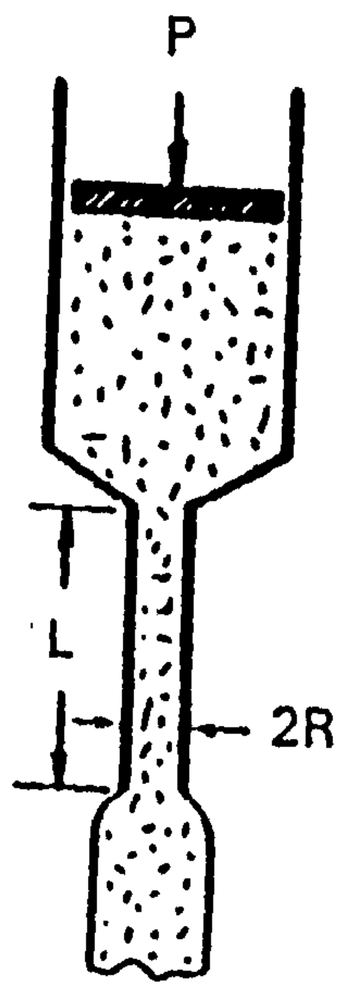

P
L
2R

Figure 11 : The ideal pressure behaviour associated with capillary viscometers (39).

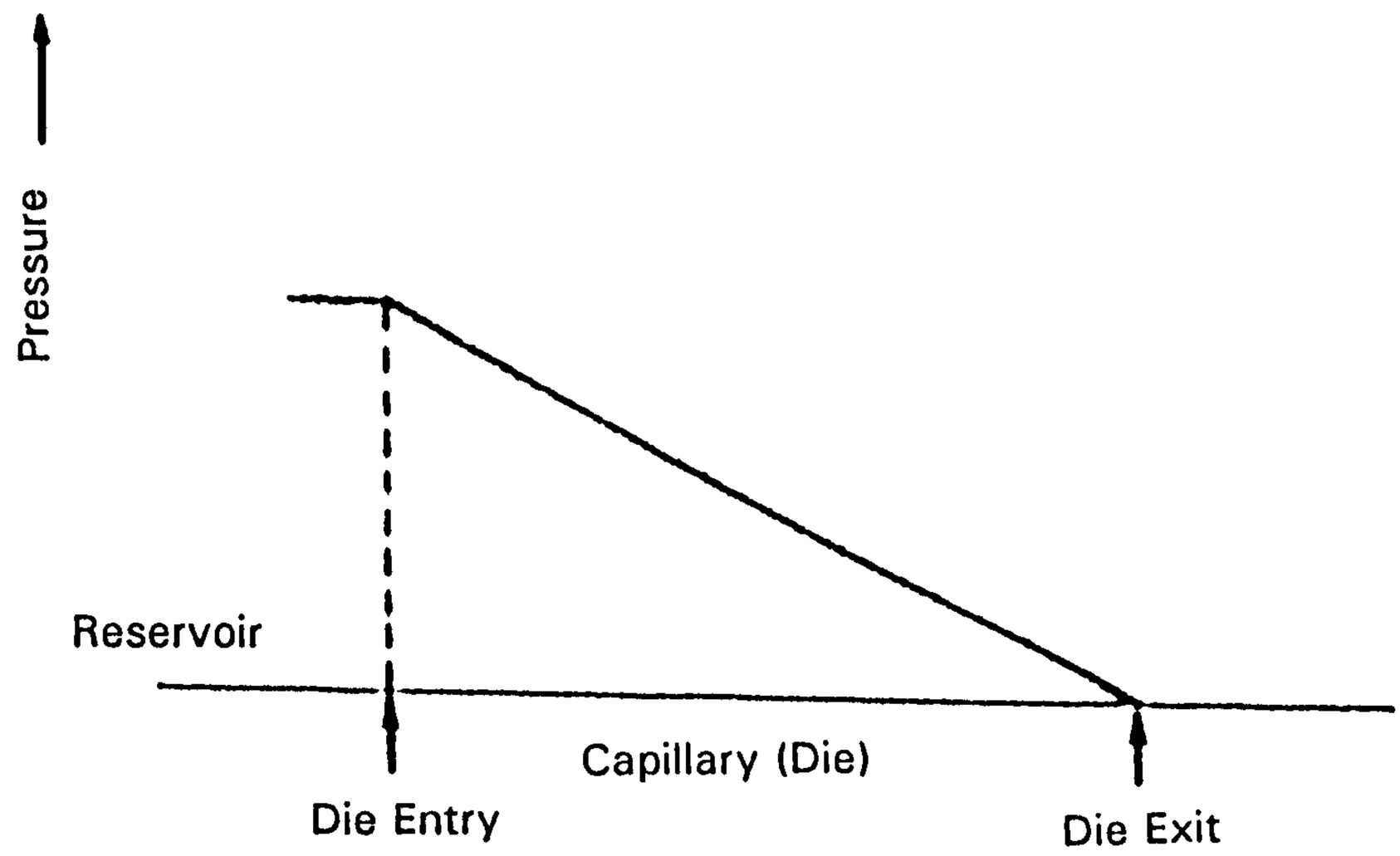

Pressure
Reservoir
Capillary (Die)
Die Entry
Die Exit

Figure 12 : The deviations from the ideal pressure behaviour in capillary viscometers due to end effects (44).

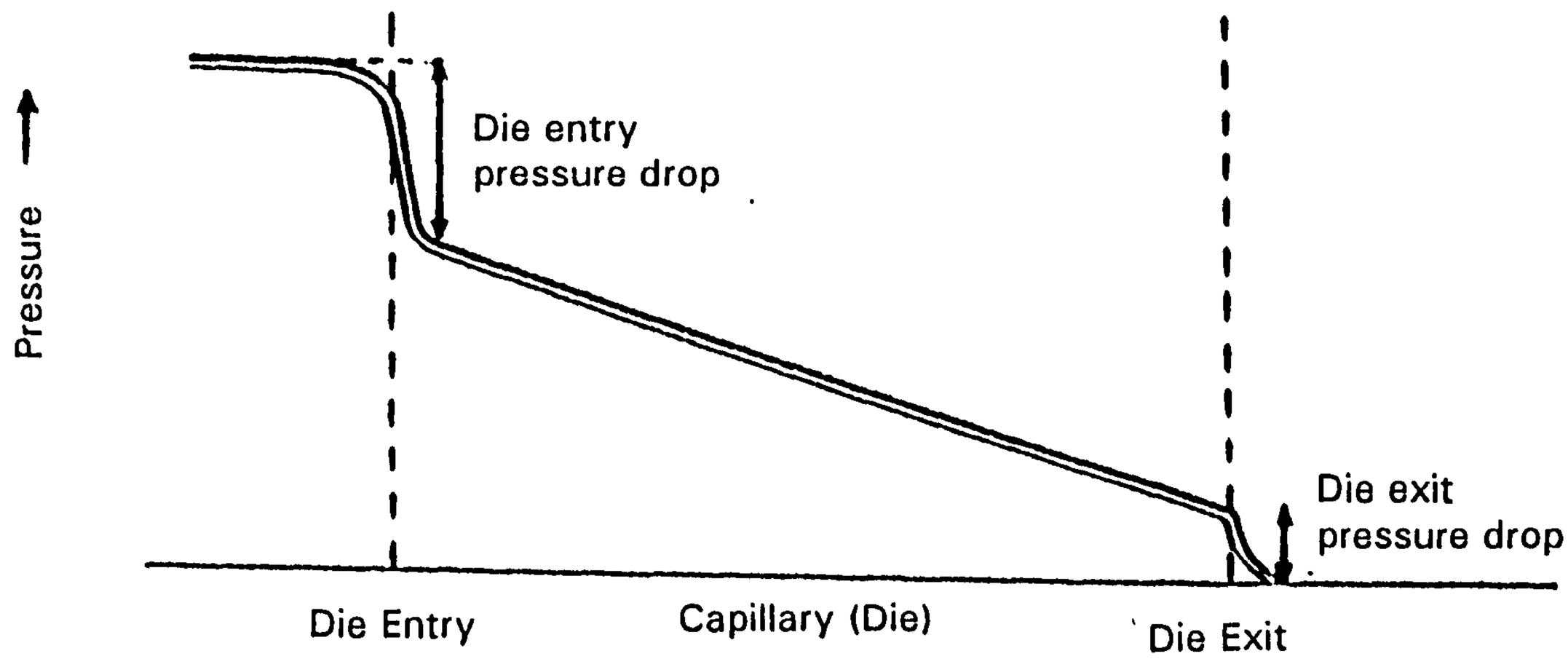
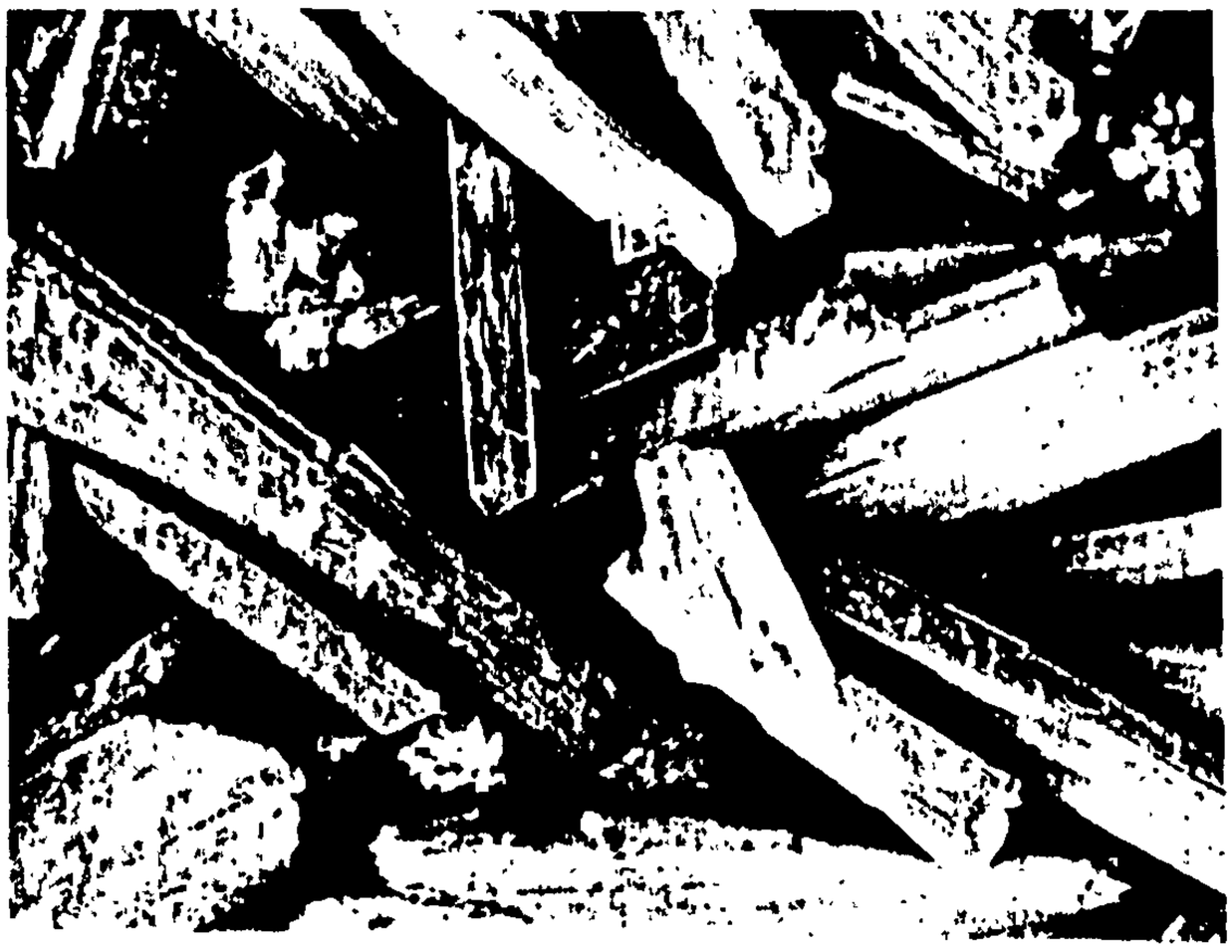

Pressure
Die entry
pressure drop
Die exit
pressure drop
Die Entry
Capillary (Die)
Die Exit

Figure 13(a) : Particle shape definitions.

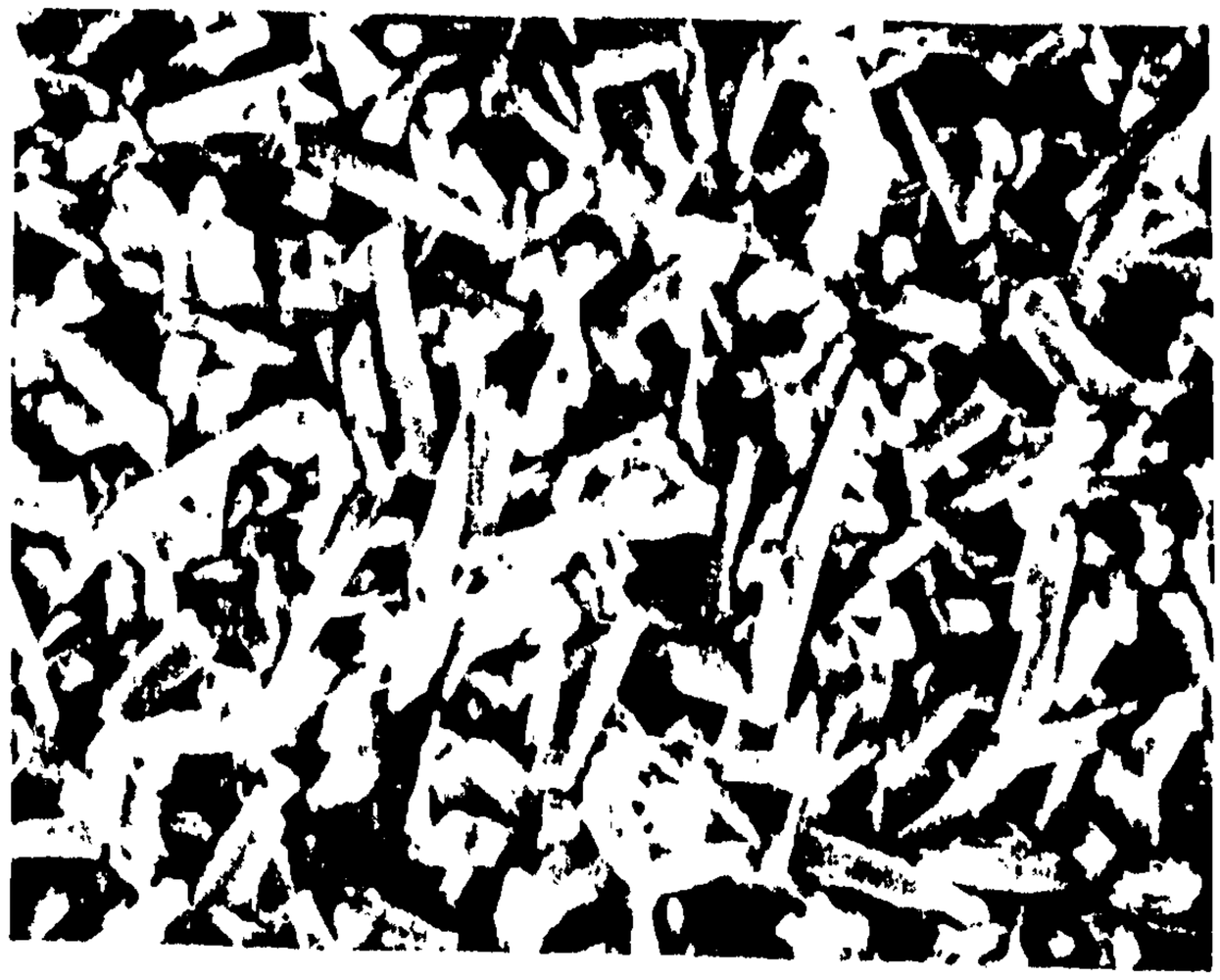


Fibrous

Flaky

Granular

Figure 13(b) : Particle shape definitions contd.

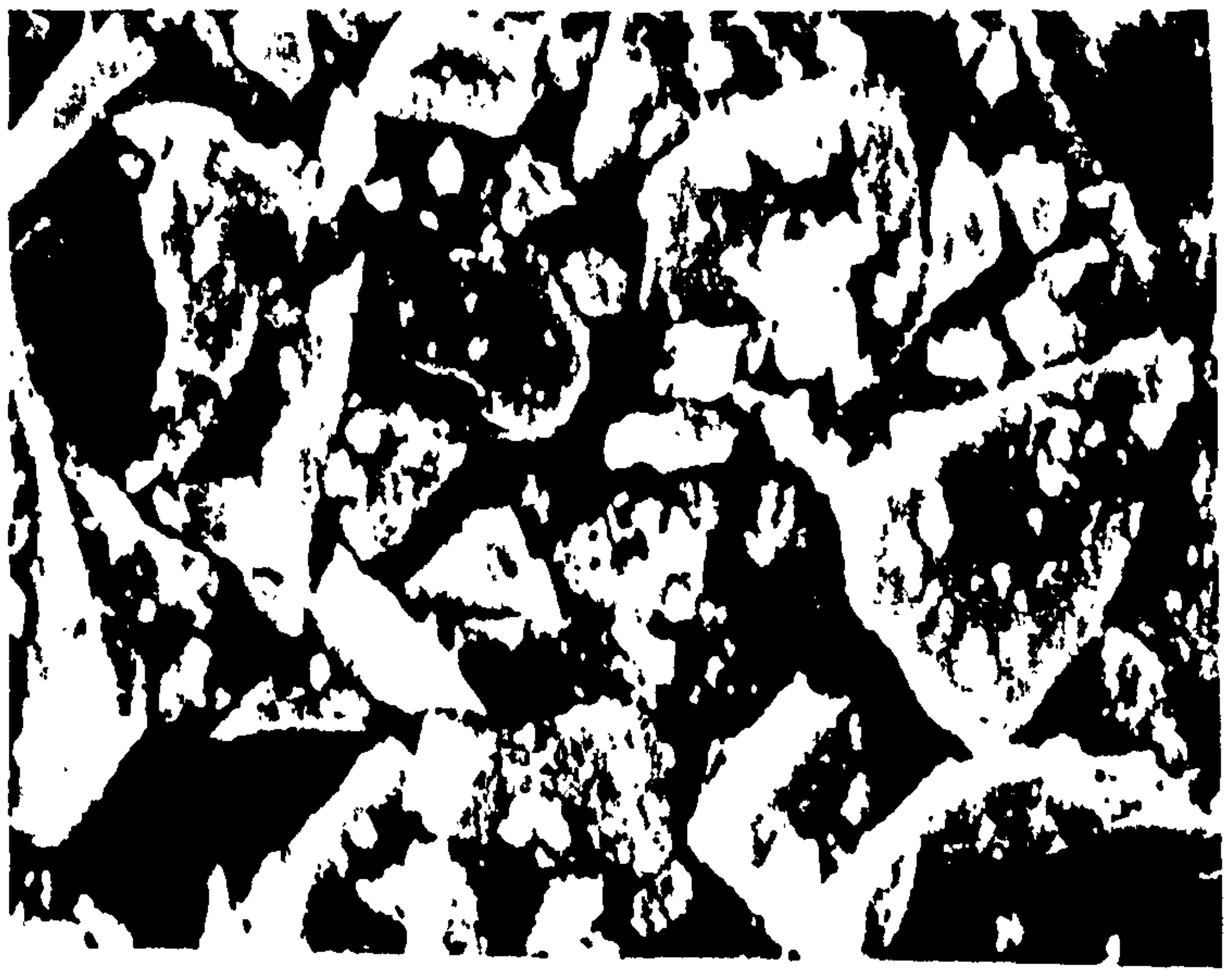


Acicular

Angular

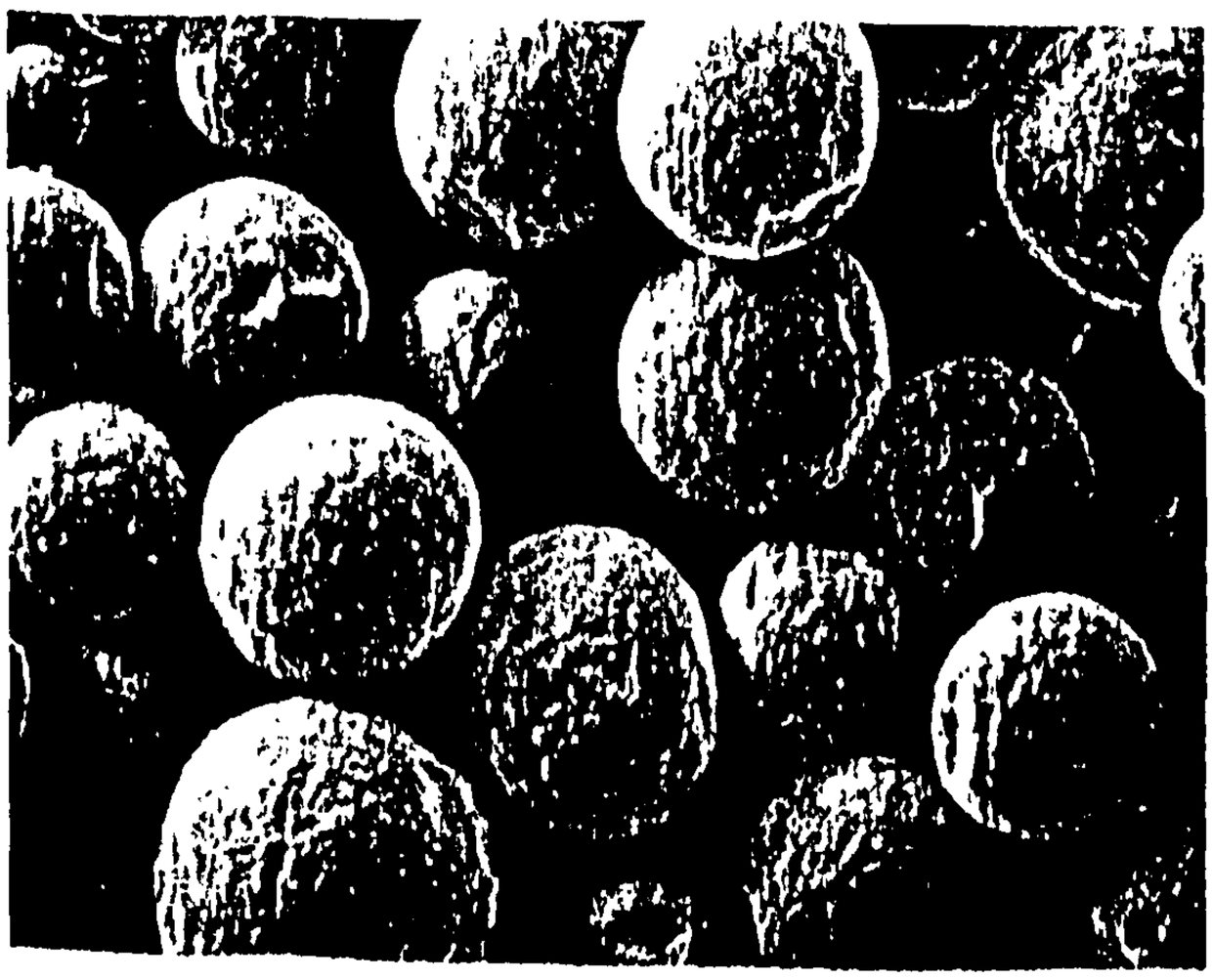
Dendritic

Figure 13(c) : Particle shape definitions contd.



Irregular

Nodular



Spheroidal

Figure 14 : Schematic diagram illustrating the AFM machine (68).

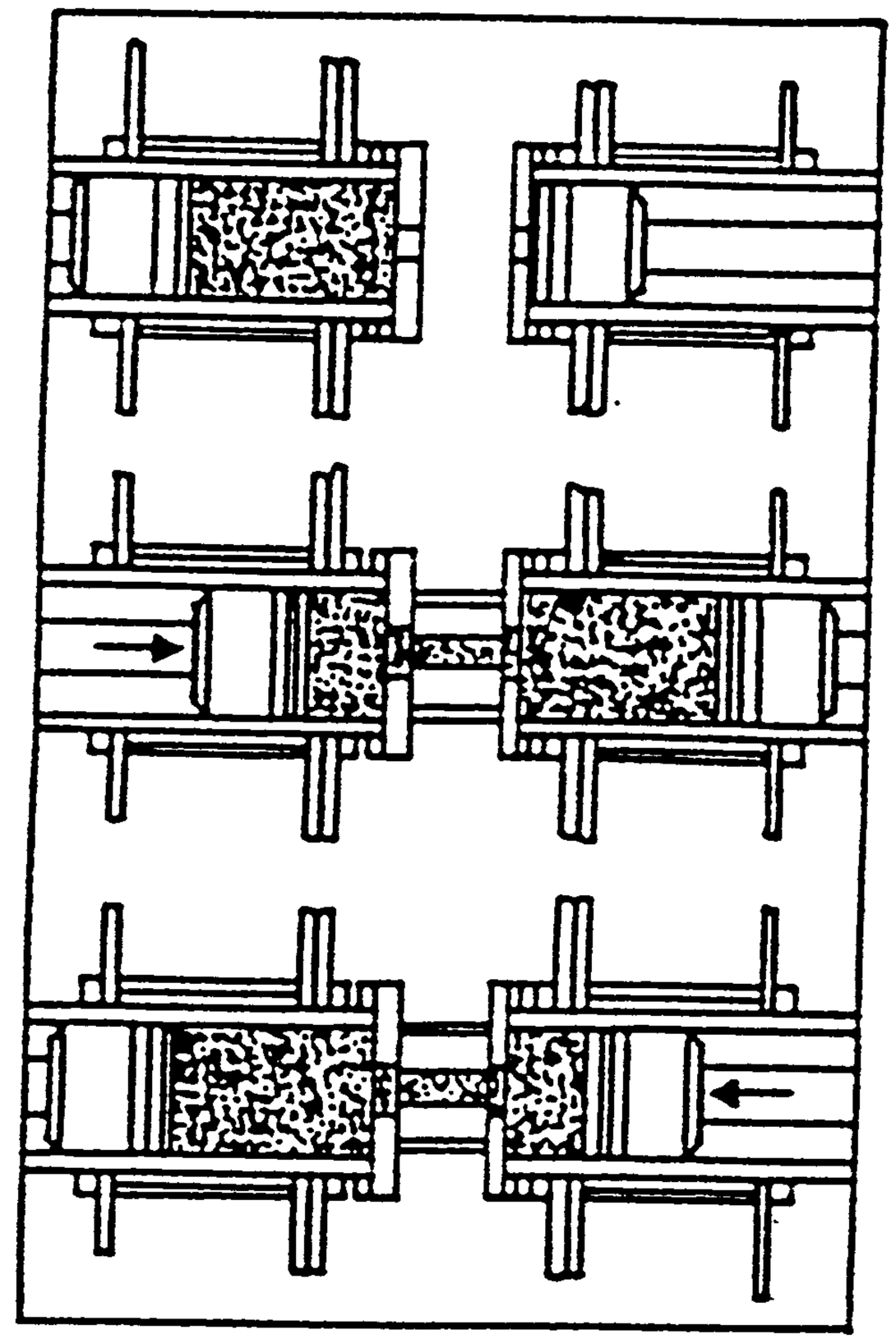


Figure 15 : Schematic diagram illustrating the AFM tooling (76).

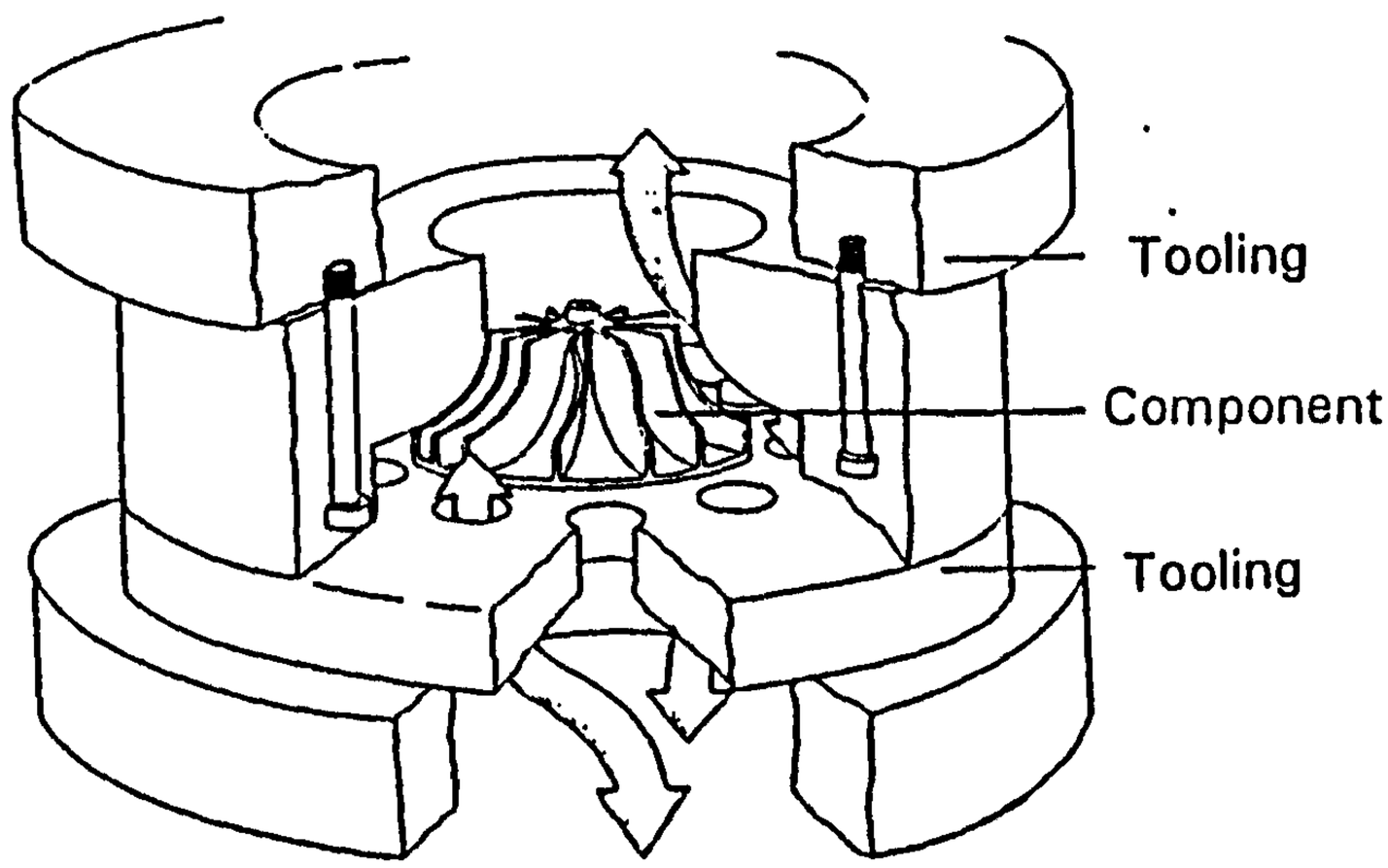

Tooling
Component
Tooling

Figure 16 : The Ferranti 750M Co-ordinate Measuring Machine.

FERRANTI
Metrology Systems
MERLIN

Figure 17 : The Form Talysurf 120L.

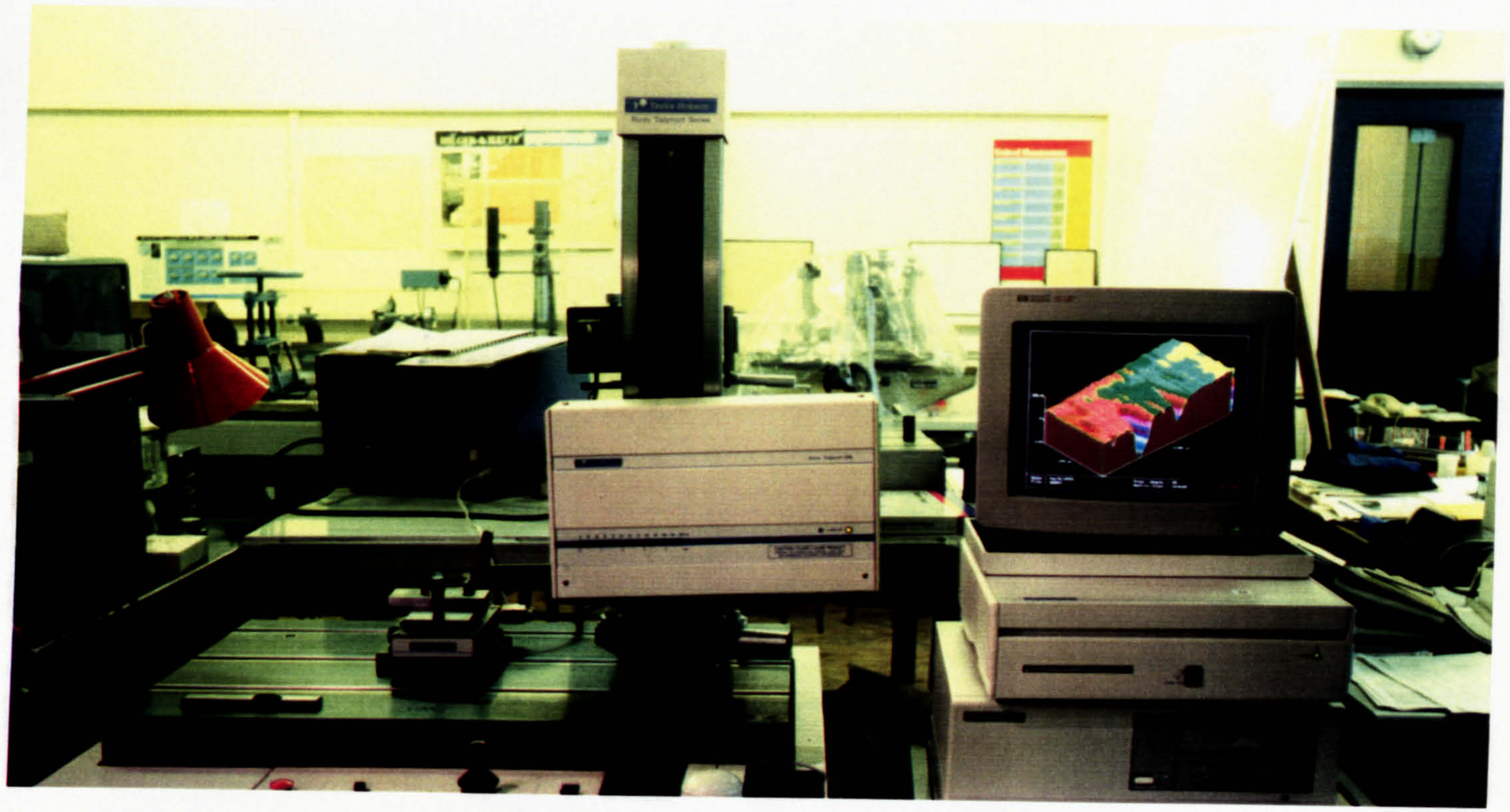


Figure 18 : The Dynisco μPR690 microprocessor units connection to the computer.

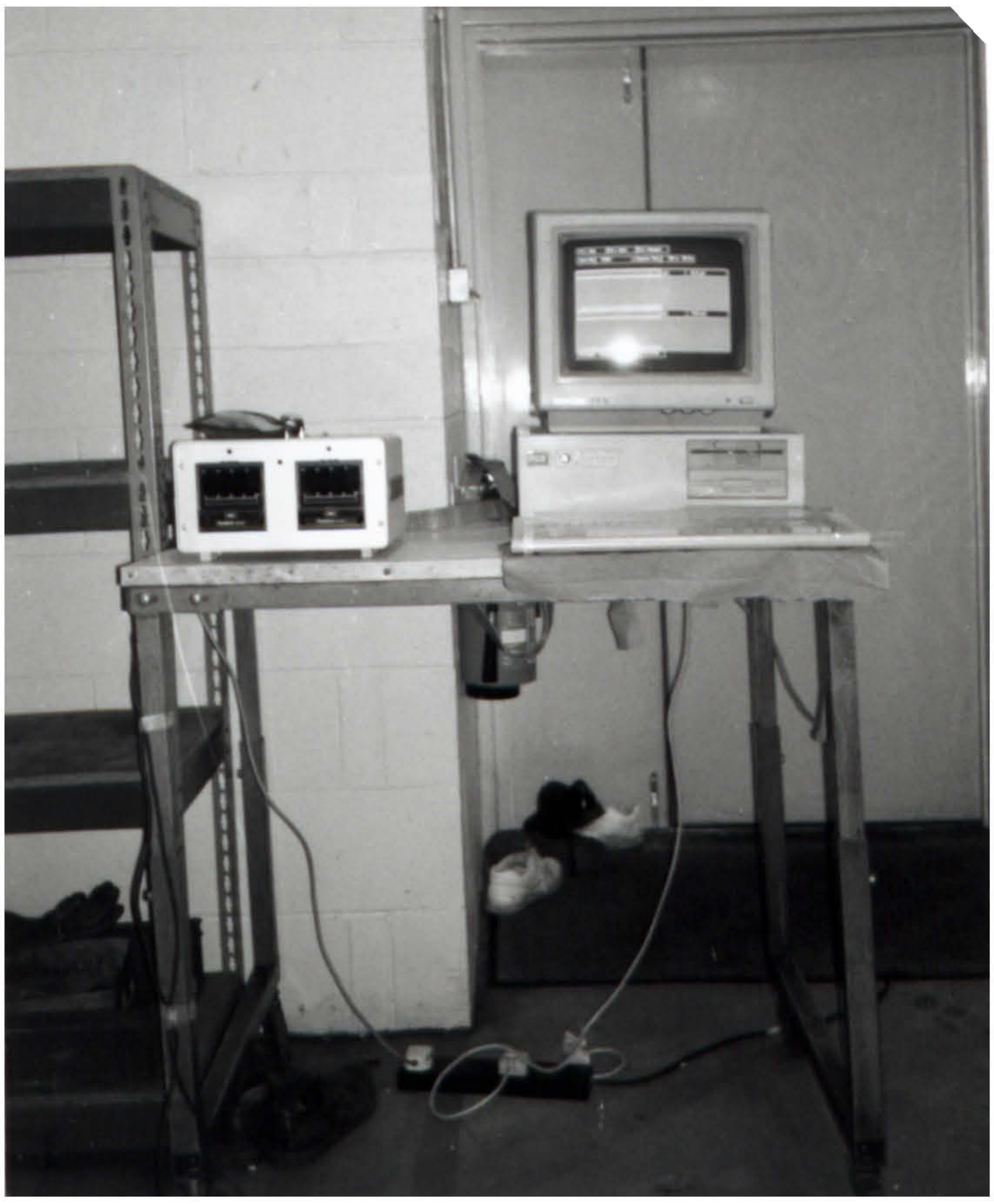


Figure 19 : The Solartron Data Logger.

Figure 20 : The Extrude Hone mark 7A machine.

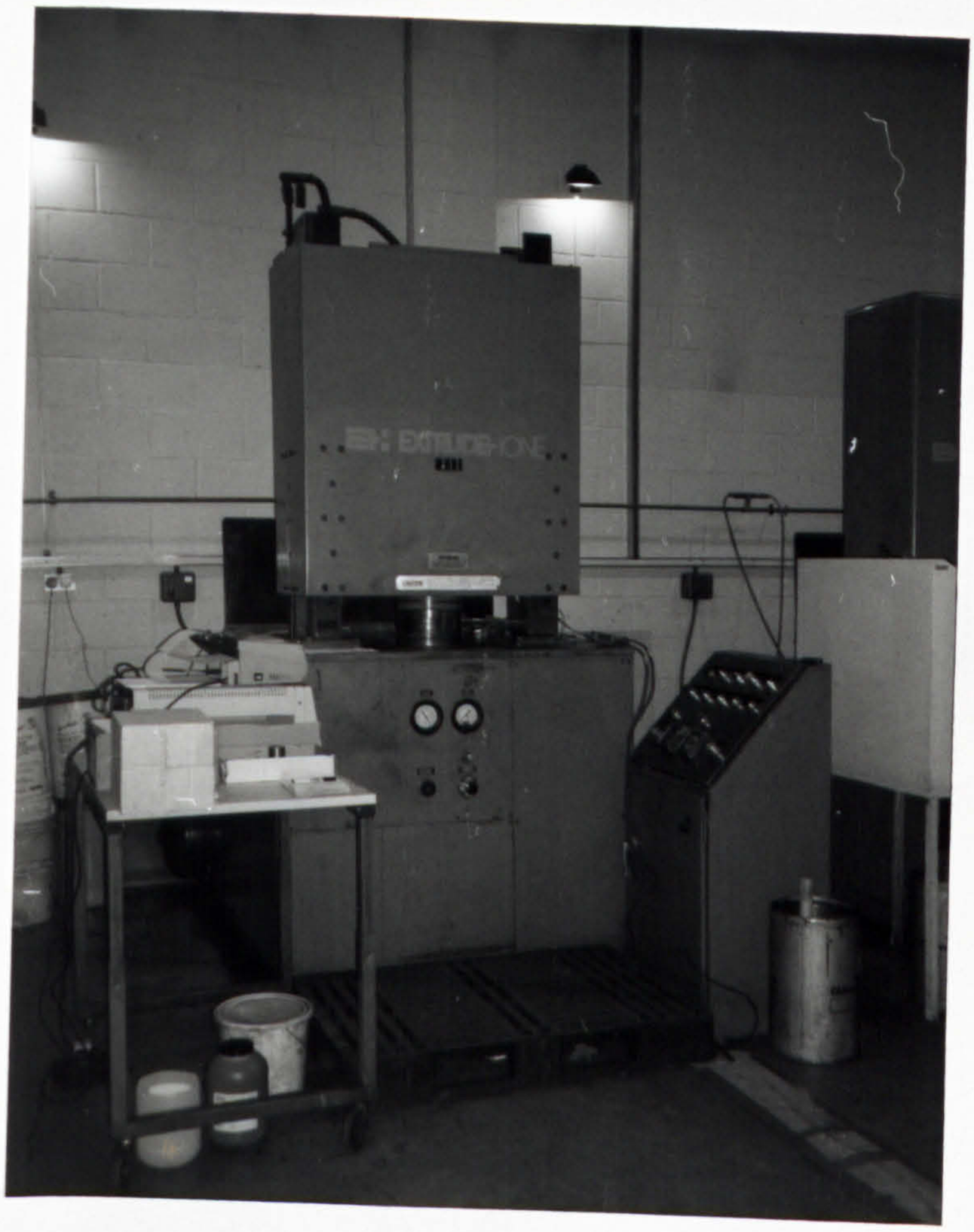
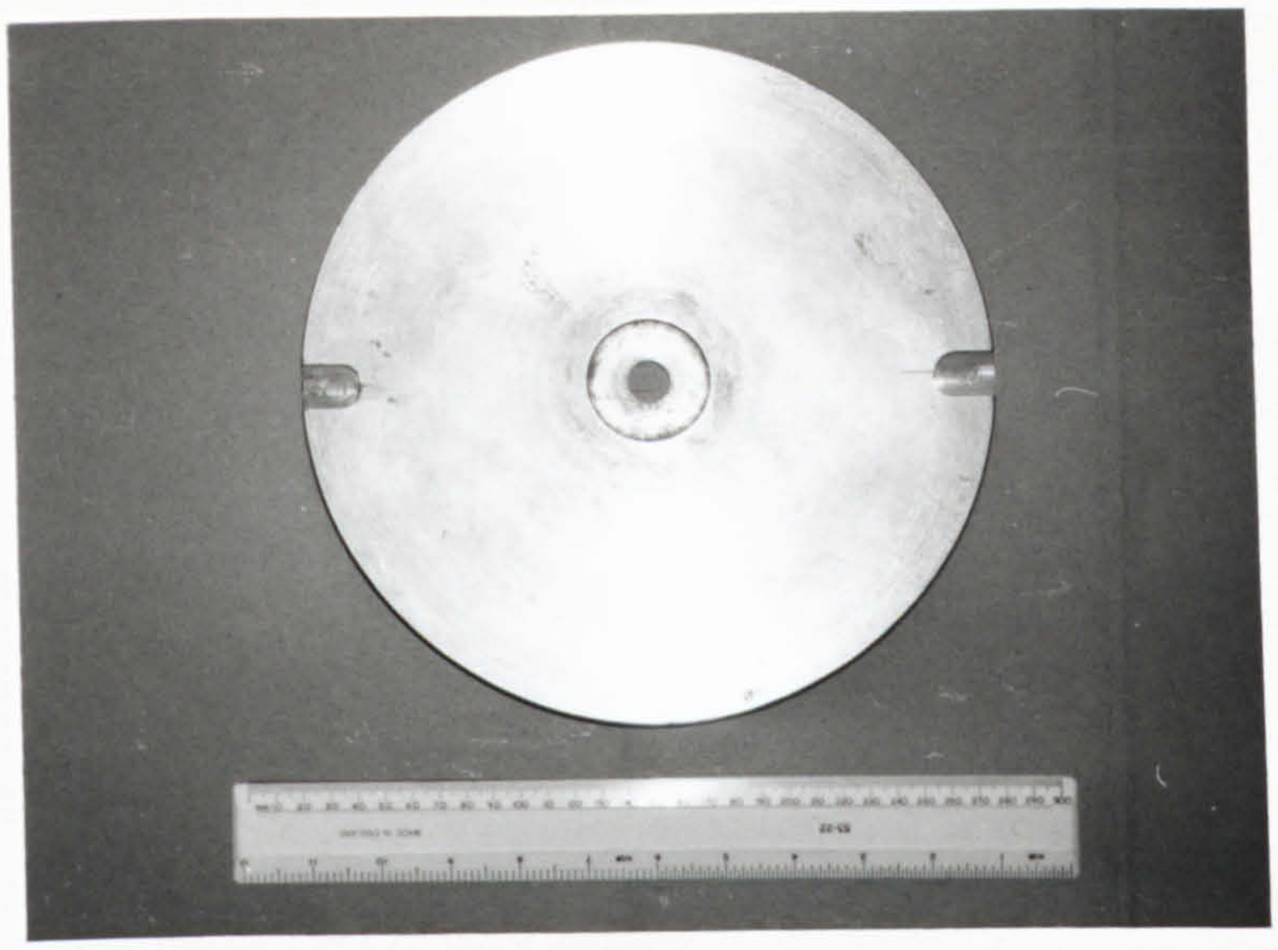

EXTREME-ONE

Figure 21(a) : Upper surface of tooling plate illustrating die location cavity.

Figure 21(b) : Transducer locations and protrusion on lower surface permitting alignment of tooling plates.



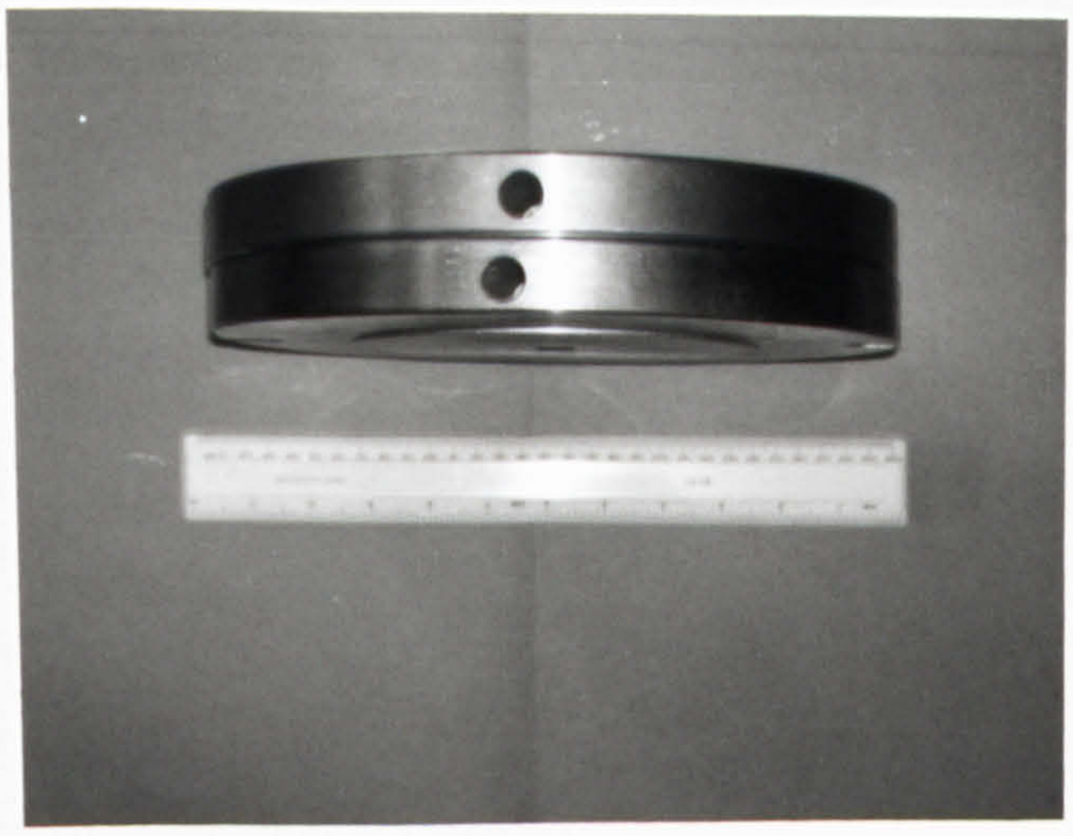


Figure 22 : The clamped 7A machine with tooling plates, die, and transducers in location.

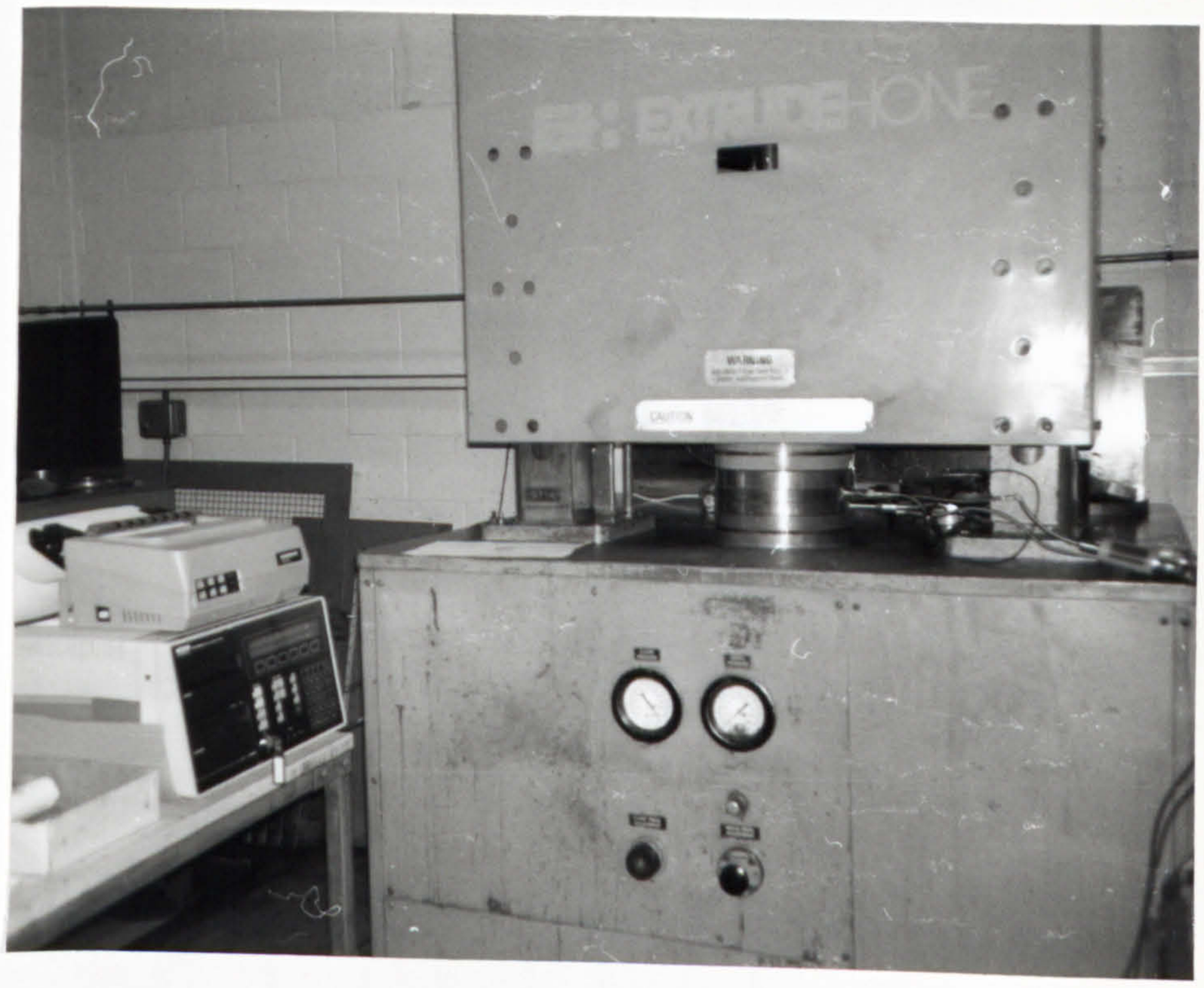
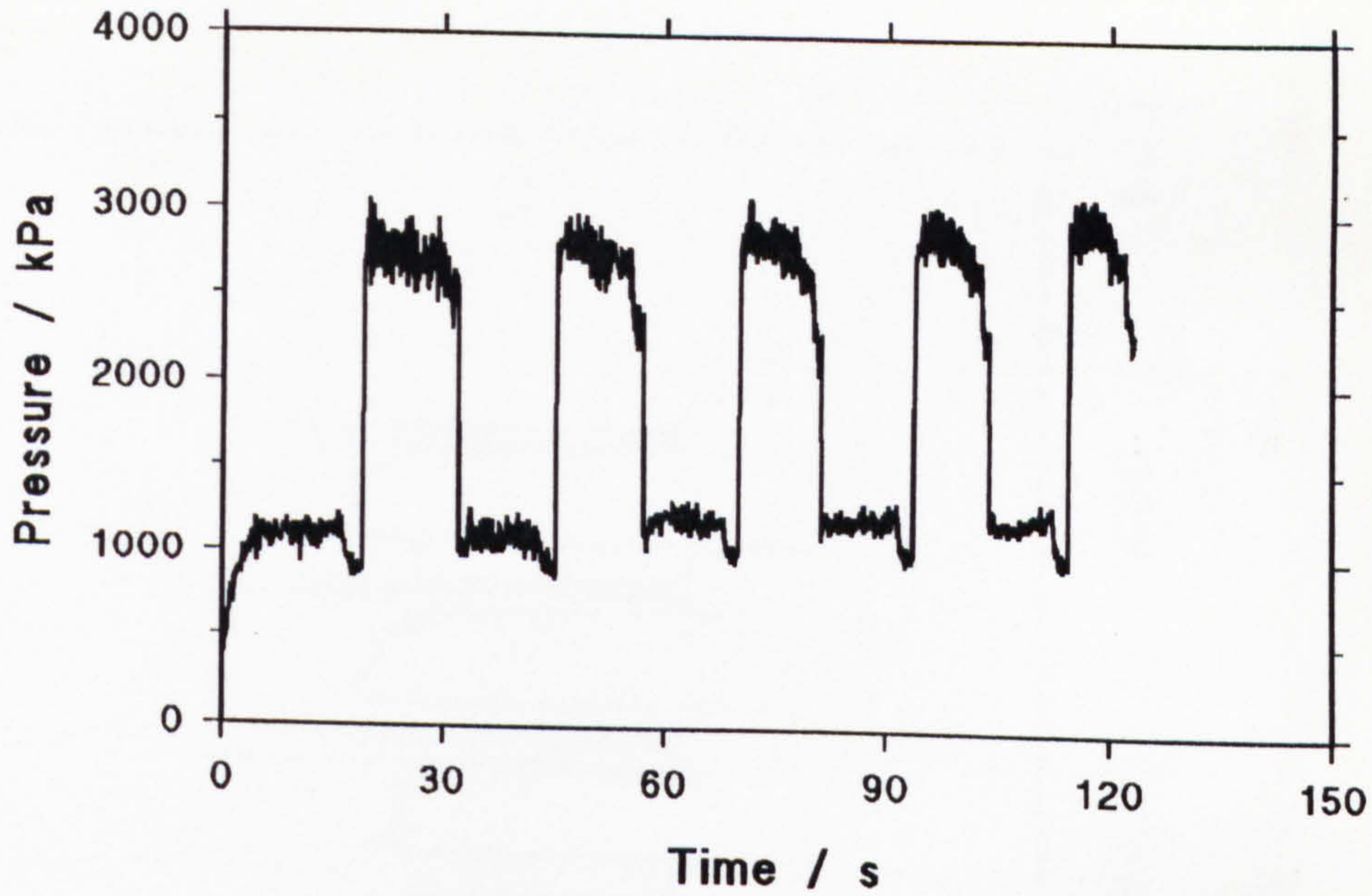

CAUTION

Figure 23(a) : The upper transducer trace.

Figure 23(b) : The corresponding lower transducer trace.


4000
3000
2000
1000
0
Pressure / kPa
0
30
60
90
120
150
Time / s

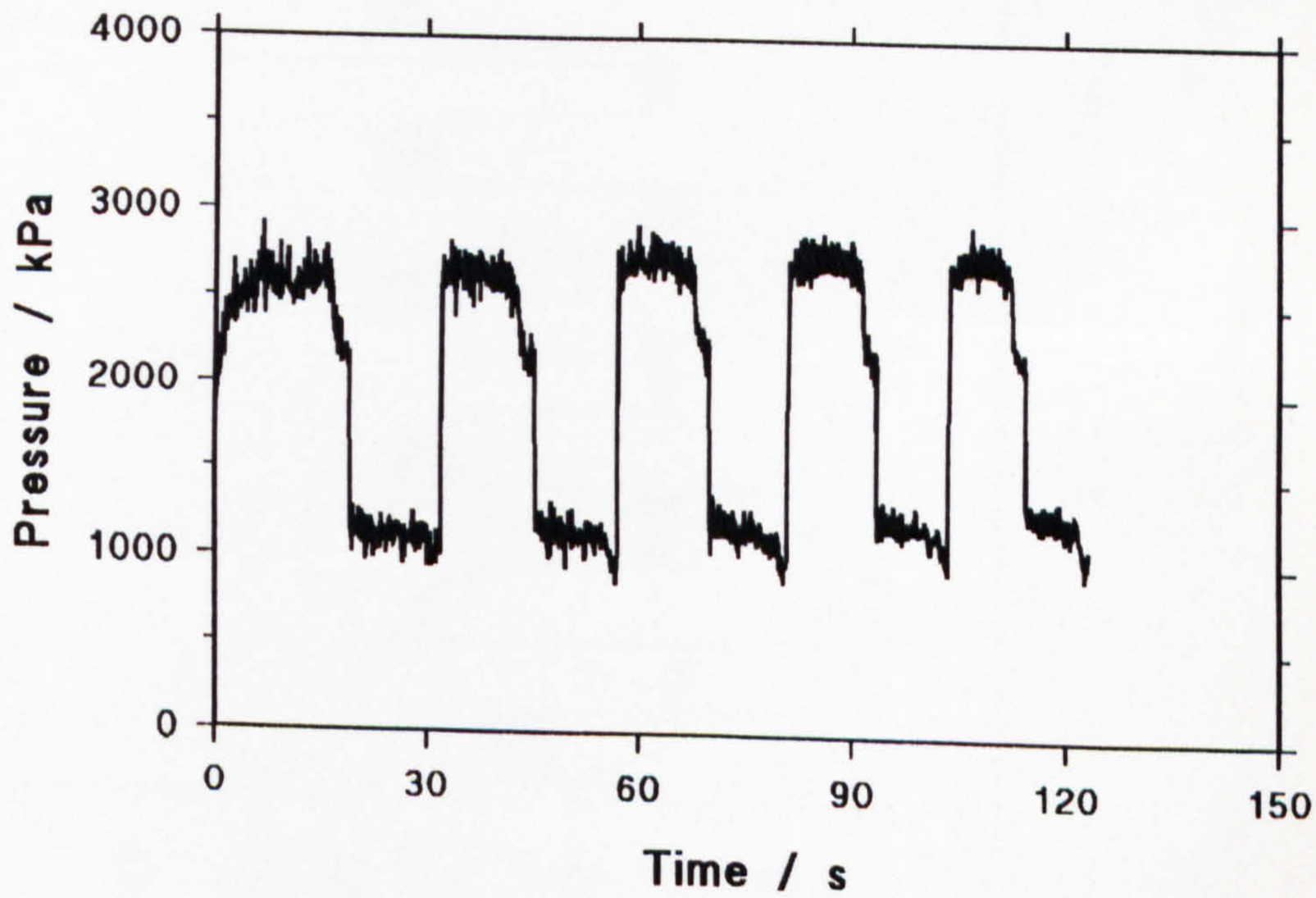

4000
3000
2000
1000
0
Pressure / kPa
0
30
60
90
120
150
Time / s

Figure 24 : A transducer trace containing spurious signals.

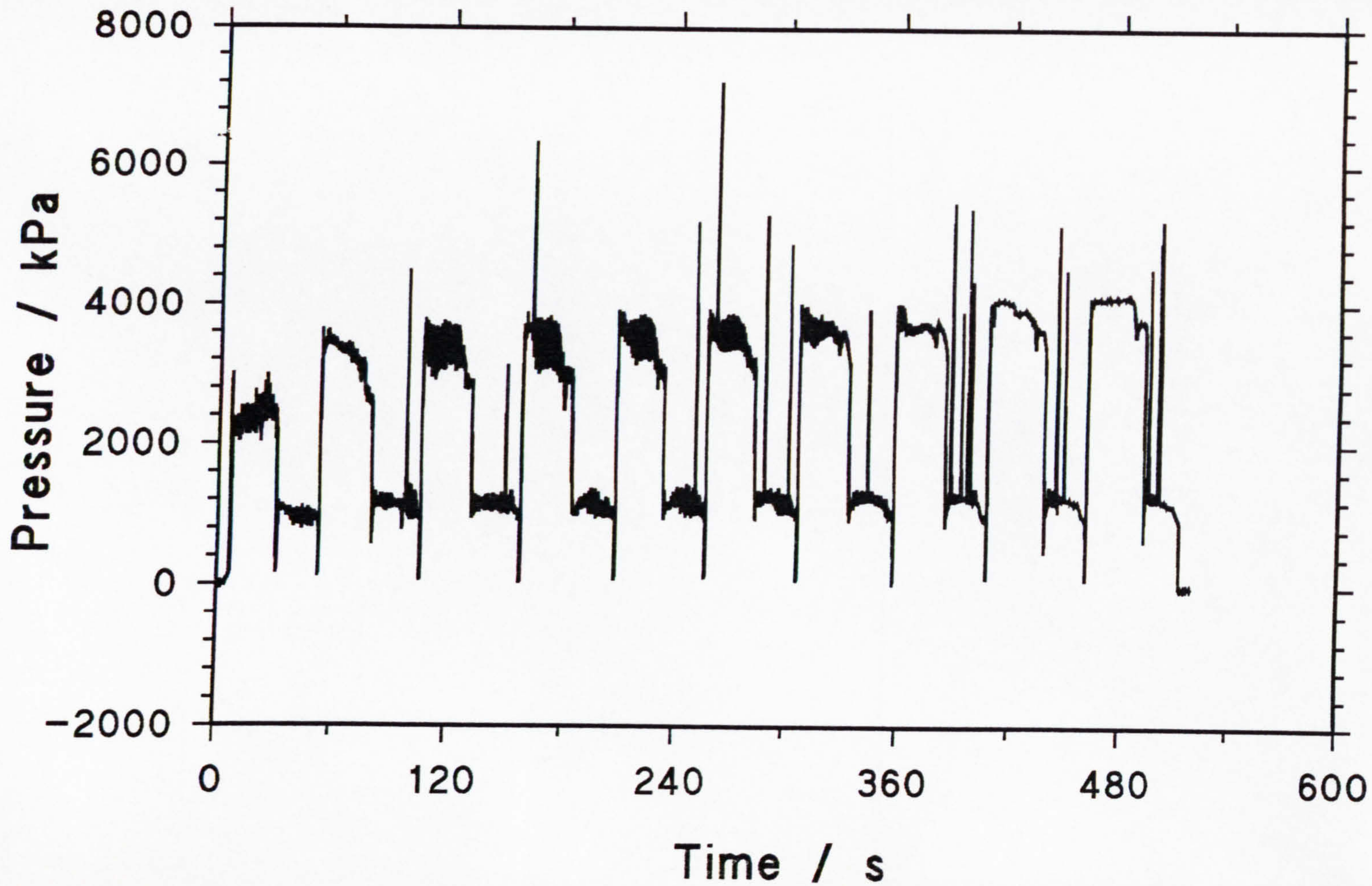
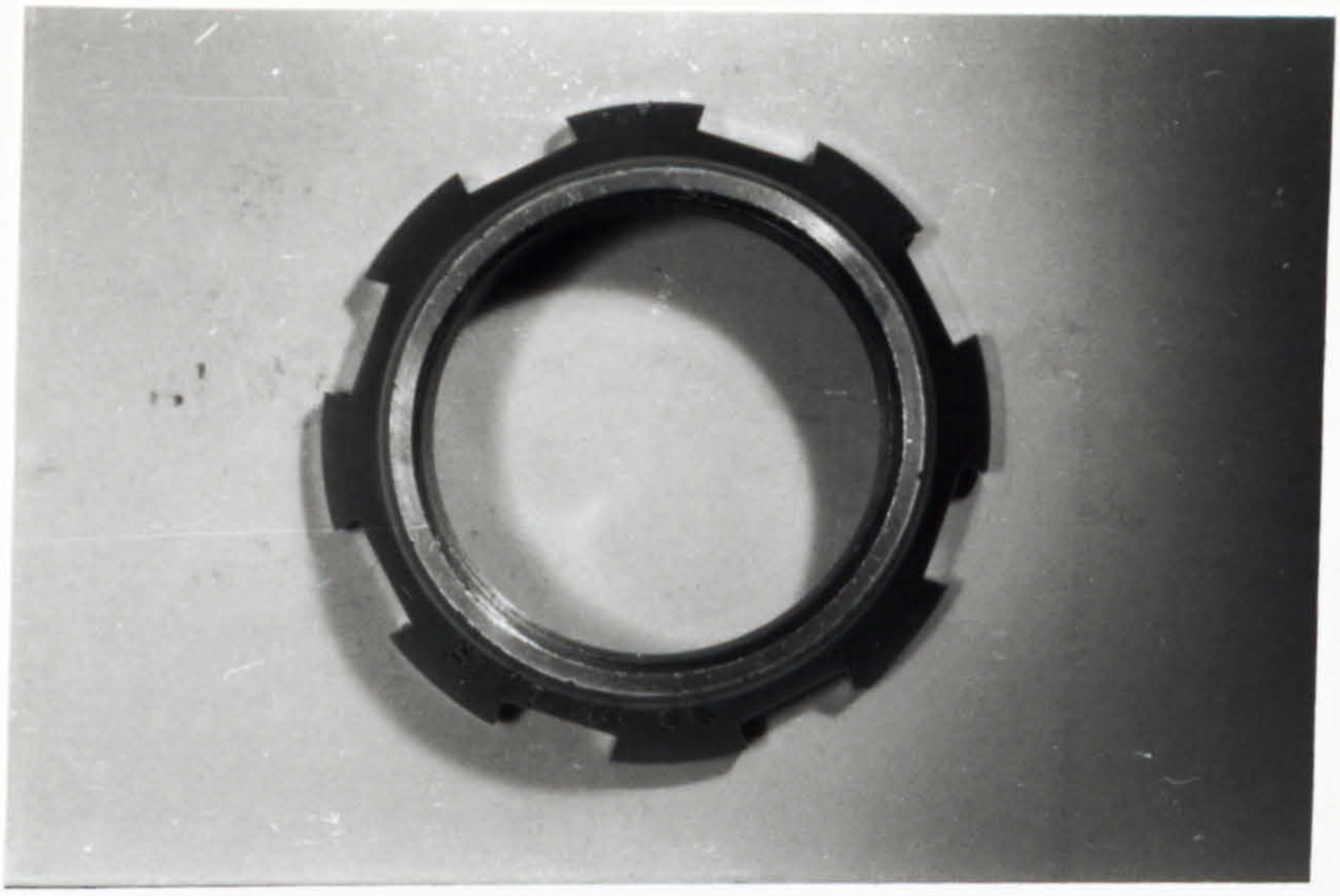

8000
6000
4000
2000
0
−2000
Pressure / kPa
0
120
240
360
480
600
Time / s

Figure 25(a) : Castle nut component - plan view. x 1.8

Figure 25(b) : Castle nut component - side view. x 1.8



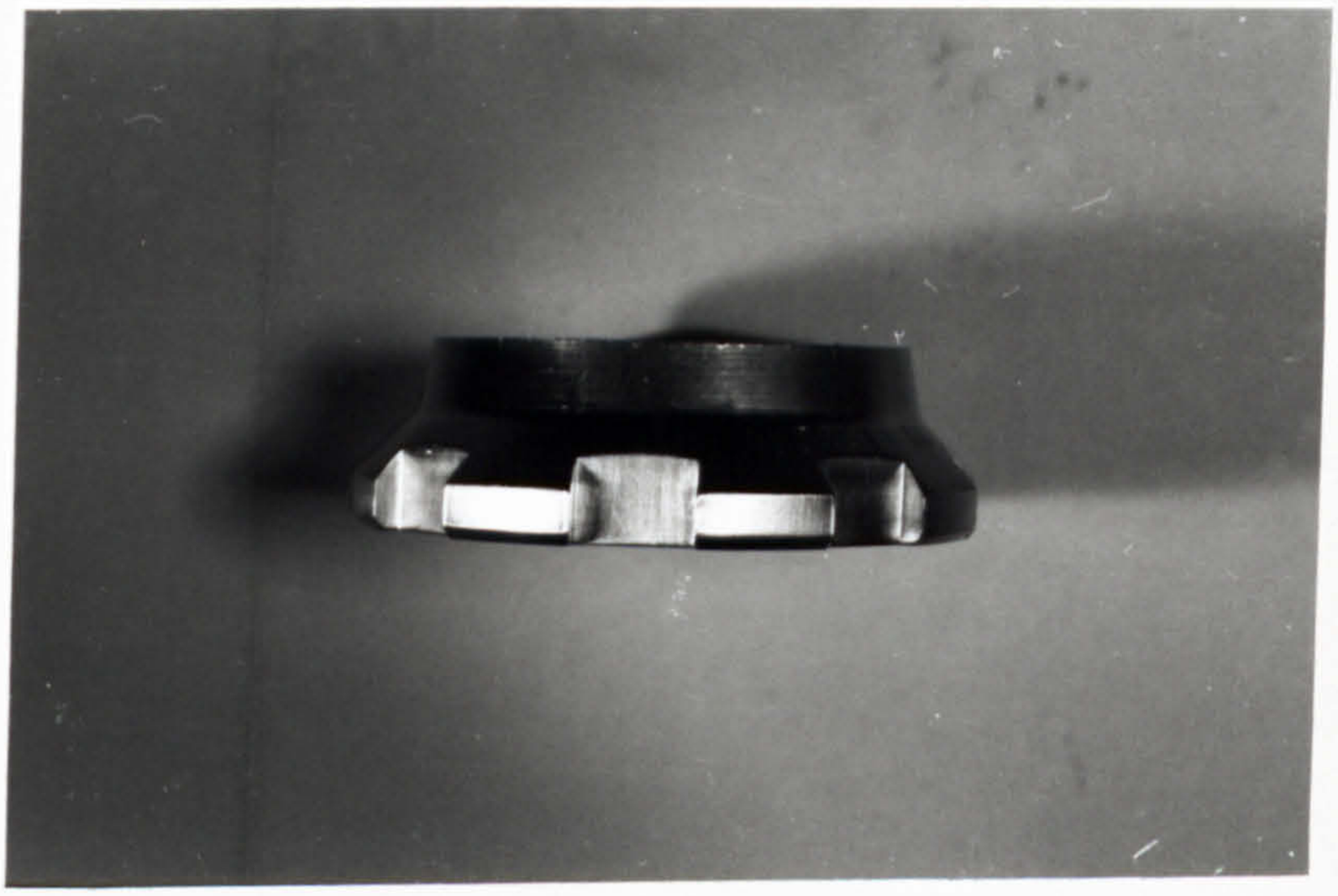


Figure 26 : Bearing component.

x 2.1

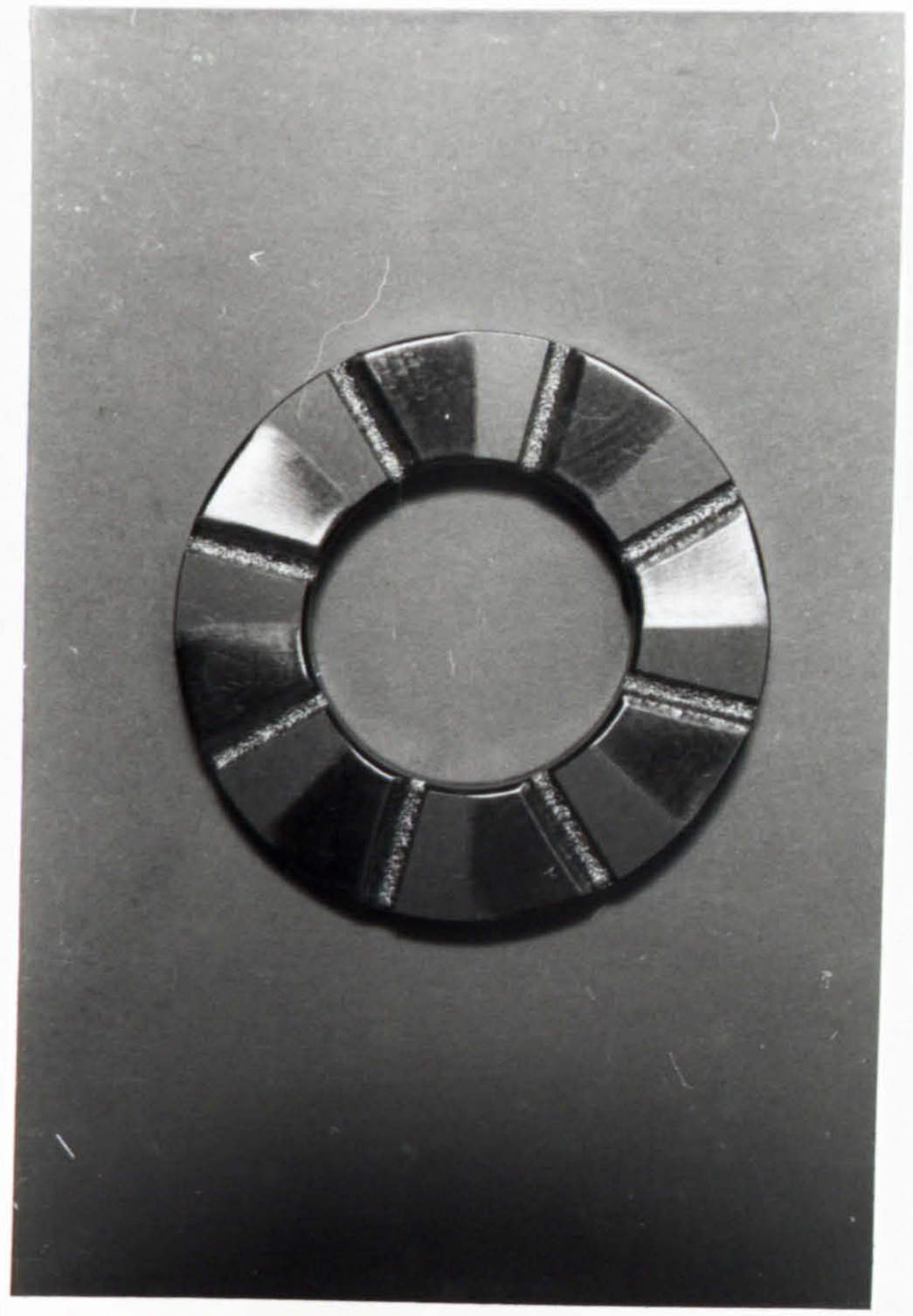
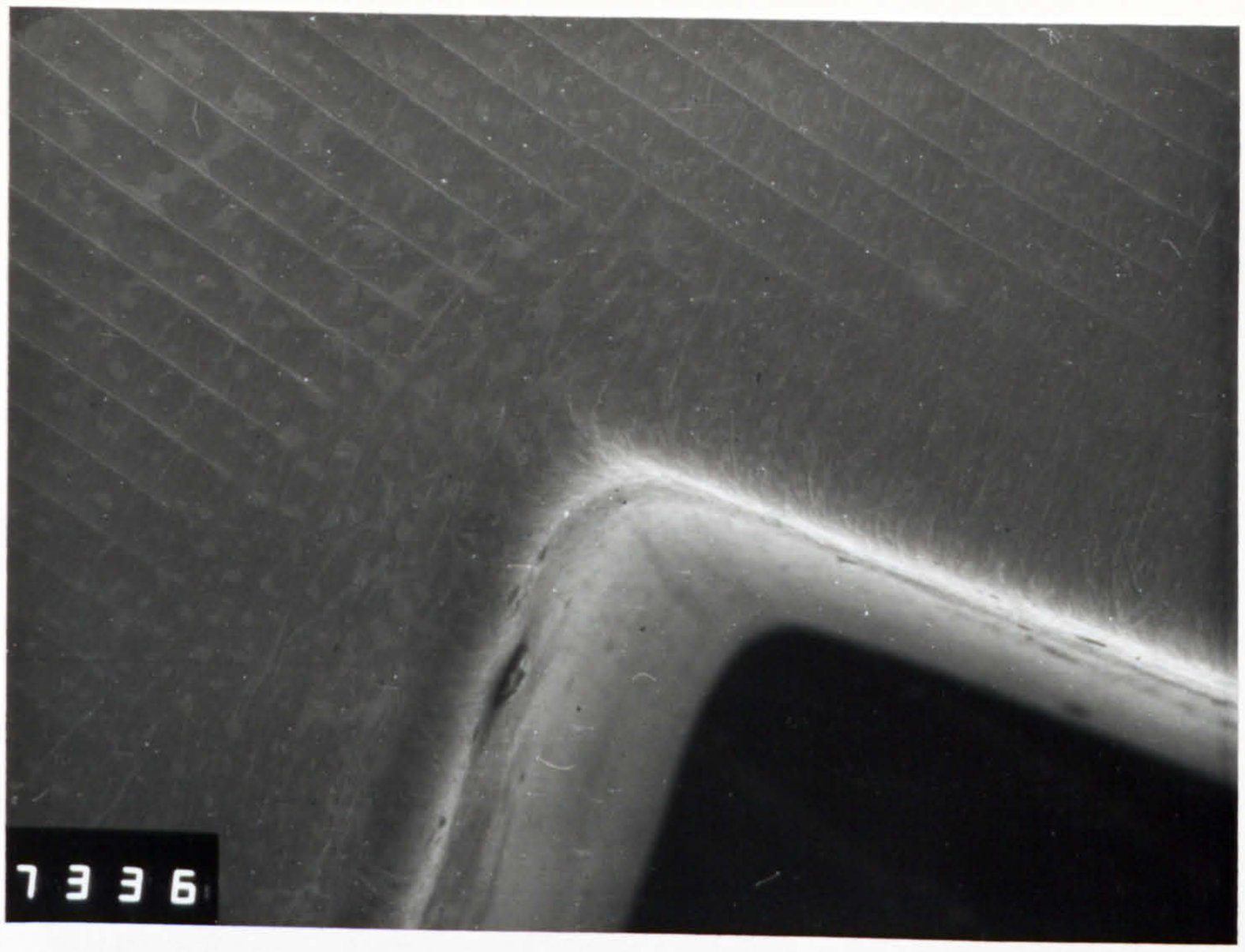


Figure 27(a) : The illustration of an inner spur corner of the castle nut component to show edge deburring.

x 70

Figure 27(b) : Illustration of the above feature at a greater magnification to show the effect of the grit particles and their direction of flow.

x 300


7336

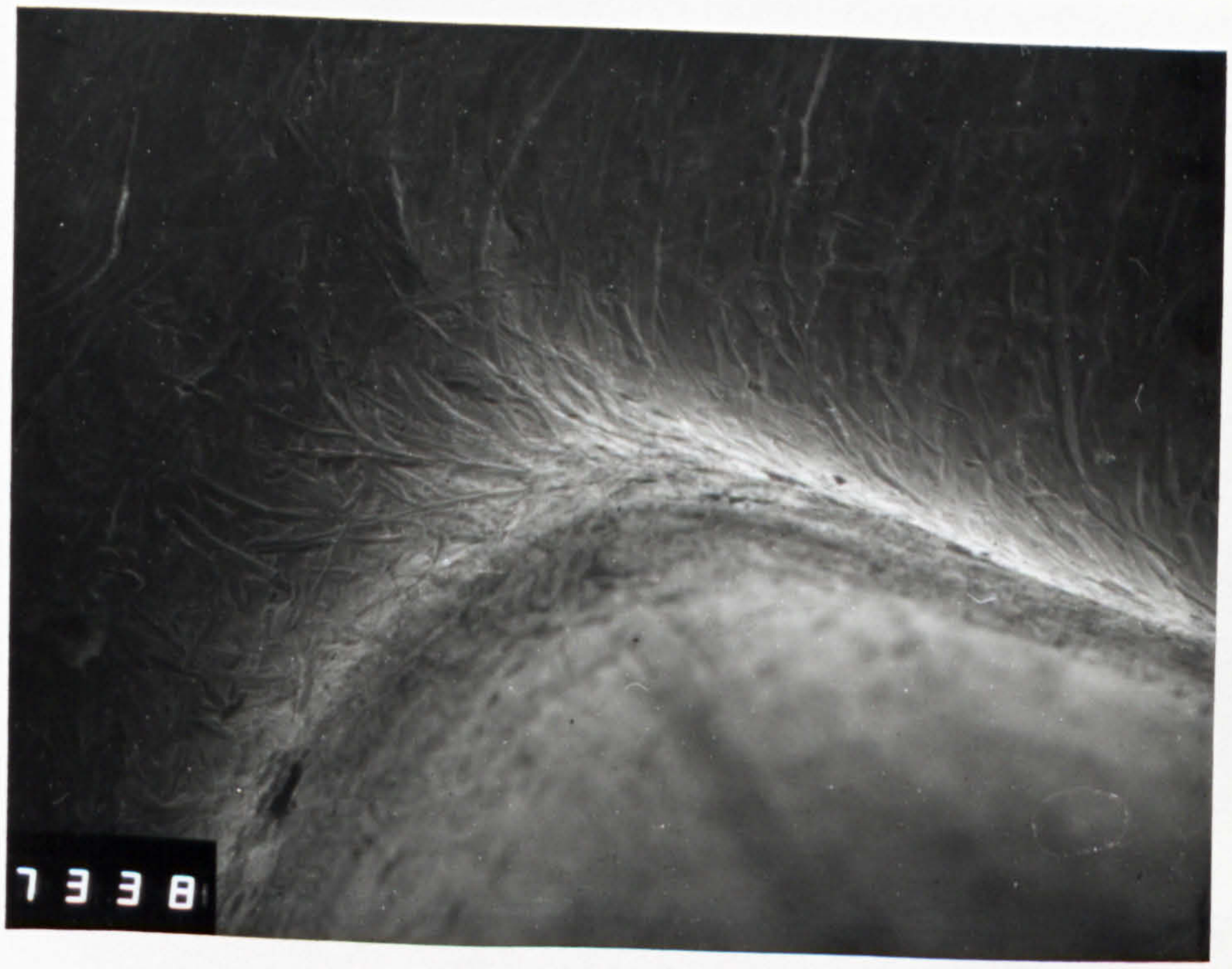

7338

Figure 28(a)* : The illustration of an inclusion contained within the castle nut component after Abrasive Flow Machining has been performed.

x 300

Figure 28(b)* : The illustration of a void on the surface of the castle nut component after Abrasive Flow Machining has been performed.

x 300

---

* both features illustrated cannot be removed without significantly affecting the component's dimensions and therefore show the limitations of the AFM process.

7341

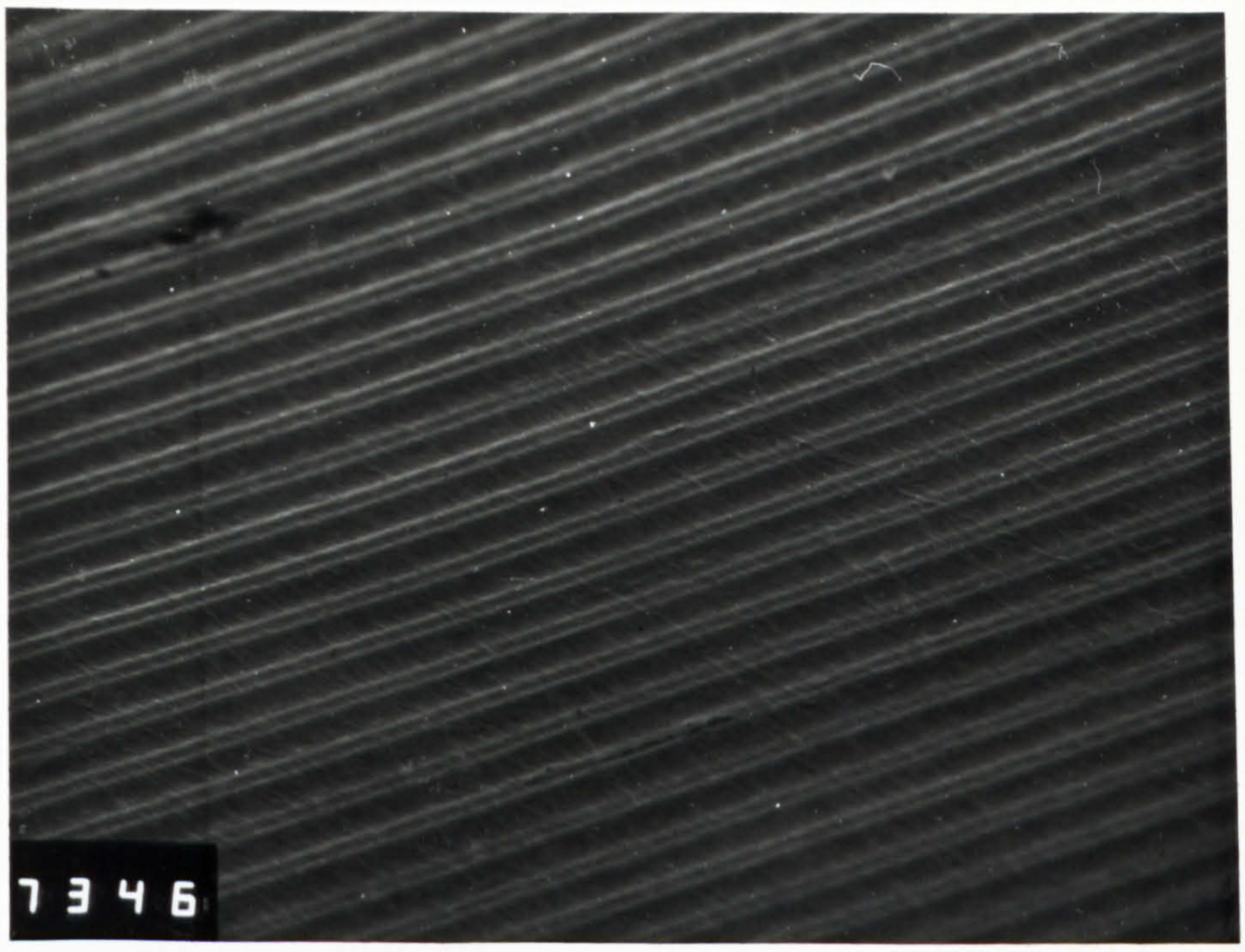
7345

Figure 29(a) : The illustration of the conventional machining marks on an inner spur surface of the castle nut component.

x 170

Figure 29(b) : The illustration of the selective machining performed on the outer spur surface of the identical spur as shown in figure 29(a).

x 140


7346

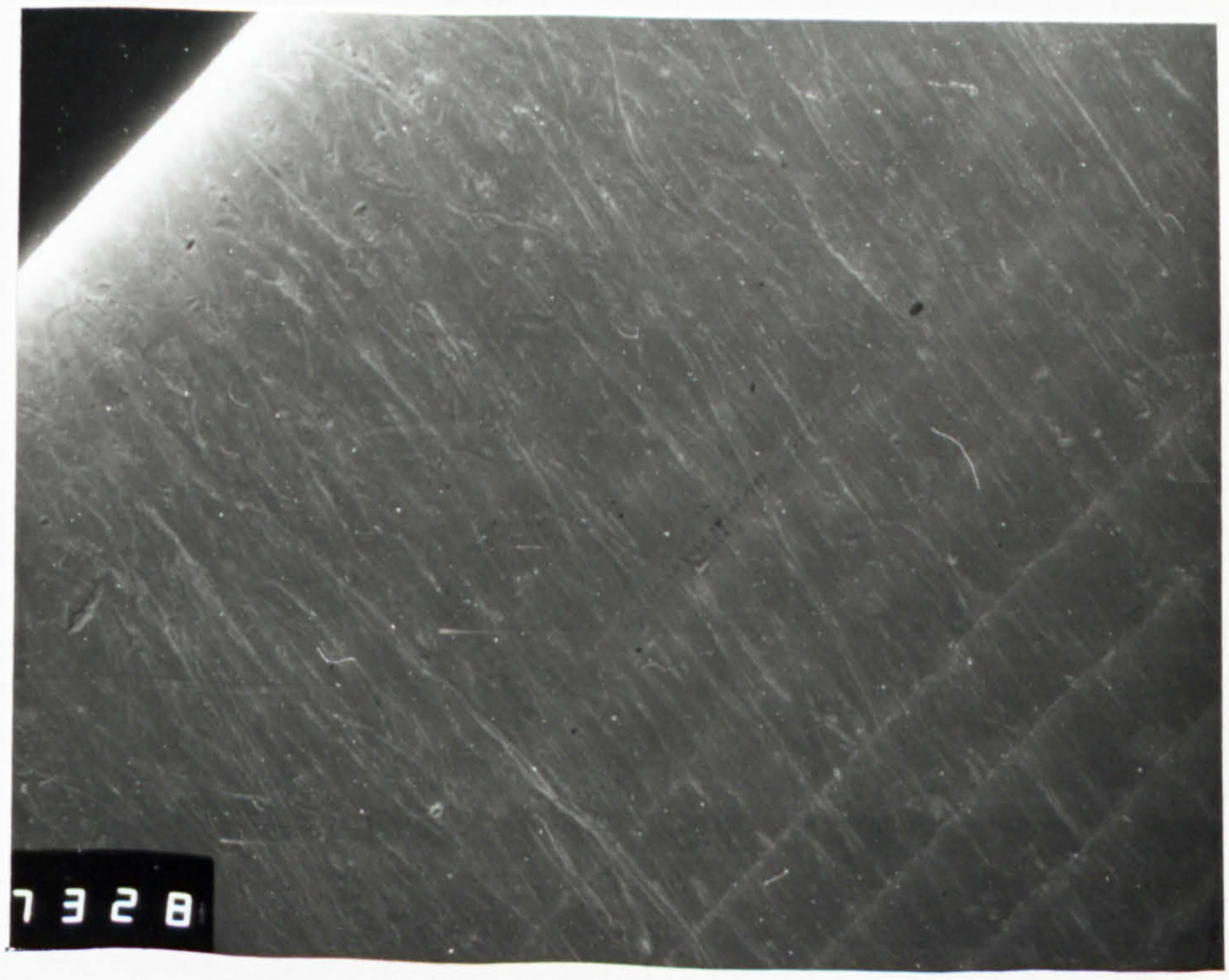

7328

Figure 30 : The illustration of the ploughing effect of the grit particles.

x 560

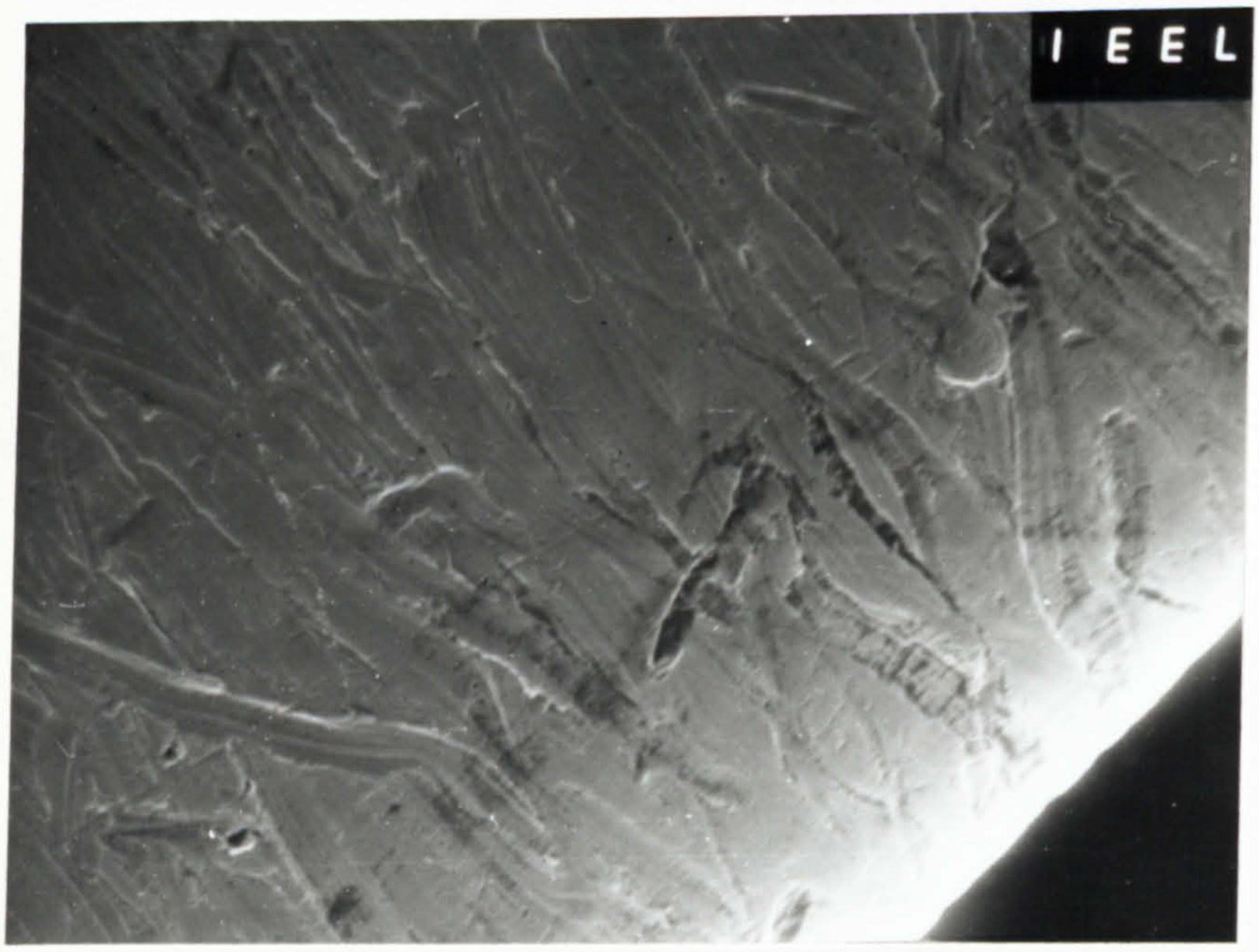
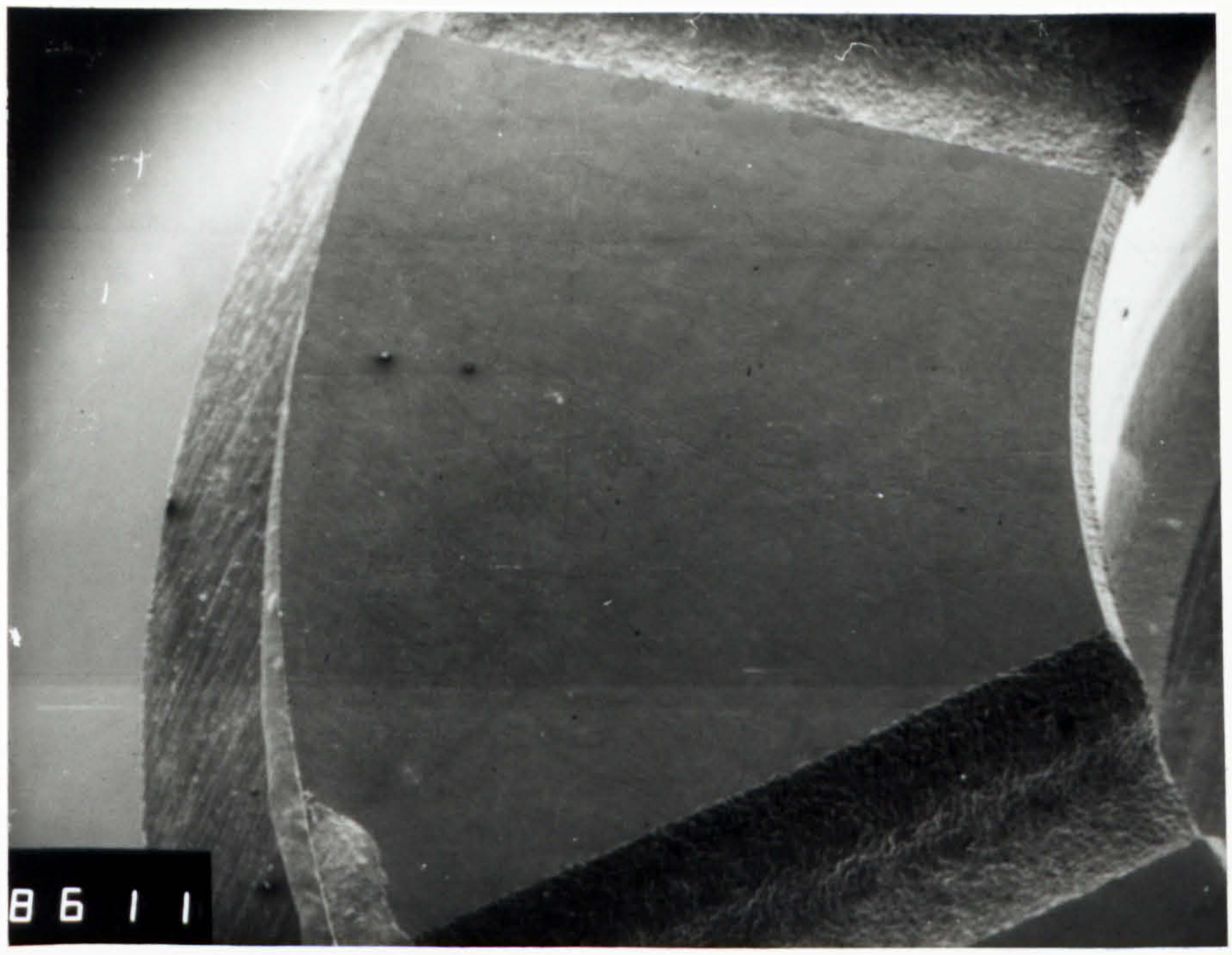

IEEL

Figure 31(a) : The illustration of the bearing component prior to AFM processing.

x 14.4

Figure 31(b) : The illustration of the bearing component after AFM processing.

x 12


8611

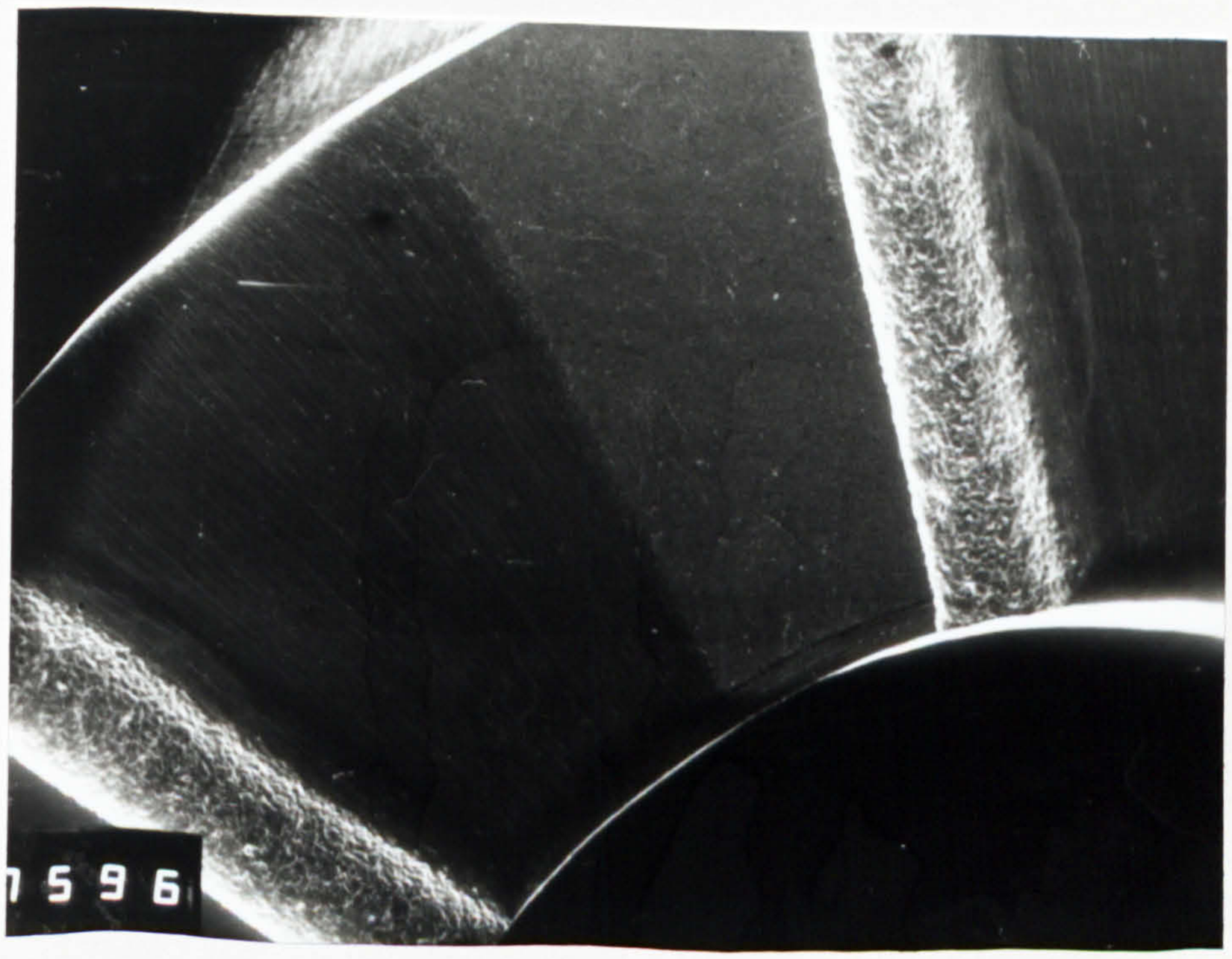
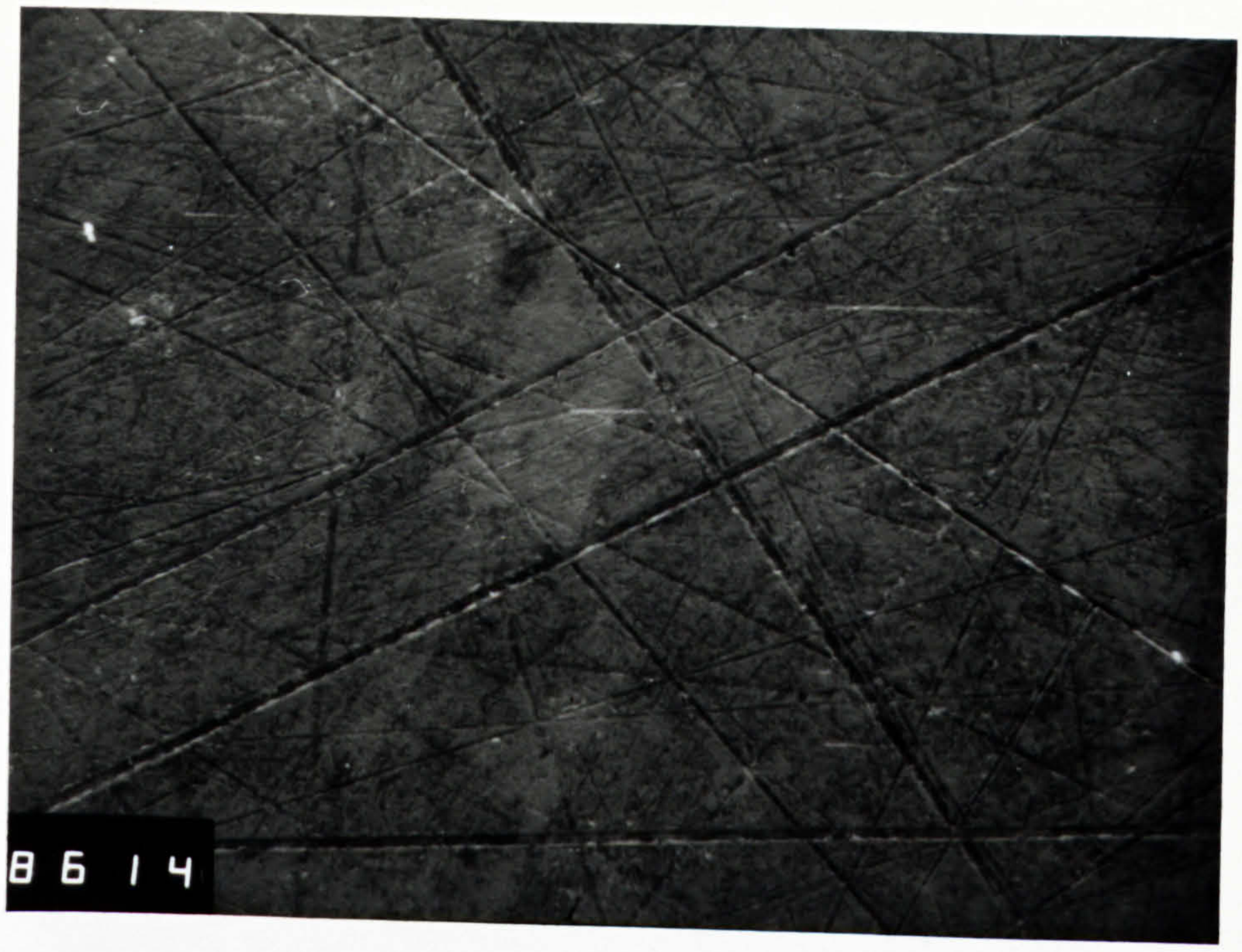

7596

Figure 32(a) : The illustration of the bearing component surface prior to machining showing a random surface pattern.

x 120

Figure 32(b) : The illustration of the bearing component surface after machining showing the characteristic uni-directional surface pattern generated by the AFM process.

x 95


8614

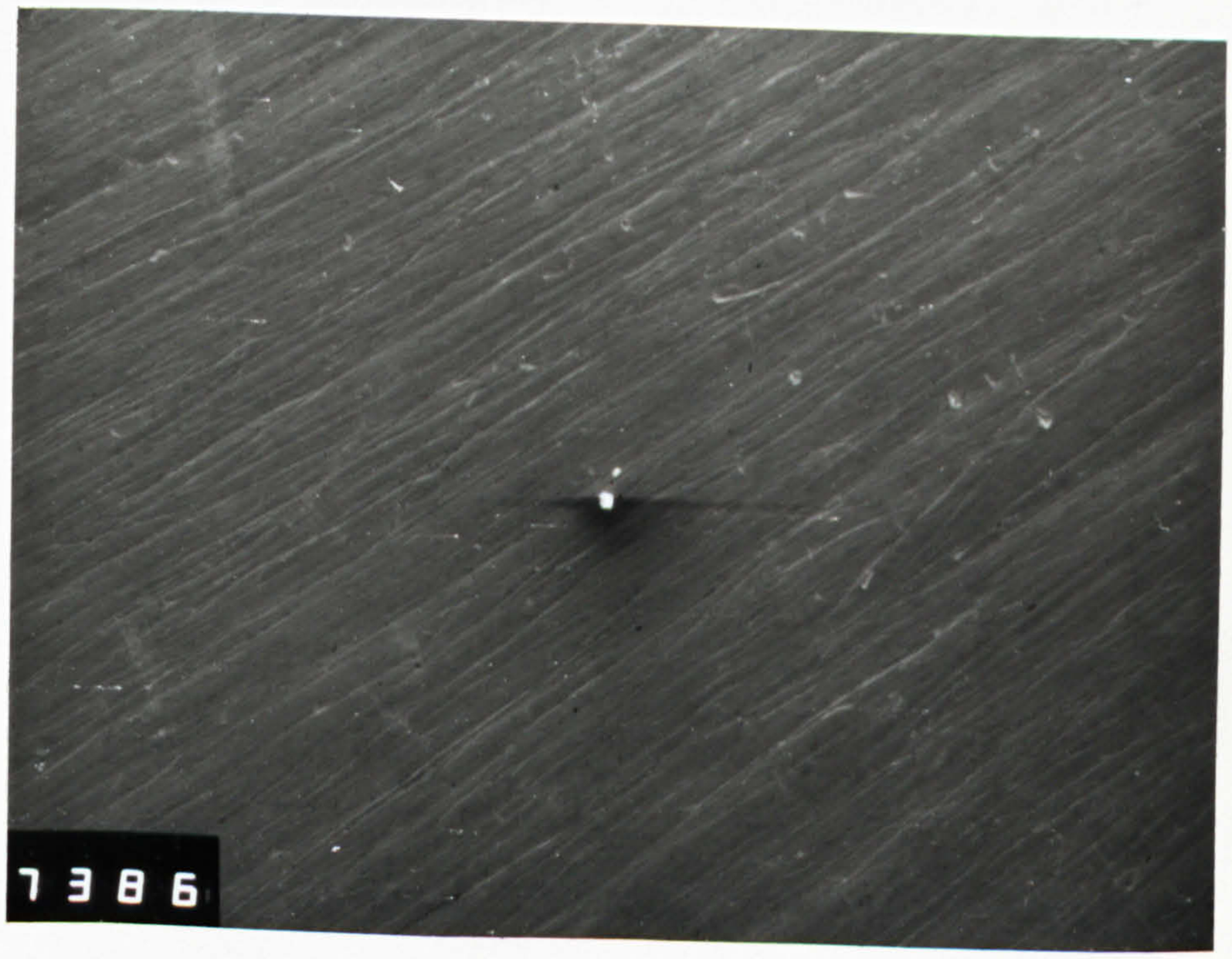

7386

Figure 33 : The illustration of the surfaces on either side of the AFM generated apex on the bearing component showing the selective machining achieved by the tooling.

x 200

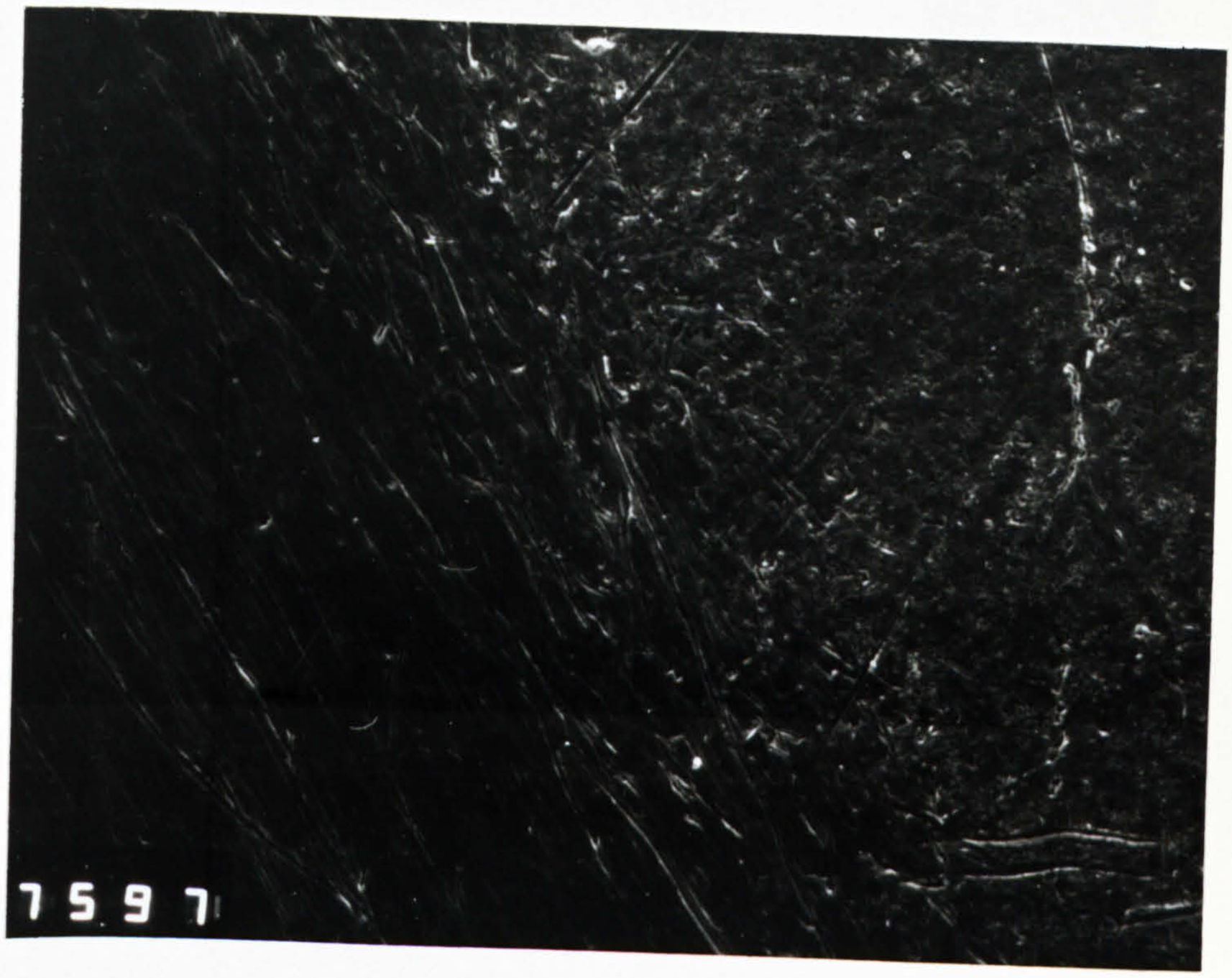
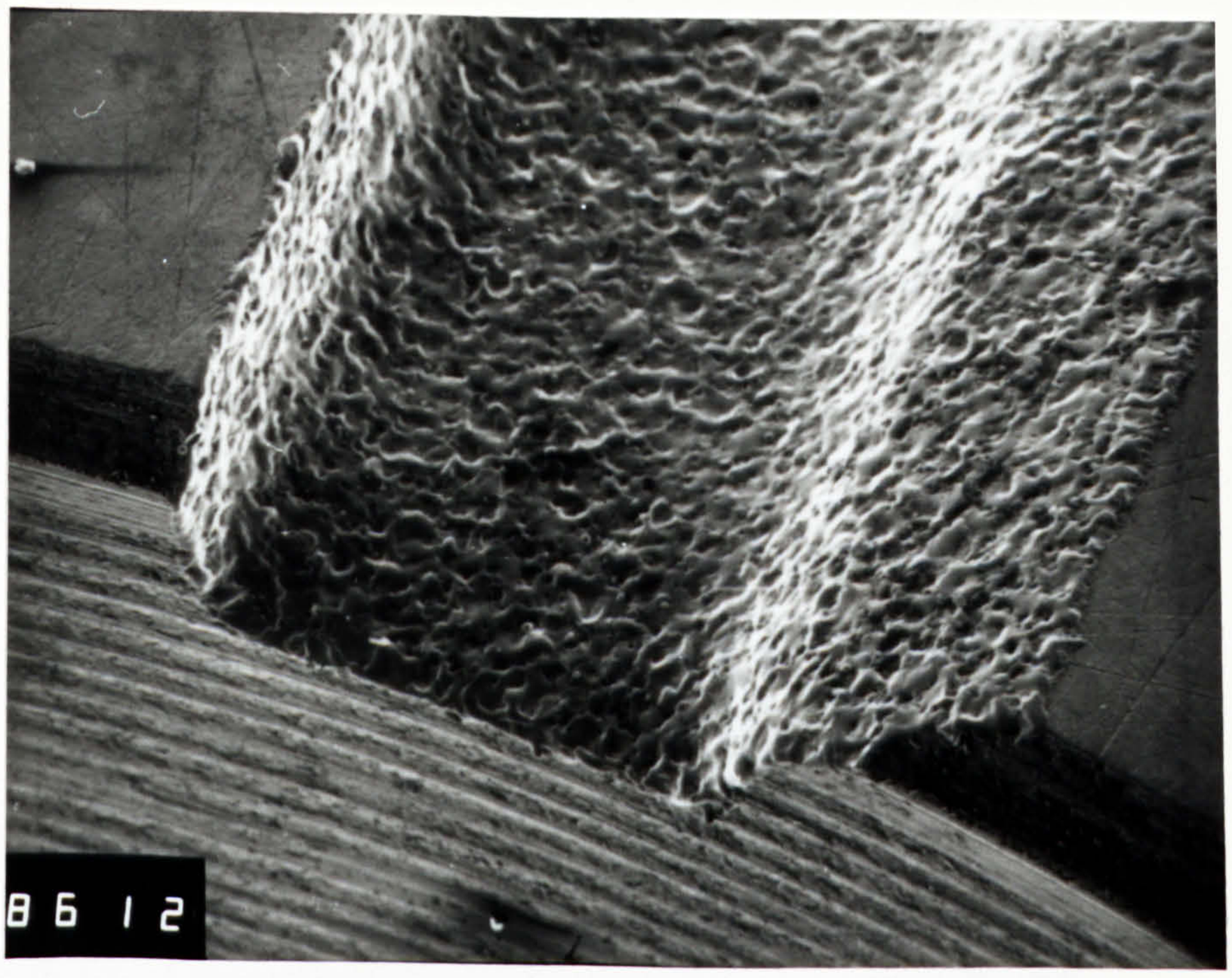

7597

Figure 34(a) : The illustration of one of the bearing component's channels before processing.

x 60

Figure 34(b) : The illustration of one of the channels after machining showing once more the selective machining achieved by the tooling.

x 47.5


8612

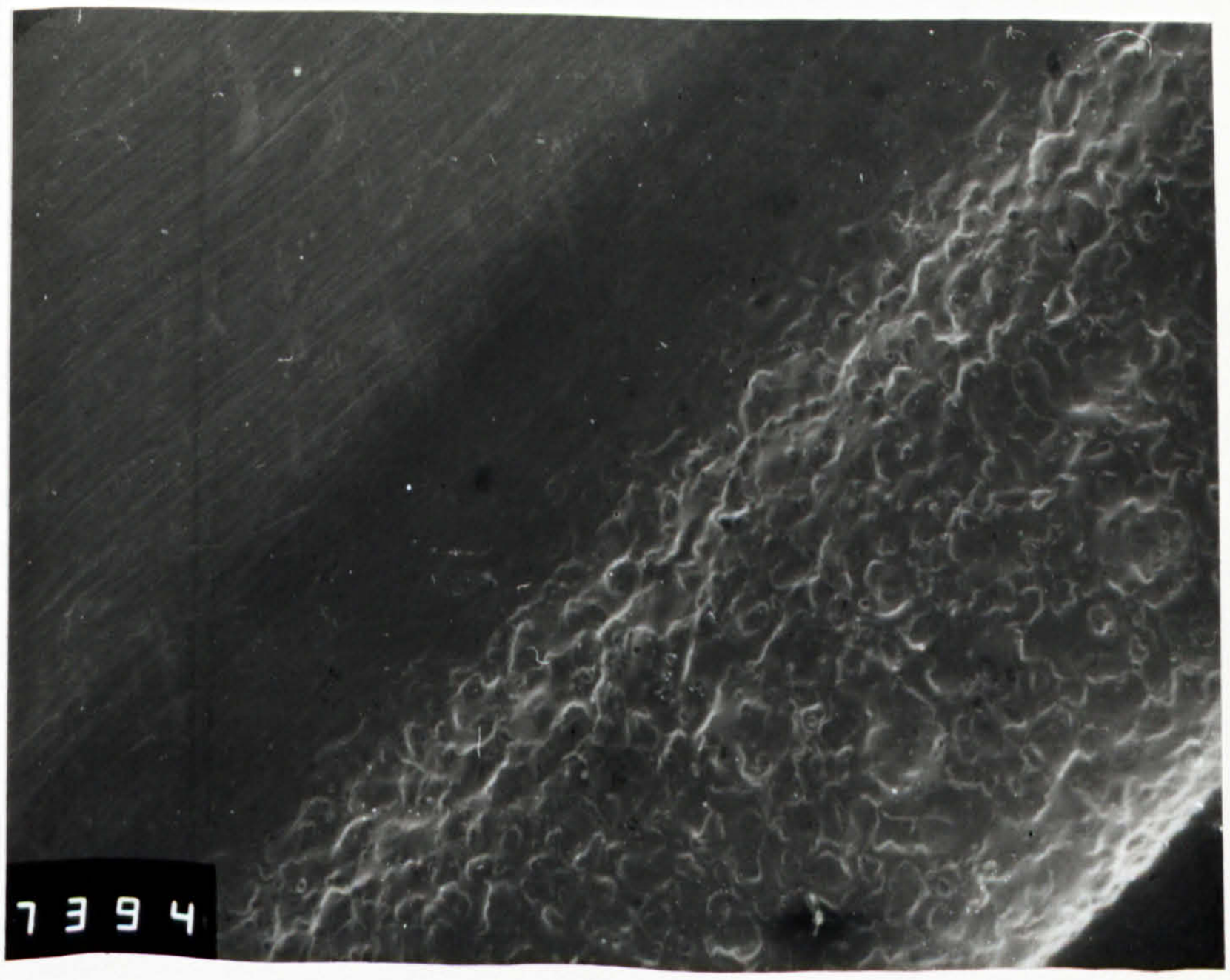

7394

Figure 35 : The relationship between the number of extrusion cycles and the change in die diameter using LMV medium and 60 Mesh SiC grit. The relationship between the medium reuse and the change in die diameter is also shown.

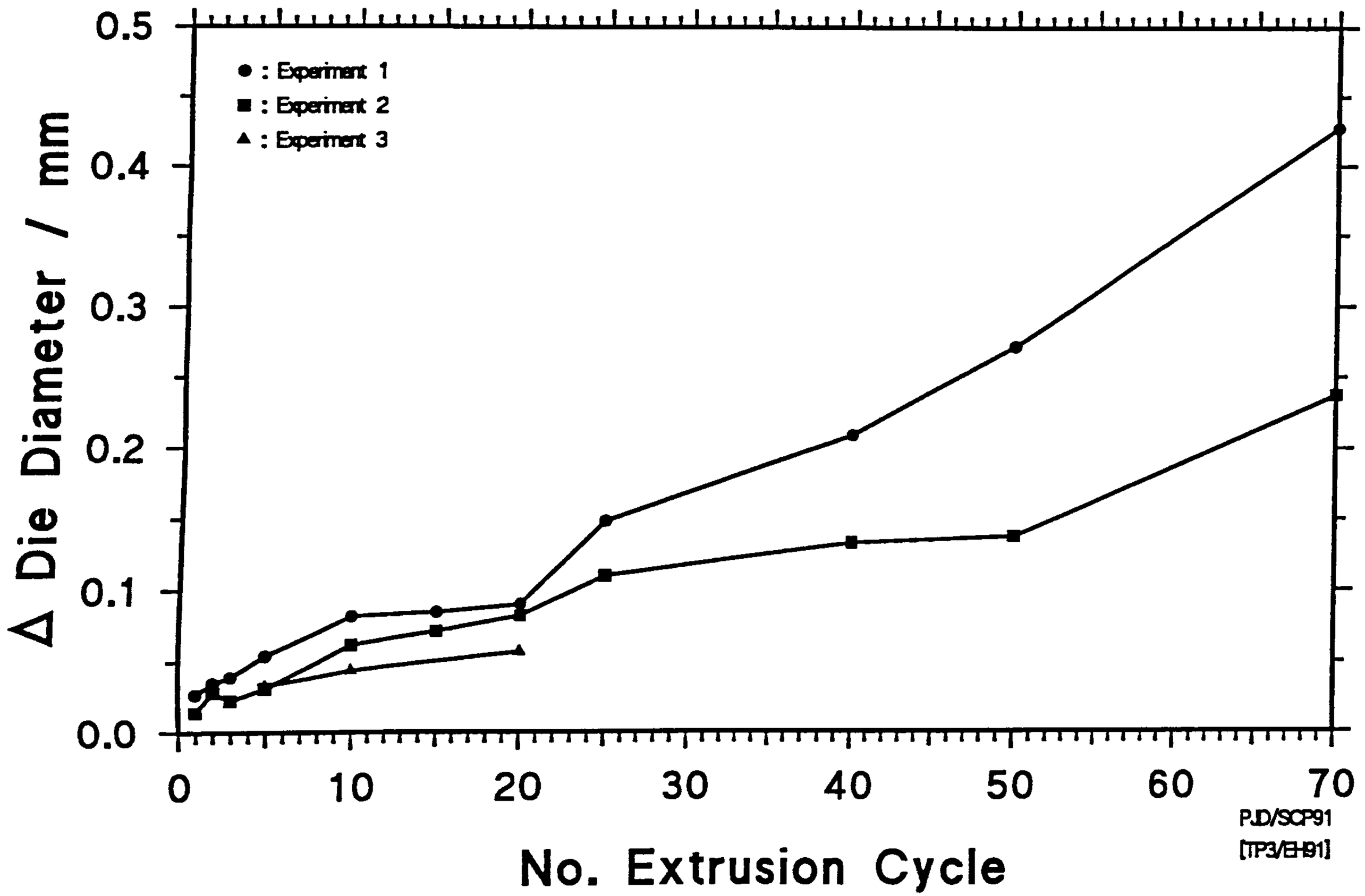

● : Experiment 1
■ : Experiment 2
▲ : Experiment 3
Δ Die Diameter / mm
0.0
0.1
0.2
0.3
0.4
0.5
0
10
20
30
40
50
60
70
No. Extrusion Cycle
PJD/SCP91
[TP3/EH91]

Figure 36 : The relationship between the number of extrusion cycles and the change in die mass using LMV medium and 60 Mesh SiC grit. The relationship between the medium reuse and the change in die mass is also shown.

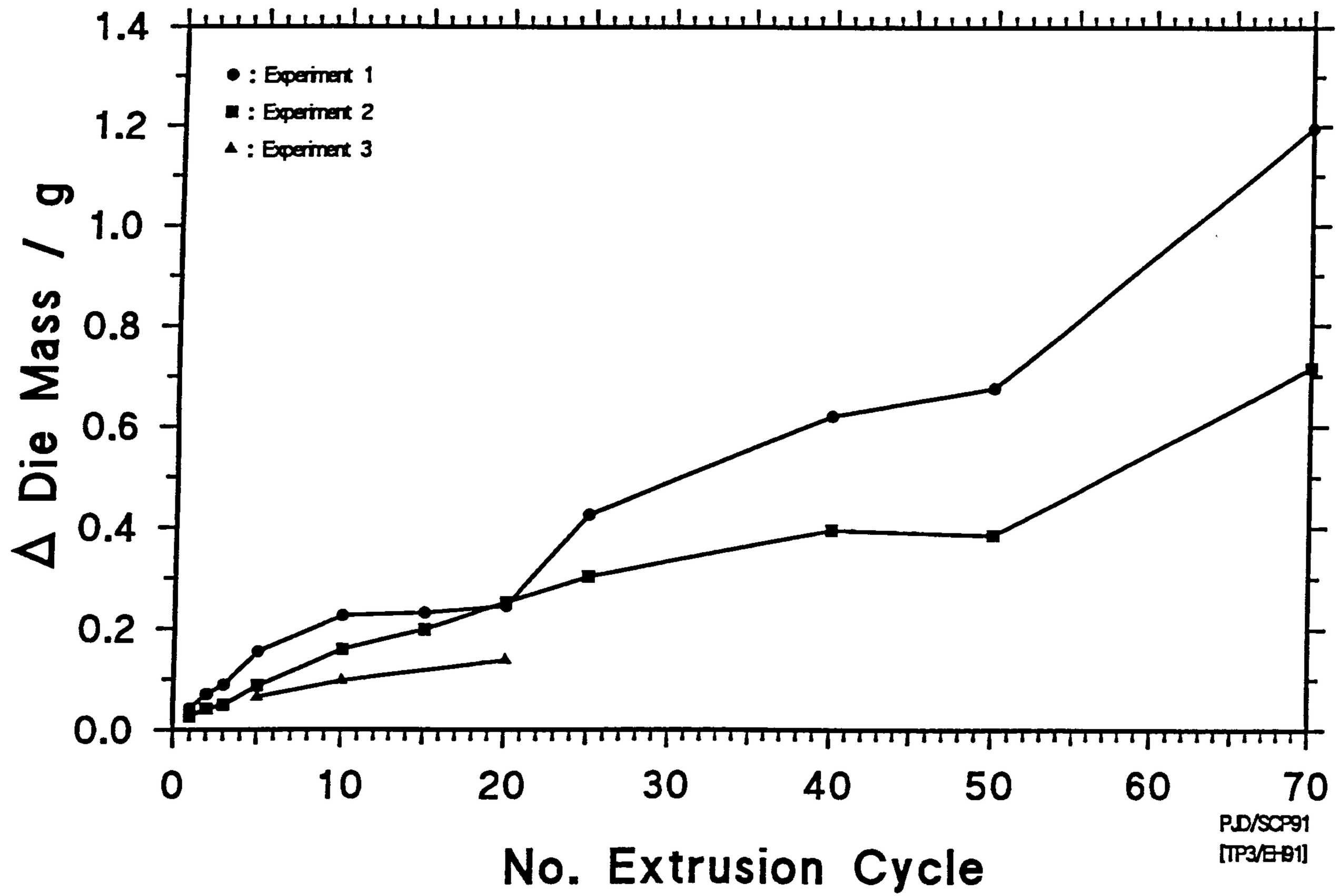

● : Experiment 1
■ : Experiment 2
▲ : Experiment 3
Δ Die Mass / g
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
60
70
No. Extrusion Cycle
PJD/SCP91
[TP3/EH-91]

Figure 37 : The relationship between the number of extrusion cycles and the surface roughness improvement using LMV medium and 60 Mesh SiC grit. The relationship between the medium reuse and the change in surface roughness improvement is also shown.

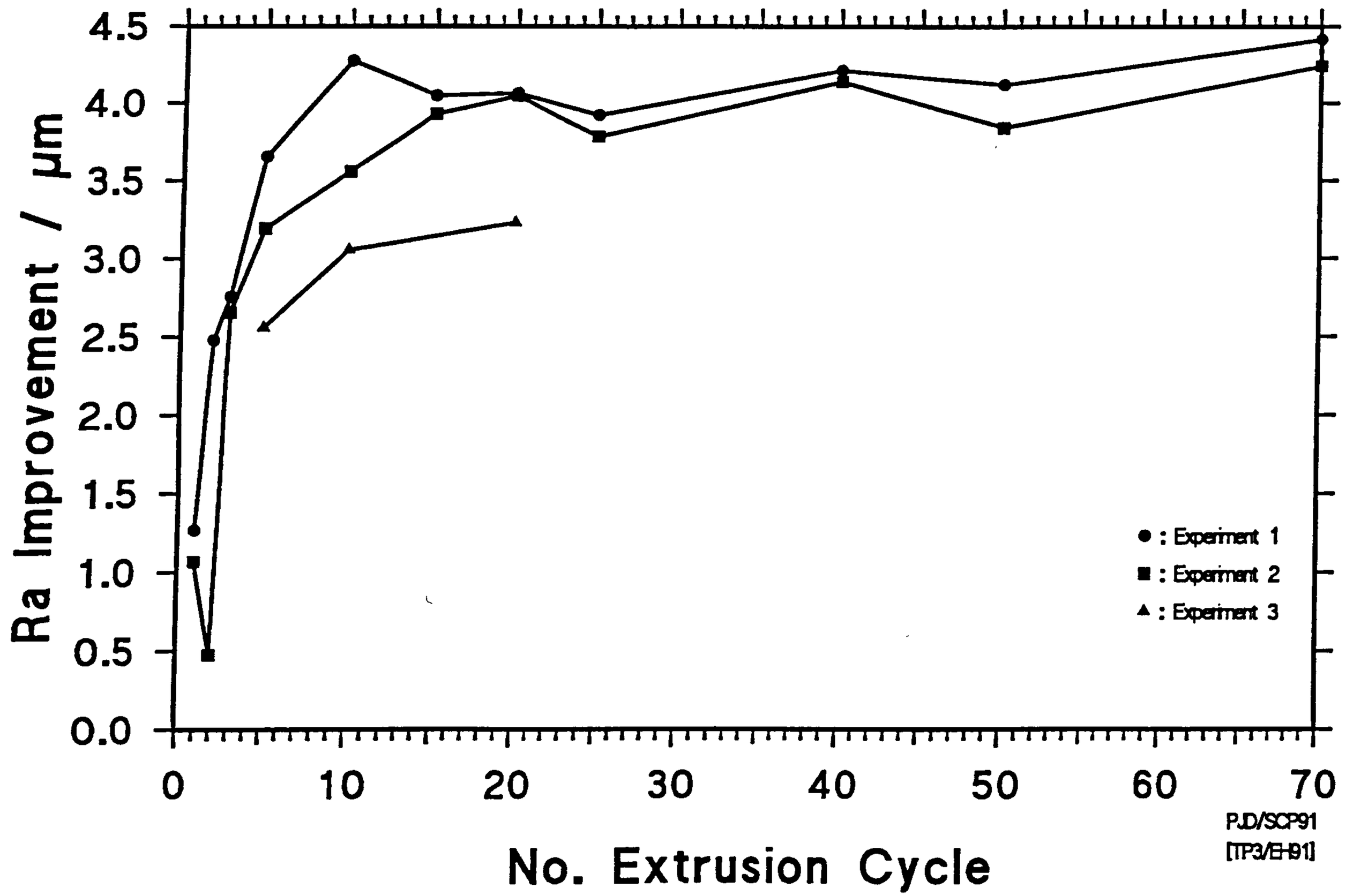
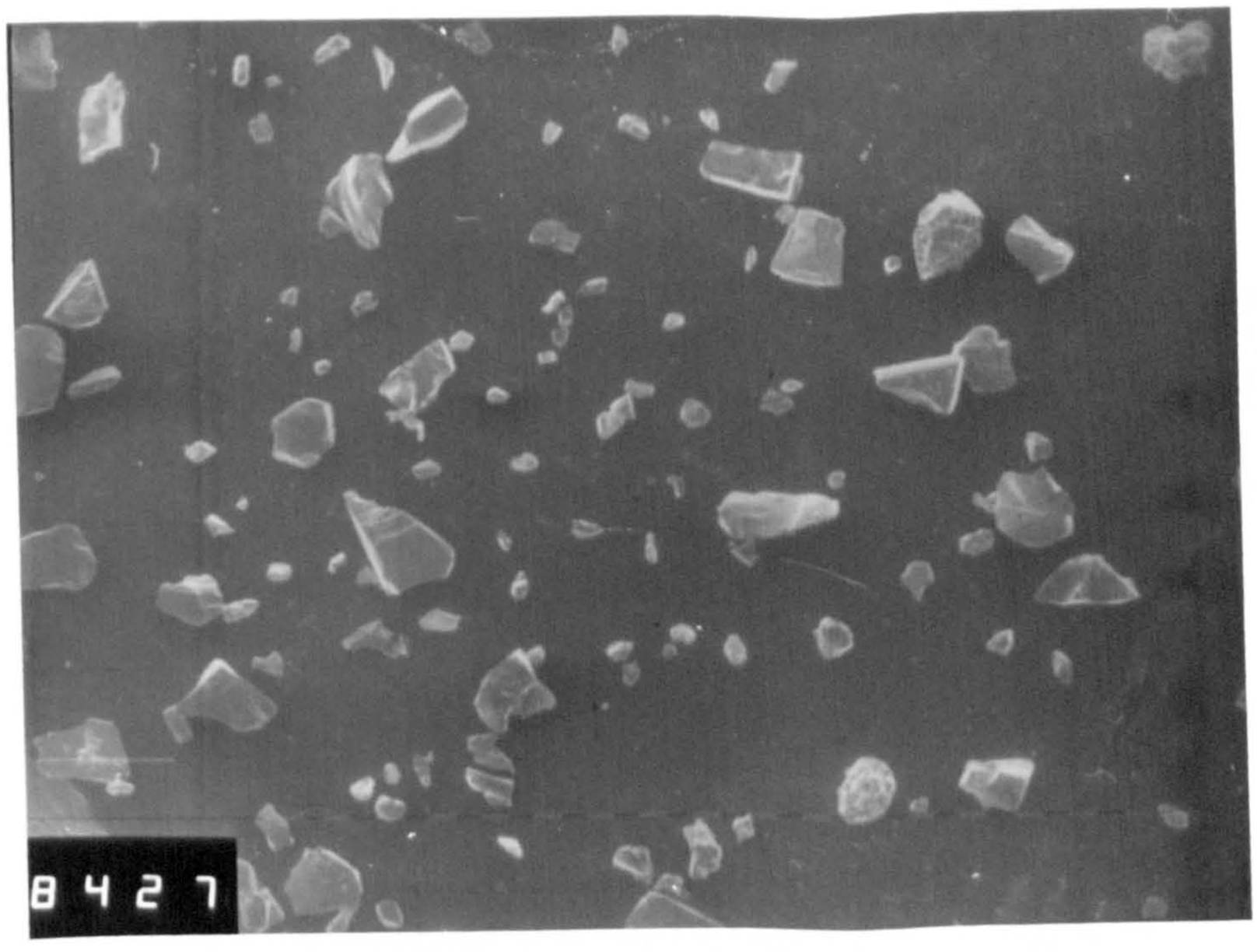

Ra Improvement / µm
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
No. Extrusion Cycle
● : Experiment 1
■ : Experiment 2
▲ : Experiment 3
PJD/SCP91
[TP3/EH91]

Figure 38(a) : Illustration of SiC grit that underwent 0 extrusion cycles.

x 16.25

Figure 38(b) : Illustration of SiC grit that underwent 1 extrusion cycle.

x 17.50


8427

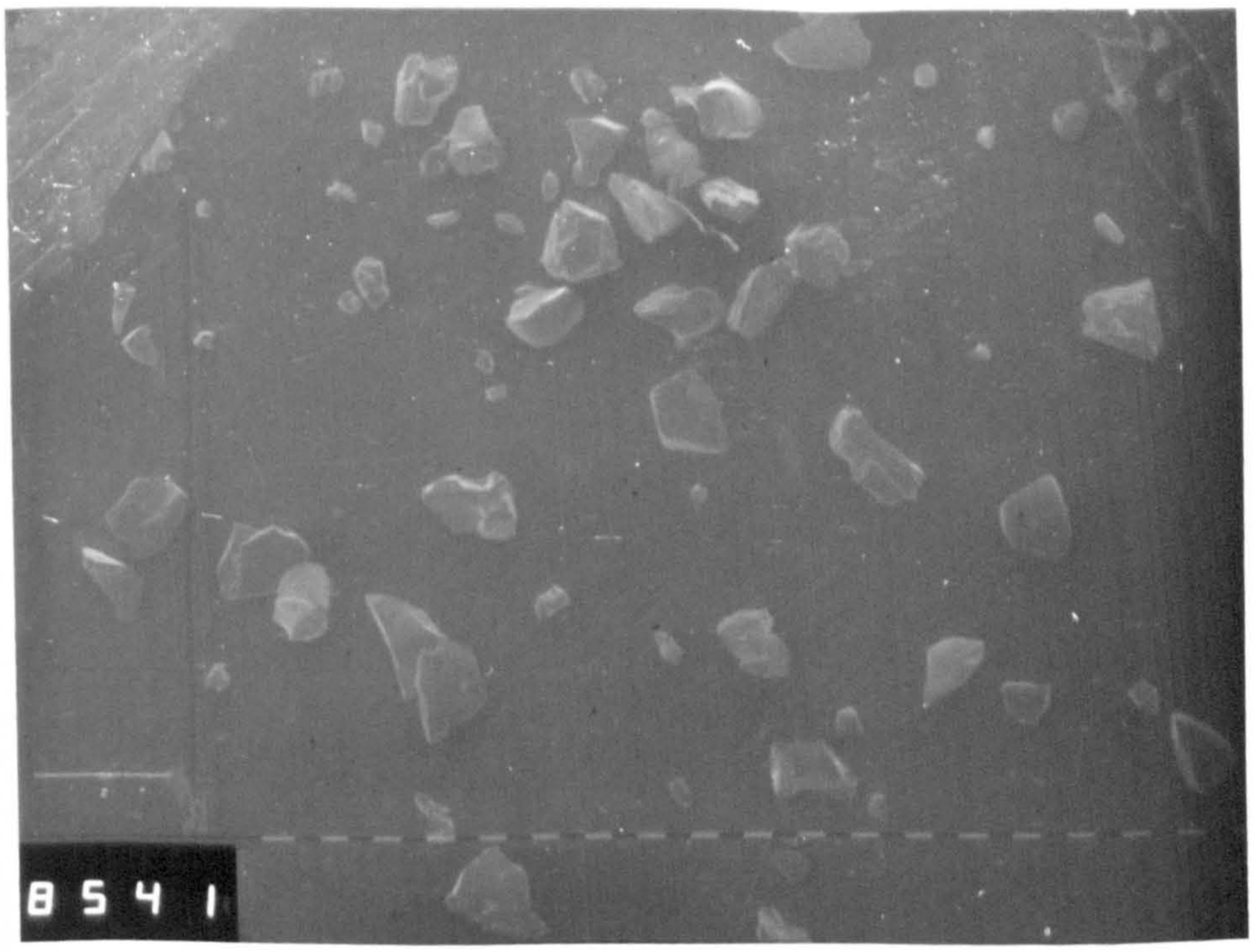
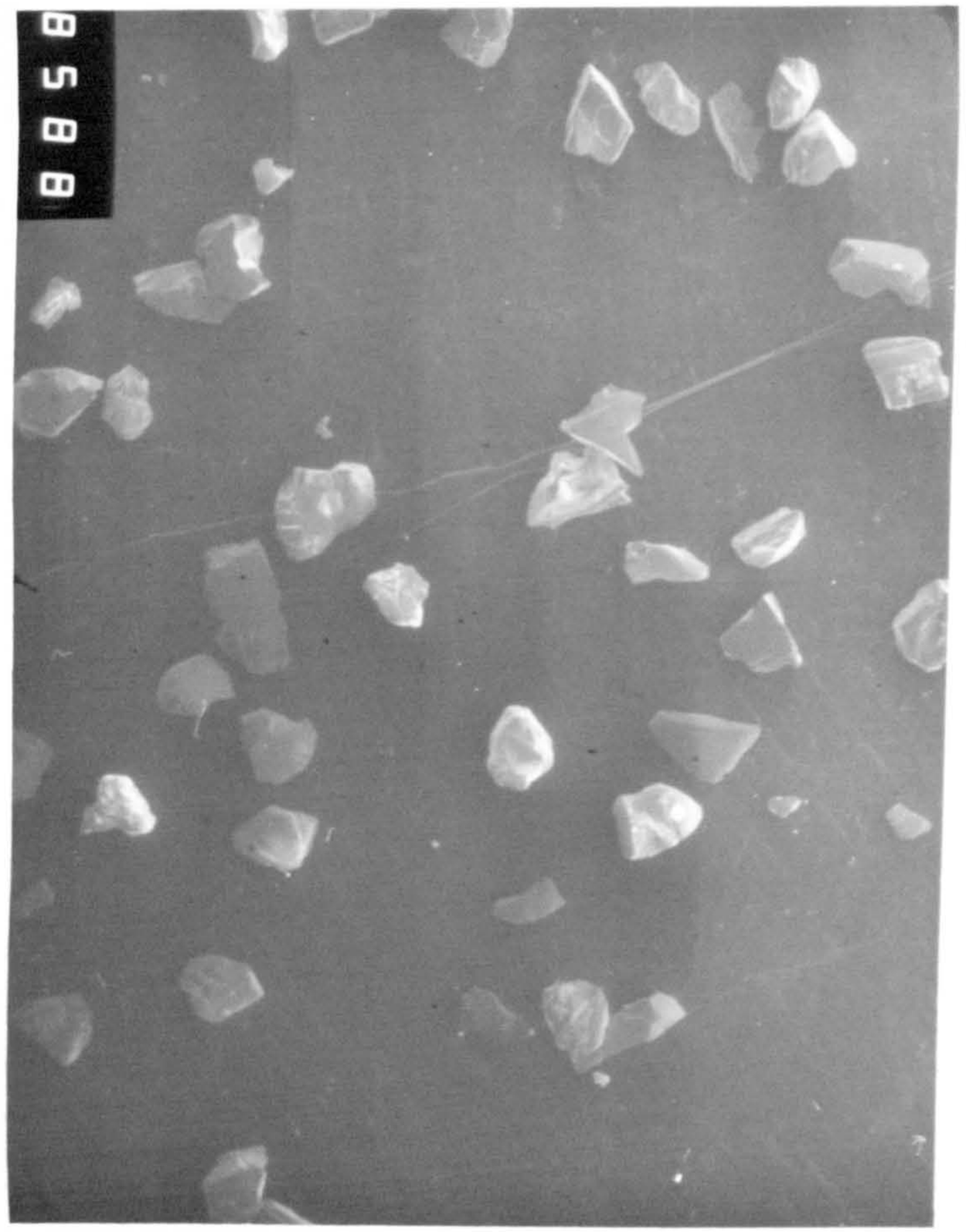

8541

Figure 38(c) : Illustration of SiC grit that underwent 7 extrusion cycles.

x 18.75

Figure 38(d) : Illustration of SiC grit that underwent 21 extrusion cycles.

x 18.75


8858

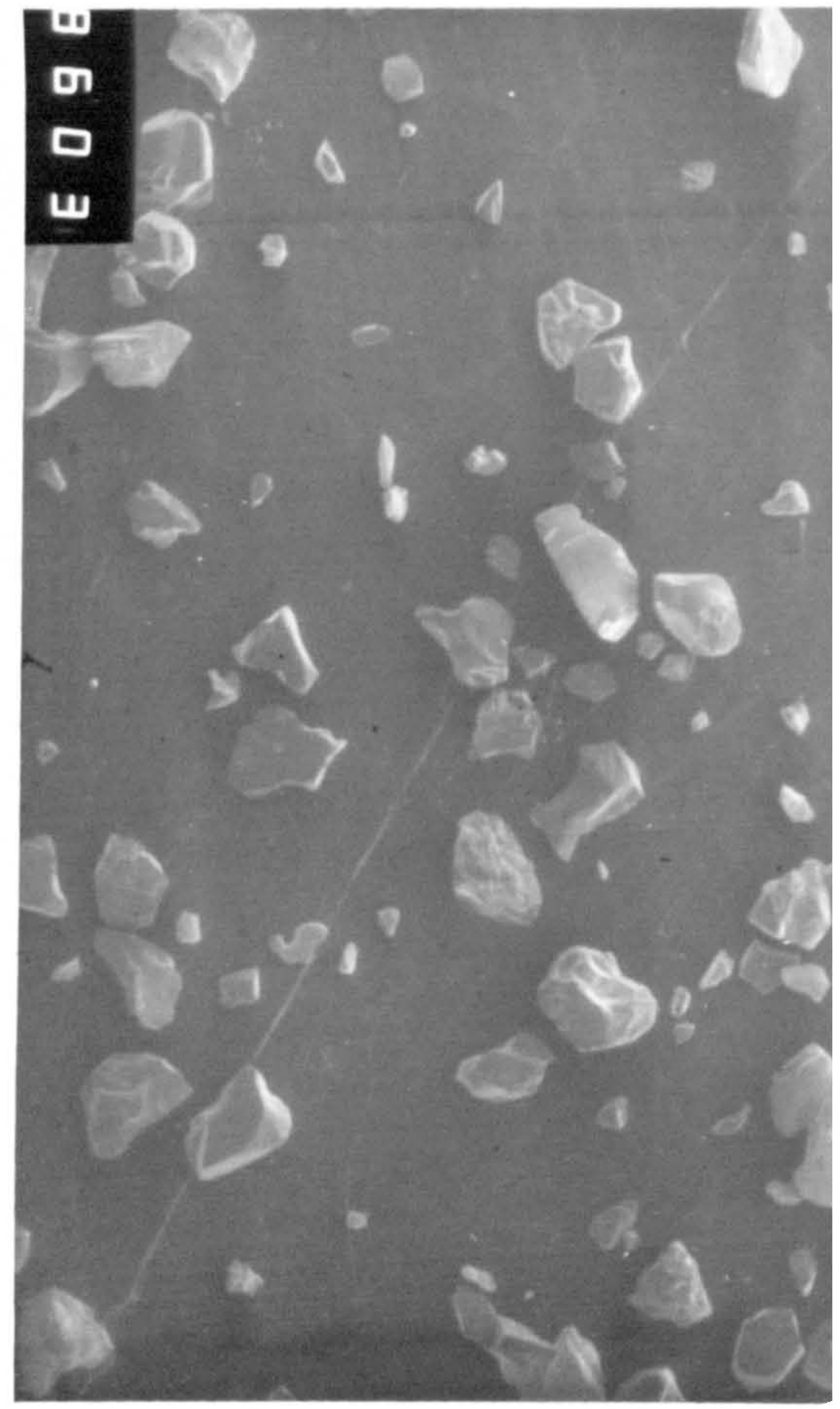
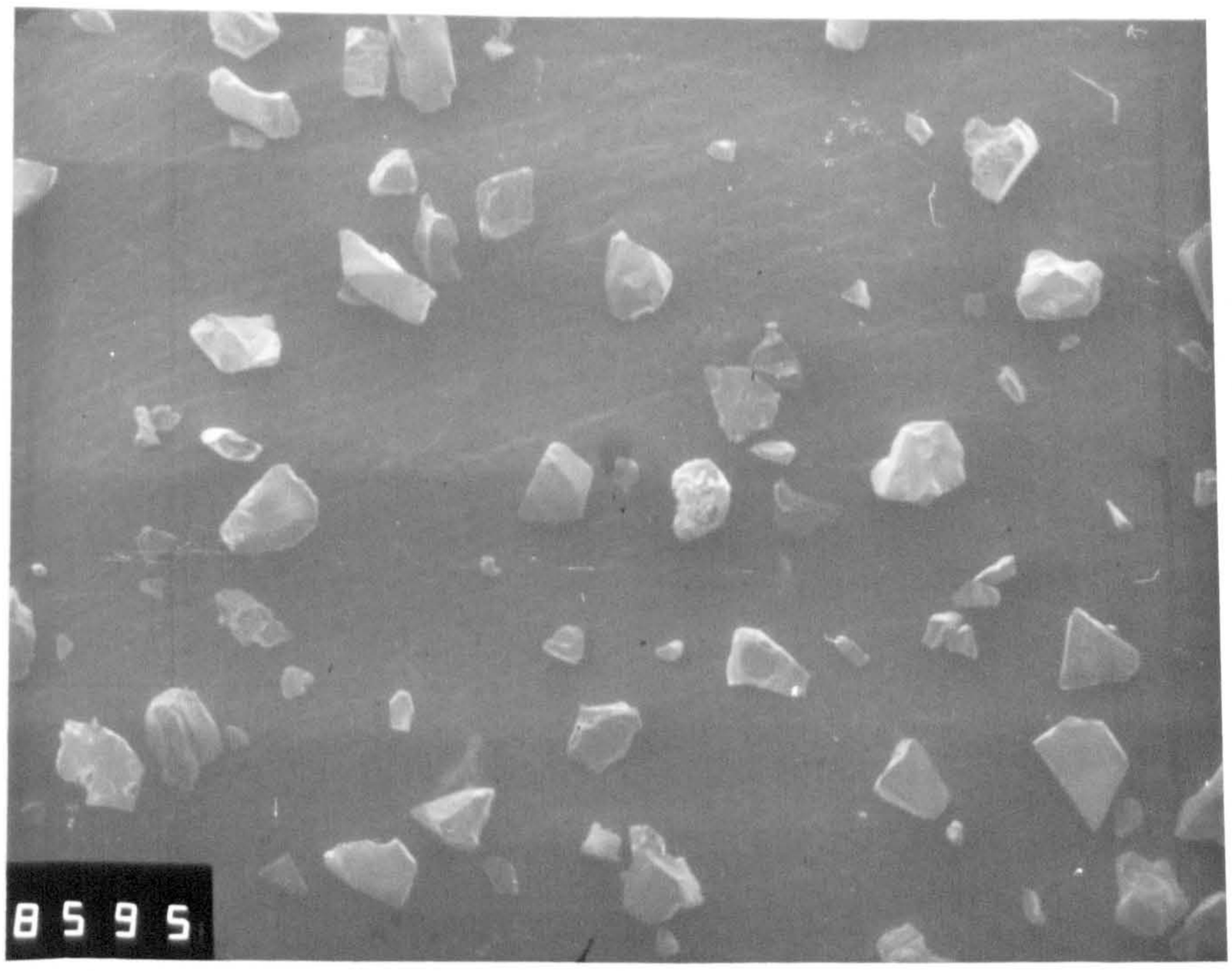

8603

Figure 38(e) : Illustration of SiC grit that underwent 46 extrusion cycles.

x 18.75

Figure 38(f) : Illustration of SiC grit that underwent 91 extrusion cycles.

x 20


8595

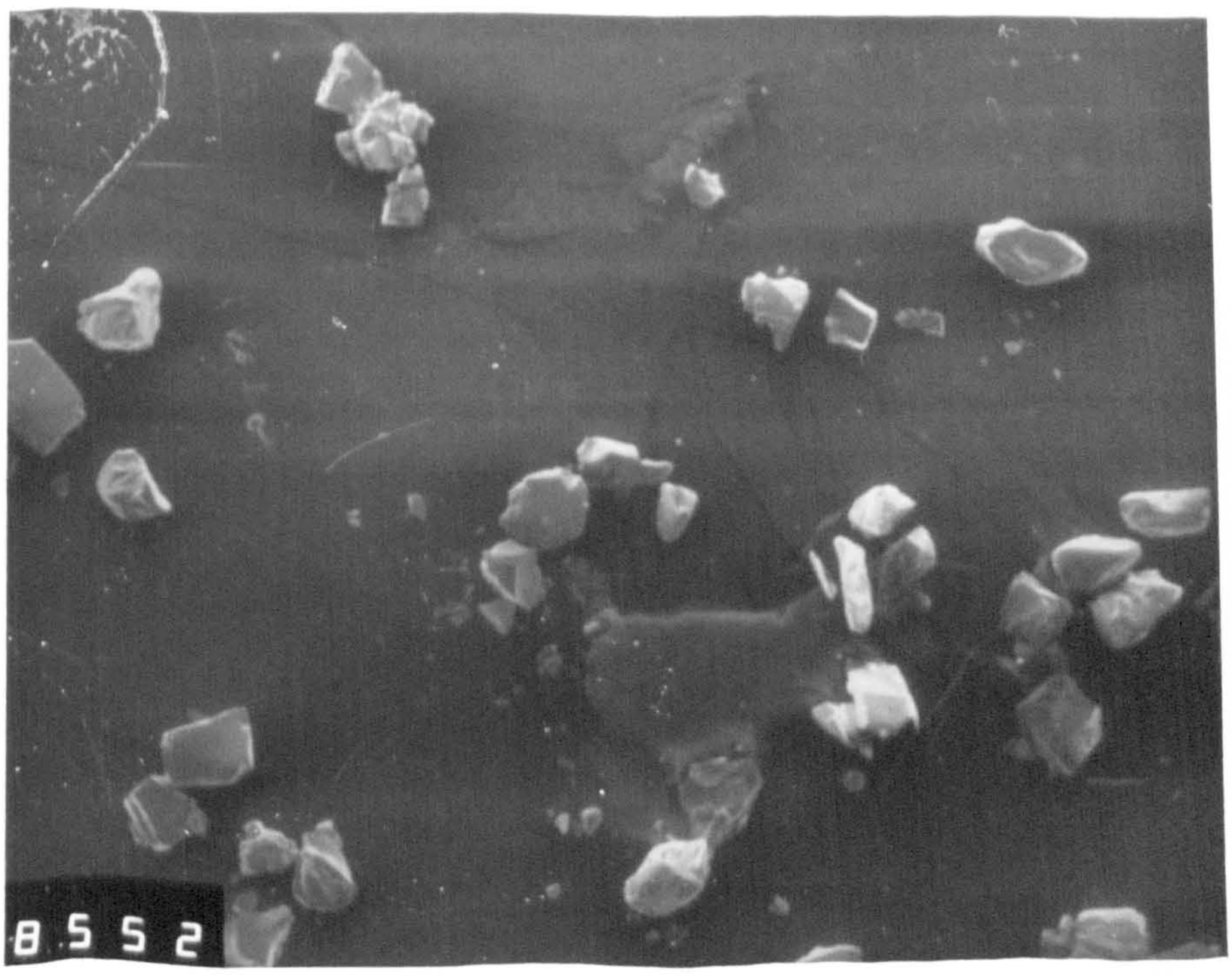

8552

Figure 39 : A graph illustrating the results from the sieve analysis conducted on fresh and exhausted SiC grit.

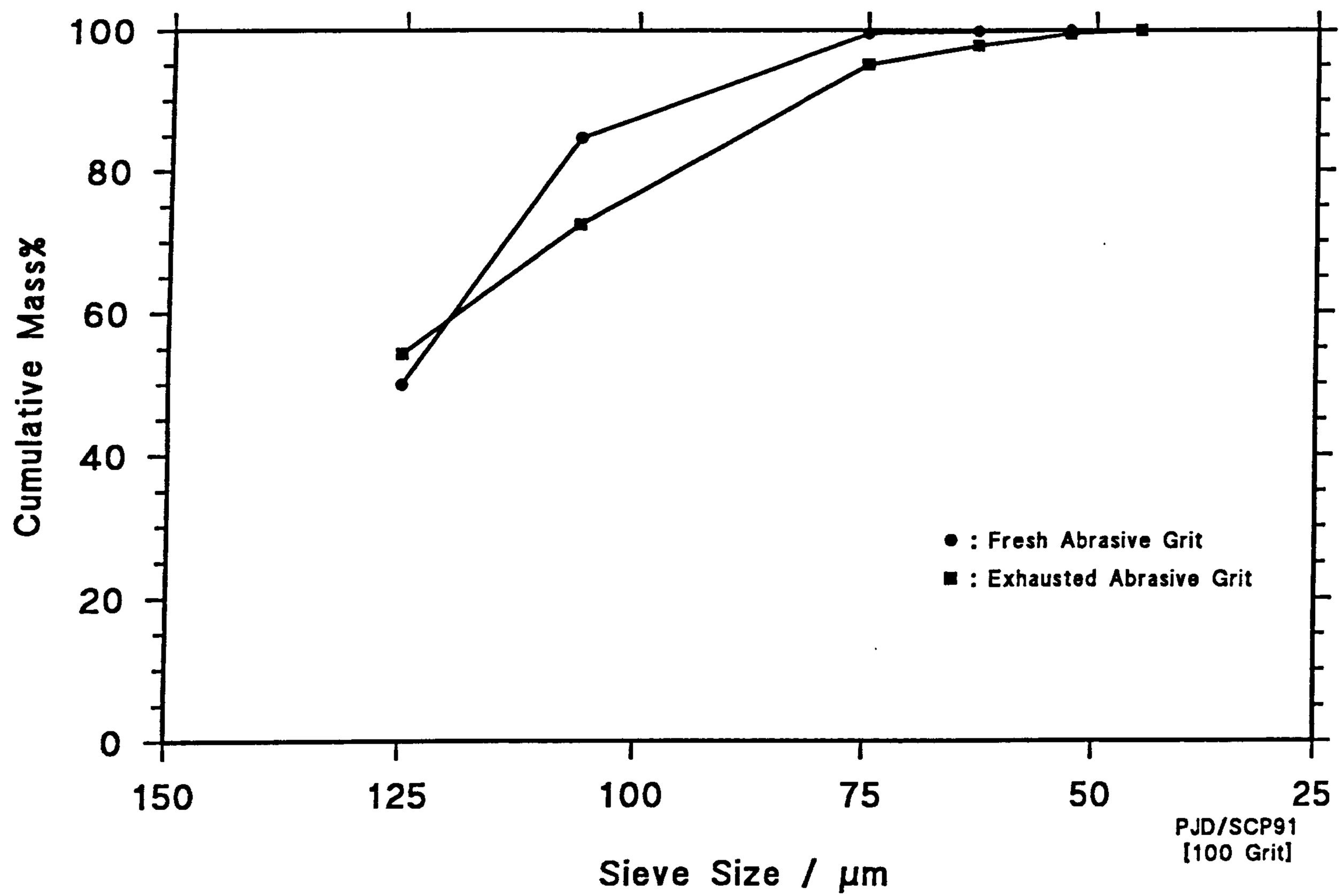
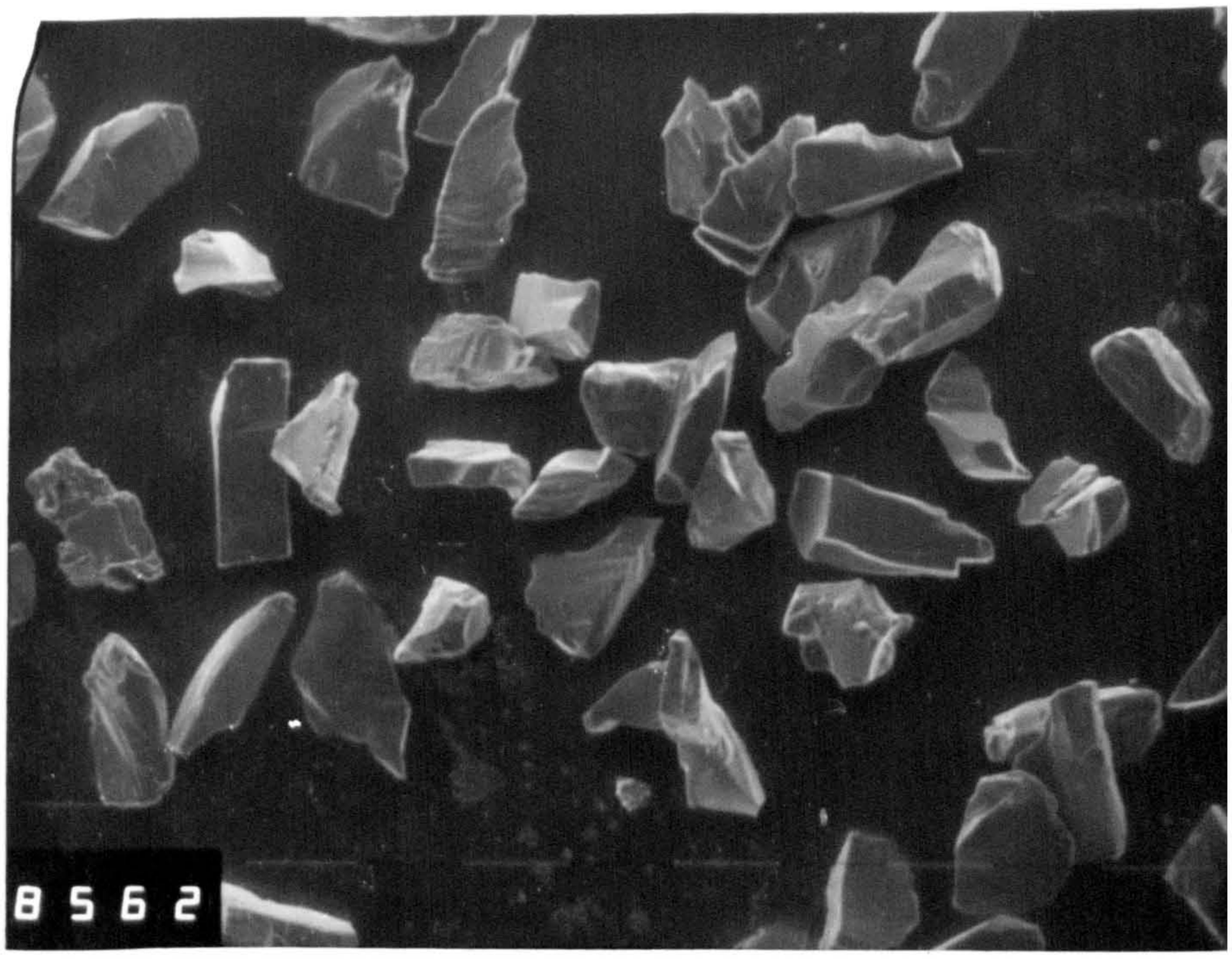
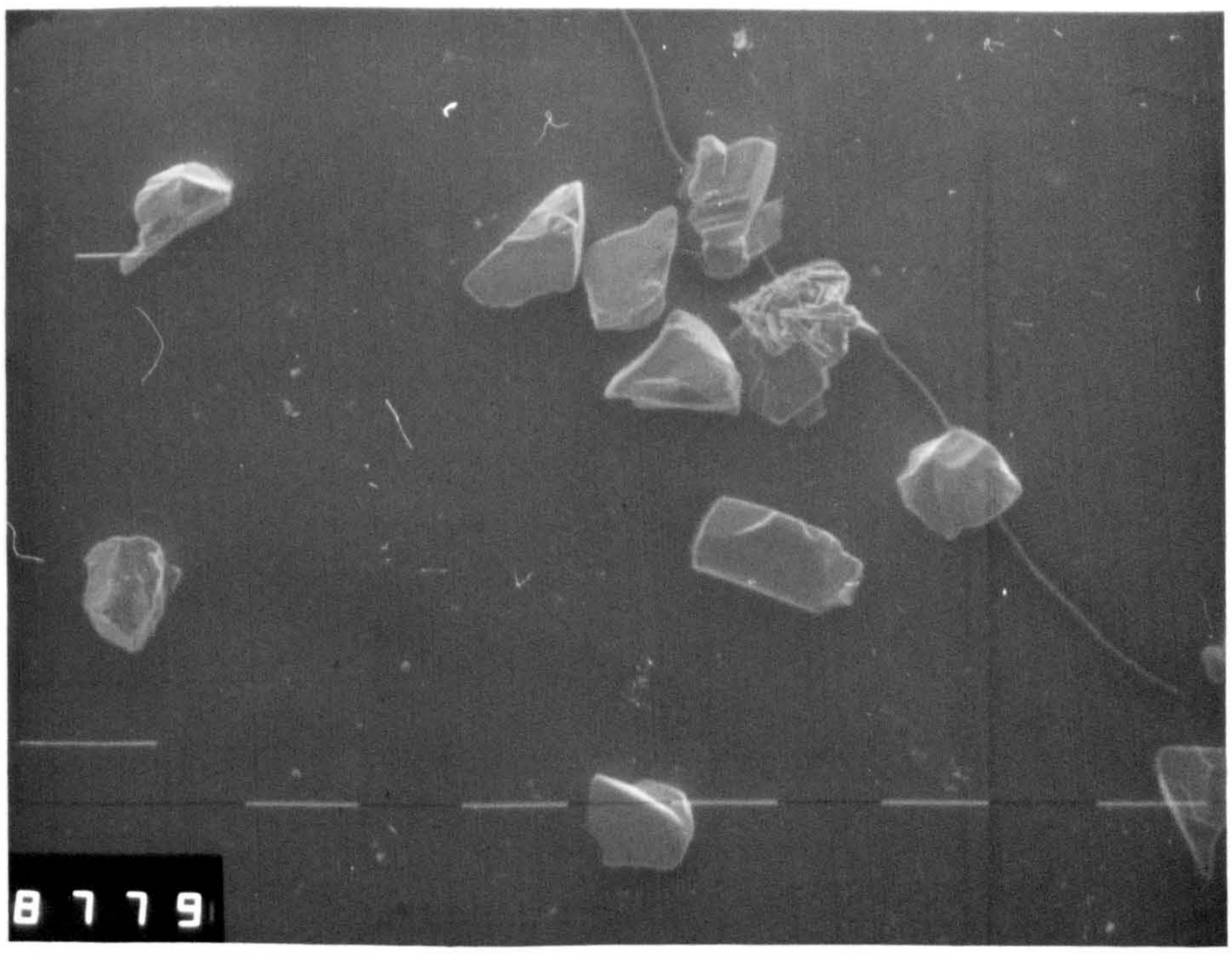

100
80
60
40
20
0
Cumulative Mass%
150
125
100
75
50
25
Sieve Size / µm
● : Fresh Abrasive Grit
■ : Exhausted Abrasive Grit
PJD/SCP91
[100 Grit]

Figure 40(a) : The illustration of the grit particles retained on the 75μm sieve from the sieve analysis conducted on both the fresh and exhausted SiC grit.

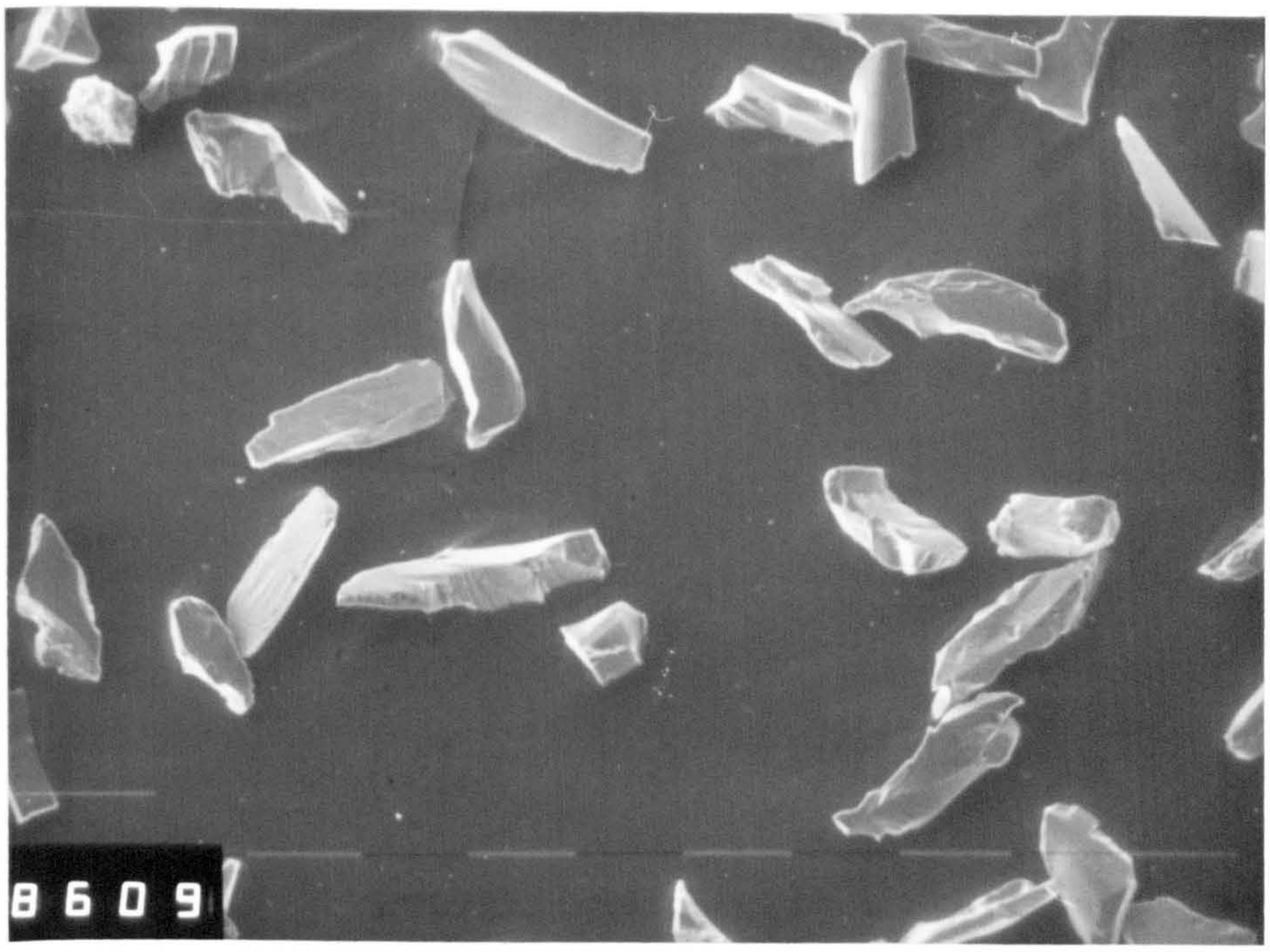


Fresh Grit x 75

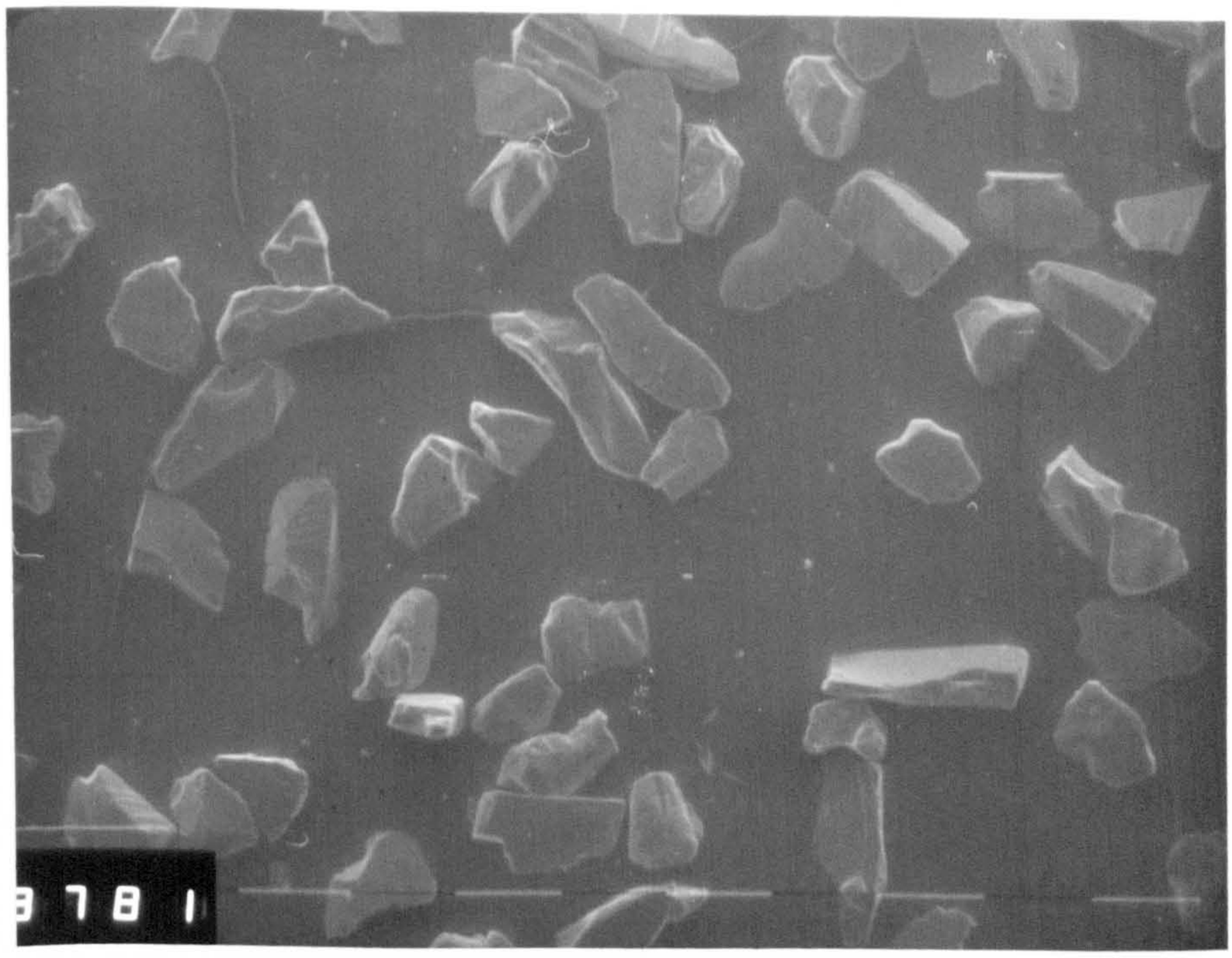


Exhausted Grit x 95

Figure 40(b) : The illustration of the grit particles retained on the 63μm sieve from the sieve analysis conducted on both the fresh and exhausted SiC grit.

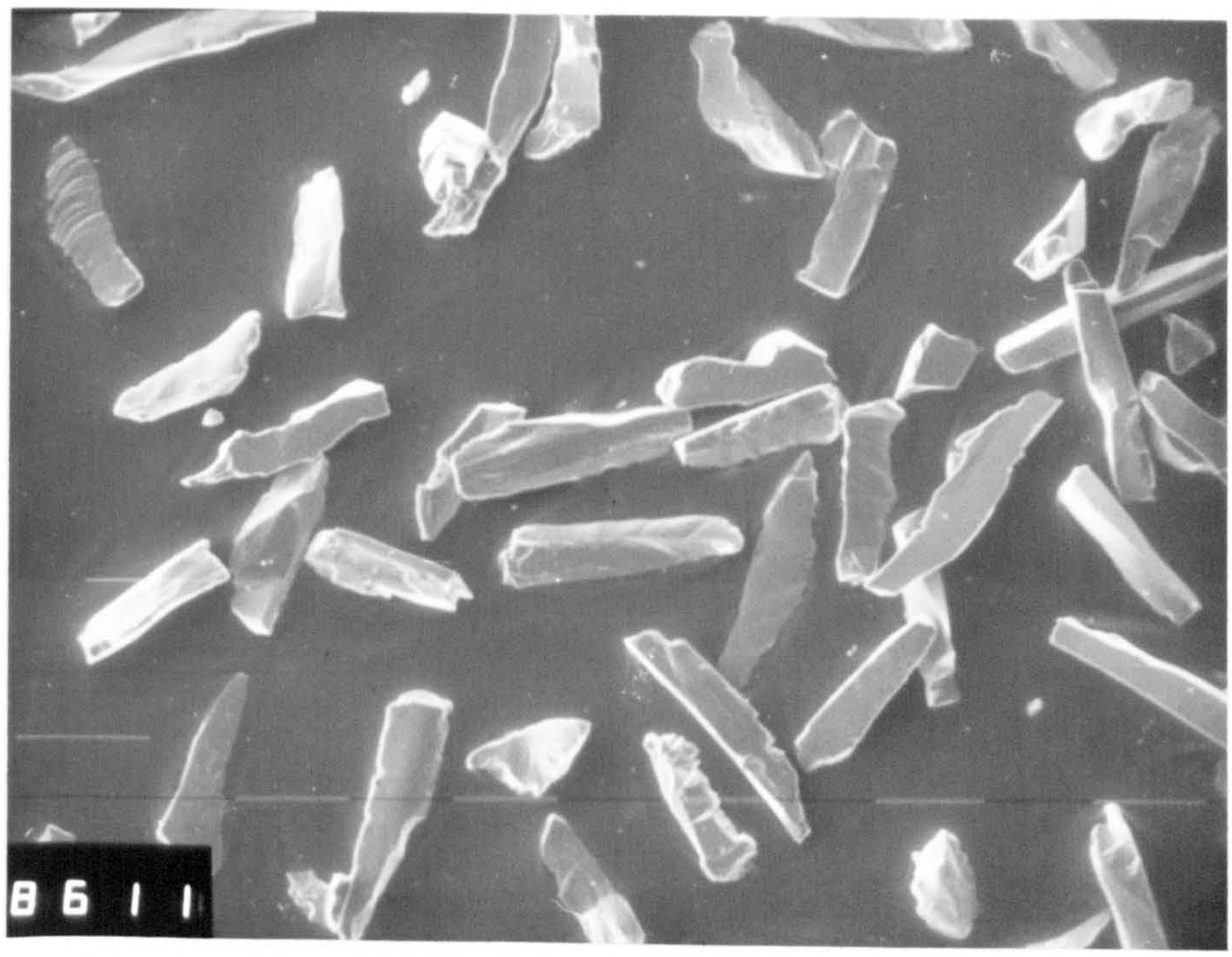


Fresh Grit x 75

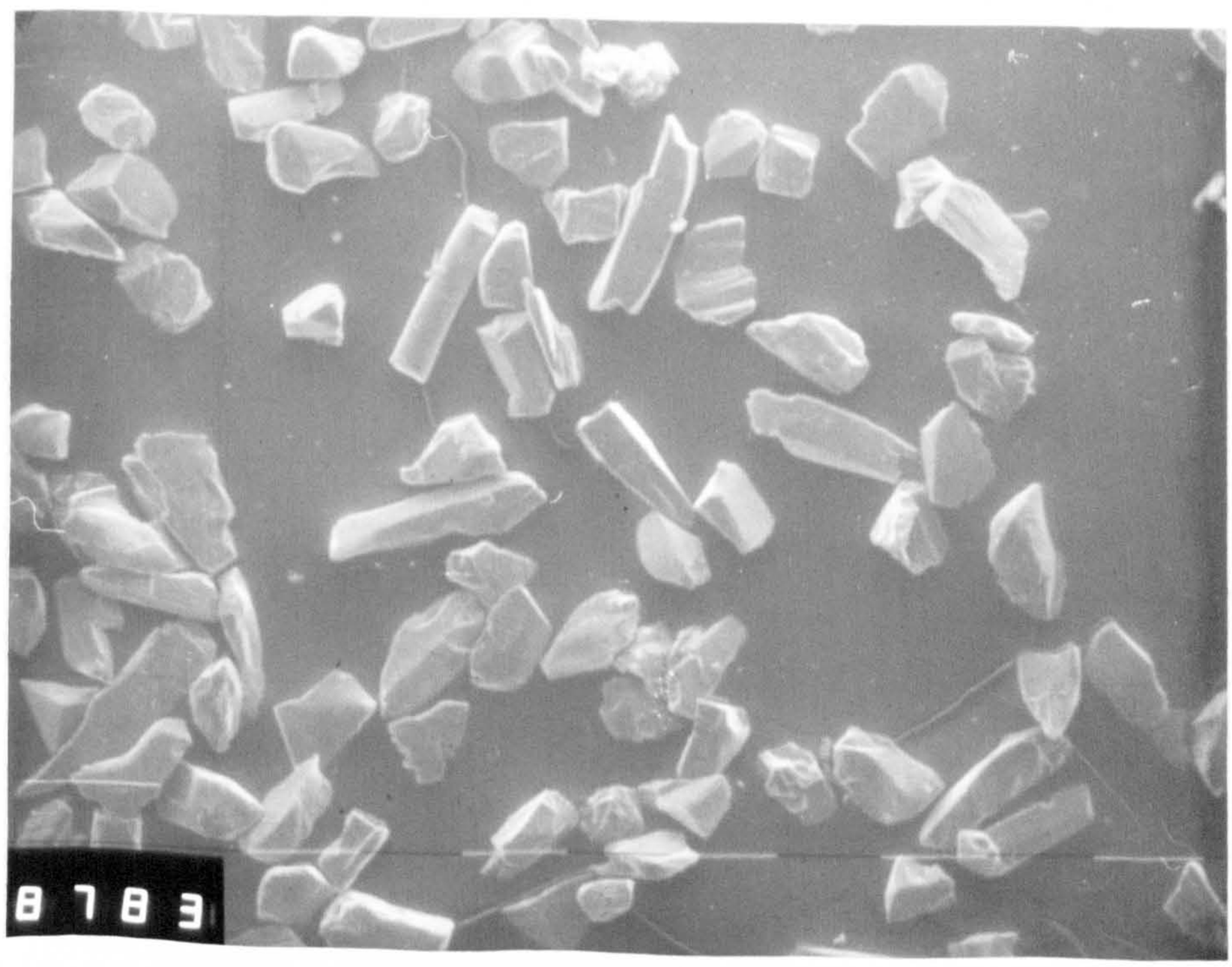


Exhausted Grit x 90

Figure 40(c) : The illustration of the grit particles retained on the 53μm sieve from the sieve analysis conducted on both the fresh and exhausted SiC grit.

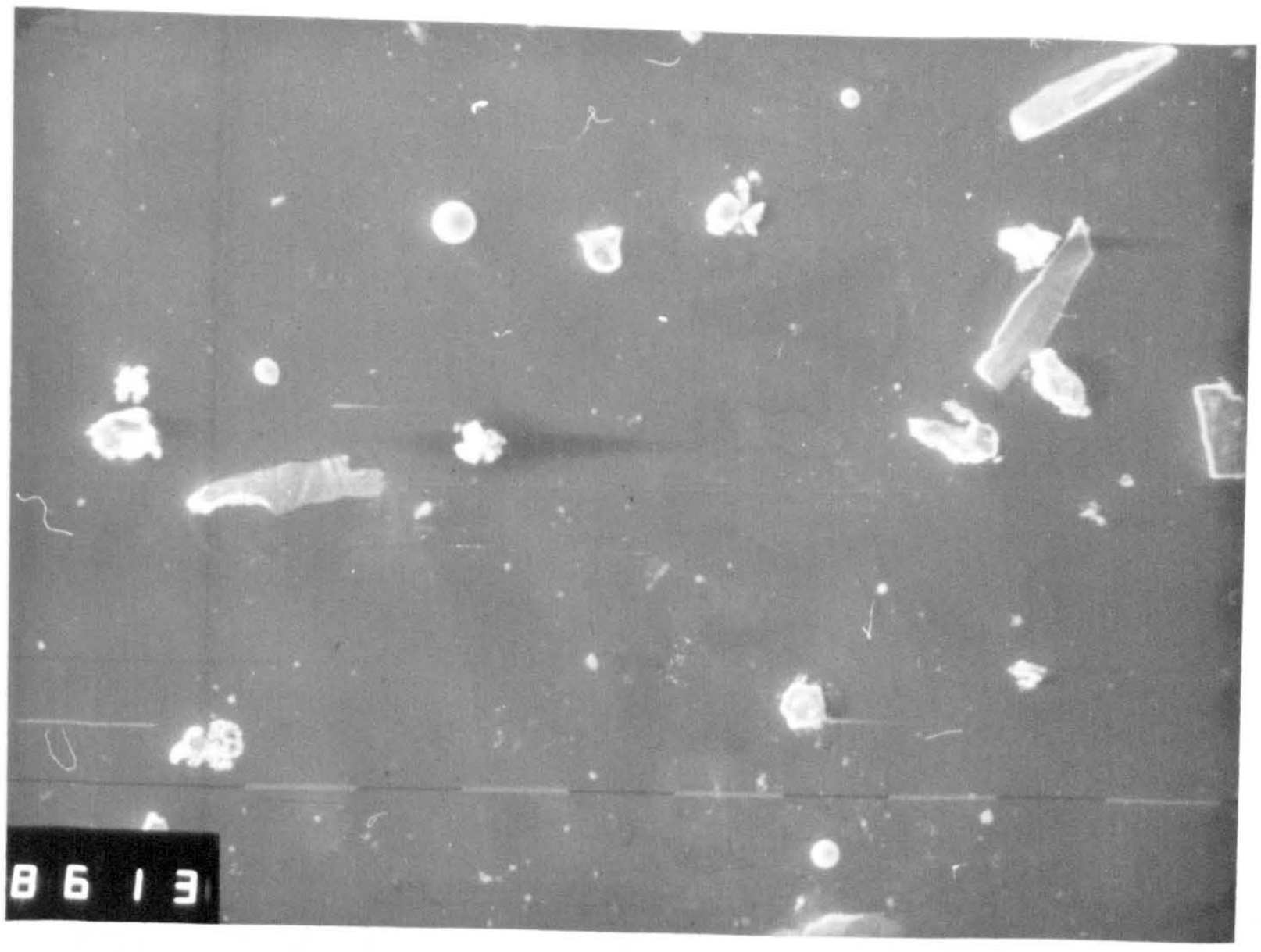


Fresh Grit x 80

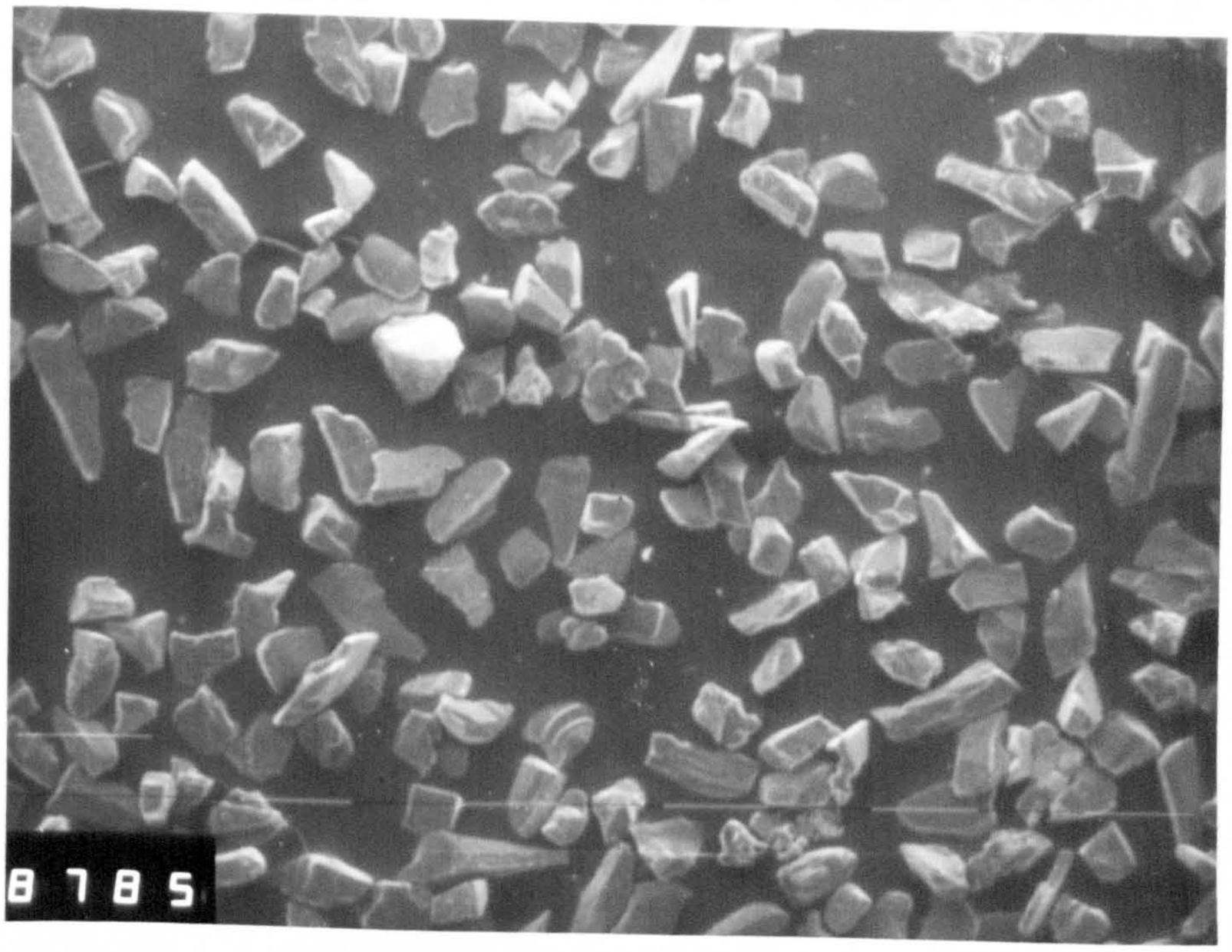


Exhausted Grit x 95

Figure 40(d) : The illustration of the grit particles retained on the 45μm sieve from the sieve analysis conducted on both the fresh and exhausted SiC grit.



Fresh Grit x 80



Exhausted Grit x 95

Figure 41 : The relationship between the number of extrusion cycles and the die diameter using LV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

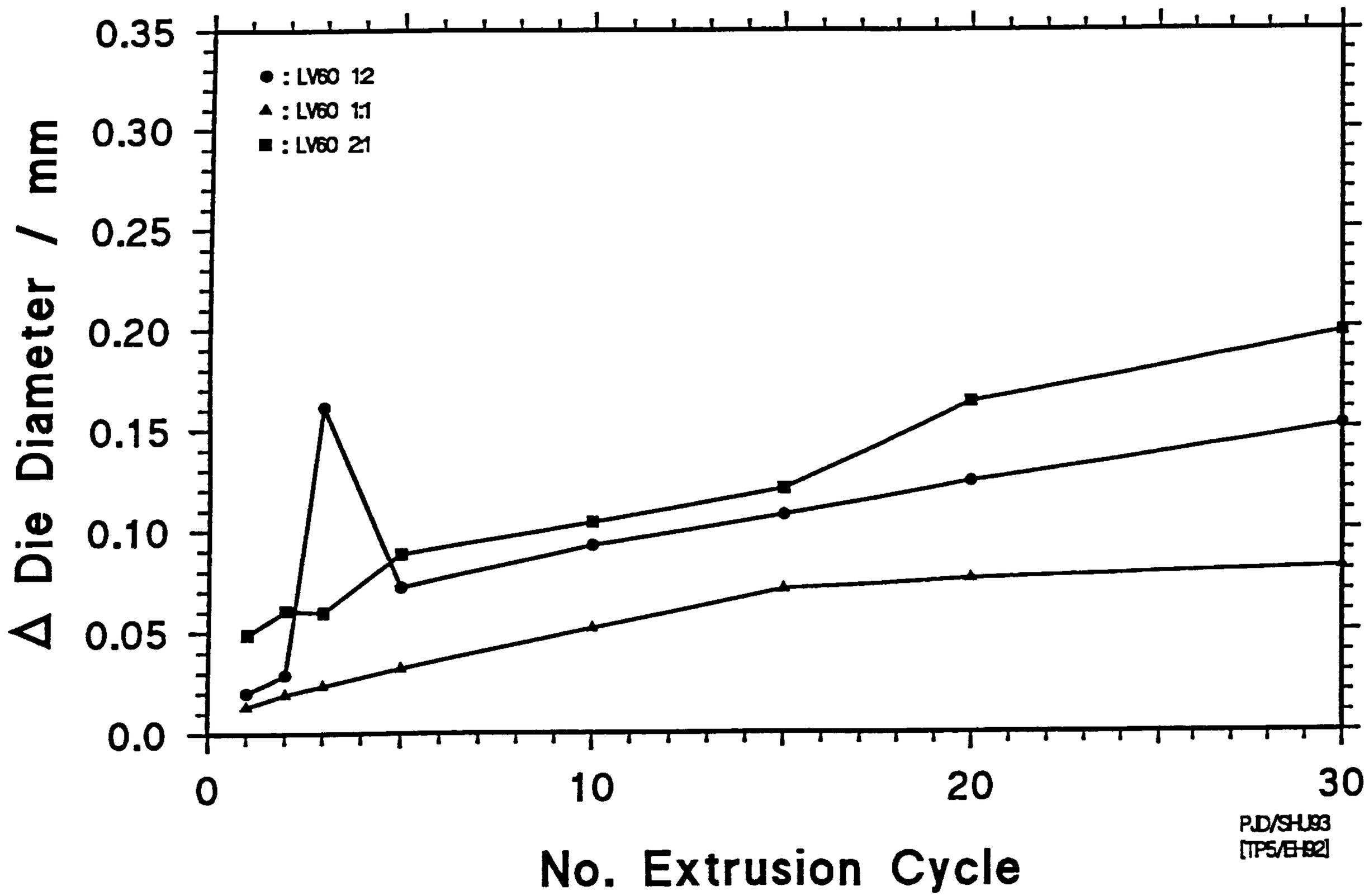

● : LV60 1:2
▲ : LV60 1:1
■ : LV60 2:1
Δ Die Diameter / mm
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.0
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 42 : The relationship between the number of extrusion cycles and the die diameter using LV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

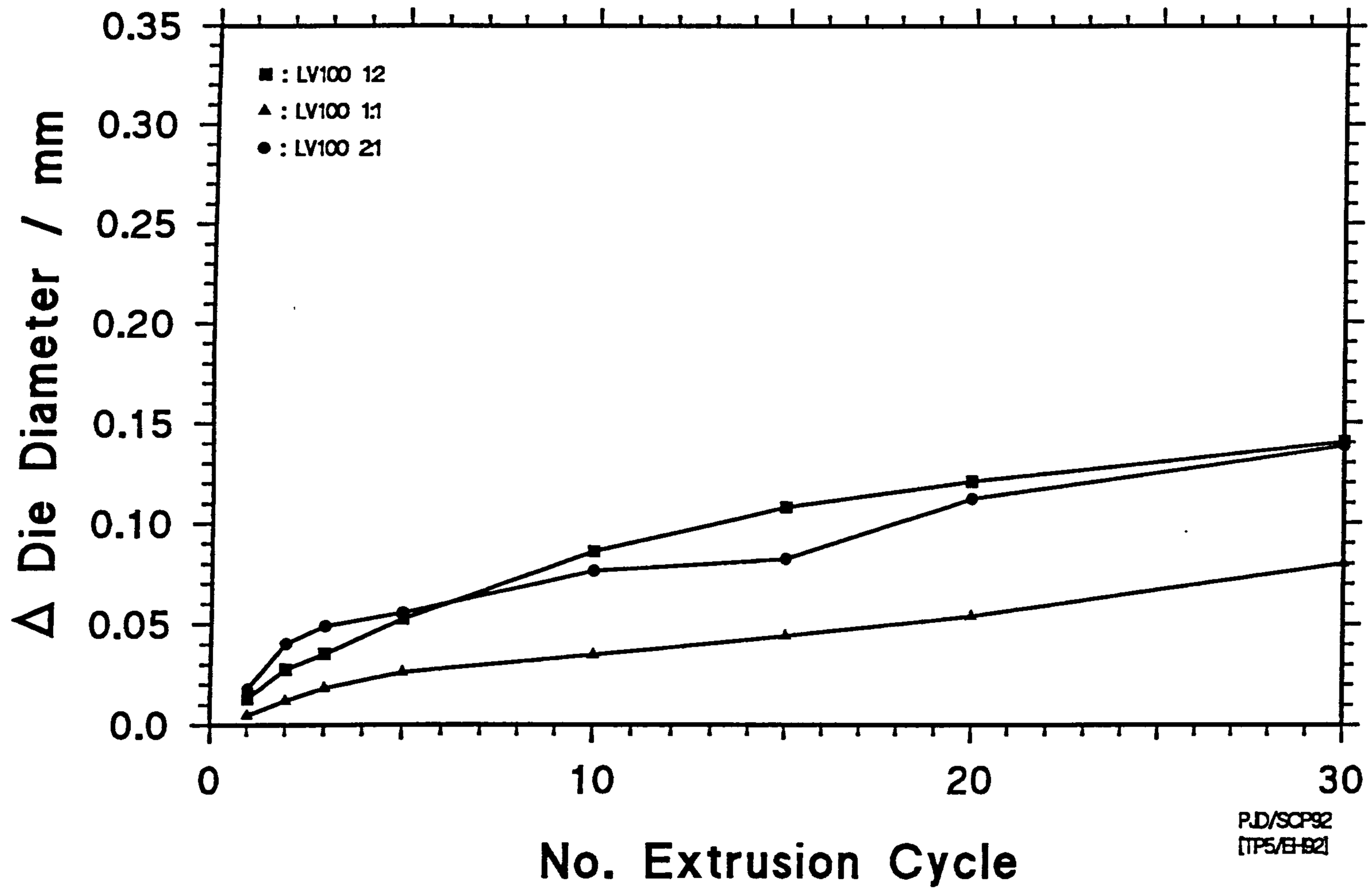

■ : LV100 12
▲ : LV100 1:1
● : LV100 21
Δ Die Diameter / mm
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.0
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 43 : The relationship between the number of extrusion cycles and the die diameter using MV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

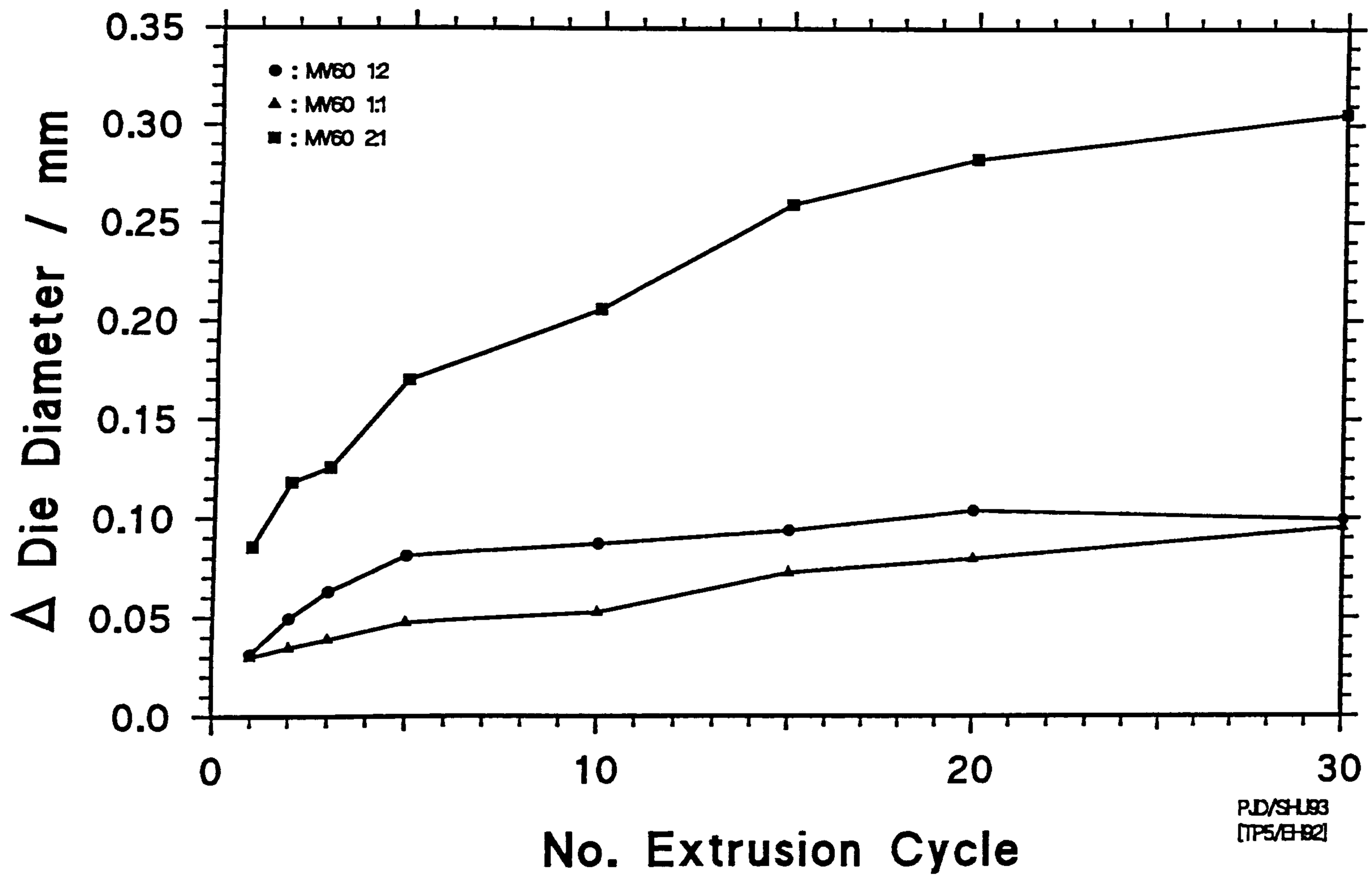

0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.0
Δ Die Diameter / mm
● : MV60 1:2
▲ : MV60 1:1
■ : MV60 2:1
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 44 : The relationship between the number of extrusion cycles and the die diameter using MV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

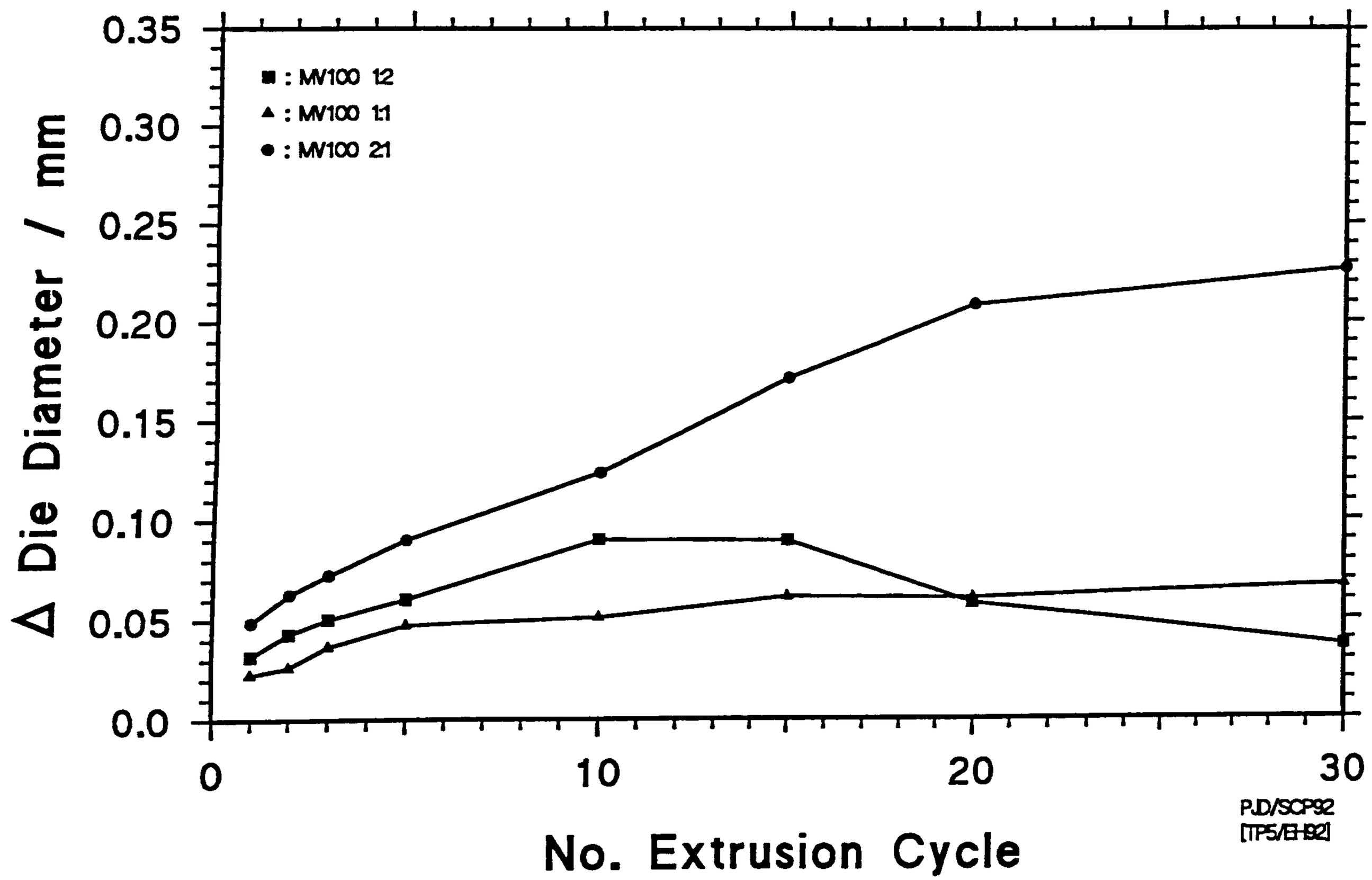

■ : MV100 12
▲ : MV100 11
● : MV100 21
Δ Die Diameter / mm
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.0
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 45 : The relationship between the number of extrusion cycles and the die diameter using HV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

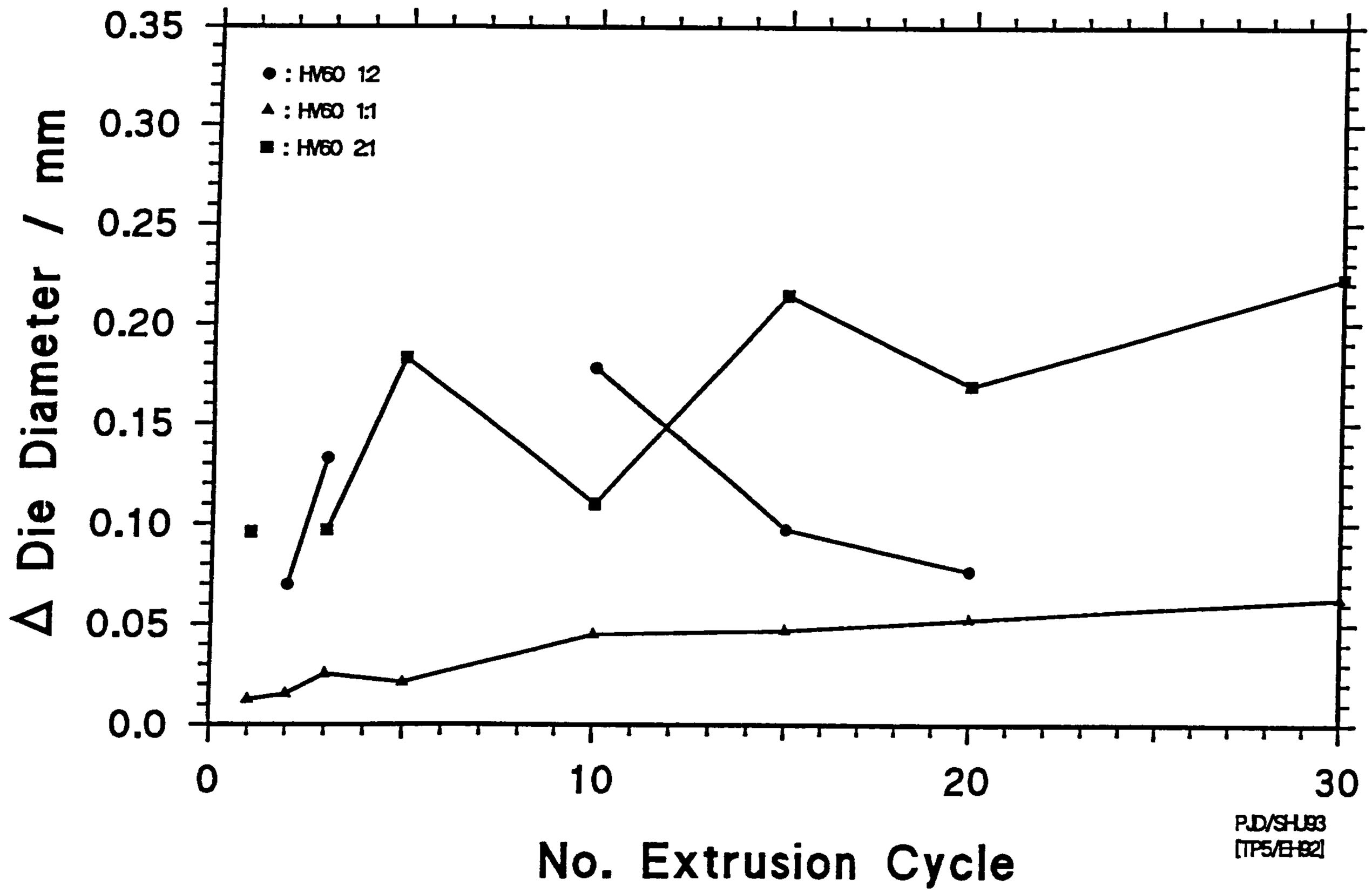

0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.0
Δ Die Diameter / mm
● : HV60 1:2
▲ : HV60 1:1
■ : HV60 2:1
0
10
20
30
No. Extrusion Cycle
P.J.D/SHU93
[TP5/EH92]

Figure 46 : The relationship between the number of extrusion cycles and the die diameter using HV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

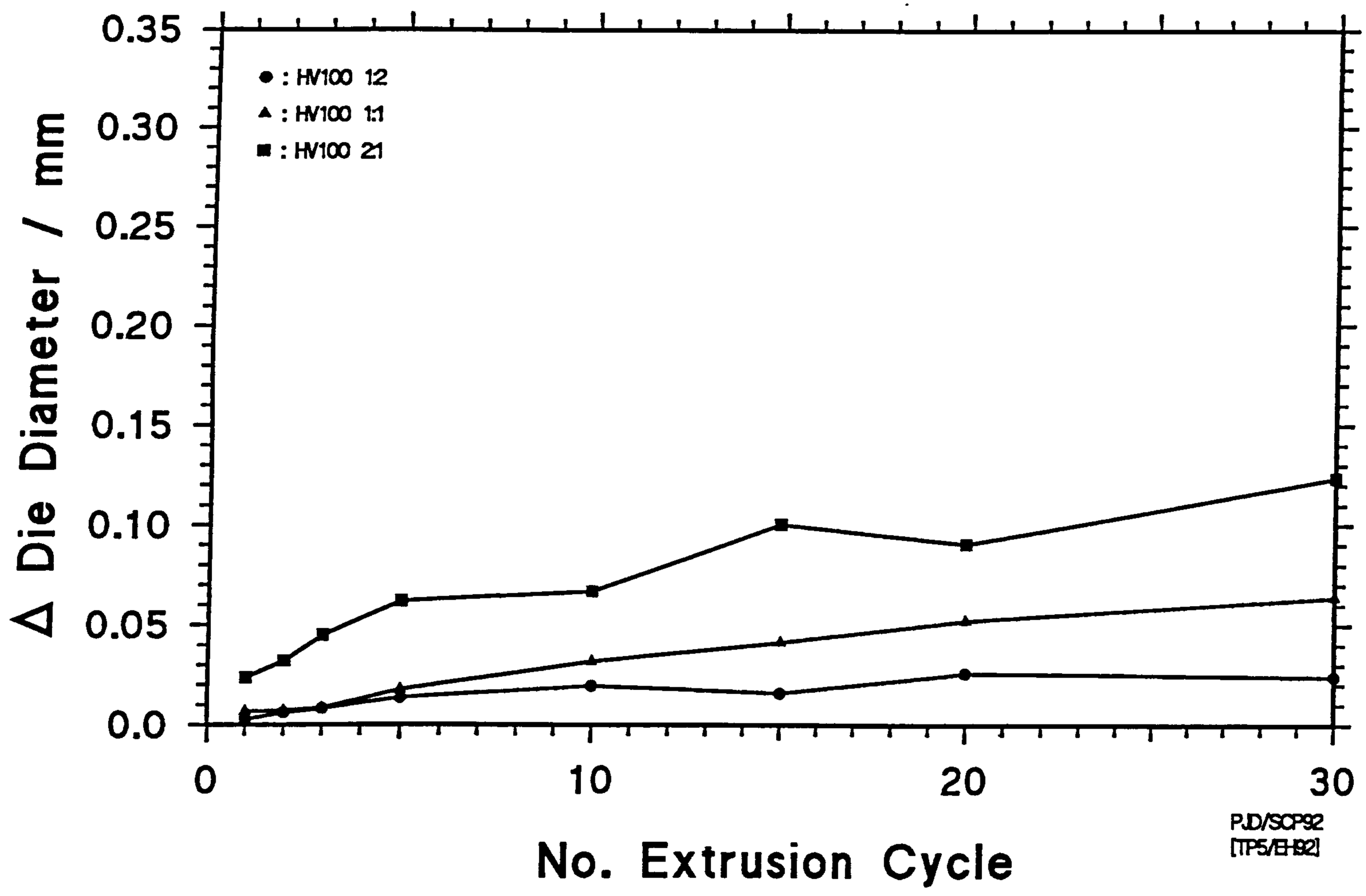

0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.0
Δ Die Diameter / mm
● : HV100 1:2
▲ : HV100 1:1
■ : HV100 2:1
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 47 : The relationship between the number of extrusion cycles and the die mass using LV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

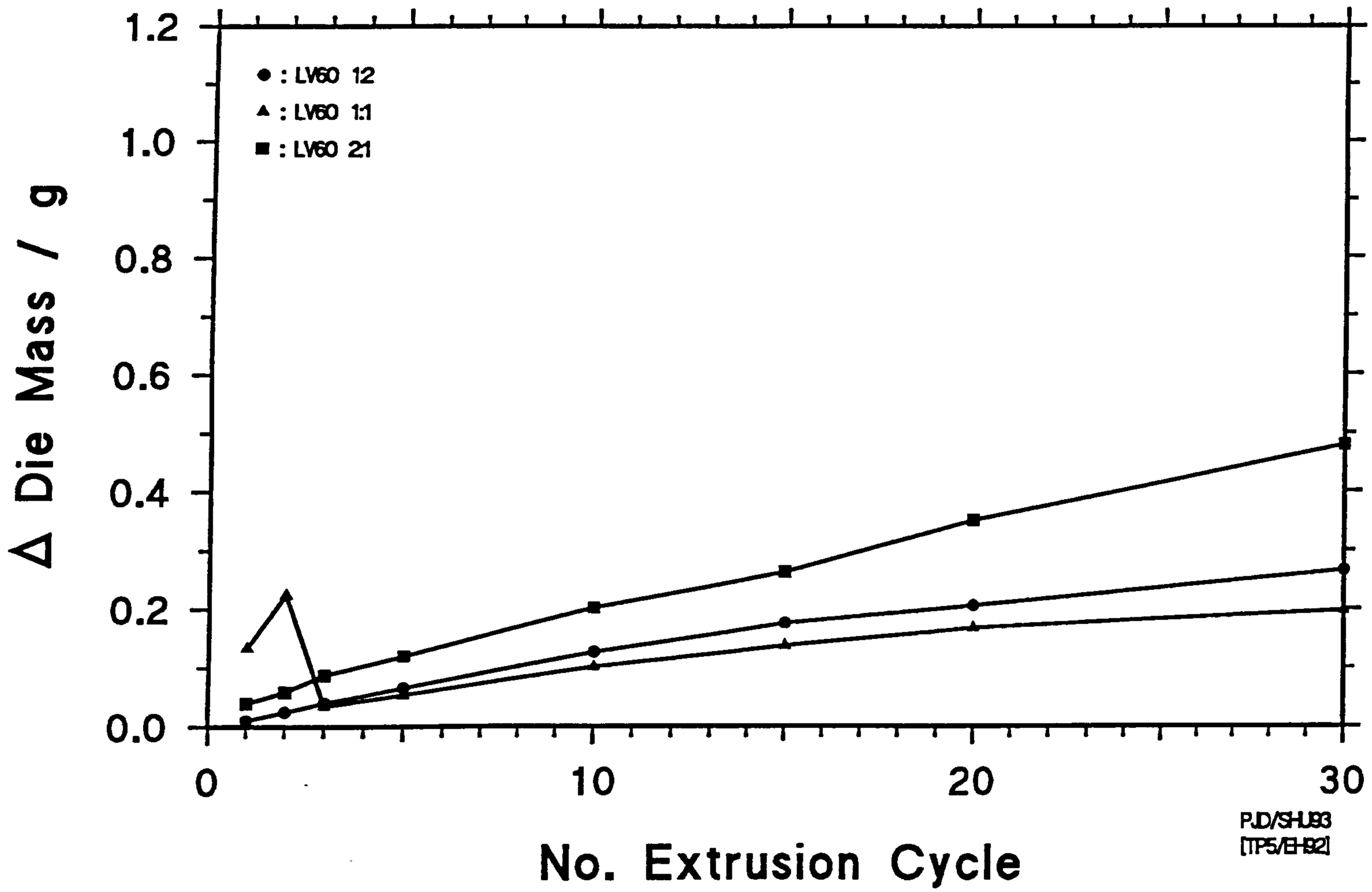

1.2
1.0
0.8
0.6
0.4
0.2
0.0
Δ Die Mass / g
● : LV60 1:2
▲ : LV60 1:1
■ : LV60 2:1
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 48 : The relationship between the number of extrusion cycles and the die mass using LV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

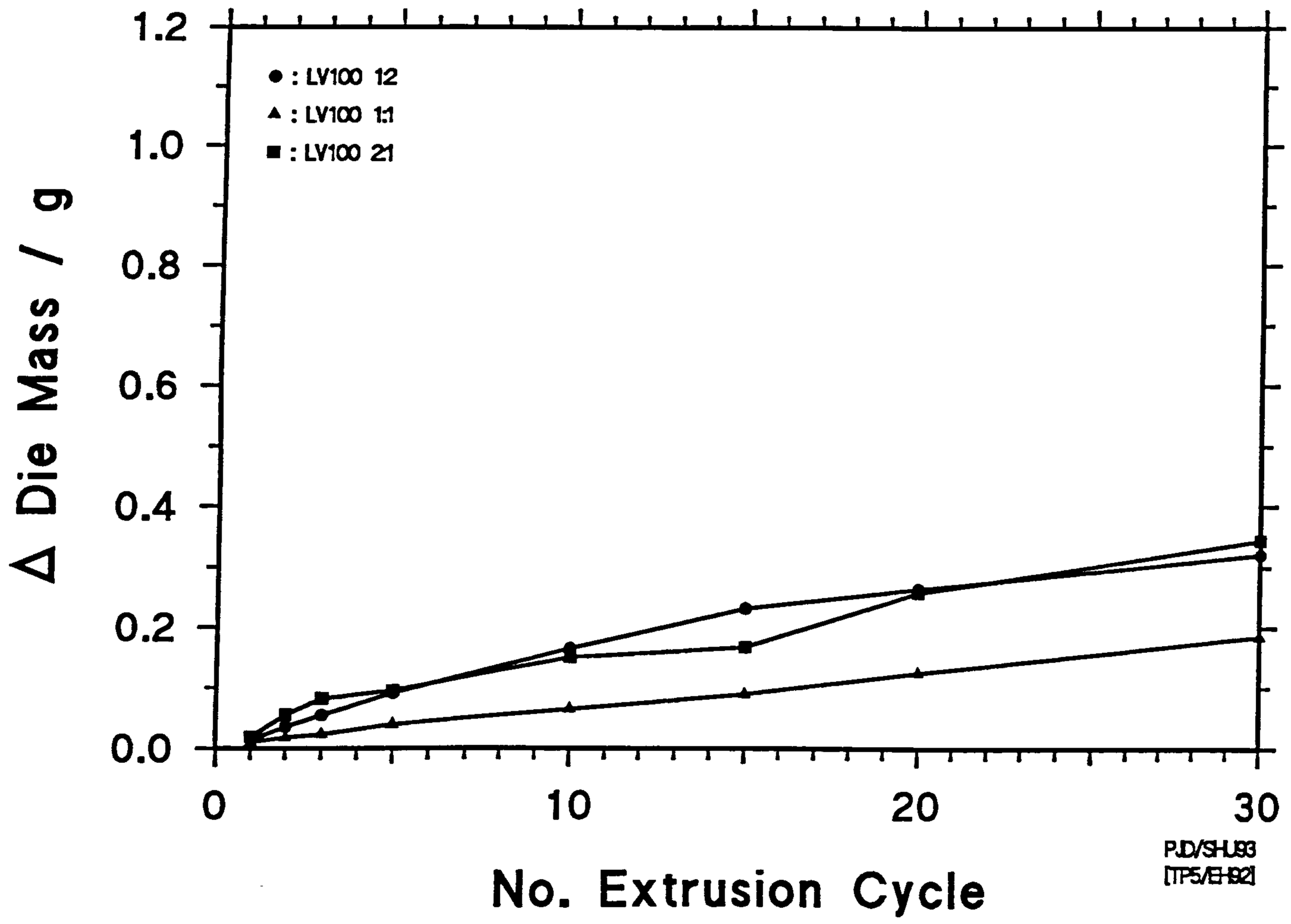

1.2
1.0
0.8
0.6
0.4
0.2
0.0
Δ Die Mass / g
● : LV100 12
▲ : LV100 1:1
■ : LV100 21
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 49 : The relationship between the number of extrusion cycles and the die mass using MV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

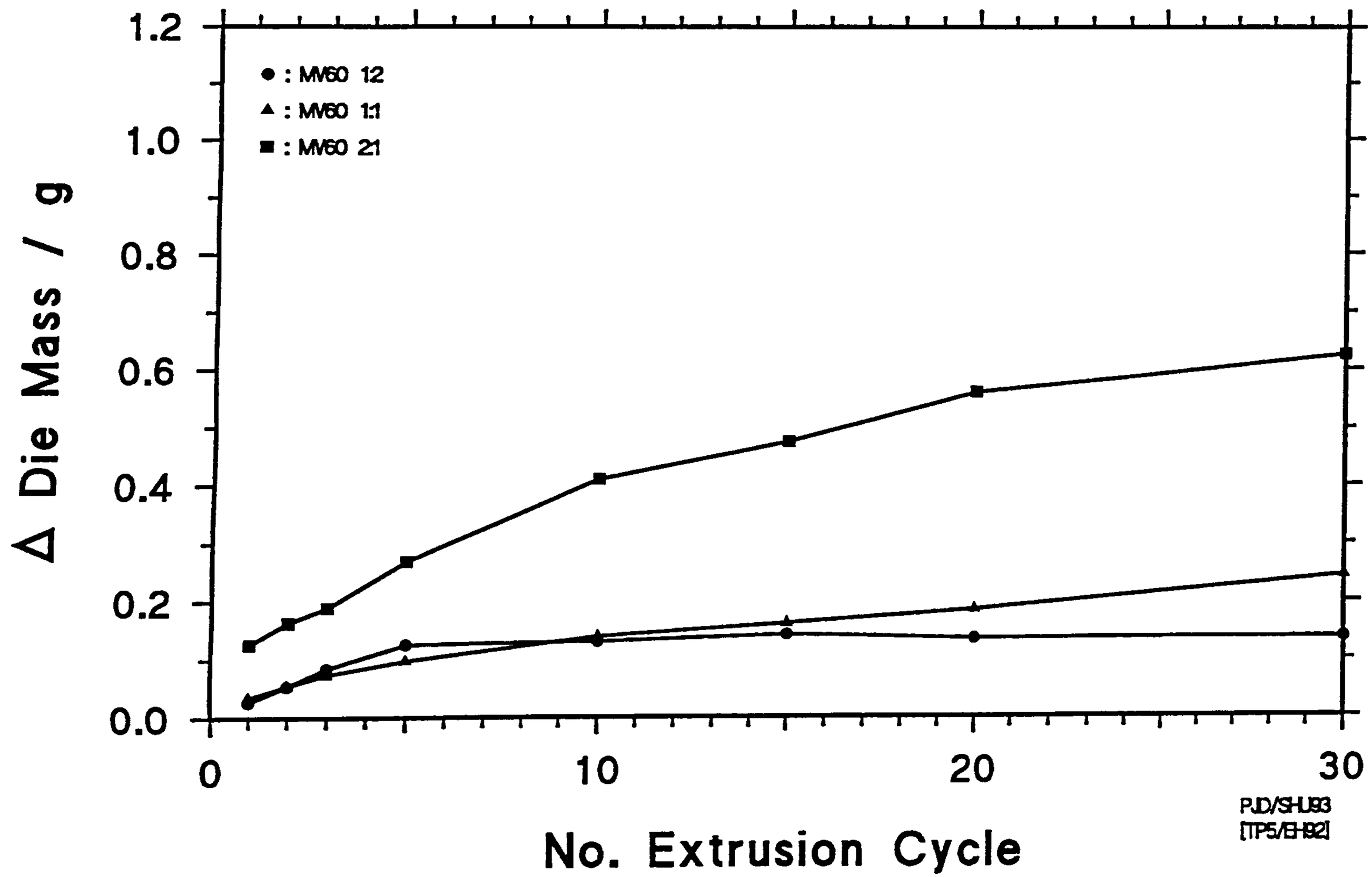

1.2
1.0
0.8
0.6
0.4
0.2
0.0
Δ Die Mass / g
● : MV60 1:2
▲ : MV60 1:1
■ : MV60 2:1
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 50 : The relationship between the number of extrusion cycles and the die mass using MV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

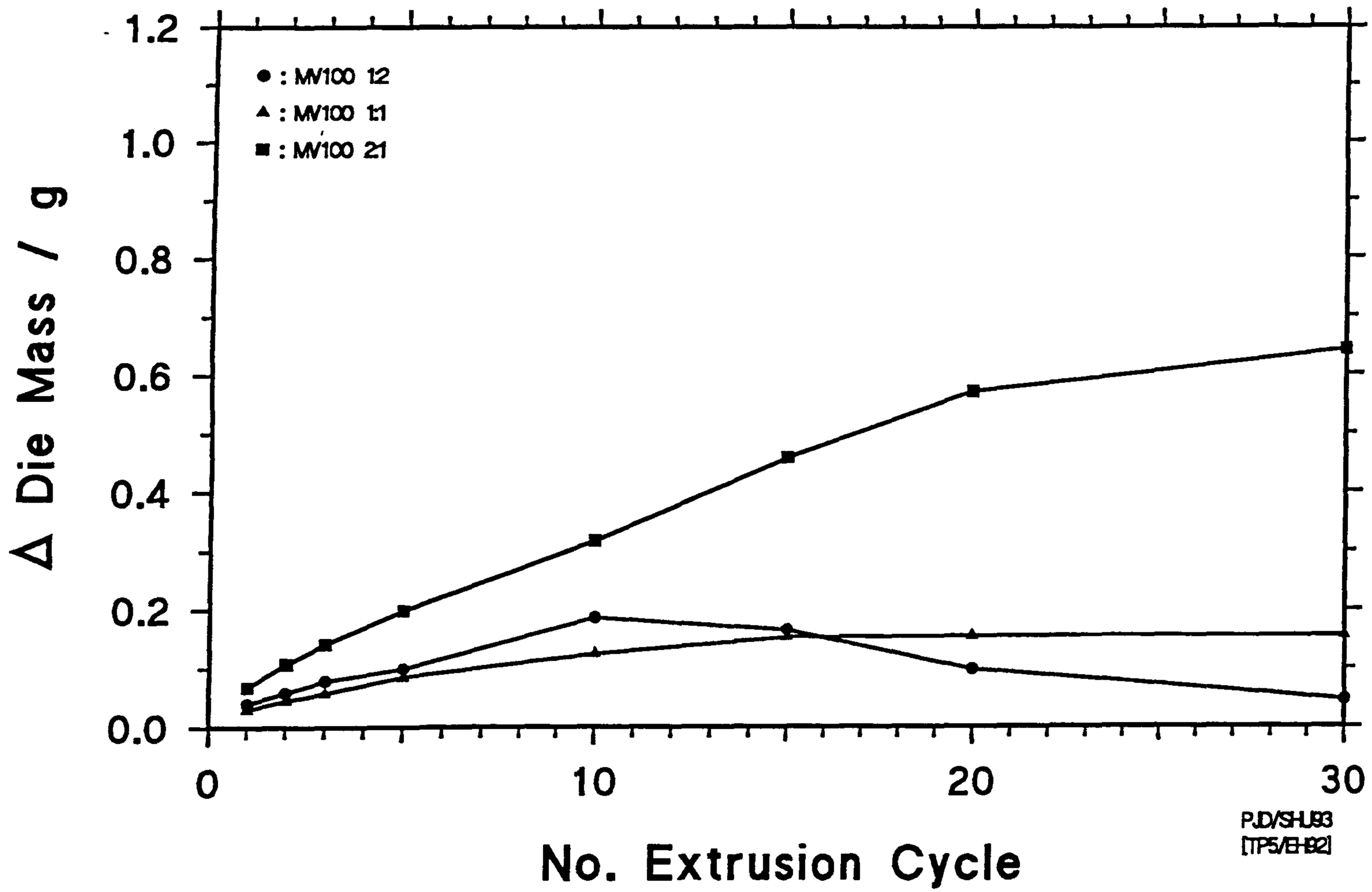

1.2
1.0
0.8
0.6
0.4
0.2
0.0
Δ Die Mass / g
● : MV100 12
▲ : MV100 11
■ : MV100 21
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 51 : The relationship between the number of extrusion cycles and the die mass using HV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

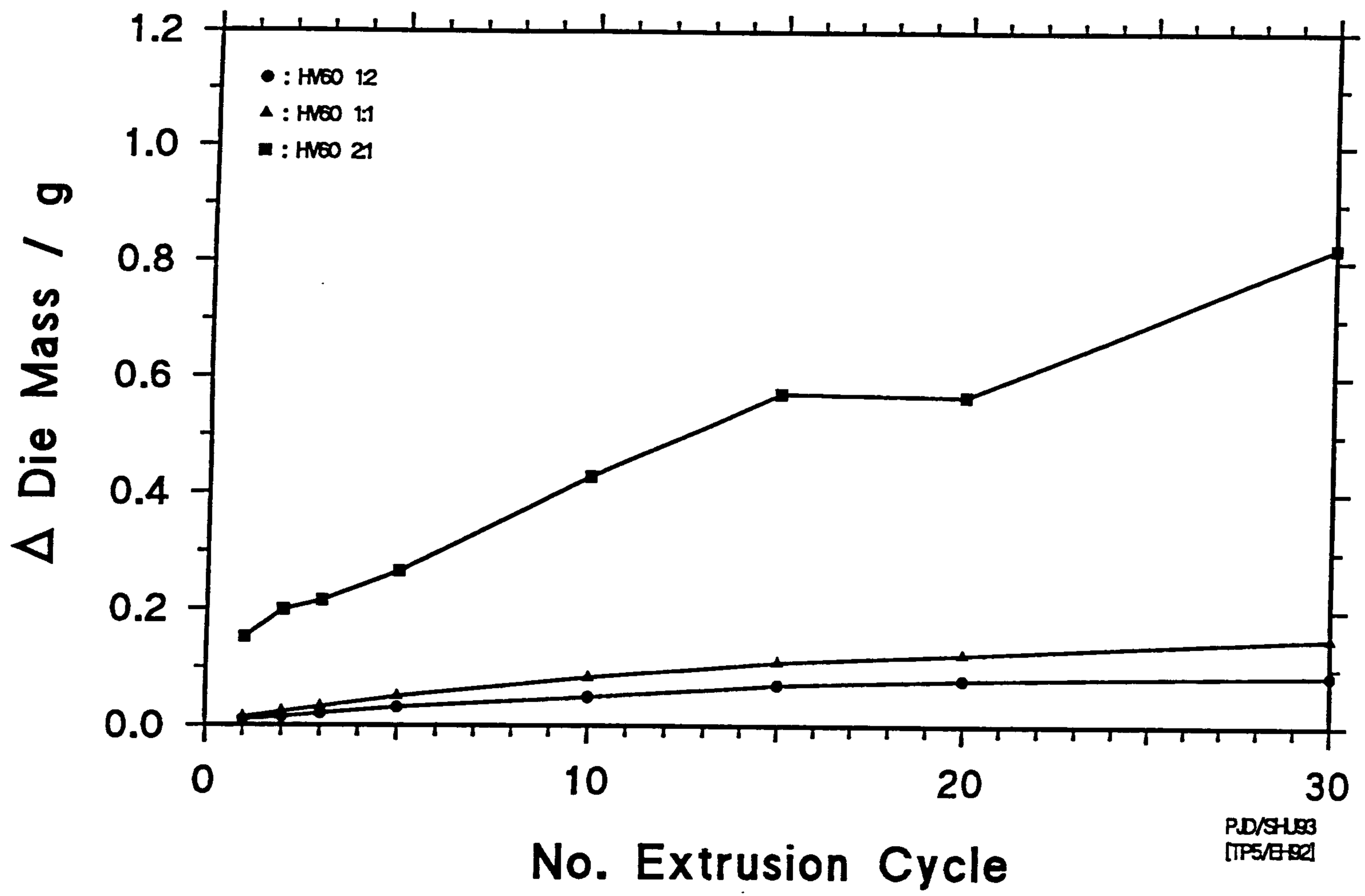

1.2
1.0
0.8
0.6
0.4
0.2
0.0
Δ Die Mass / g
● : HV60 1:2
▲ : HV60 1:1
■ : HV60 2:1
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 52 : The relationship between the number of extrusion cycles and the die mass using HV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

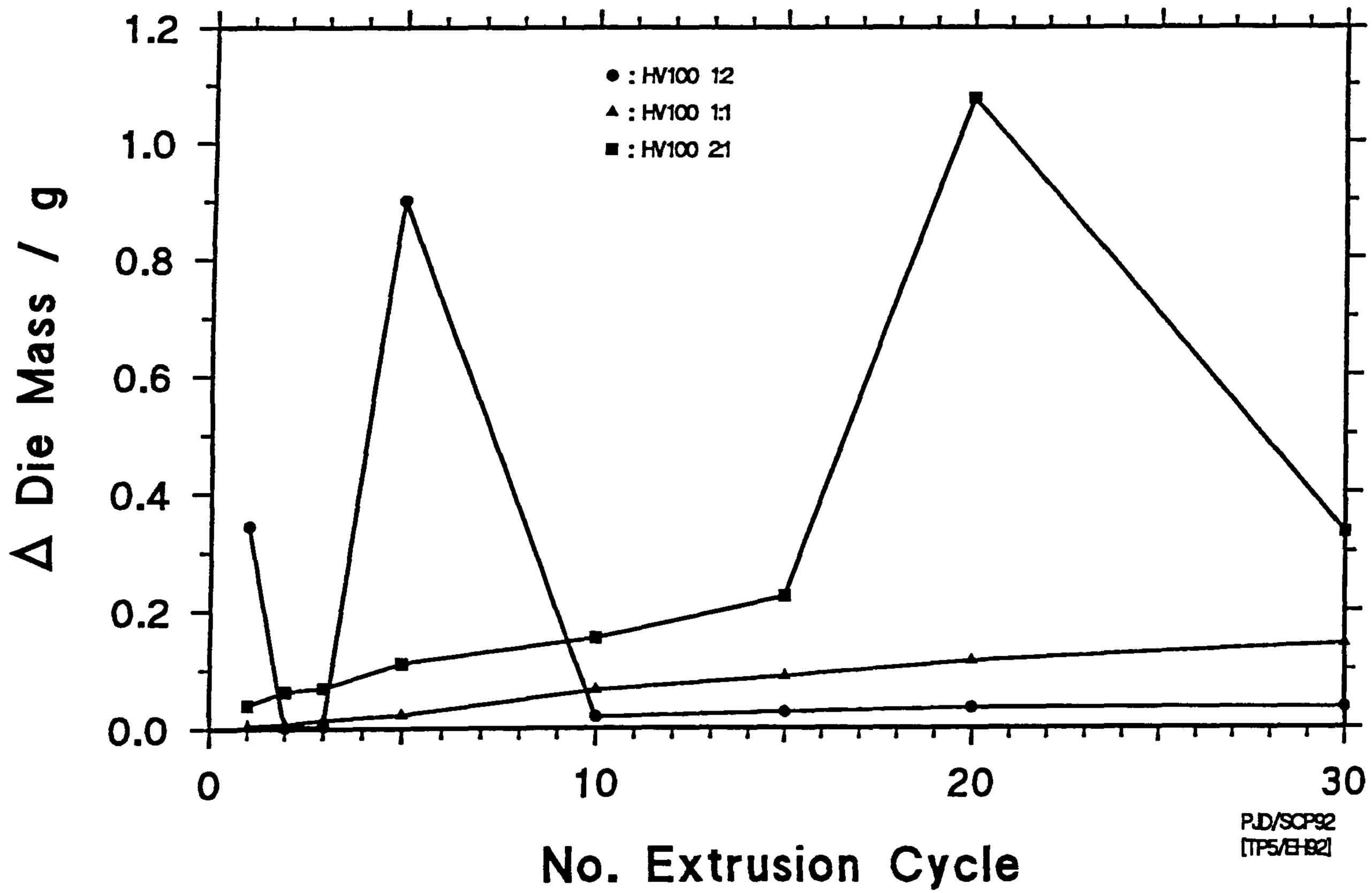

● : HV100 1:2
▲ : HV100 1:1
■ : HV100 2:1
Δ Die Mass / g
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 53 : The relationship between the number of extrusion cycles and the percentage surface roughness improvement using LV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

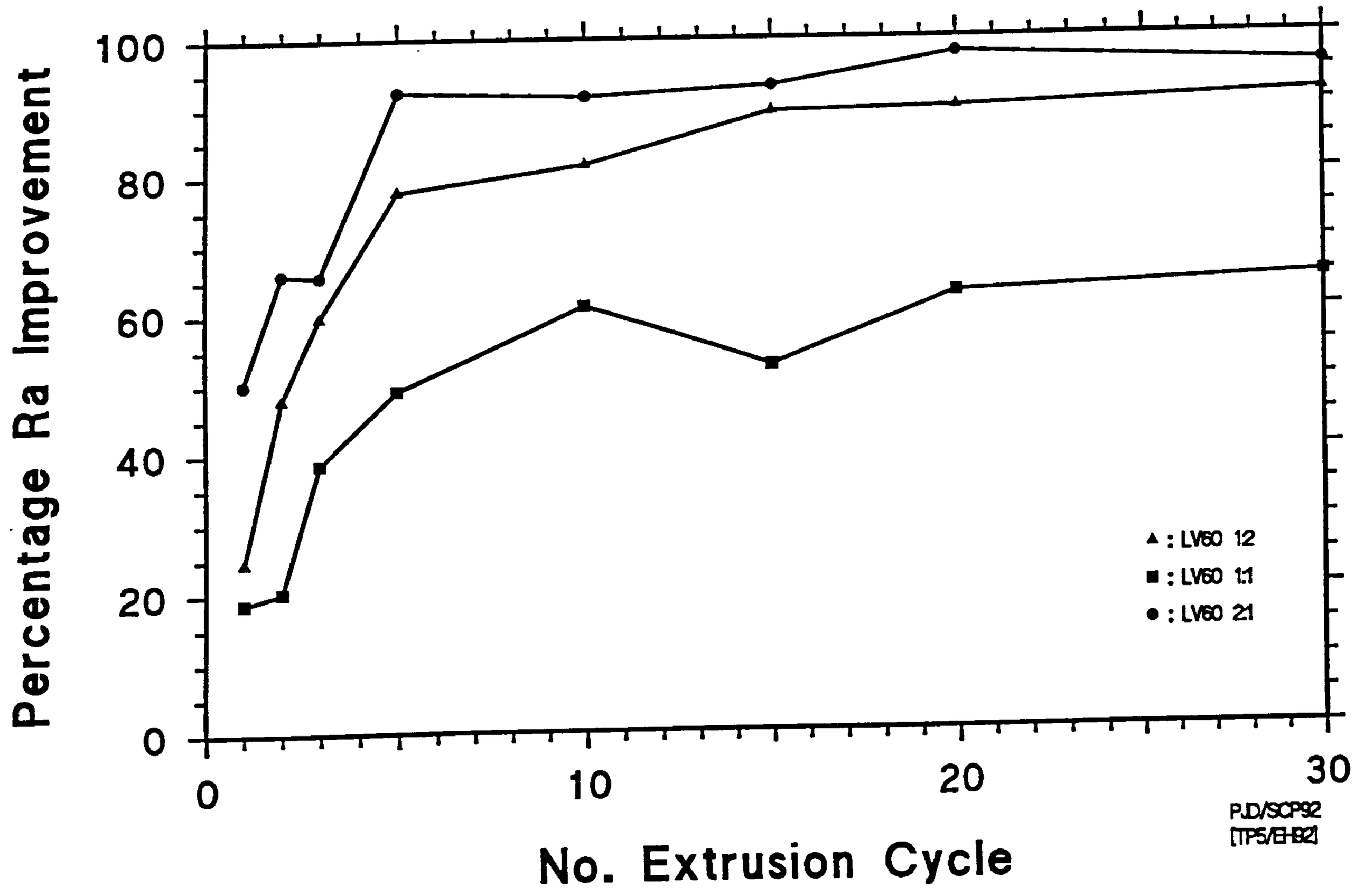

Percentage Ra Improvement
100
80
60
40
20
0
0
10
20
30
No. Extrusion Cycle
▲ : LV60 1:2
■ : LV60 1:1
● : LV60 2:1
PJD/SCP92
[TP5/EHB2]

Figure 54 : The relationship between the number of extrusion cycles and the percentage surface roughness improvement using LV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

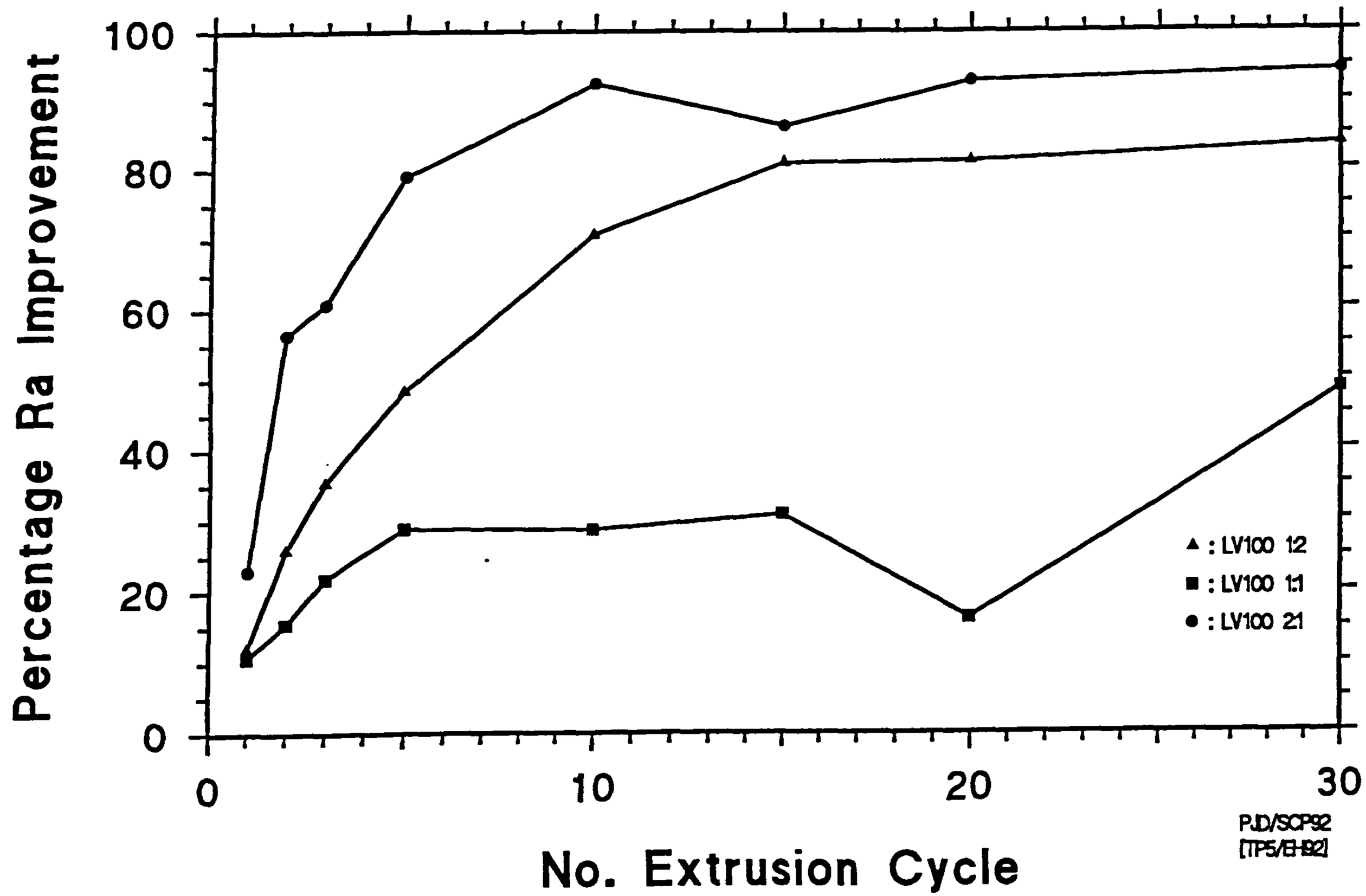

Percentage Ra Improvement
100
80
60
40
20
0
0
10
20
30
No. Extrusion Cycle
▲ : LV100 1:2
■ : LV100 1:1
● : LV100 2:1
PJD/SCP92
[TP5/EH92]

Figure 55 : The relationship between the number of extrusion cycles and the percentage surface roughness improvement using MV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

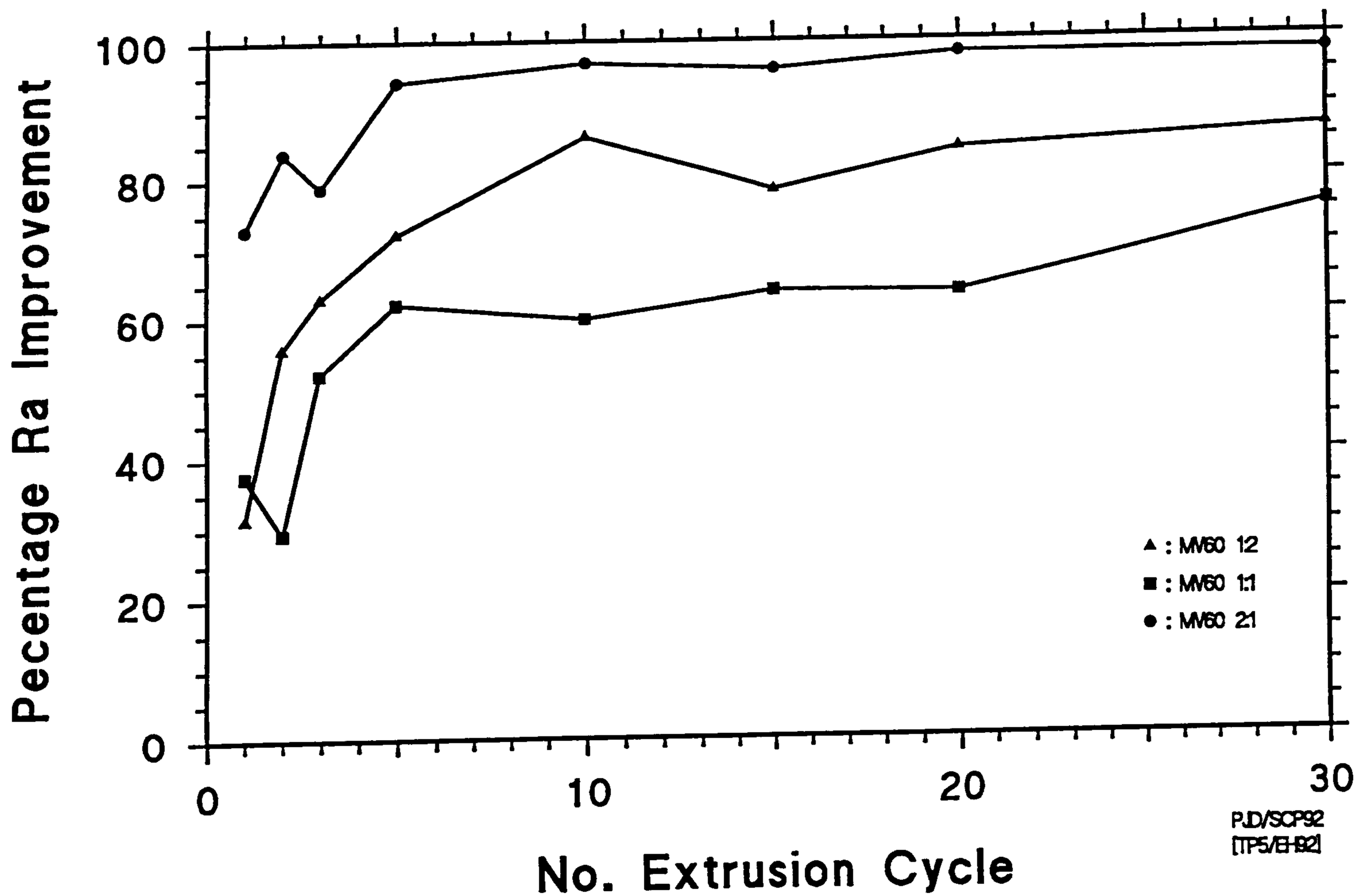

Pecentage Ra Improvement
100
80
60
40
20
0
0
10
20
30
No. Extrusion Cycle
▲ : MV60 1:2
■ : MV60 1:1
● : MV60 2:1
PJD/SCP92
[TP5/EH92]

Figure 56 : The relationship between the number of extrusion cycles and the percentage surface roughness improvement using MV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

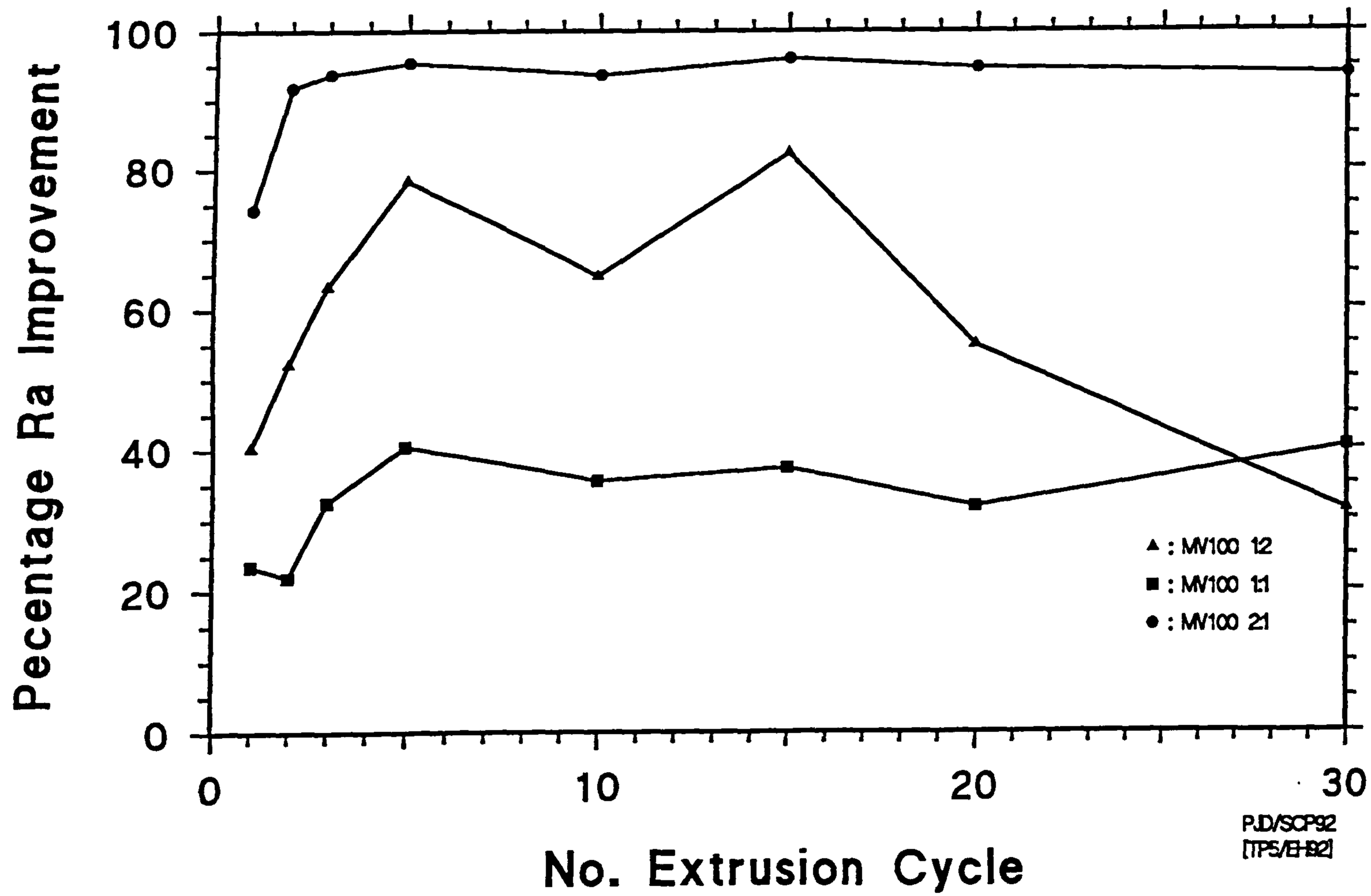

Pecentage Ra Improvement
100
80
60
40
20
0
0
10
20
30
No. Extrusion Cycle
▲ : MV100 1:2
■ : MV100 1:1
● : MV100 2:1
PJD/SCP92
[TP5/EH92]

Figure 57 : The relationship between the number of extrusion cycles and the percentage surface roughness improvement using HV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

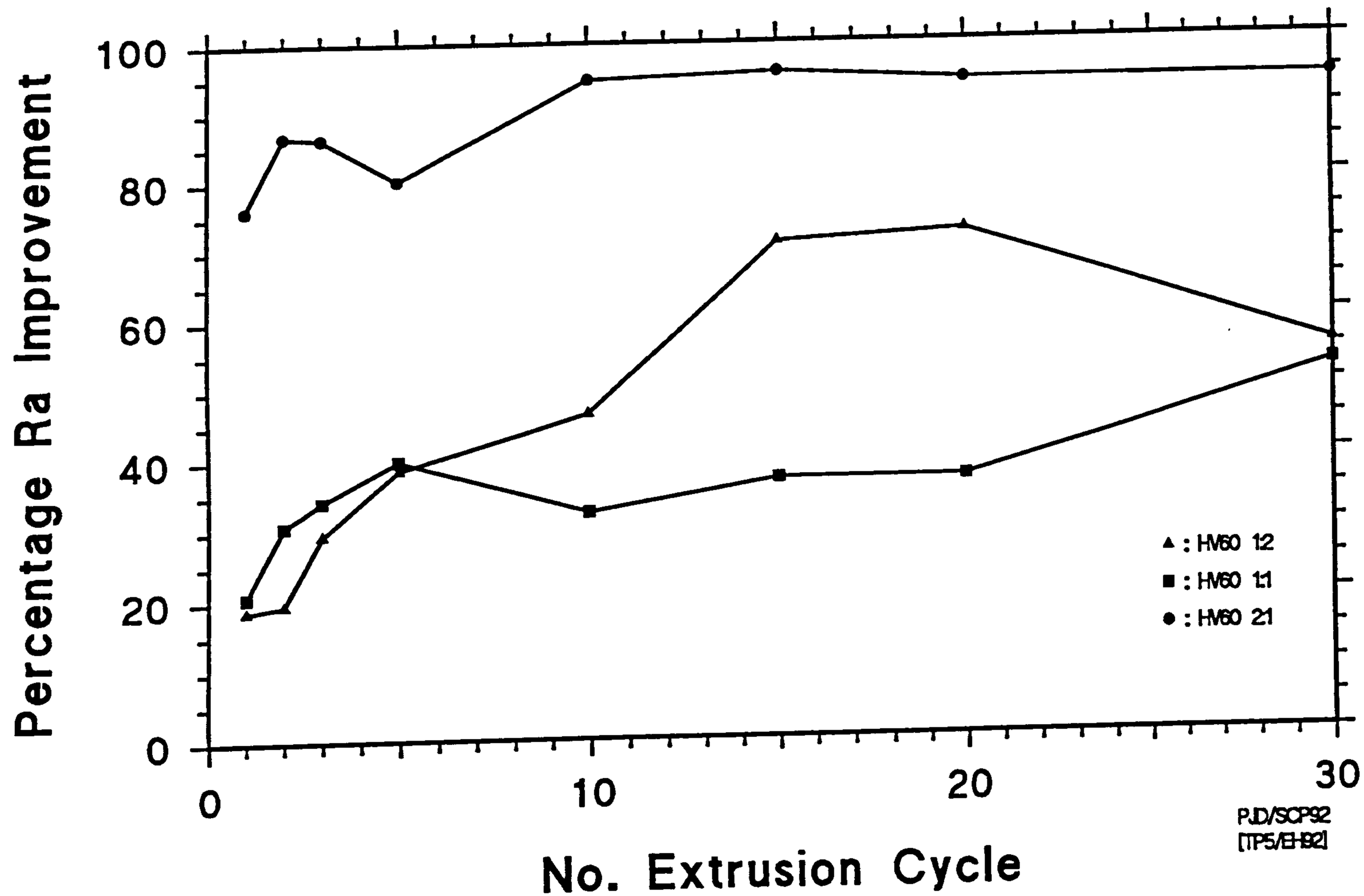

Percentage Ra Improvement
100
80
60
40
20
0
0
10
20
30
No. Extrusion Cycle
▲ : HV60 1:2
■ : HV60 1:1
● : HV60 2:1
PJD/SCP92
[TP5/EH92]

Figure 58 : The relationship between the number of extrusion cycles and the percentage surface roughness improvement using HV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

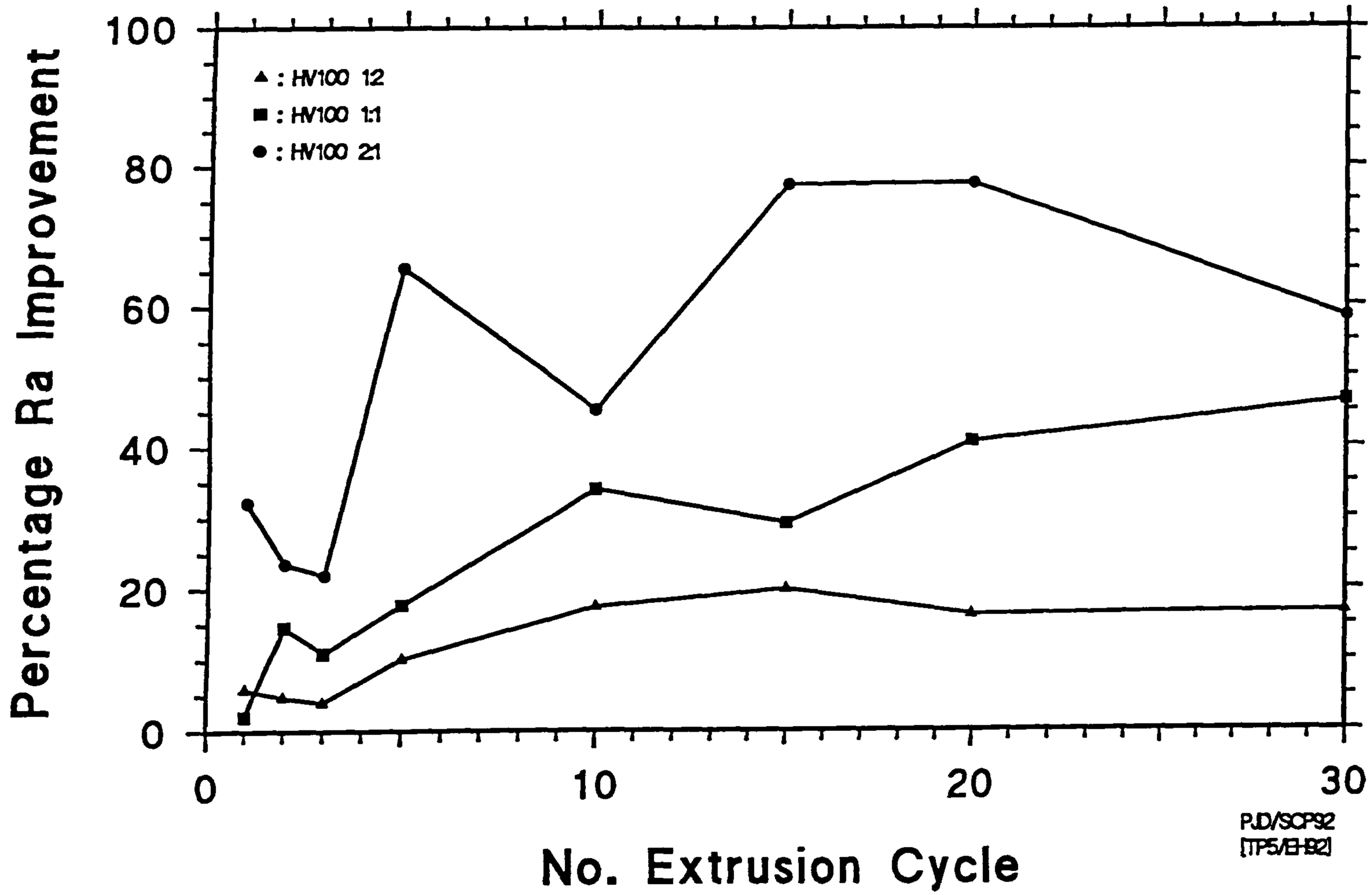
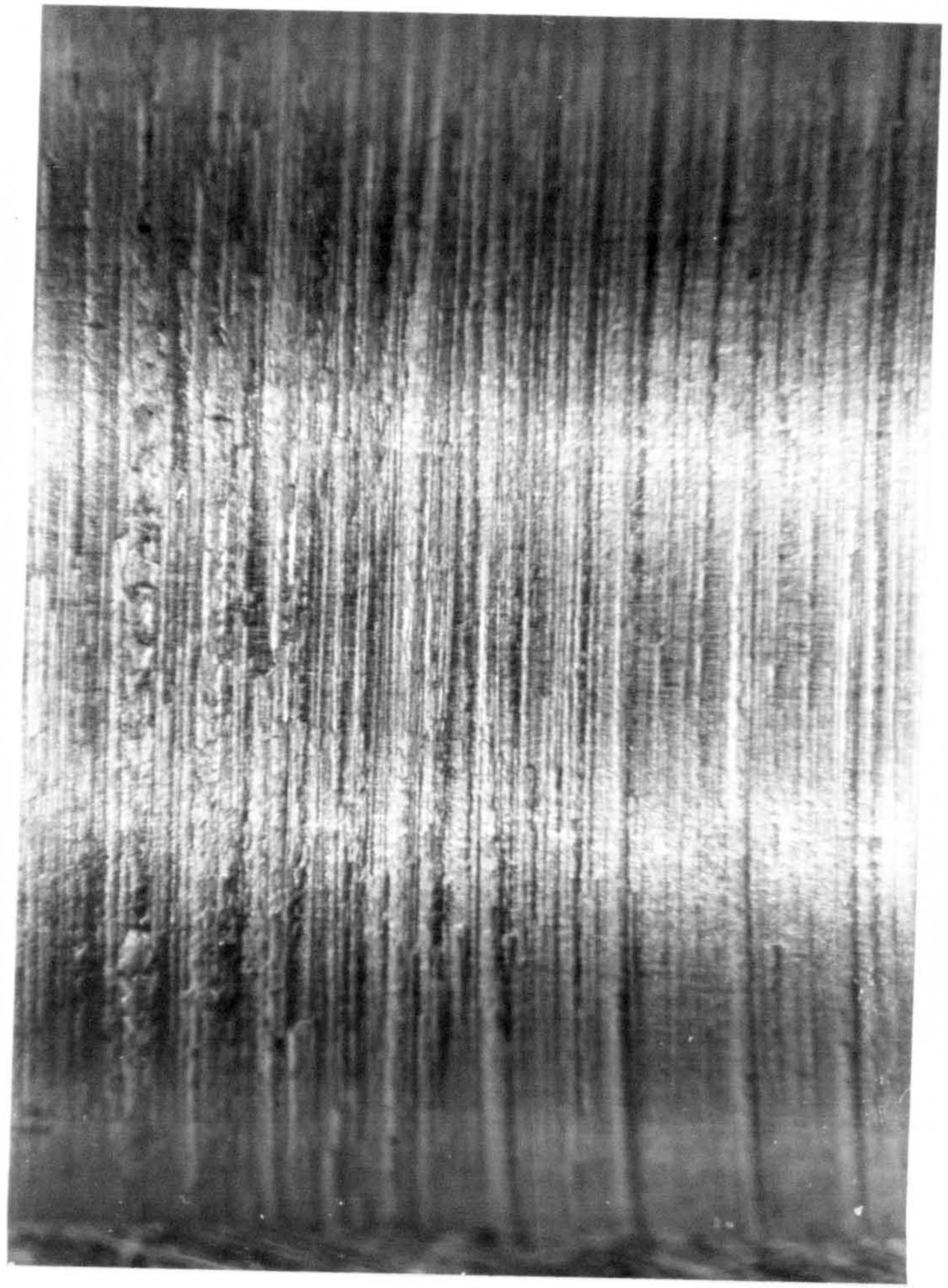

▲ : HV100 1:2
■ : HV100 1:1
● : HV100 2:1
Percentage Ra Improvement
100
80
60
40
20
0
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 59(a) : Illustration of the die surface condition after 1 extrusion cycle using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 59(b) : Illustration of the die surface condition after 2 extrusion cycles using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



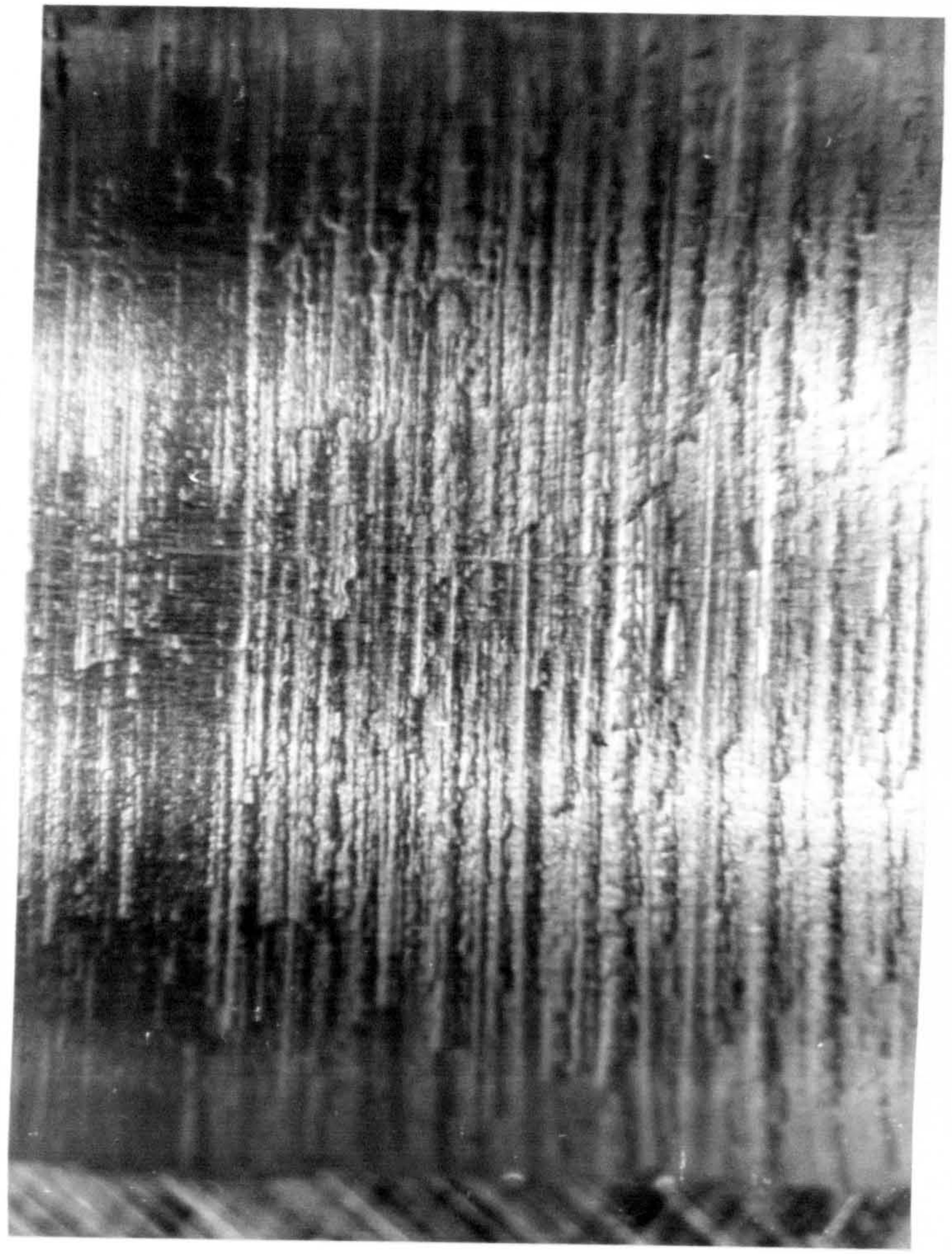
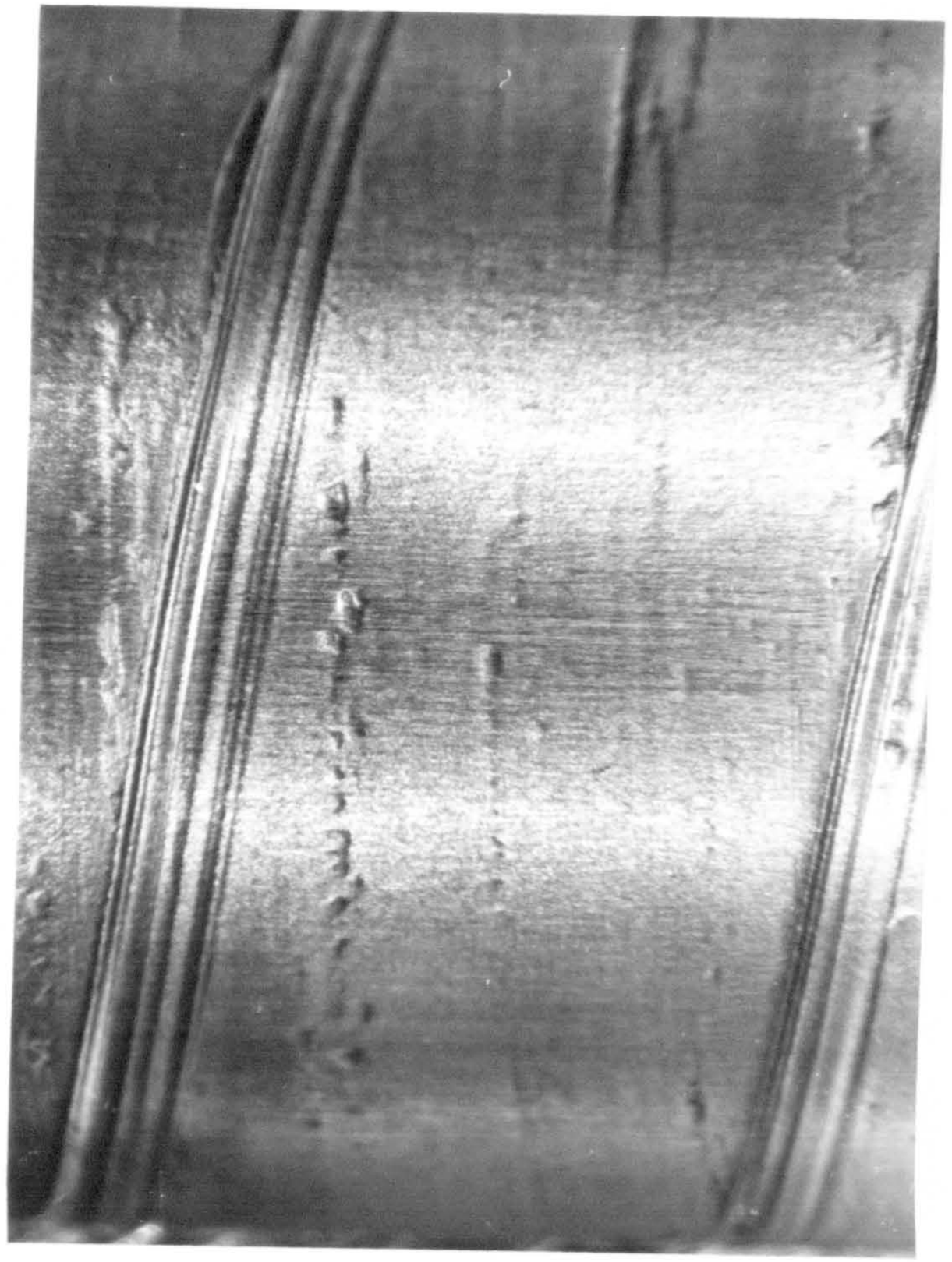


Figure 59(c) : Illustration of the die surface condition after 3 extrusion cycles using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 59(d) : Illustration of the die surface condition after 5 extrusion cycles using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



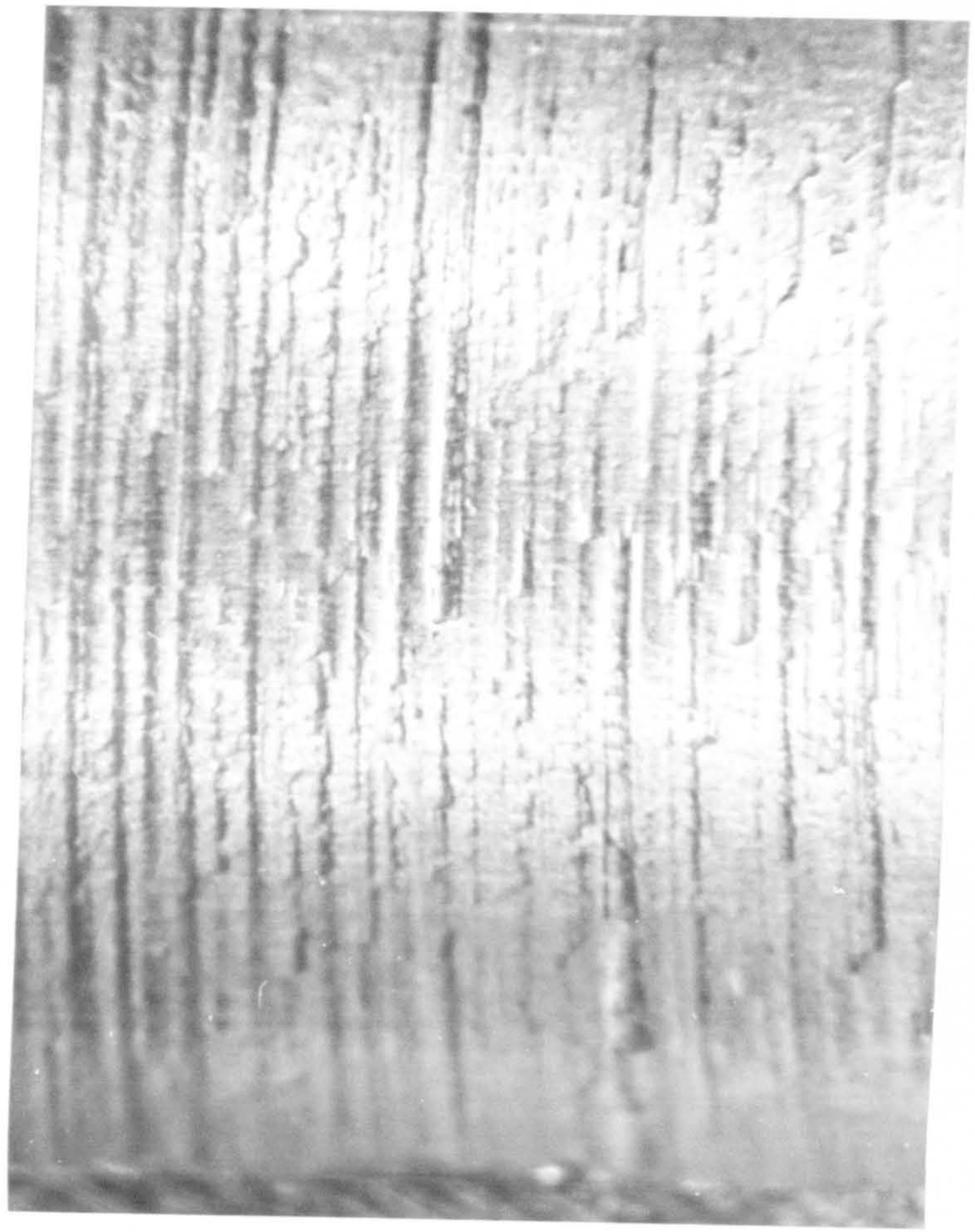
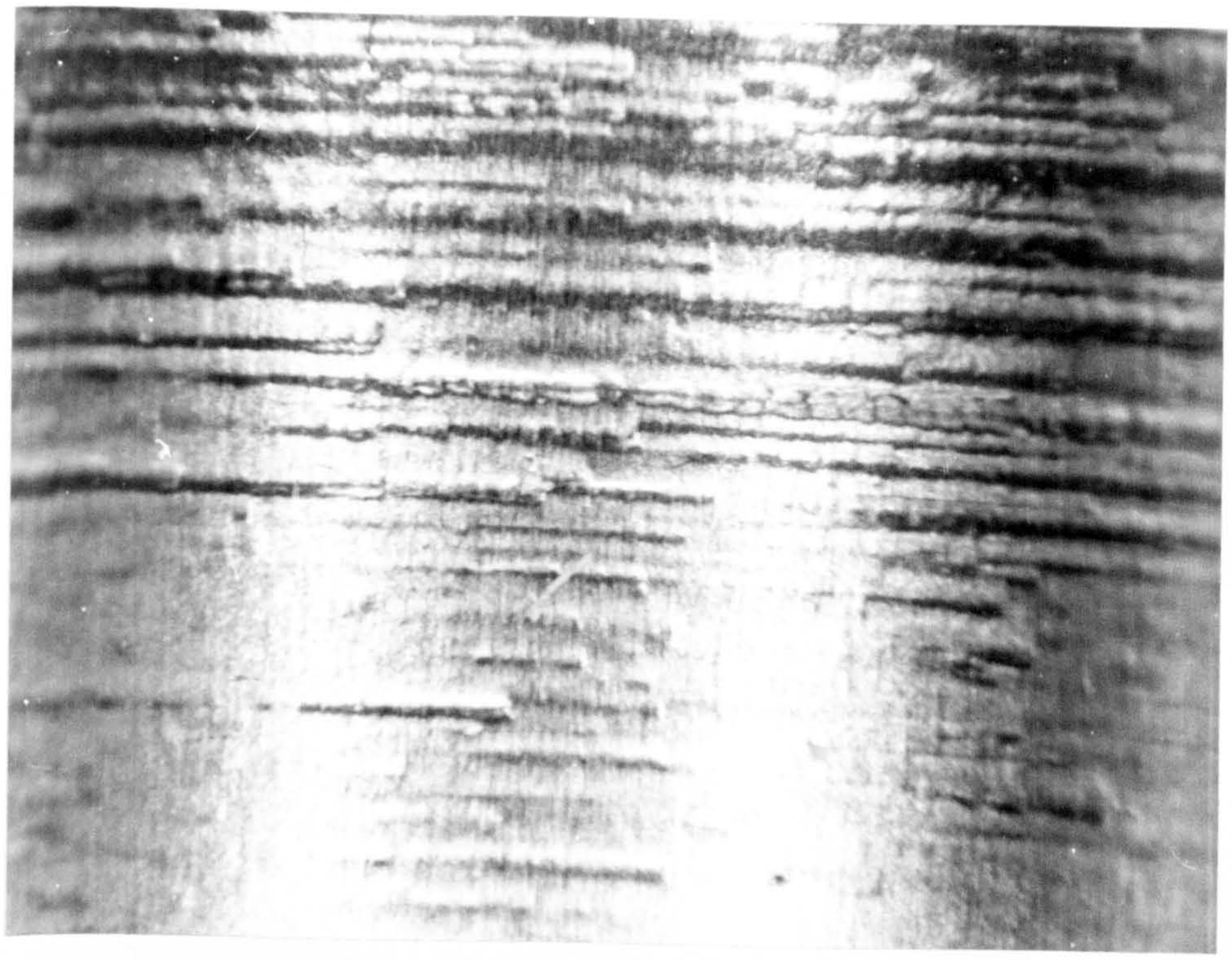


Figure 59(e) : Illustration of the die surface condition after 10 extrusion cycles using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 59(f) : Illustration of the die surface condition after 30 extrusion cycles using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



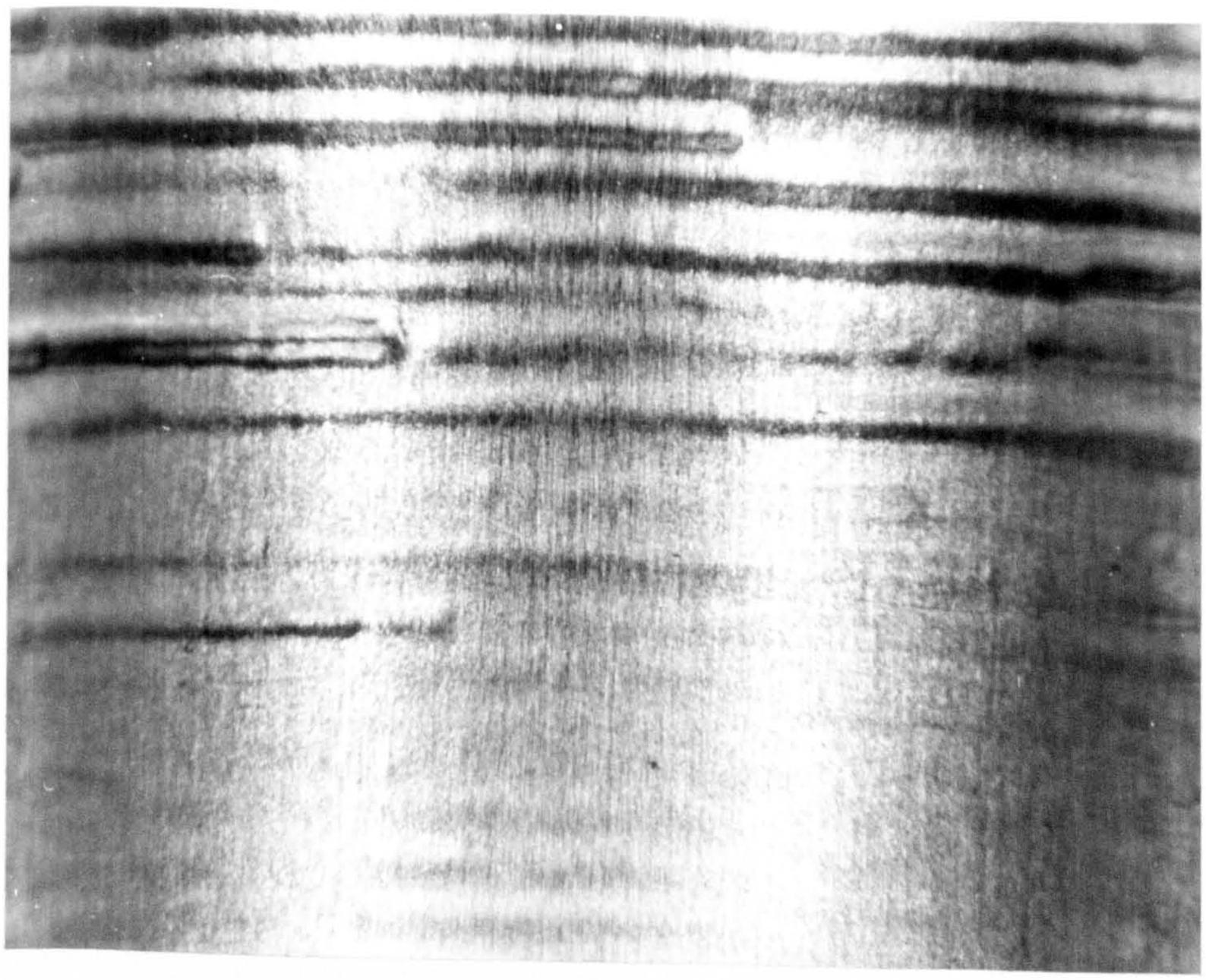
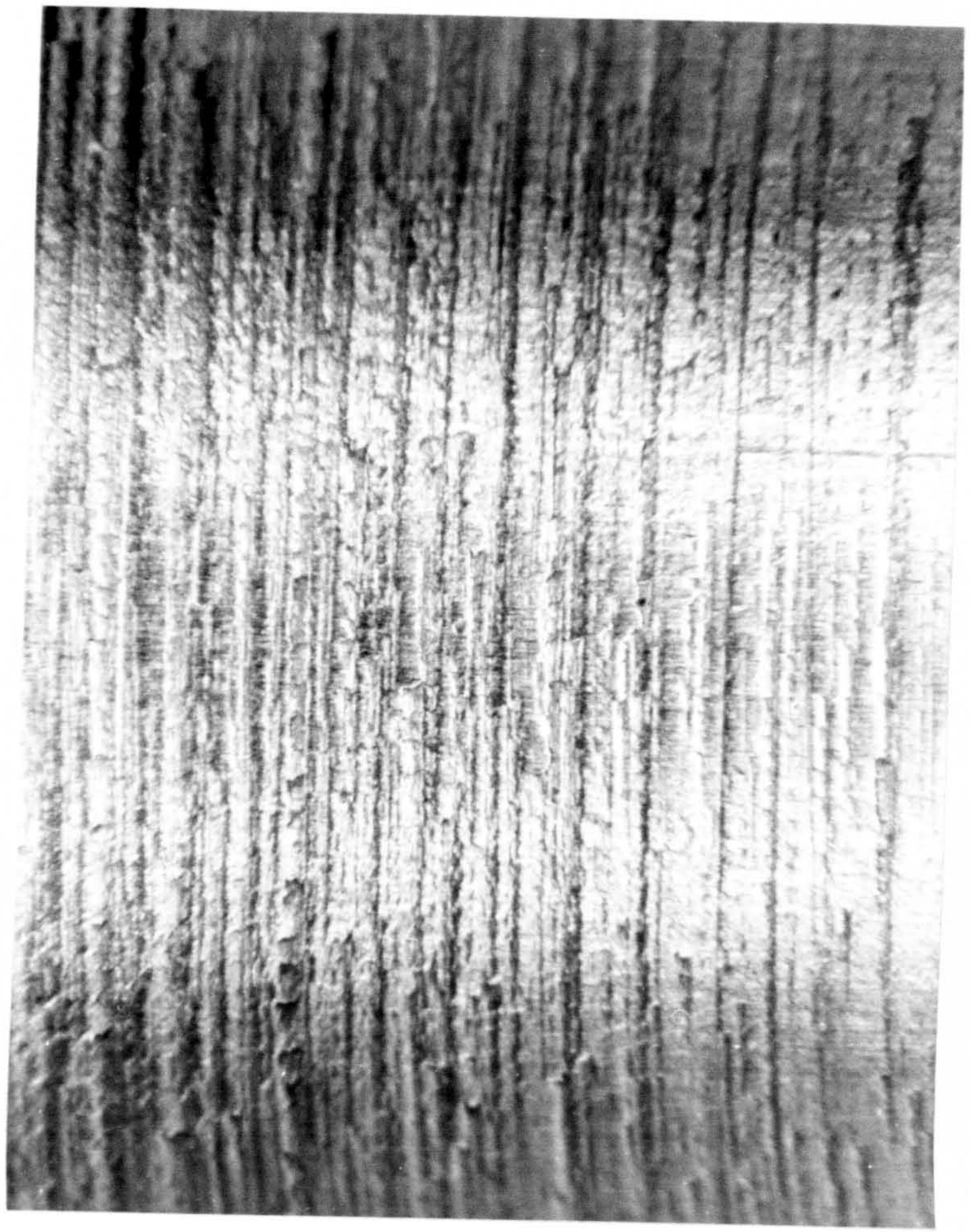


Figure 60(a) : Illustration of the die surface condition after 1 extrusion cycle using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 60(b) : Illustration of the die surface condition after 2 extrusion cycles using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



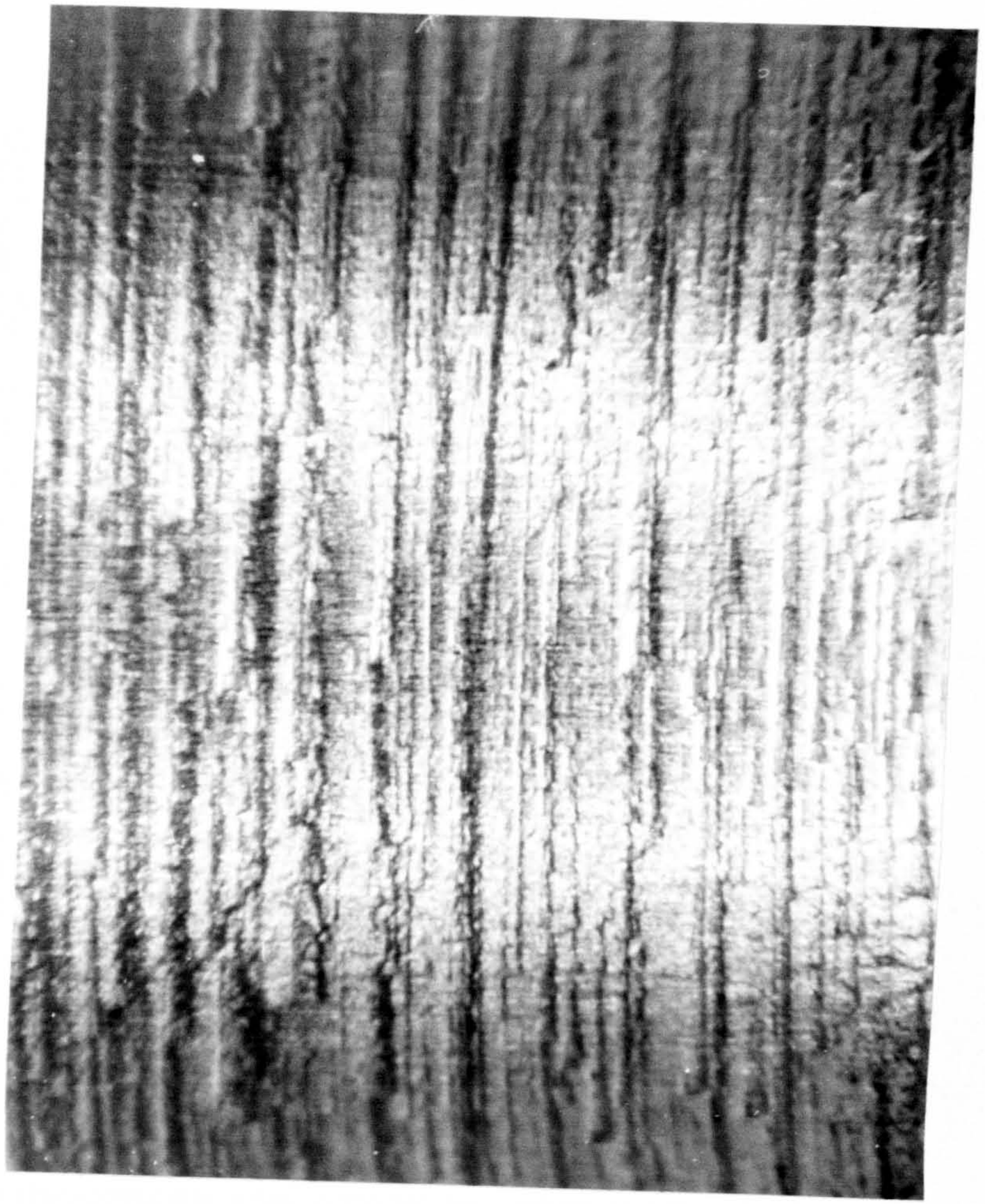
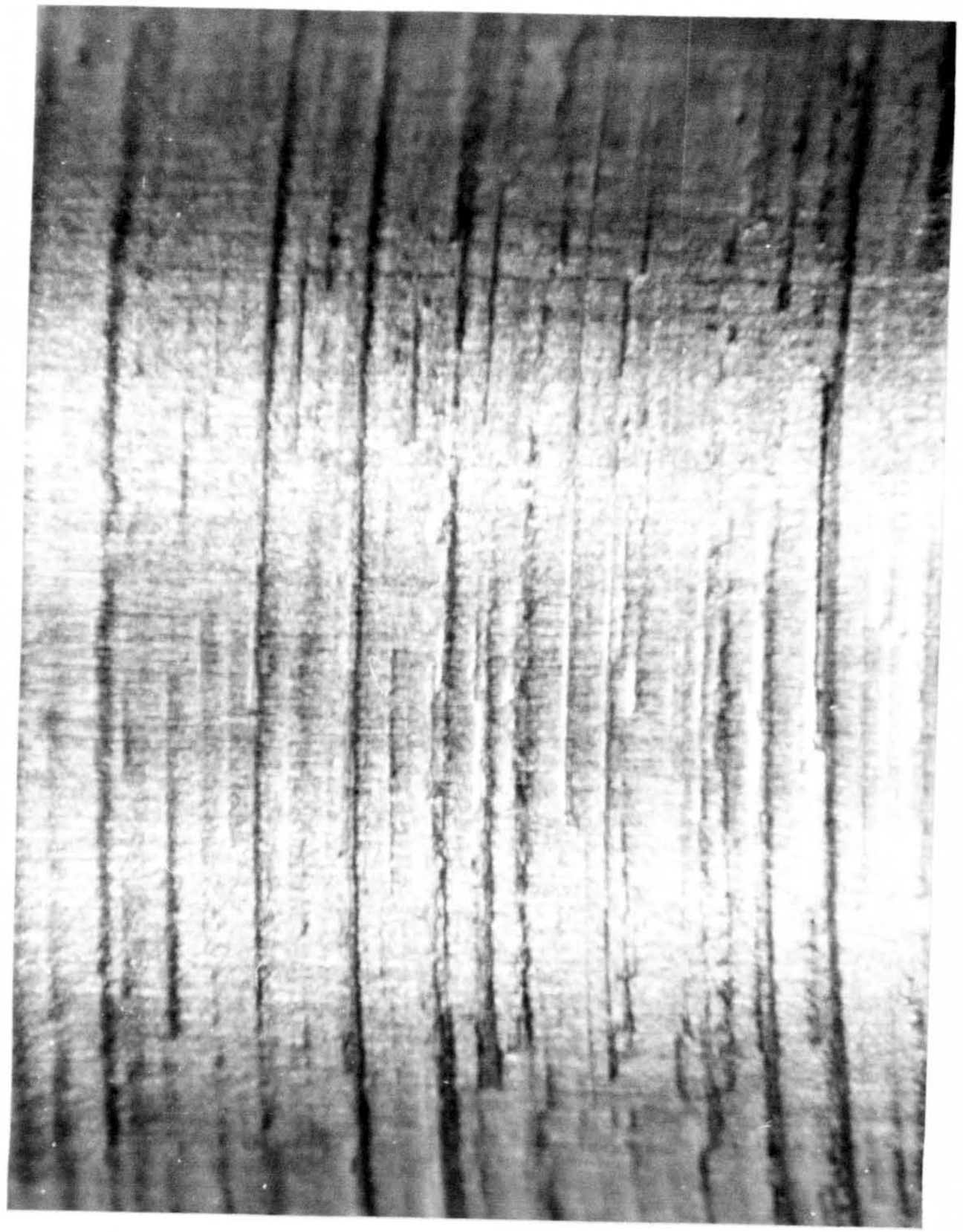


Figure 60(c) : Illustration of the die surface condition after 3 extrusion cycles using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 60(d) : Illustration of the die surface condition after 5 extrusion cycles using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



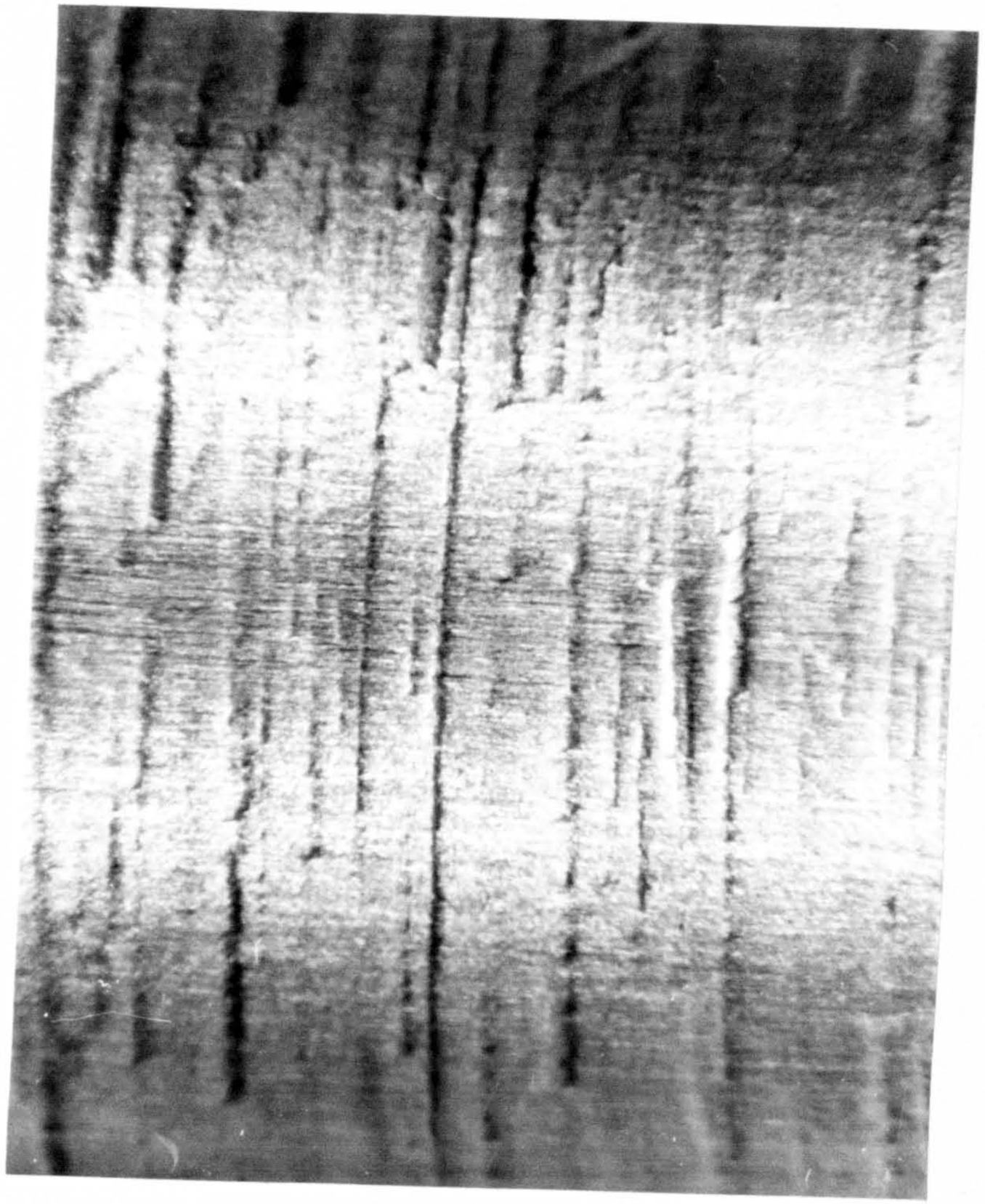
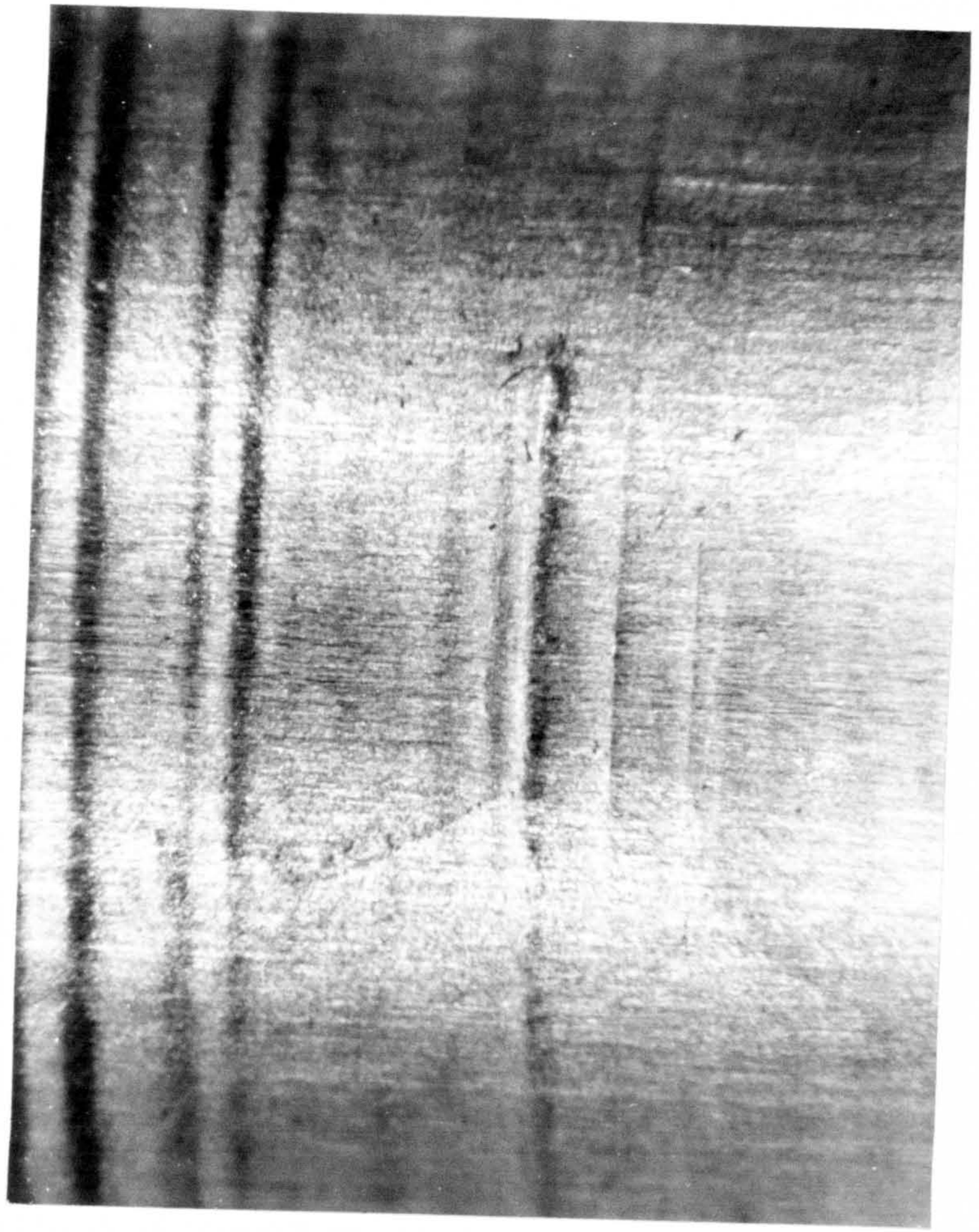


Figure 60(e) : Illustration of the die surface condition after 10 extrusion cycles using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 60(f) : Illustration of the die surface condition after 30 extrusion cycles using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



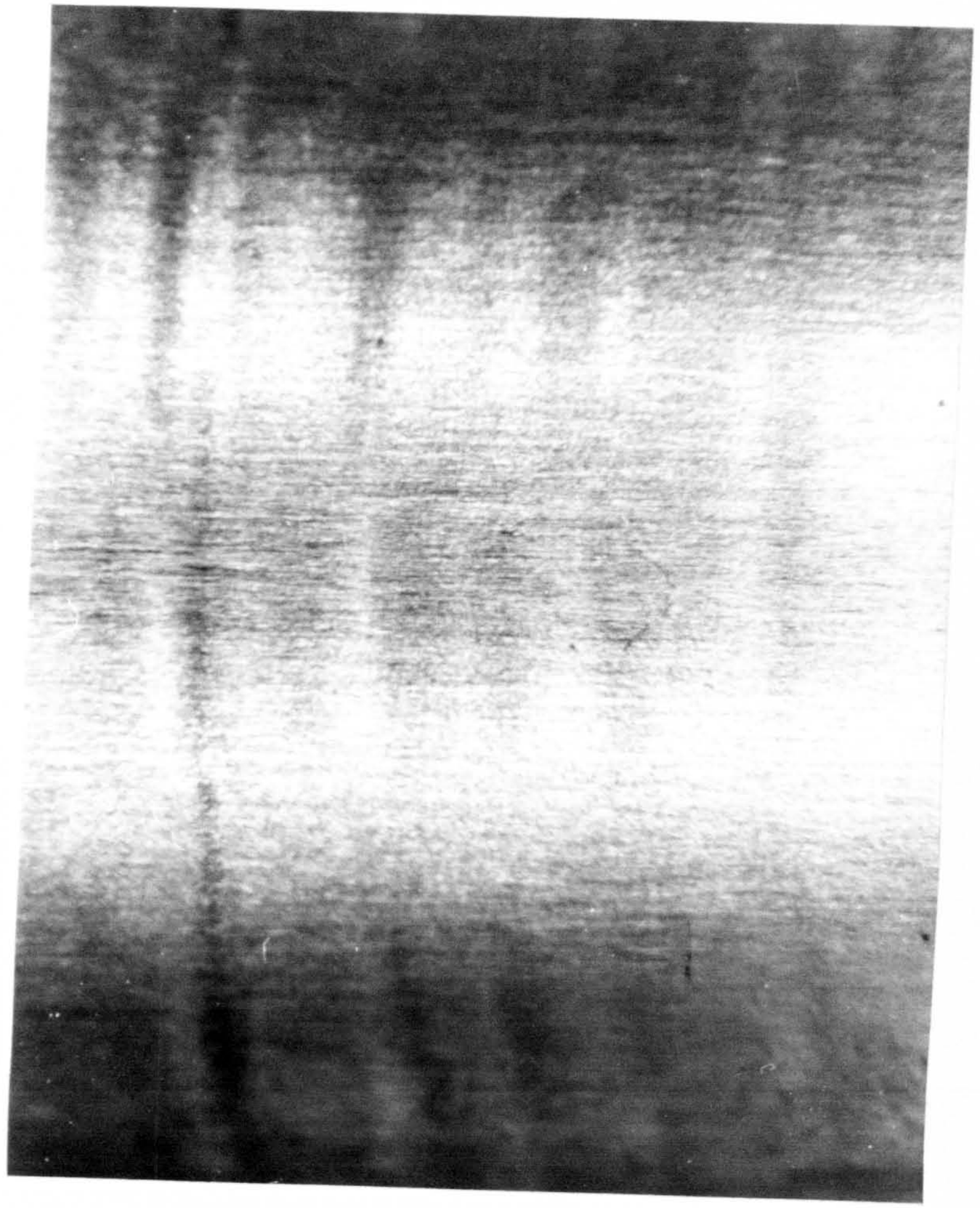
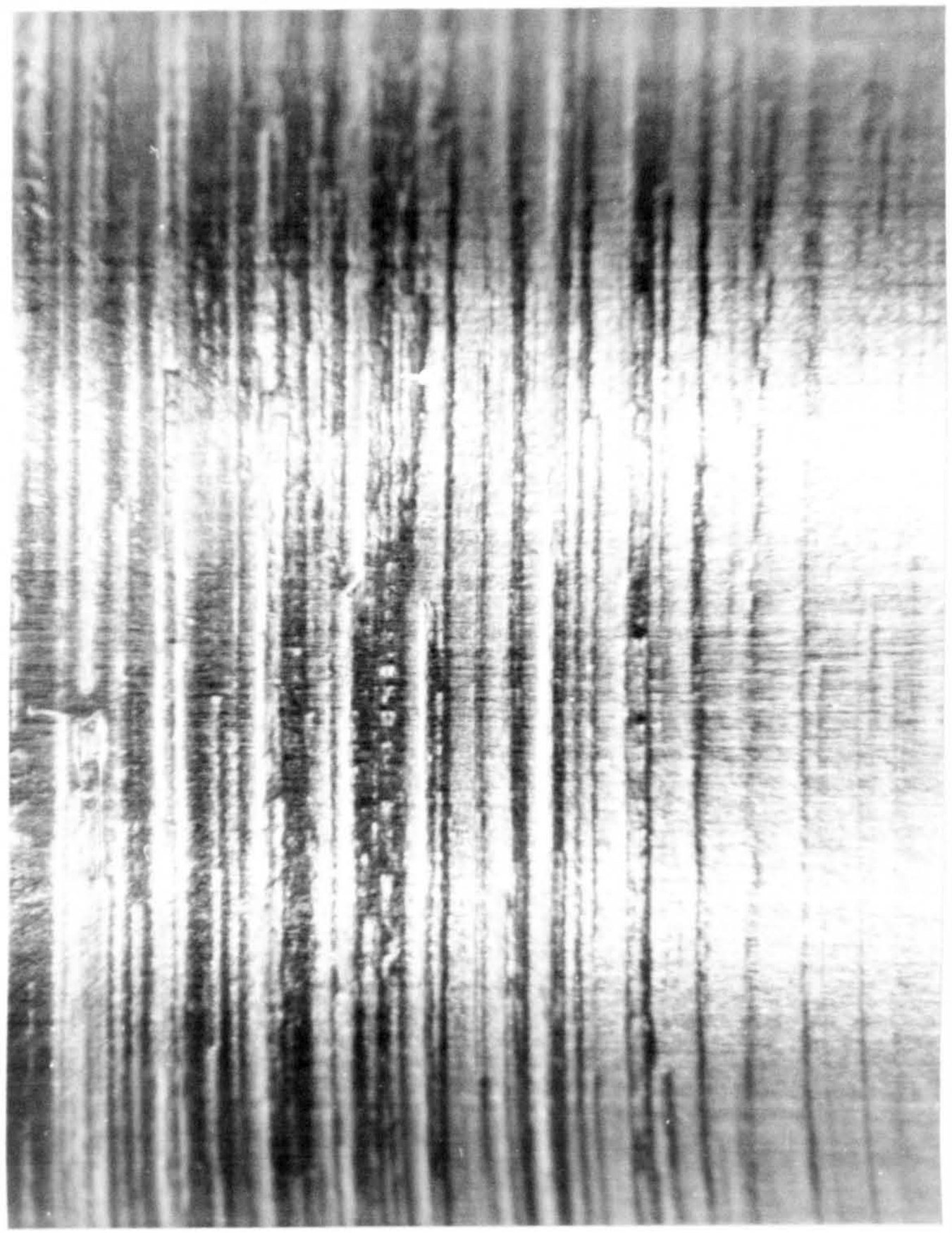


Figure 61(a) : Illustration of the die surface condition after 1 extrusion cycle using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 61(b) : Illustration of the die surface condition after 2 extrusion cycles using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



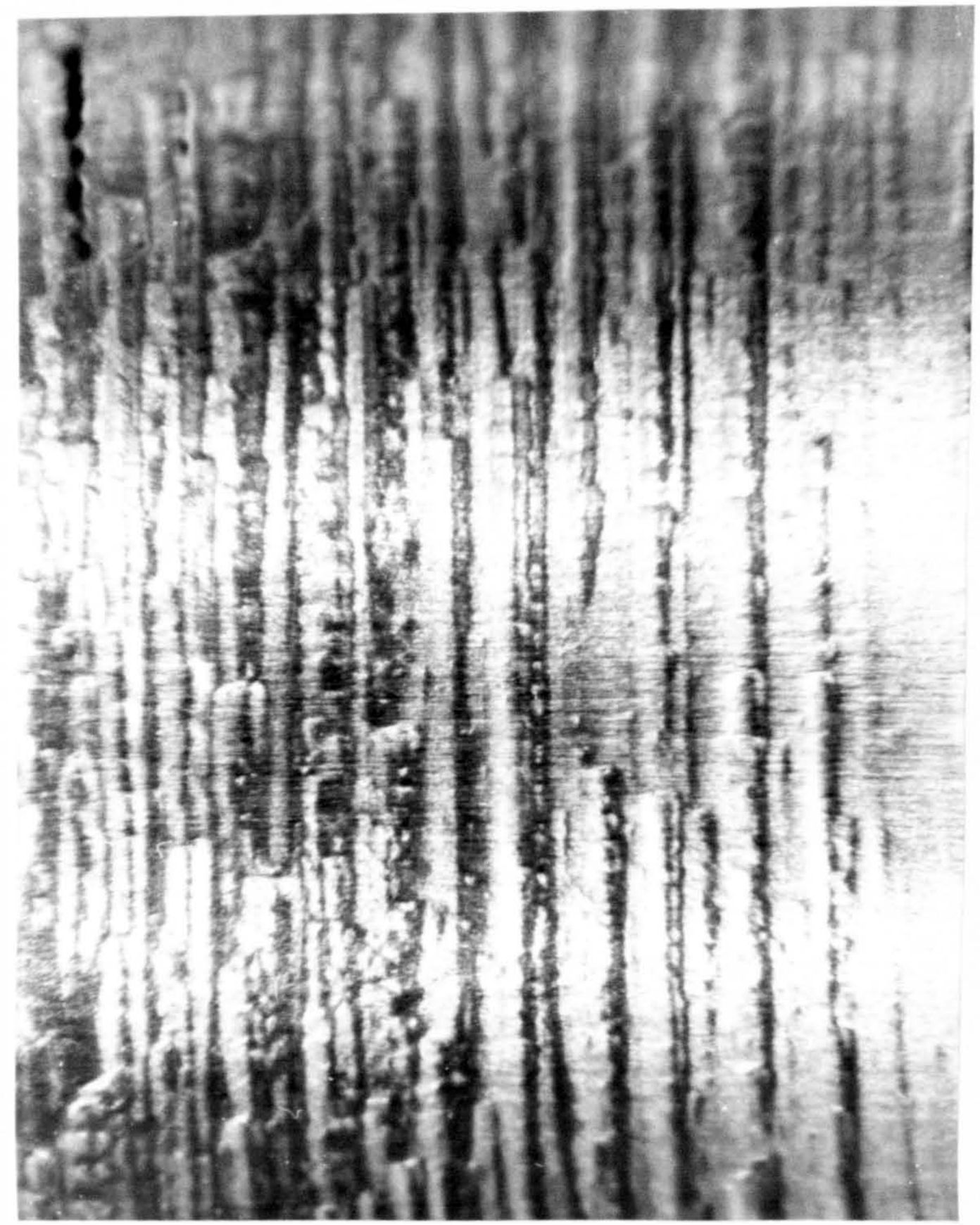
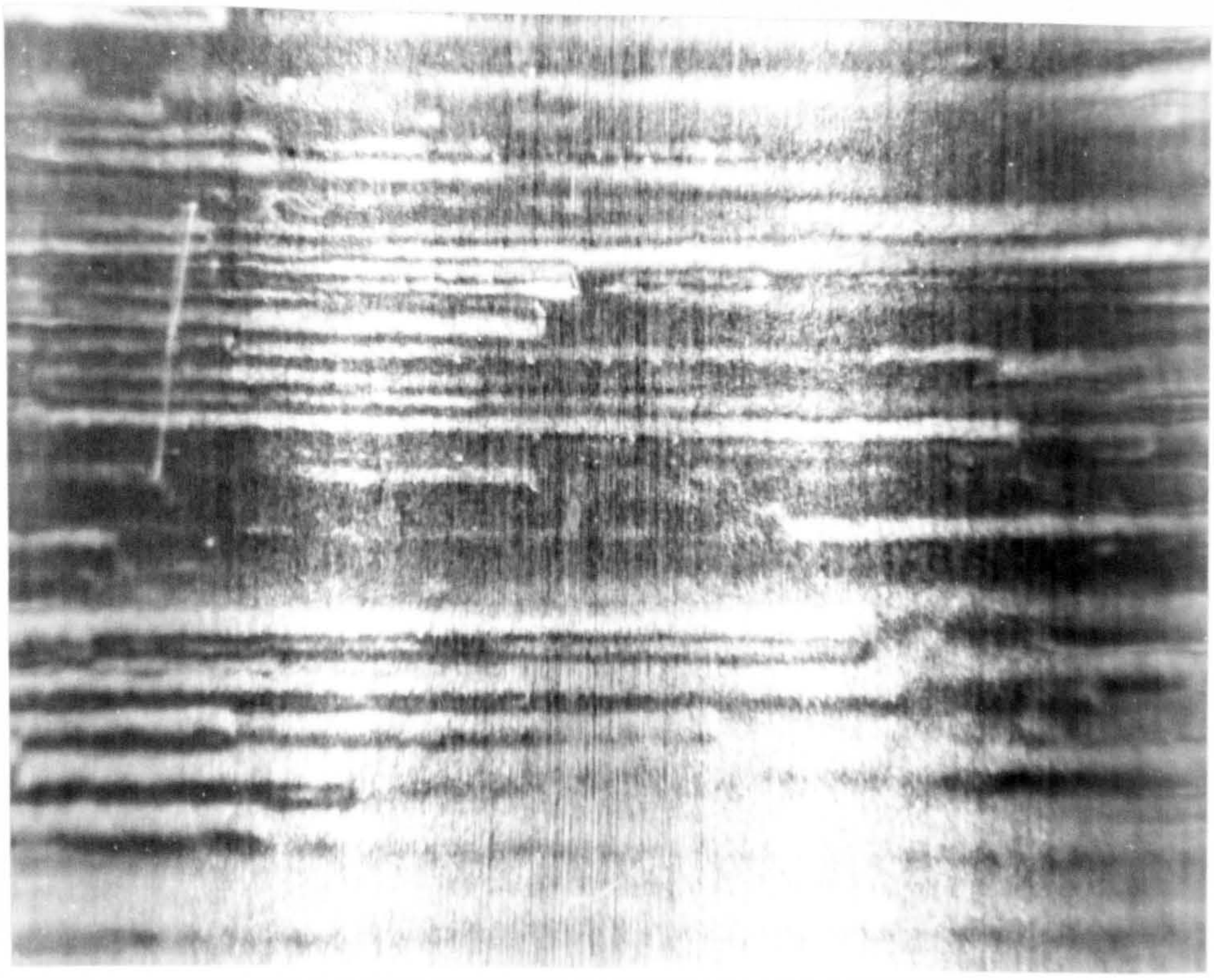


Figure 61(c) : Illustration of the die surface condition after 3 extrusion cycles using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 61(d) : Illustration of the die surface condition after 5 extrusion cycles using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



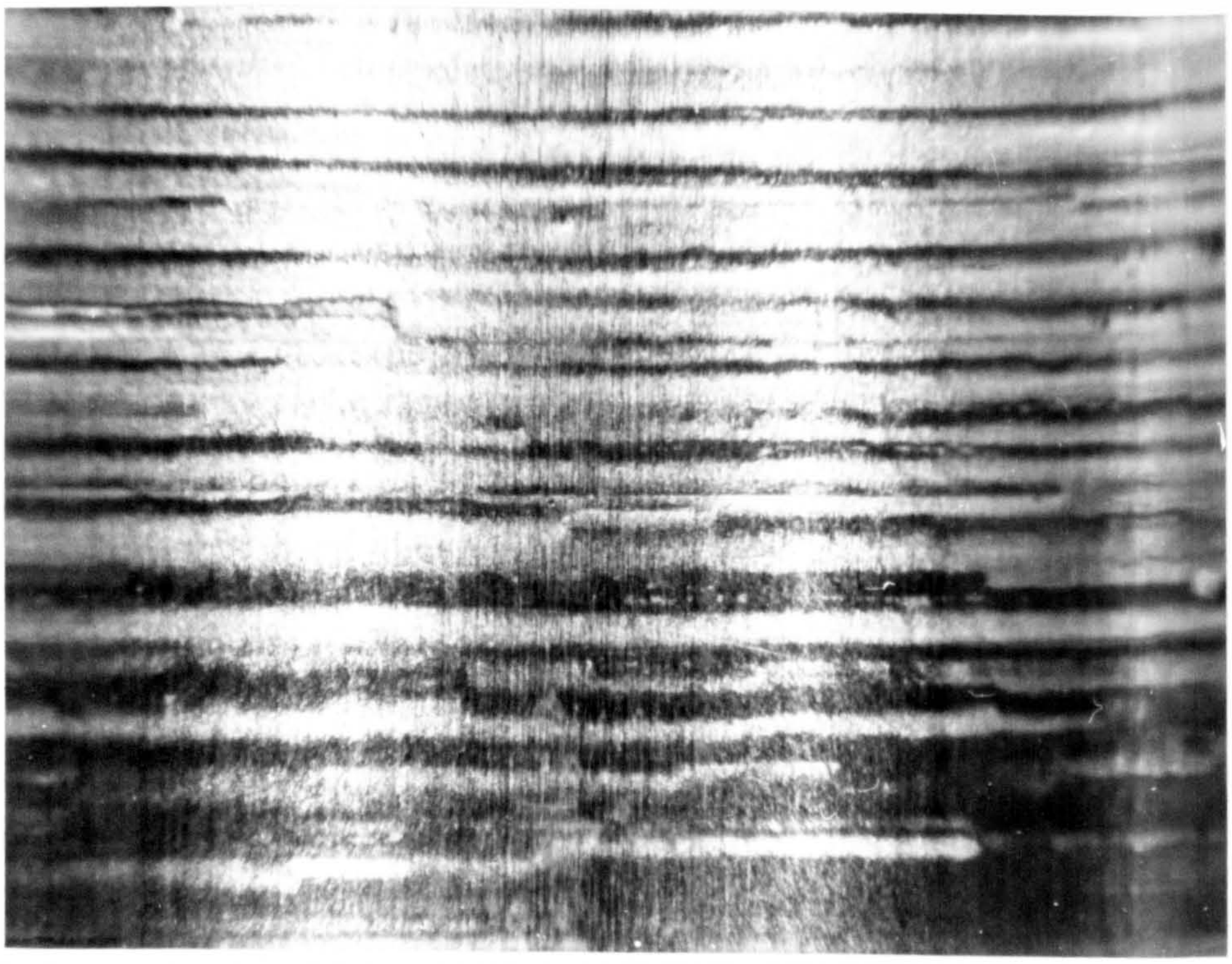
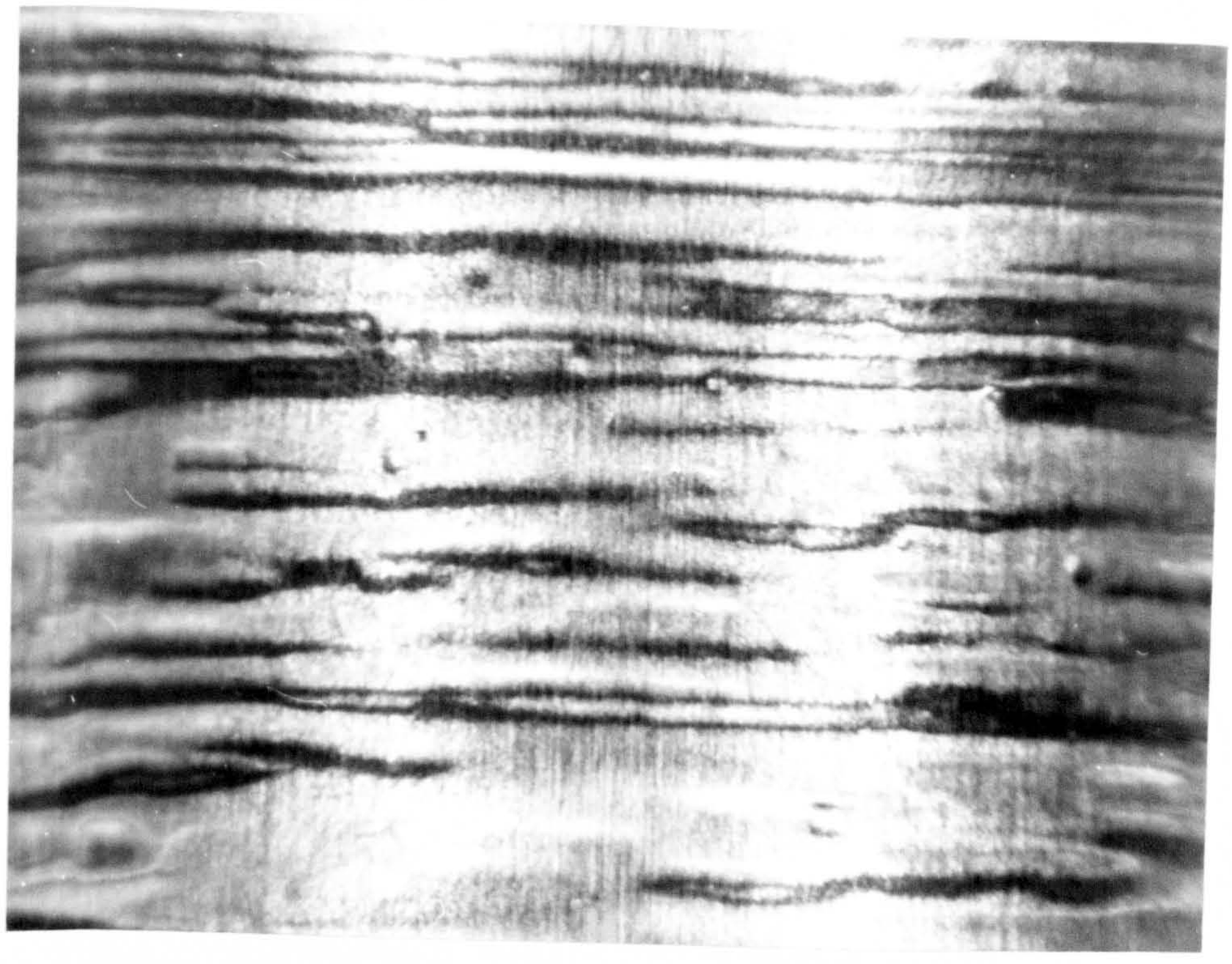


Figure 61(e) : Illustration of the die surface condition after 10 extrusion cycles using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 61(f) : Illustration of the die surface condition after 30 extrusion cycles using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



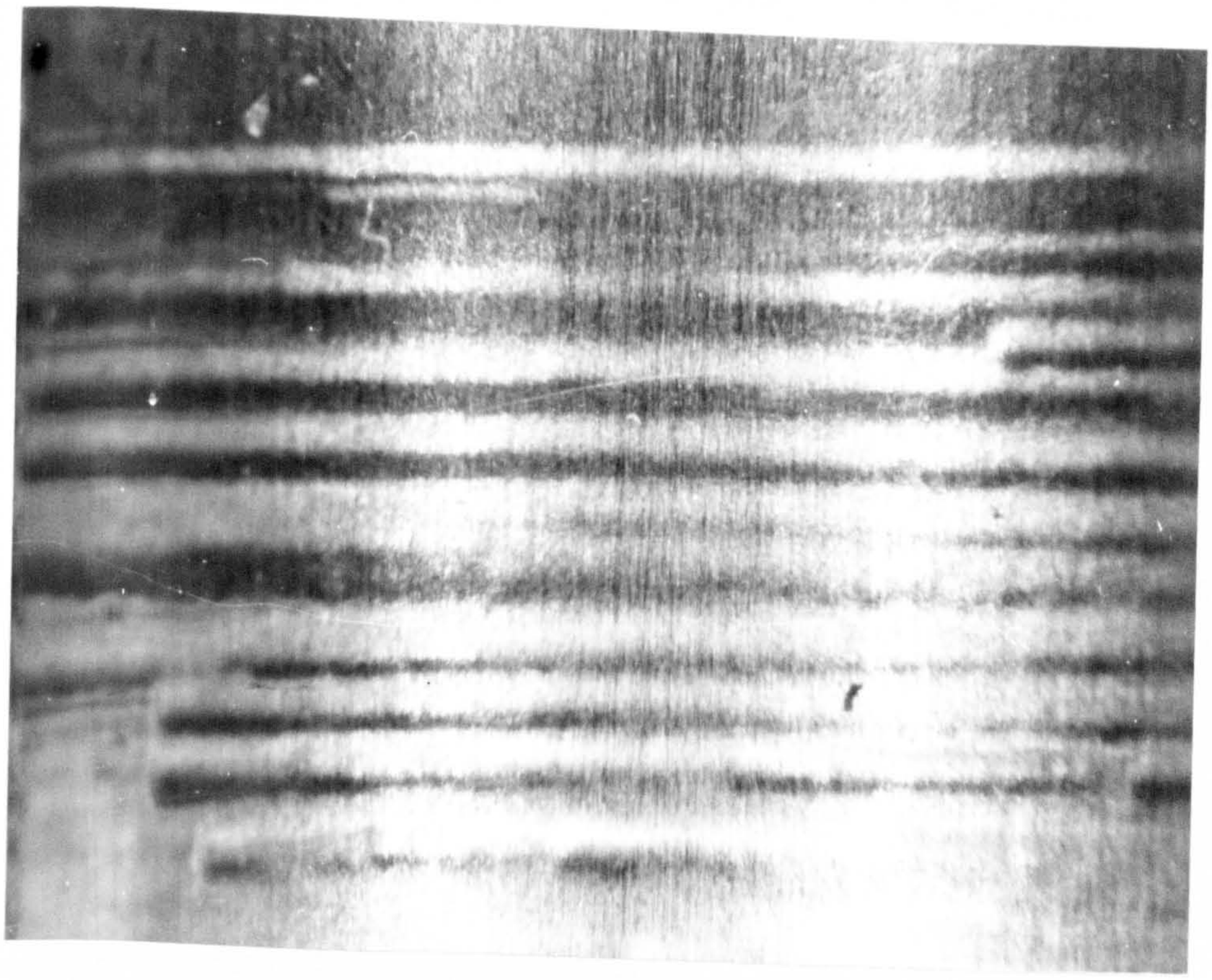
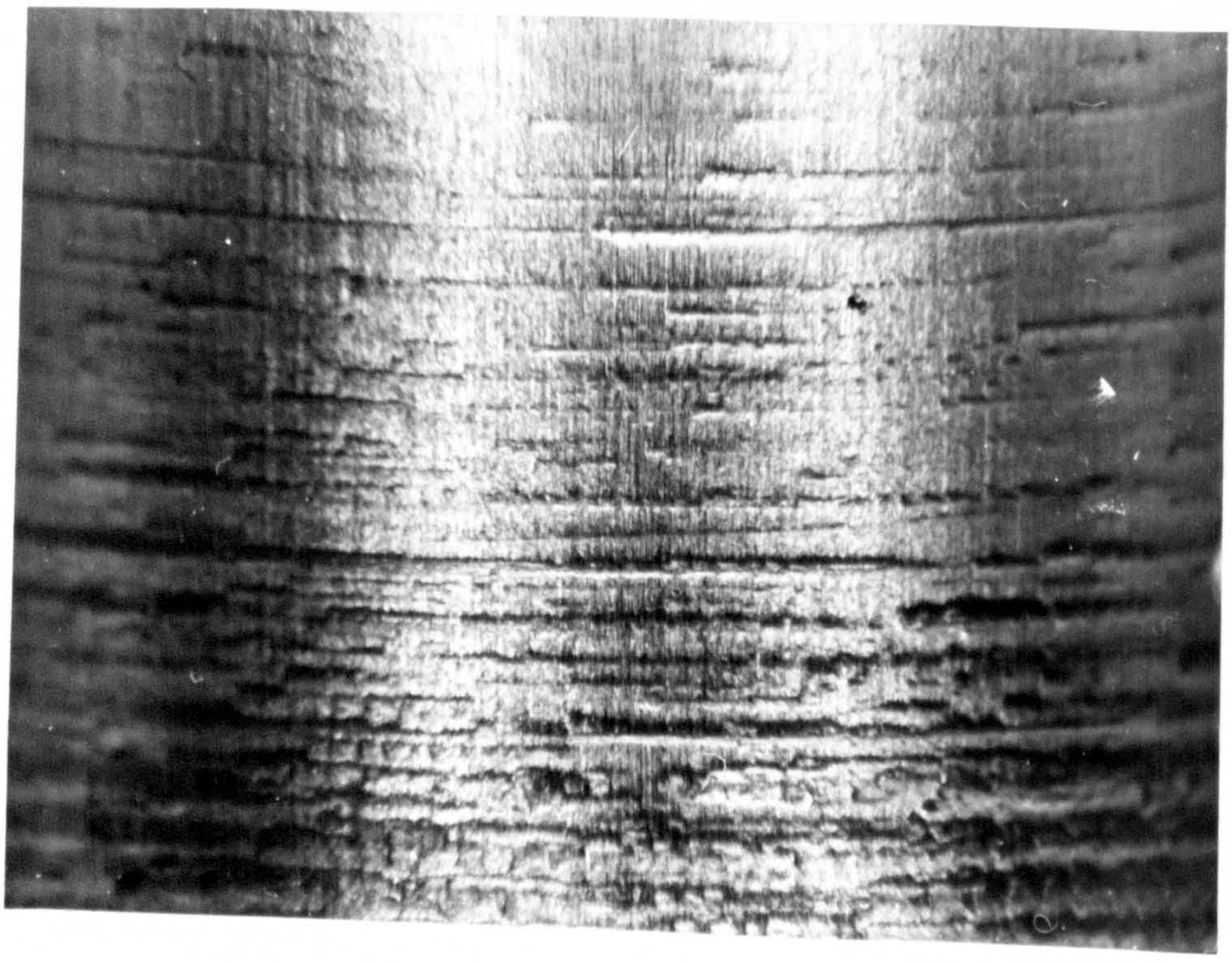


Figure 62(a) : Illustration of the die surface condition after 1 extrusion cycle using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 62(b) : Illustration of the die surface condition after 2 extrusion cycles using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



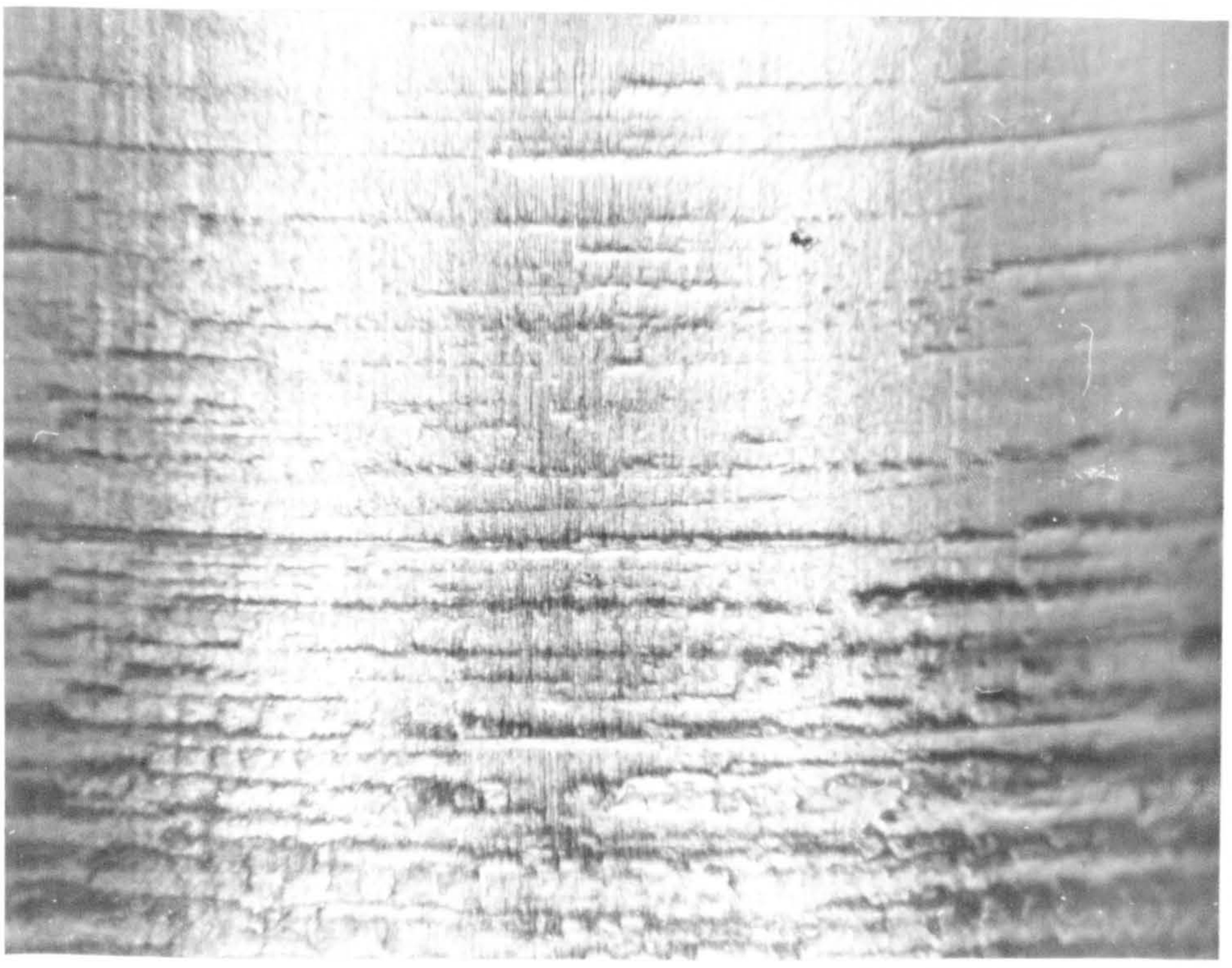
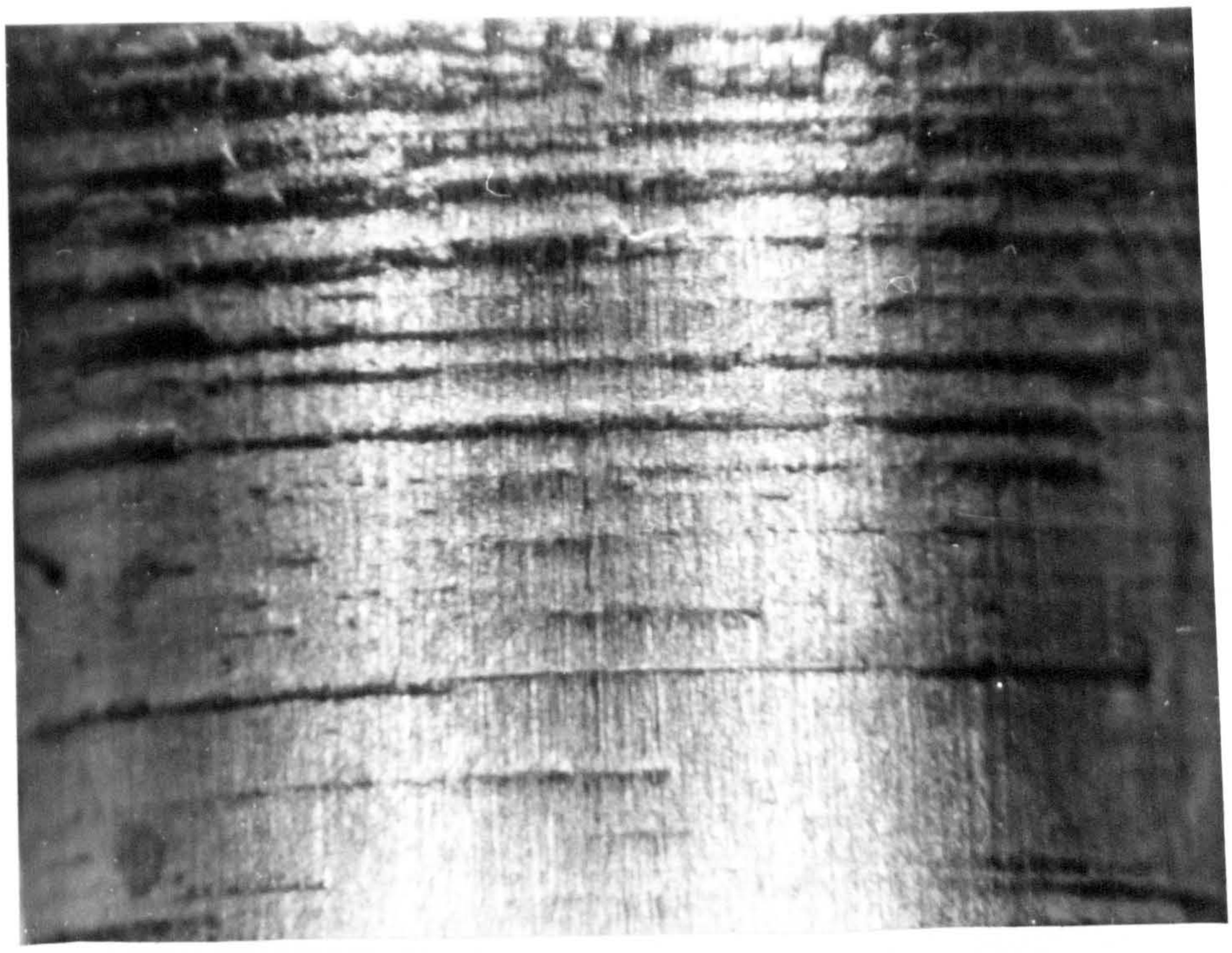


Figure 62(c) : Illustration of the die surface condition after 3 extrusion cycles using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 62(d) : Illustration of the die surface condition after 5 extrusion cycles using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



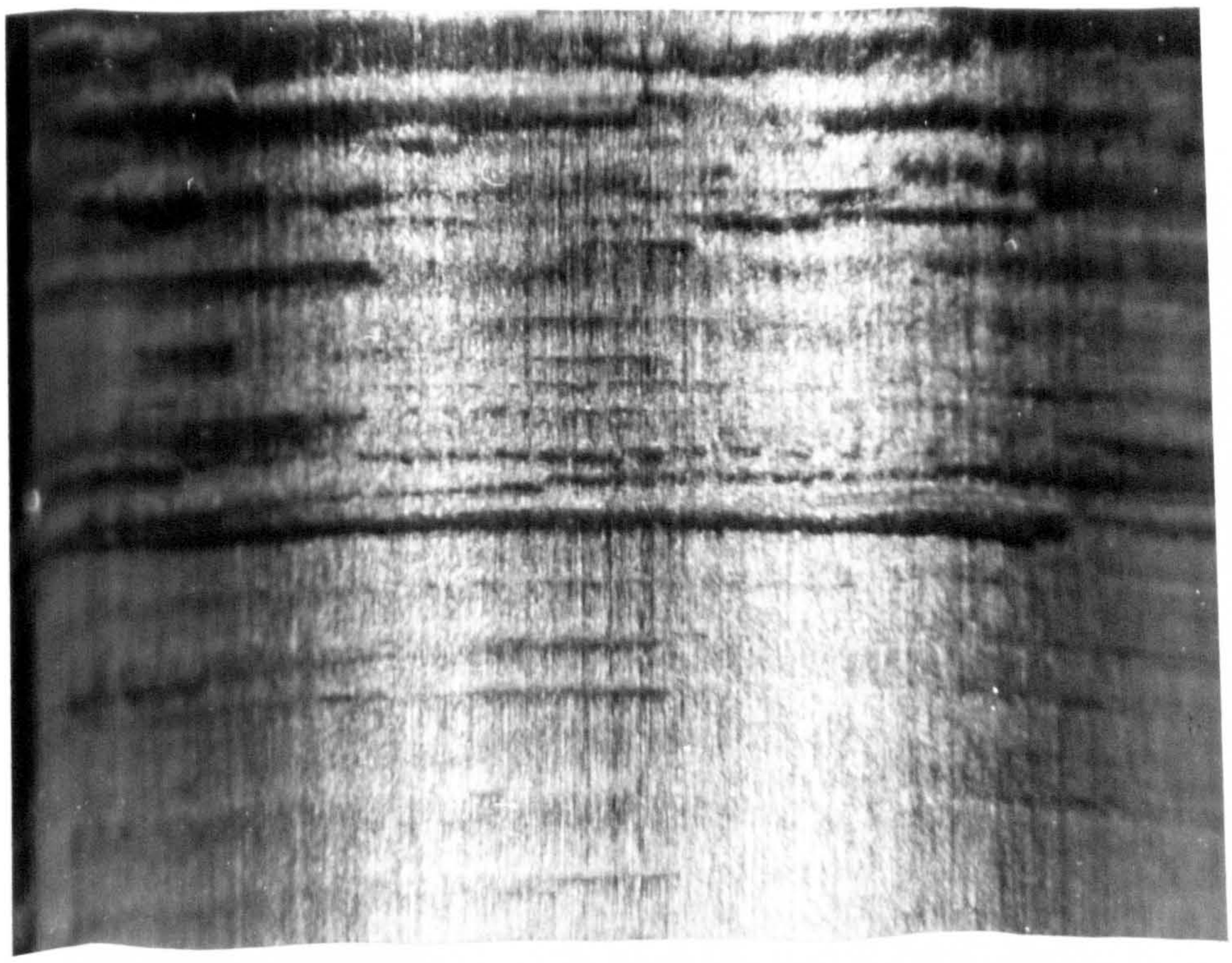
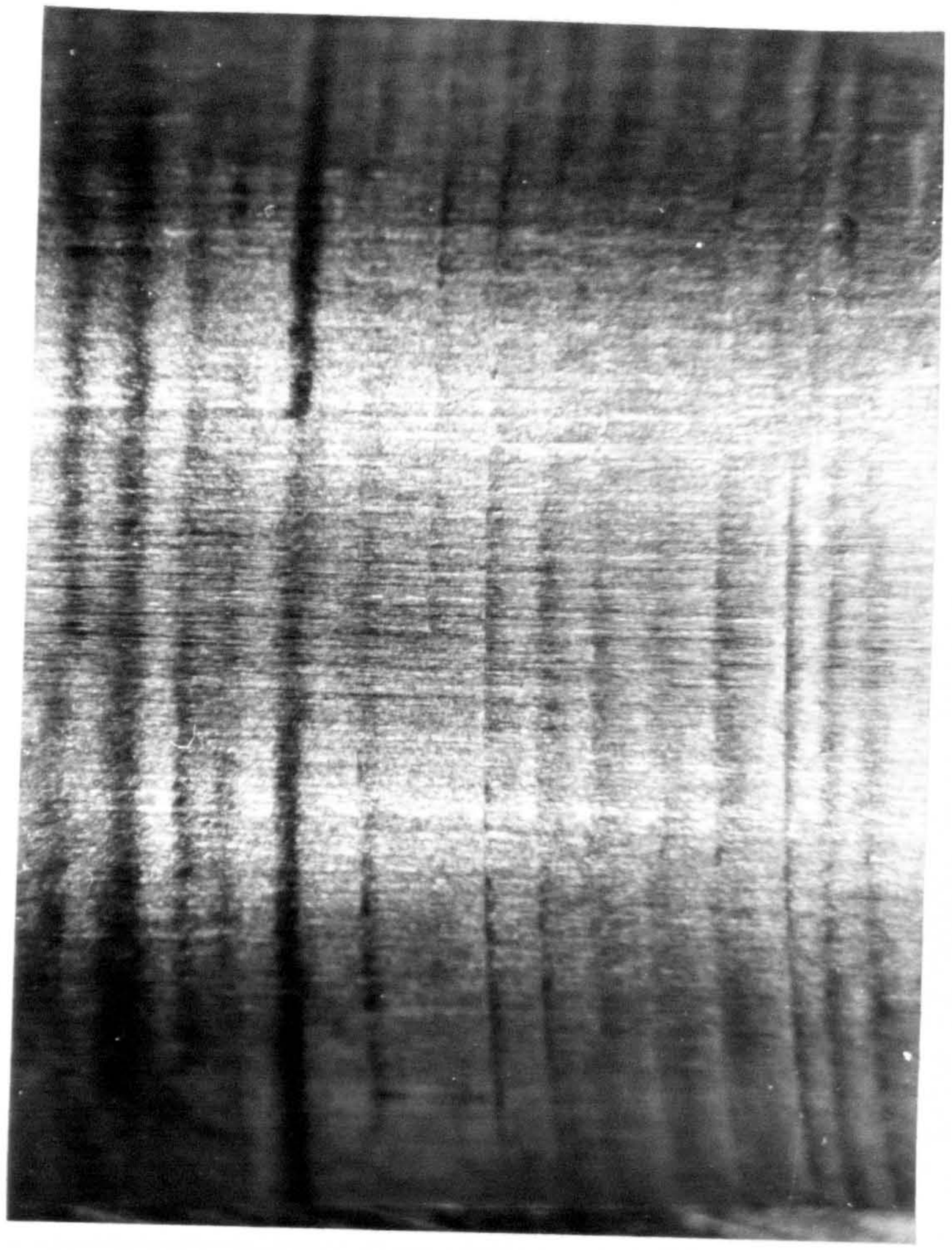


Figure 62(e) : Illustration of the die surface condition after 10 extrusion cycles using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 62(f) : Illustration of the die surface condition after 30 extrusion cycles using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



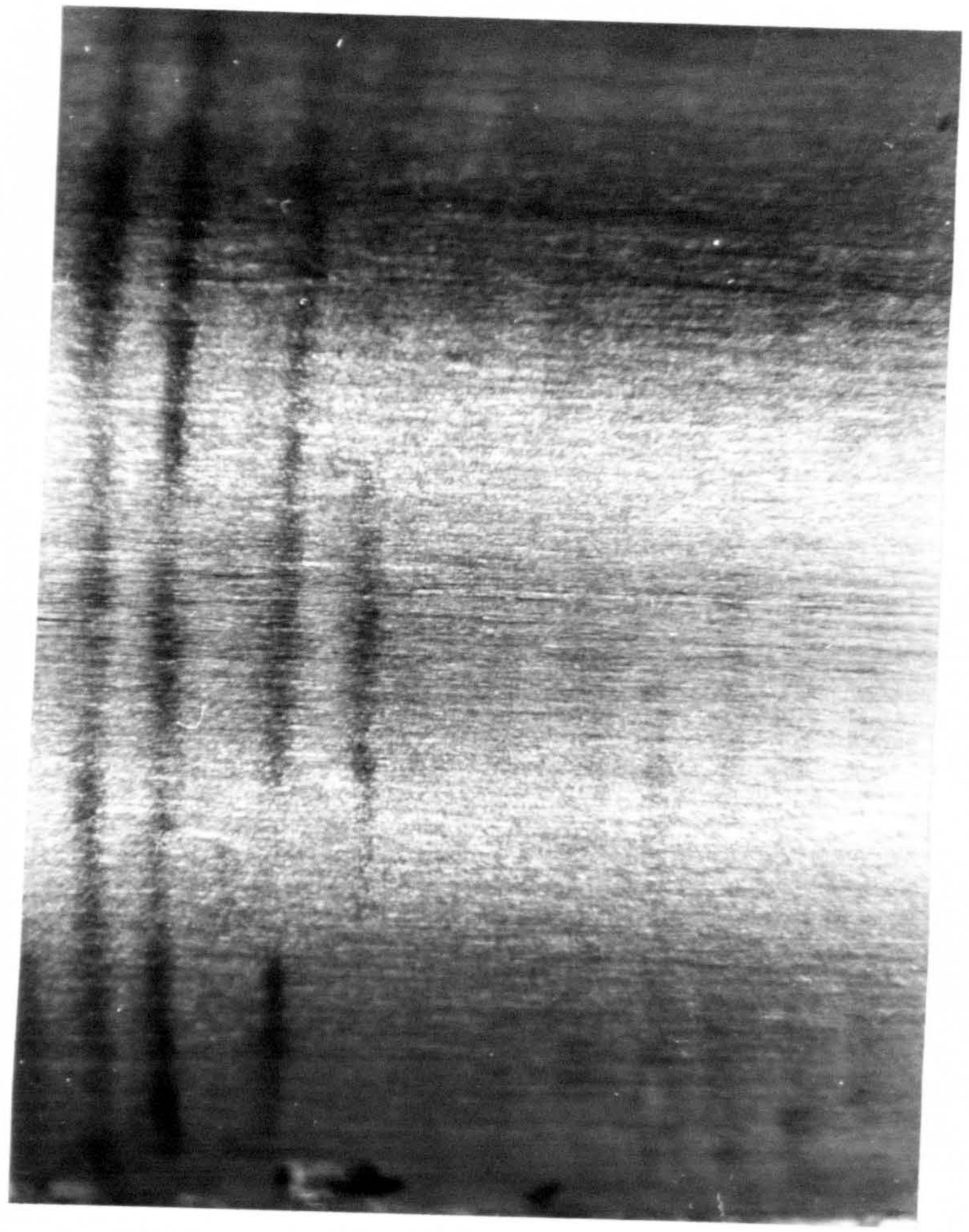
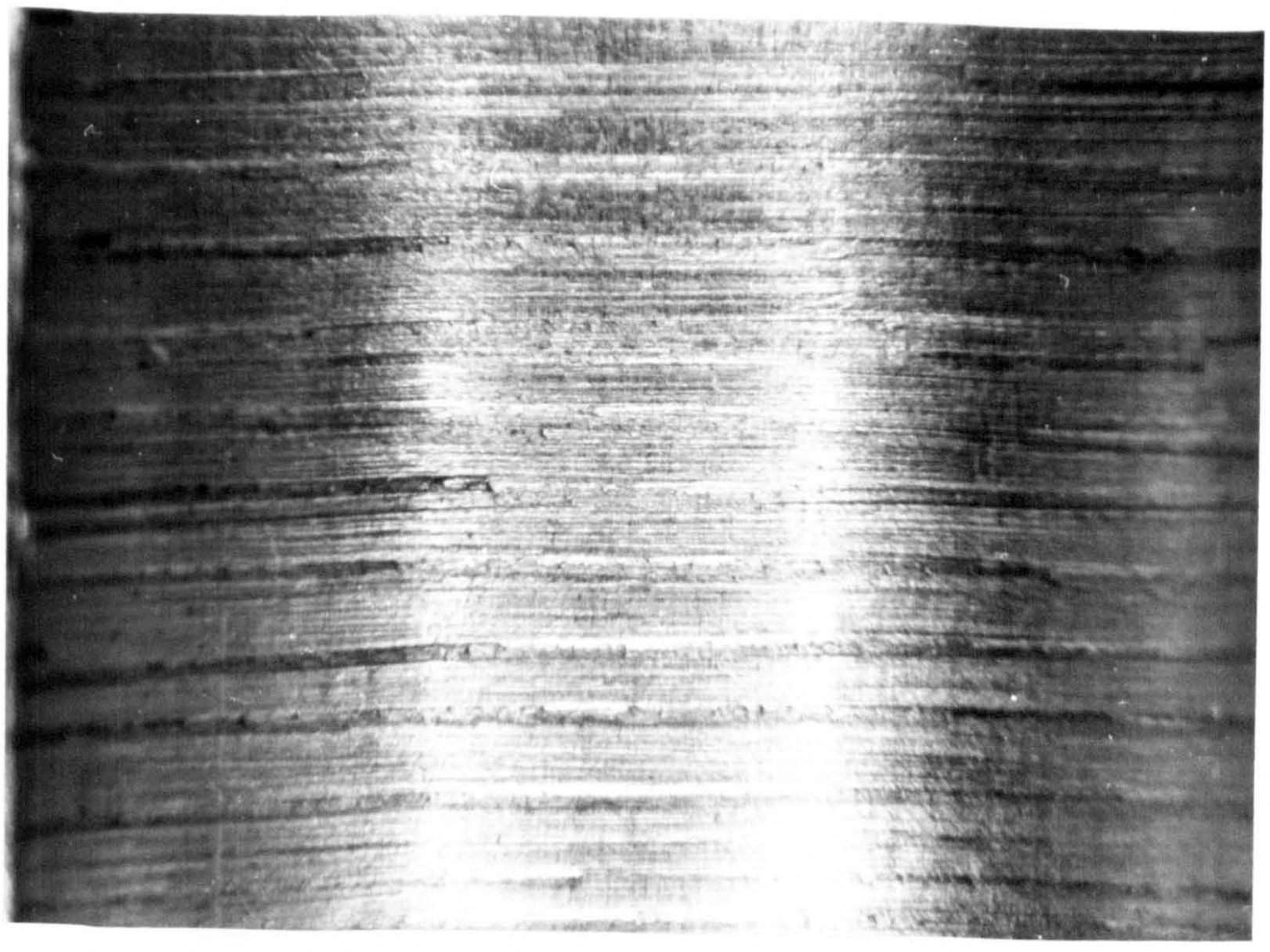


Figure 63(a) : Illustration of the die surface condition after 1 extrusion cycle using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 63(b) : Illustration of the die surface condition after 2 extrusion cycles using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



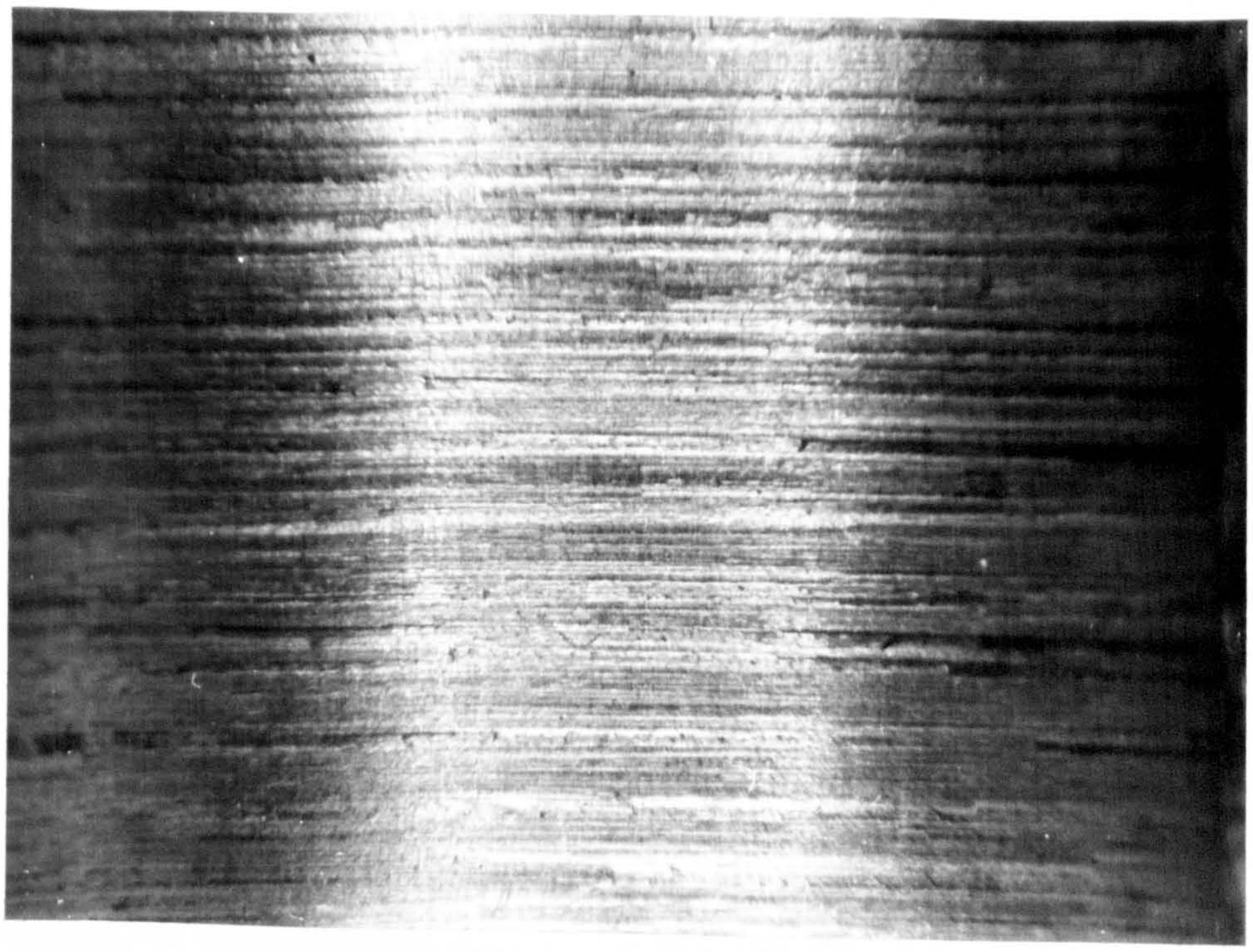
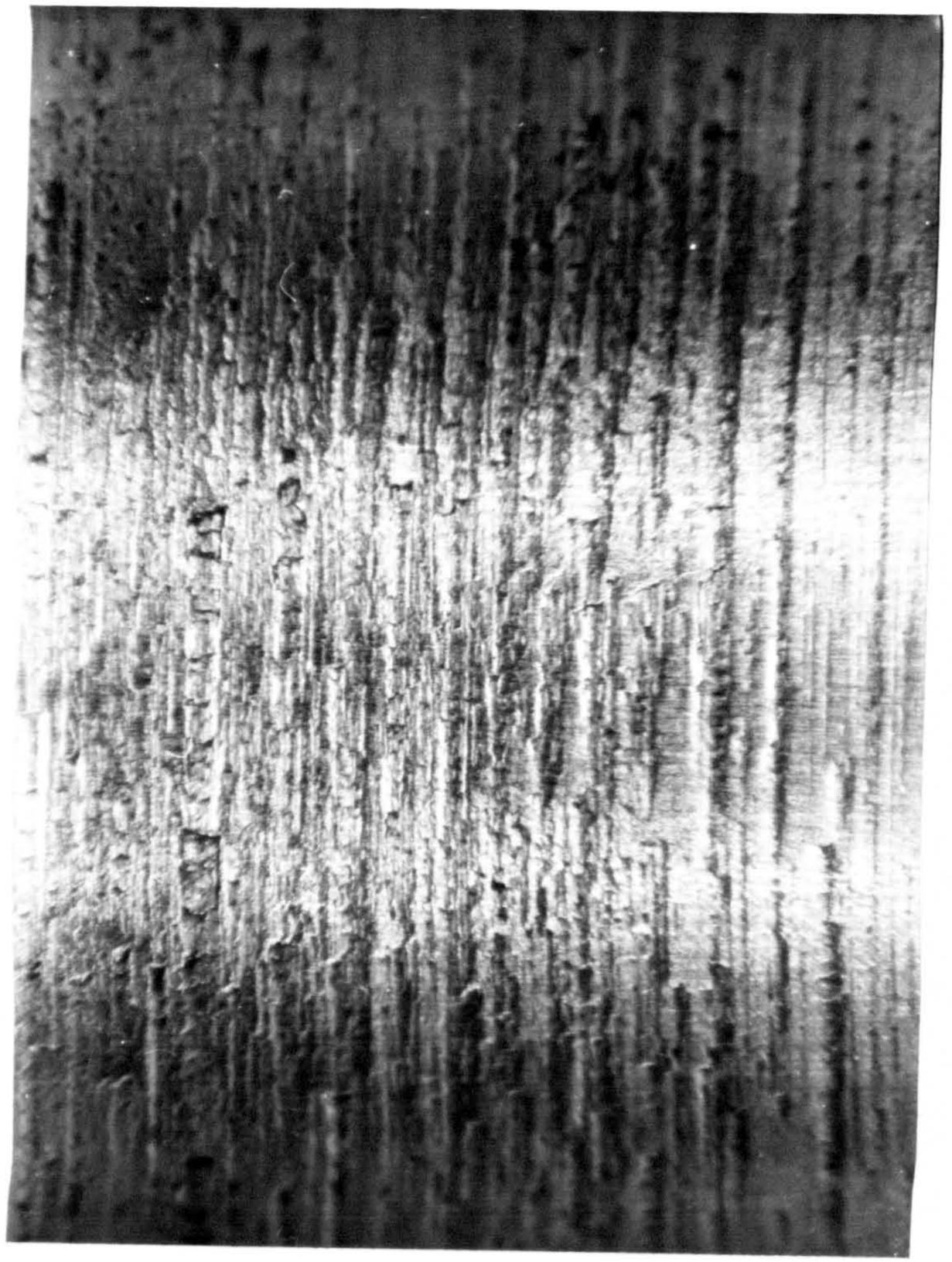


Figure 63(c) : Illustration of the die surface condition after 3 extrusion cycles using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 63(d) : Illustration of the die surface condition after 5 extrusion cycles using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



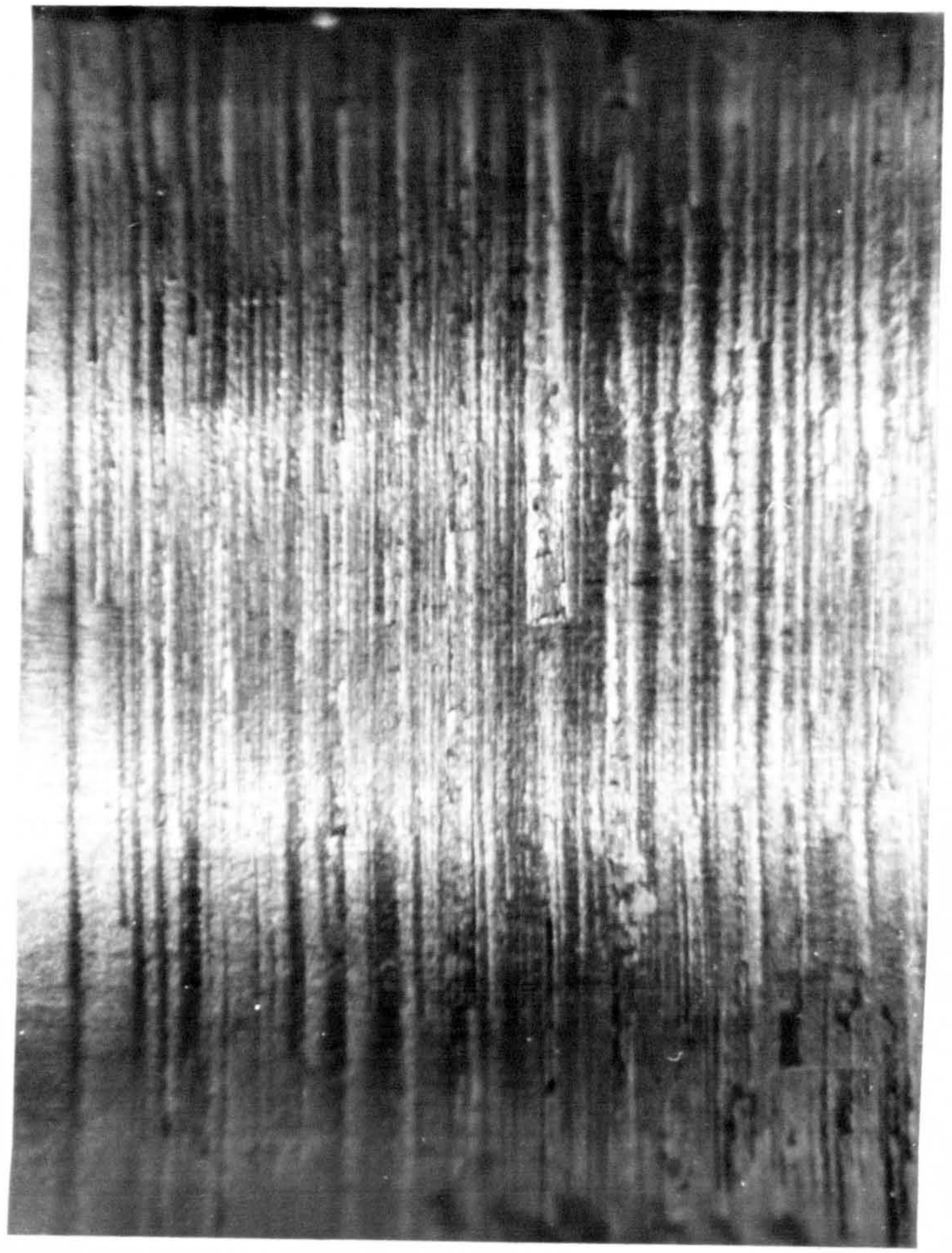
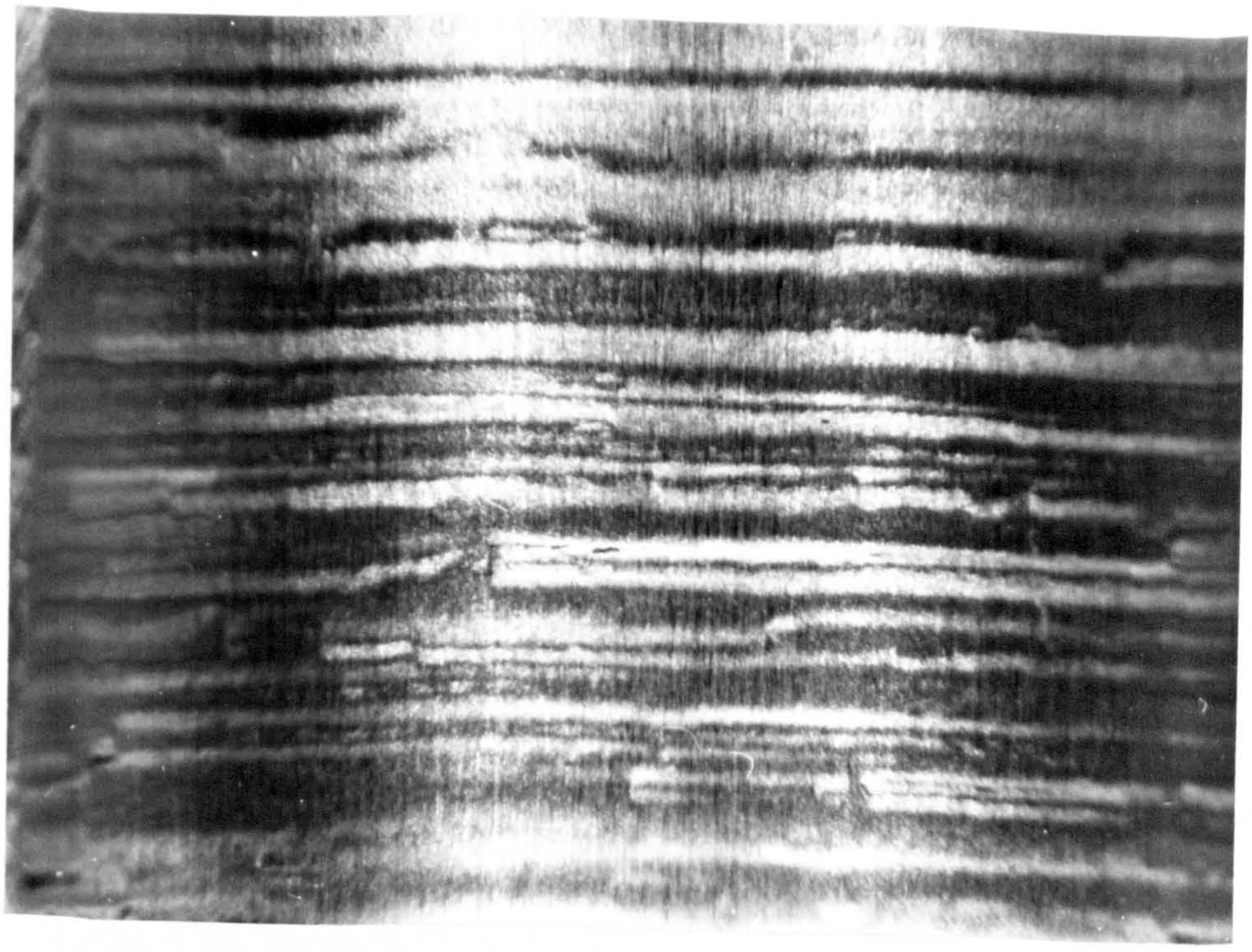


Figure 63(e) : Illustration of the die surface condition after 10 extrusion cycles using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 63(f) : Illustration of the die surface condition after 30 extrusion cycles using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

x 8



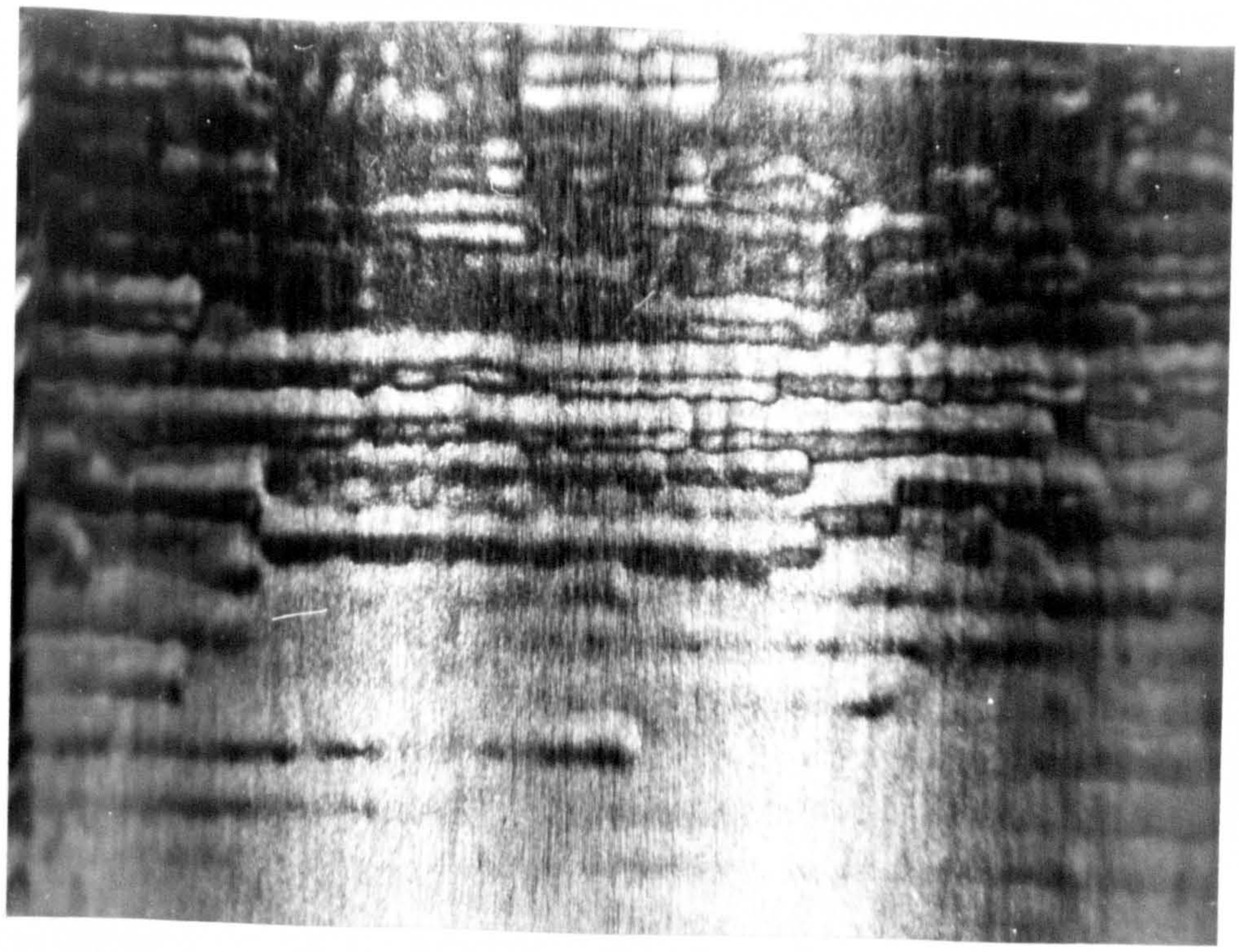
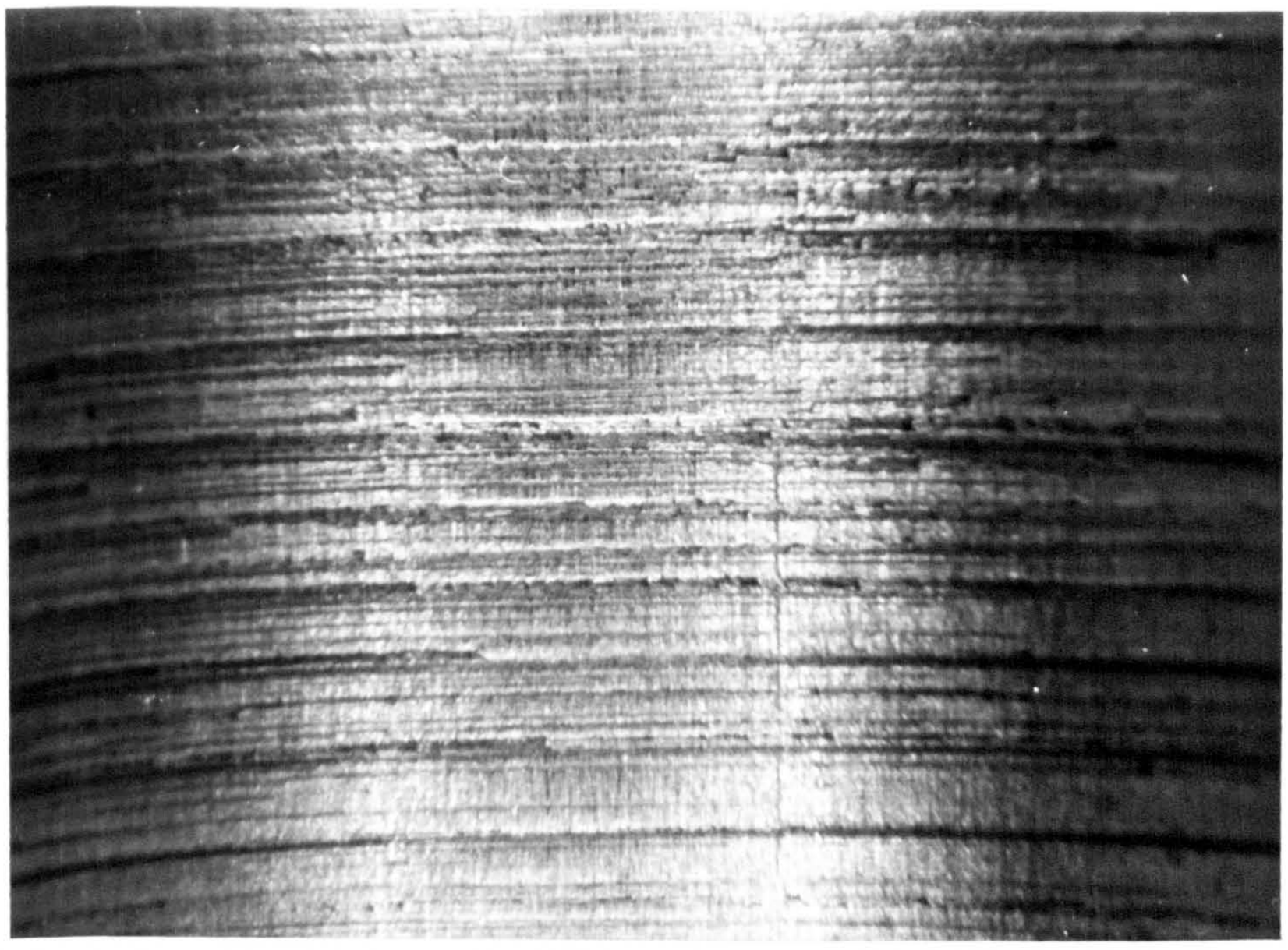


Figure 64(a) : Illustration of the die surface condition after 1 extrusion cycle using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 64(b) : Illustration of the die surface condition after 2 extrusion cycles using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



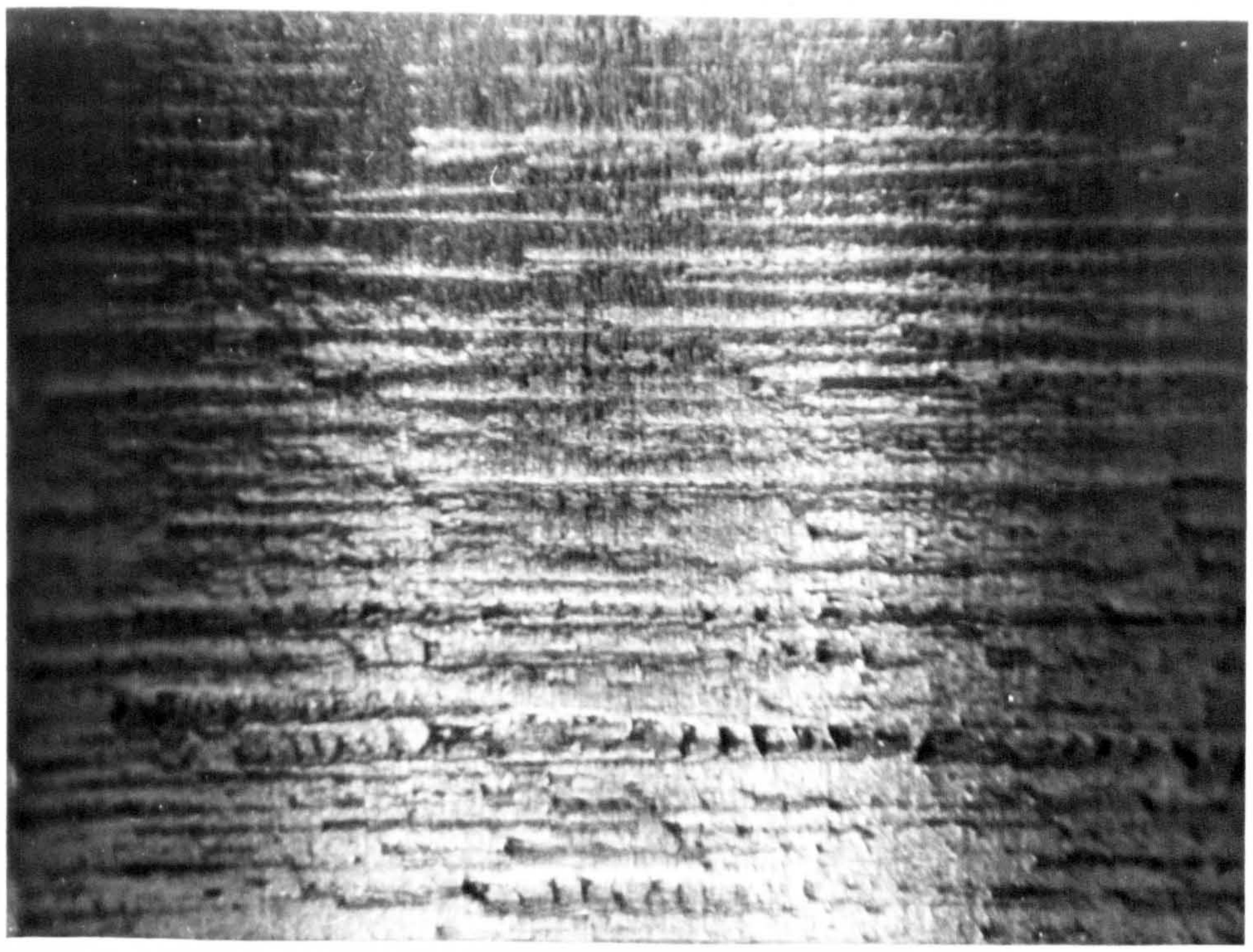
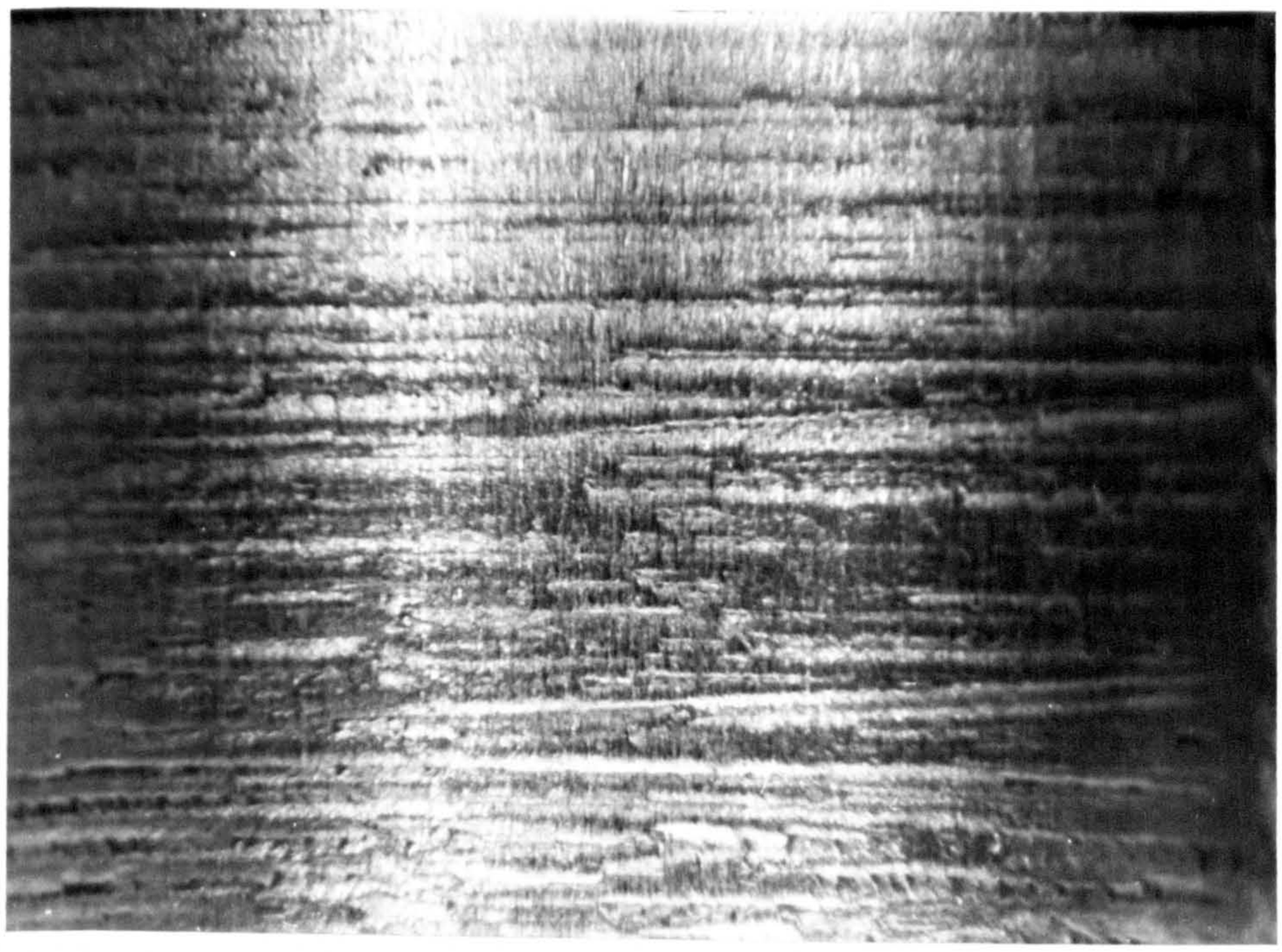


Figure 64(c) : Illustration of the die surface condition after 3 extrusion cycles using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 64(d) : Illustration of the die surface condition after 5 extrusion cycles using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



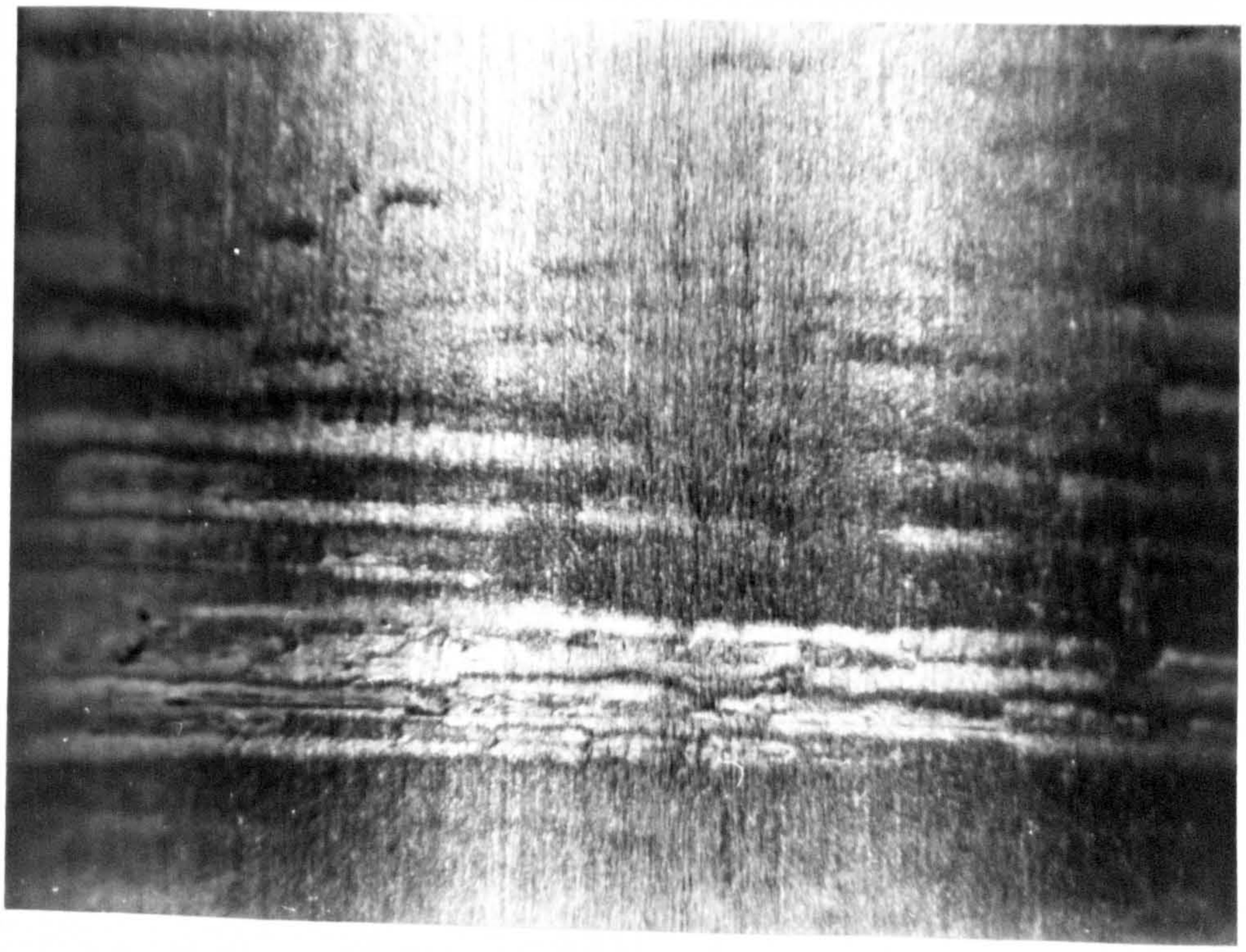
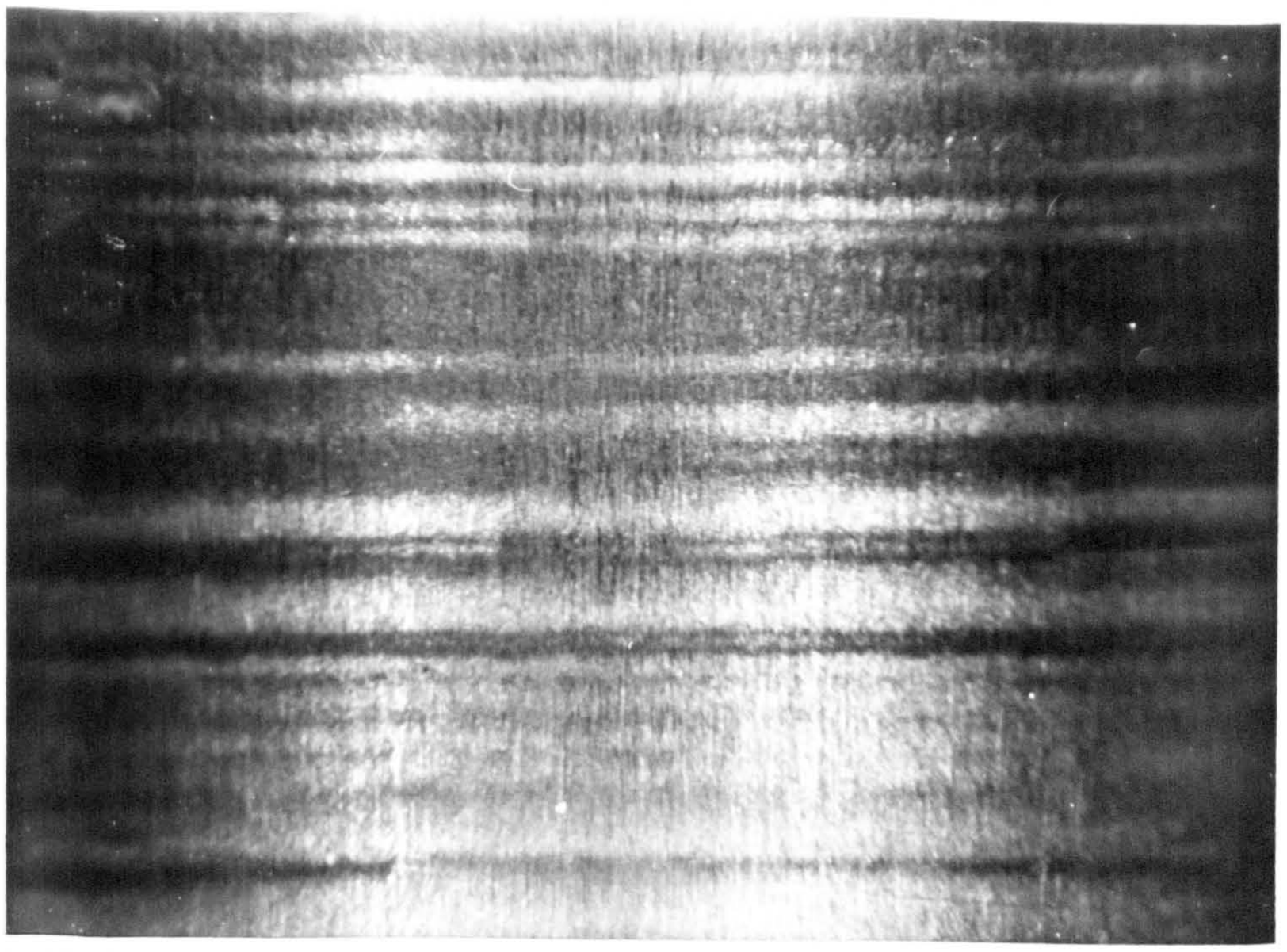


Figure 64(e) : Illustration of the die surface condition after 10 extrusion cycles using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8

Figure 64(f) : Illustration of the die surface condition after 30 extrusion cycles using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

x 8



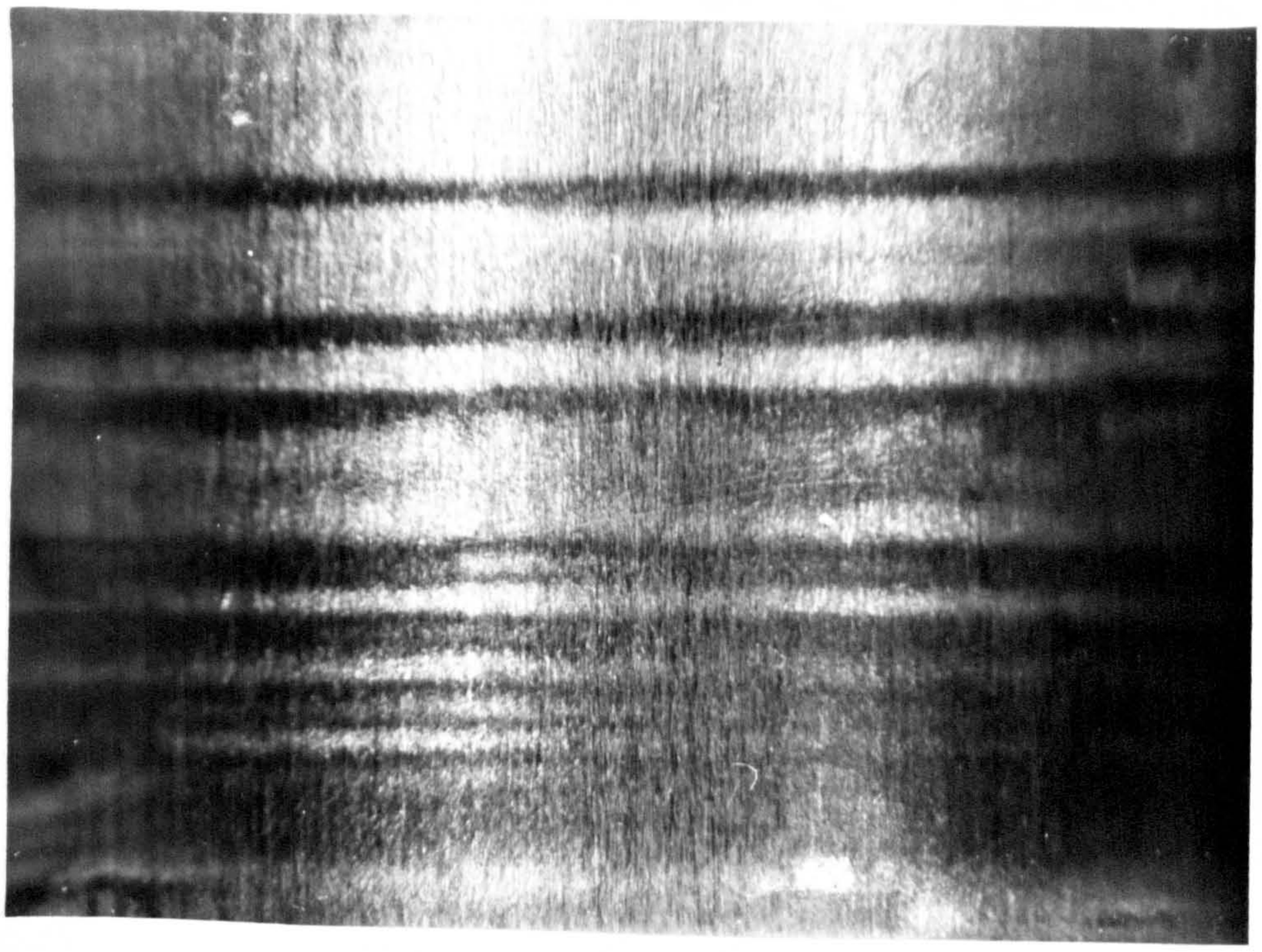


Figure 65 : The relationship between the number of extrusion cycles and the processing time required to complete machining using LV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

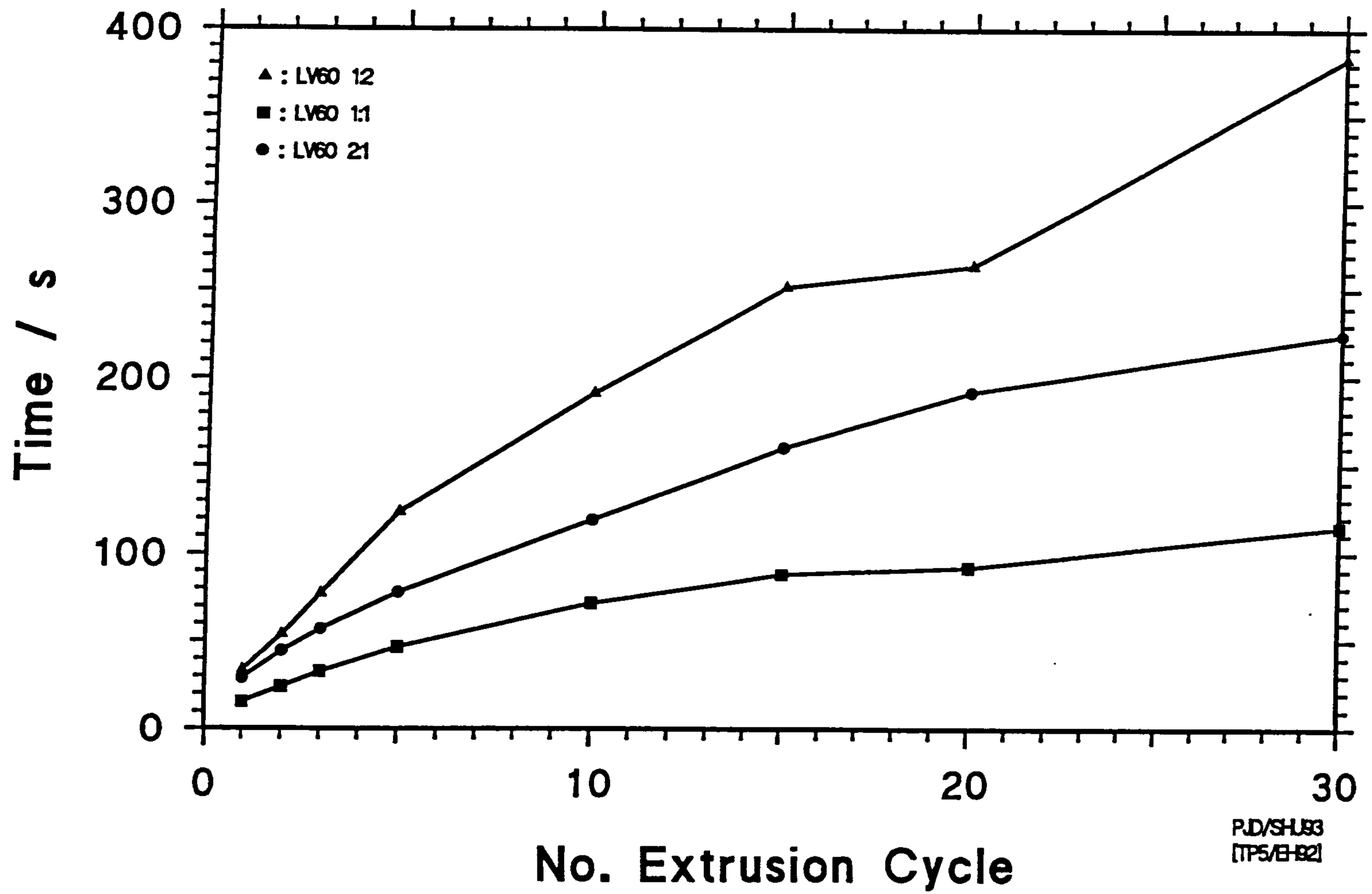

▲ : LV60 1:2
■ : LV60 1:1
● : LV60 2:1
Time / s
400
300
200
100
0
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 66 : The relationship between the number of extrusion cycles and the processing time required to complete machining using LV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

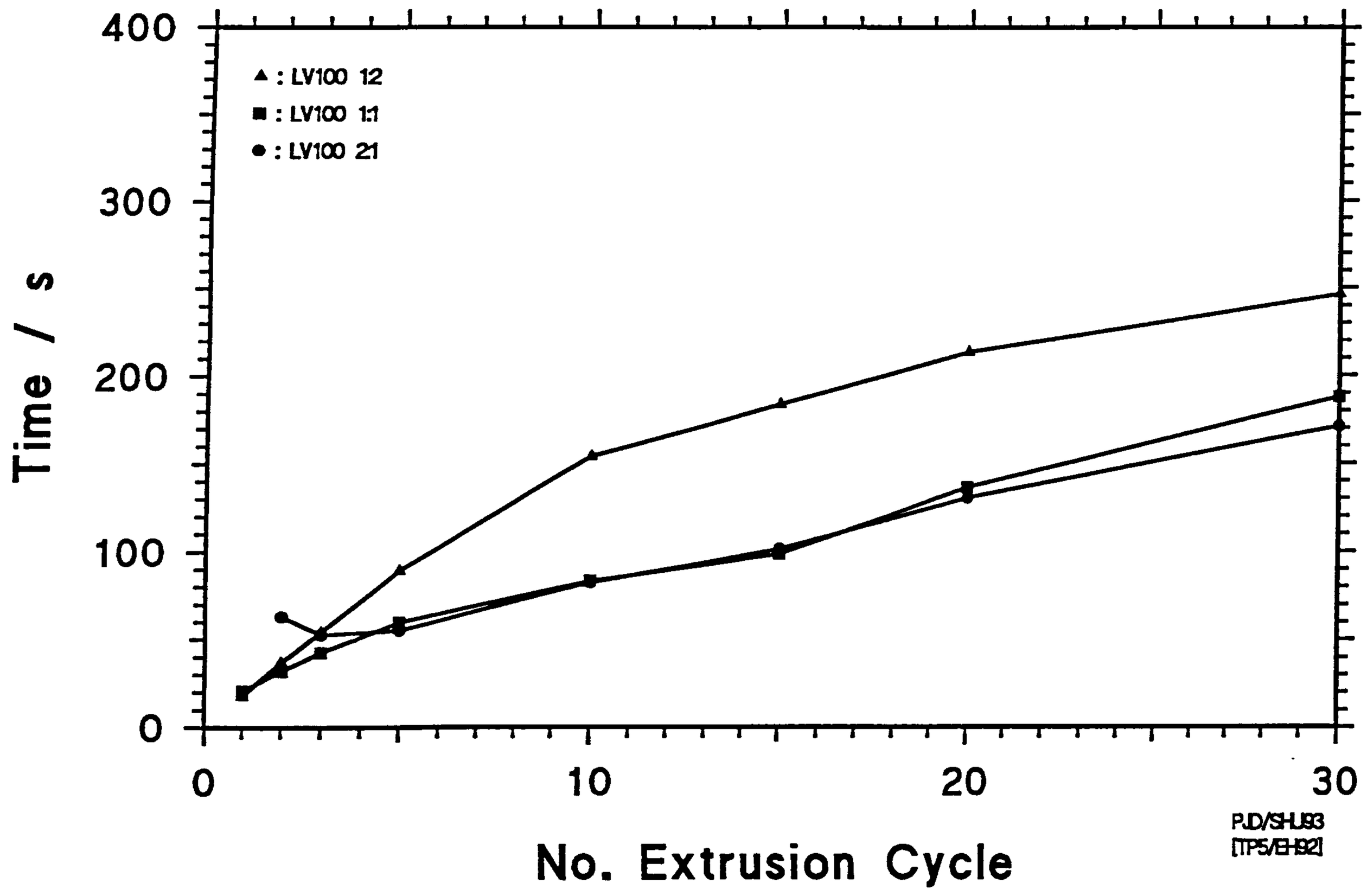

▲ : LV100 12
■ : LV100 1:1
● : LV100 21
Time / s
400
300
200
100
0
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 67 : The relationship between the number of extrusion cycles and the processing time required to complete machining using MV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

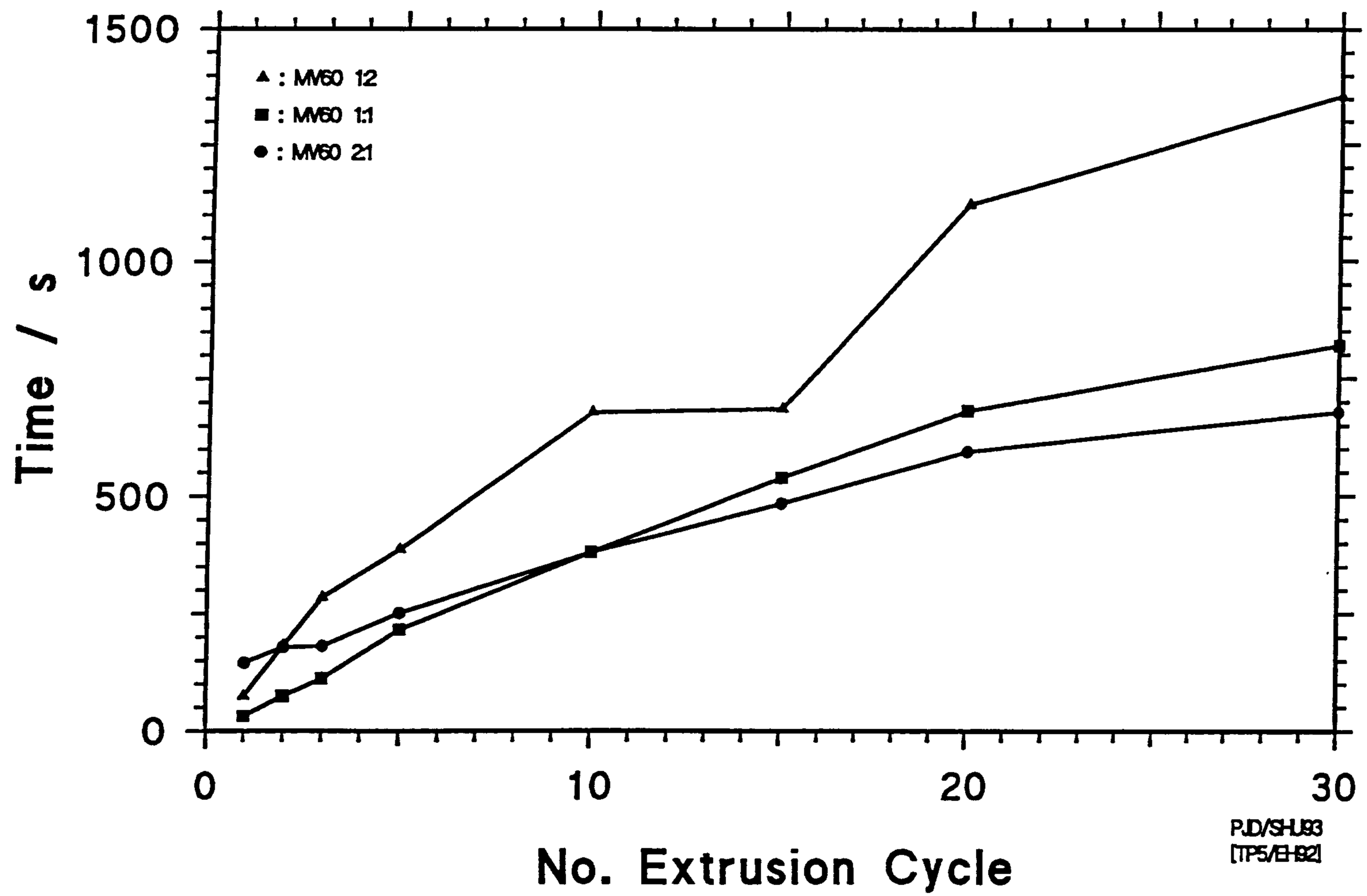

1500
1000
500
0
Time / s
▲ : MV60 1:2
■ : MV60 1:1
● : MV60 2:1
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 68 : The relationship between the number of extrusion cycles and the processing time required to complete machining using MV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

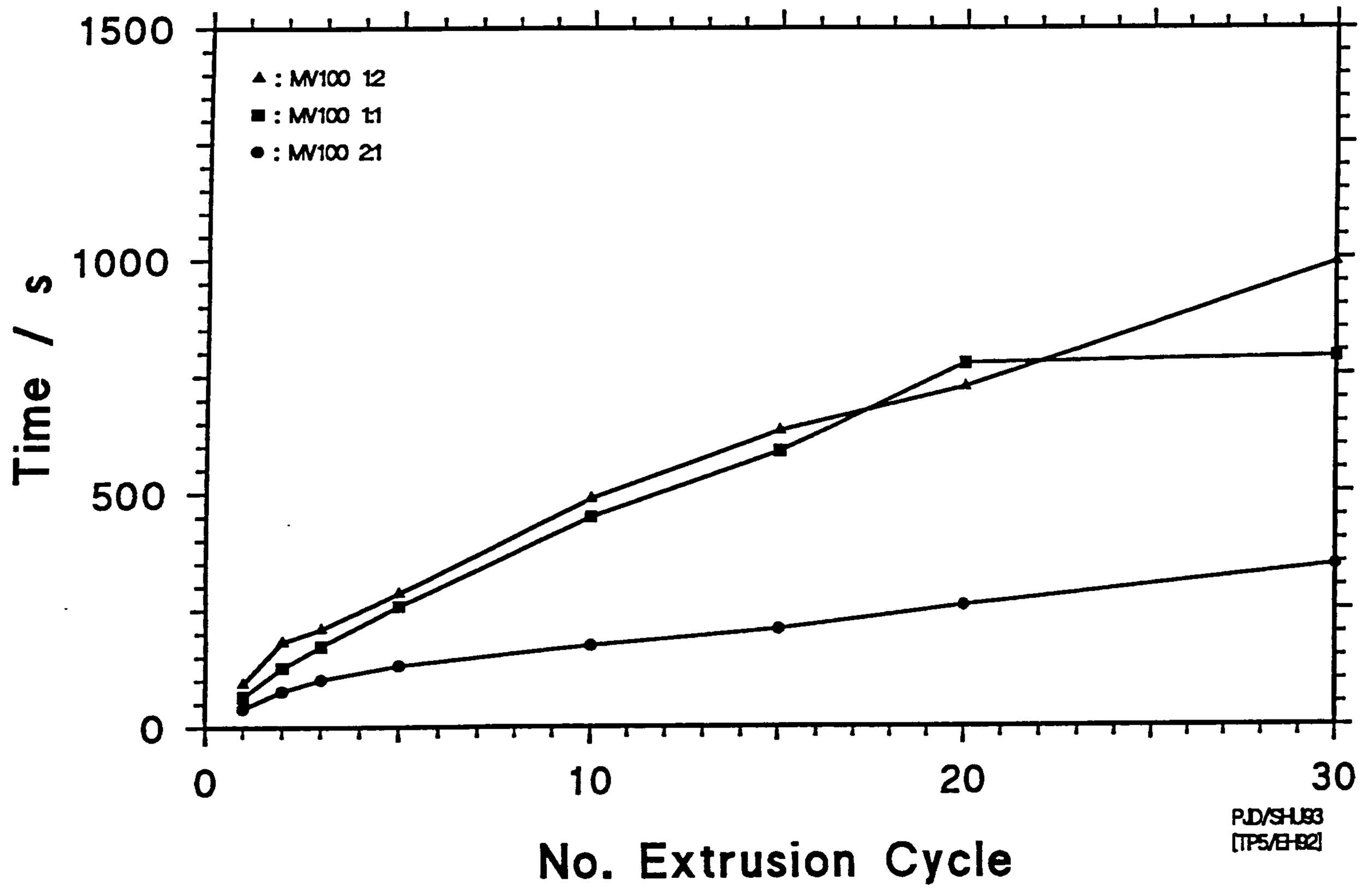

1500
1000
500
0
Time / s
▲ : MV100 12
■ : MV100 11
● : MV100 21
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 69 : The relationship between the number of extrusion cycles and the processing time required to complete machining using HV medium and 60 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

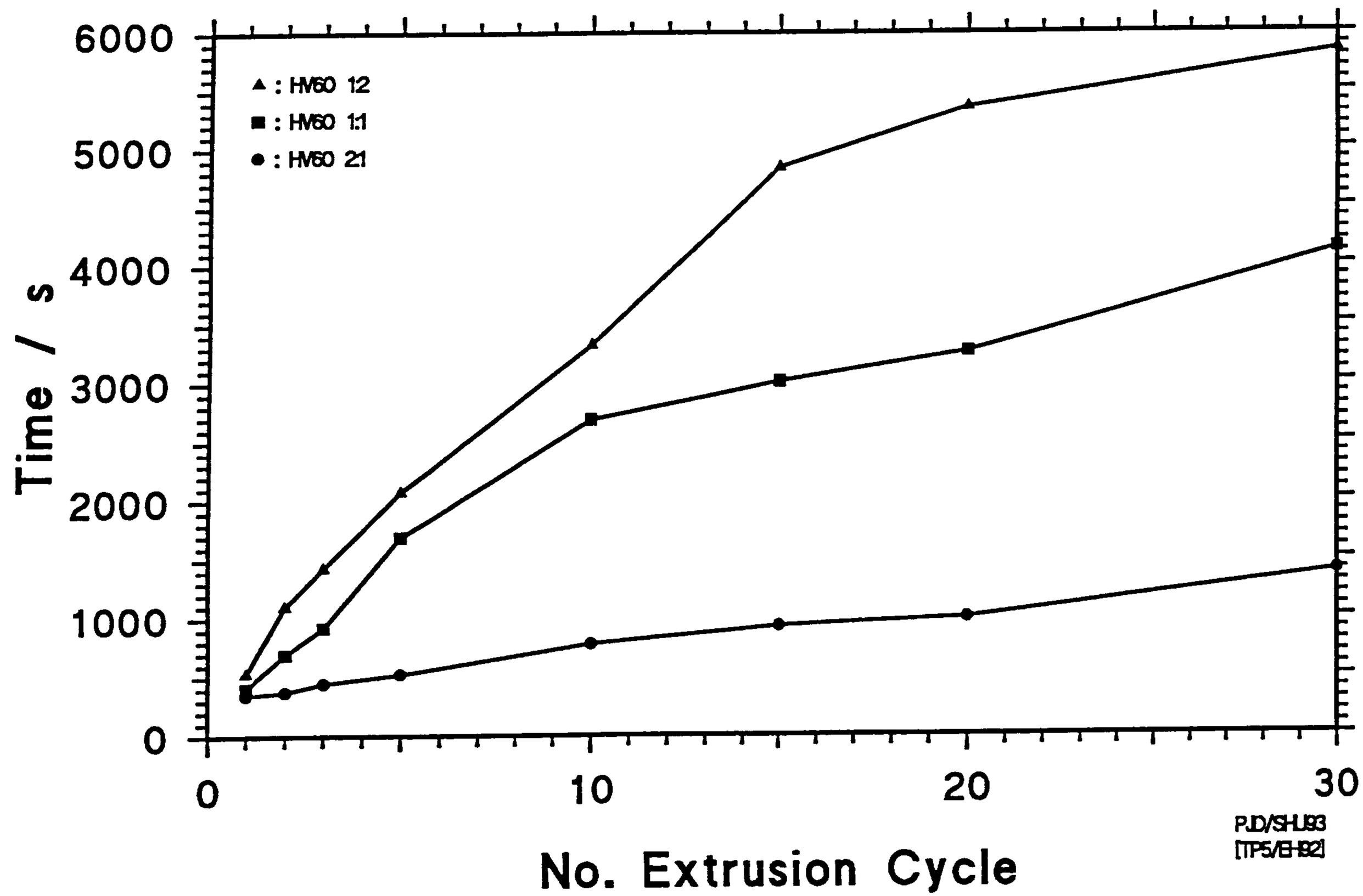

▲ : HV60 1:2
■ : HV60 1:1
● : HV60 2:1
Time / s
6000
5000
4000
3000
2000
1000
0
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 70 : The relationship between the number of extrusion cycles and the processing time required to complete machining using HV medium and 100 Mesh grit with grit to polymer ratios of 0.5, 1 and 2.

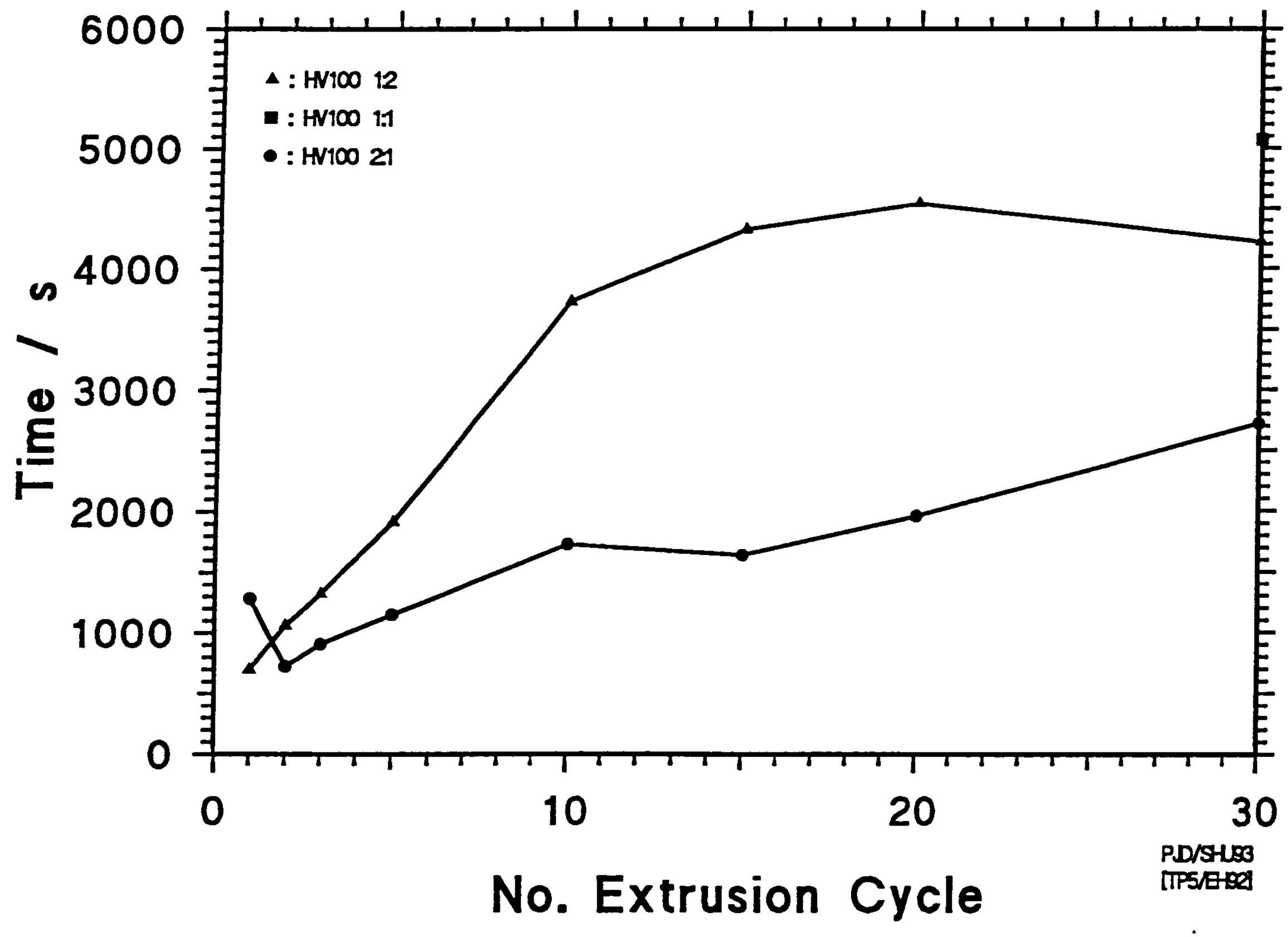
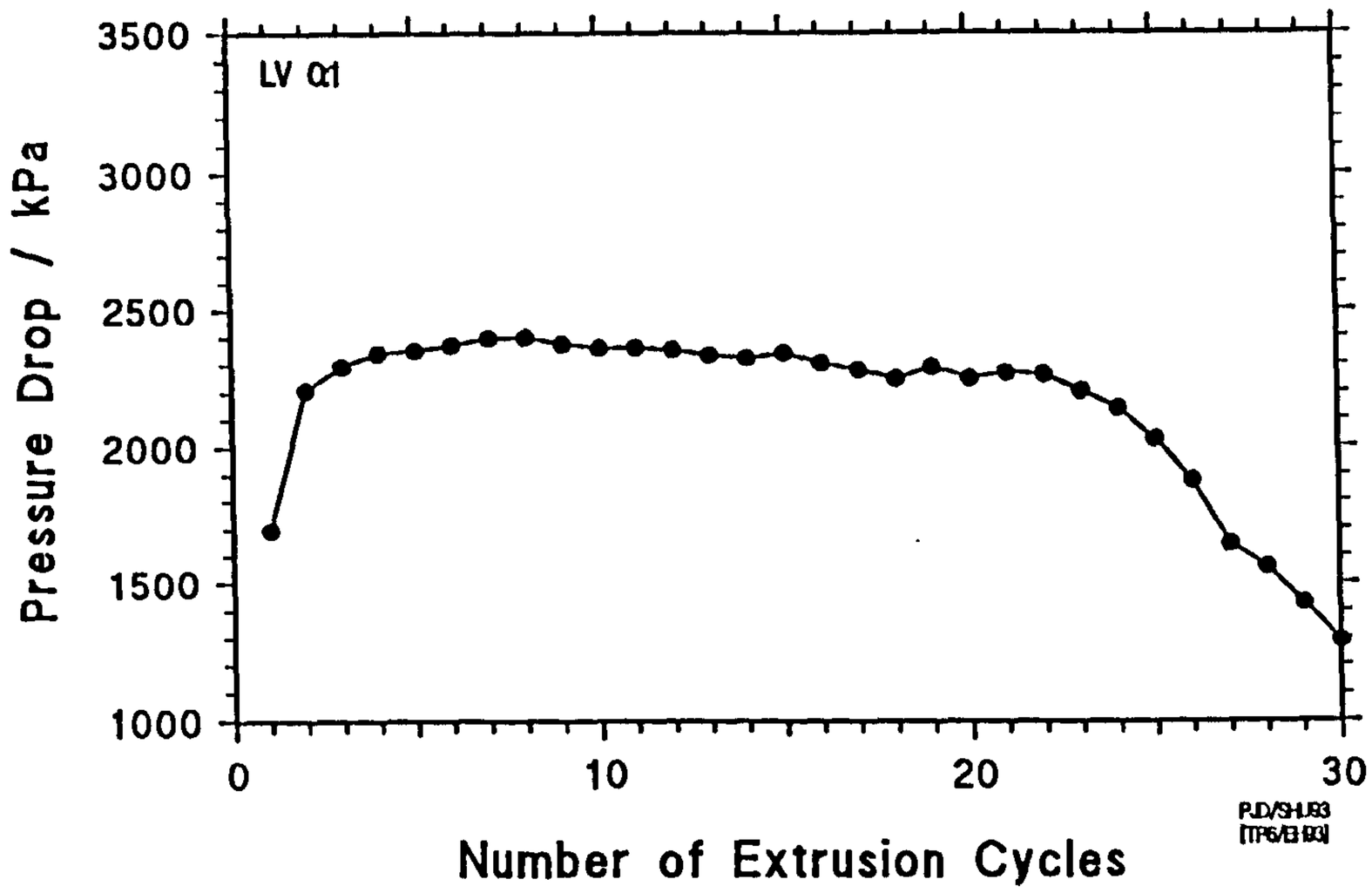
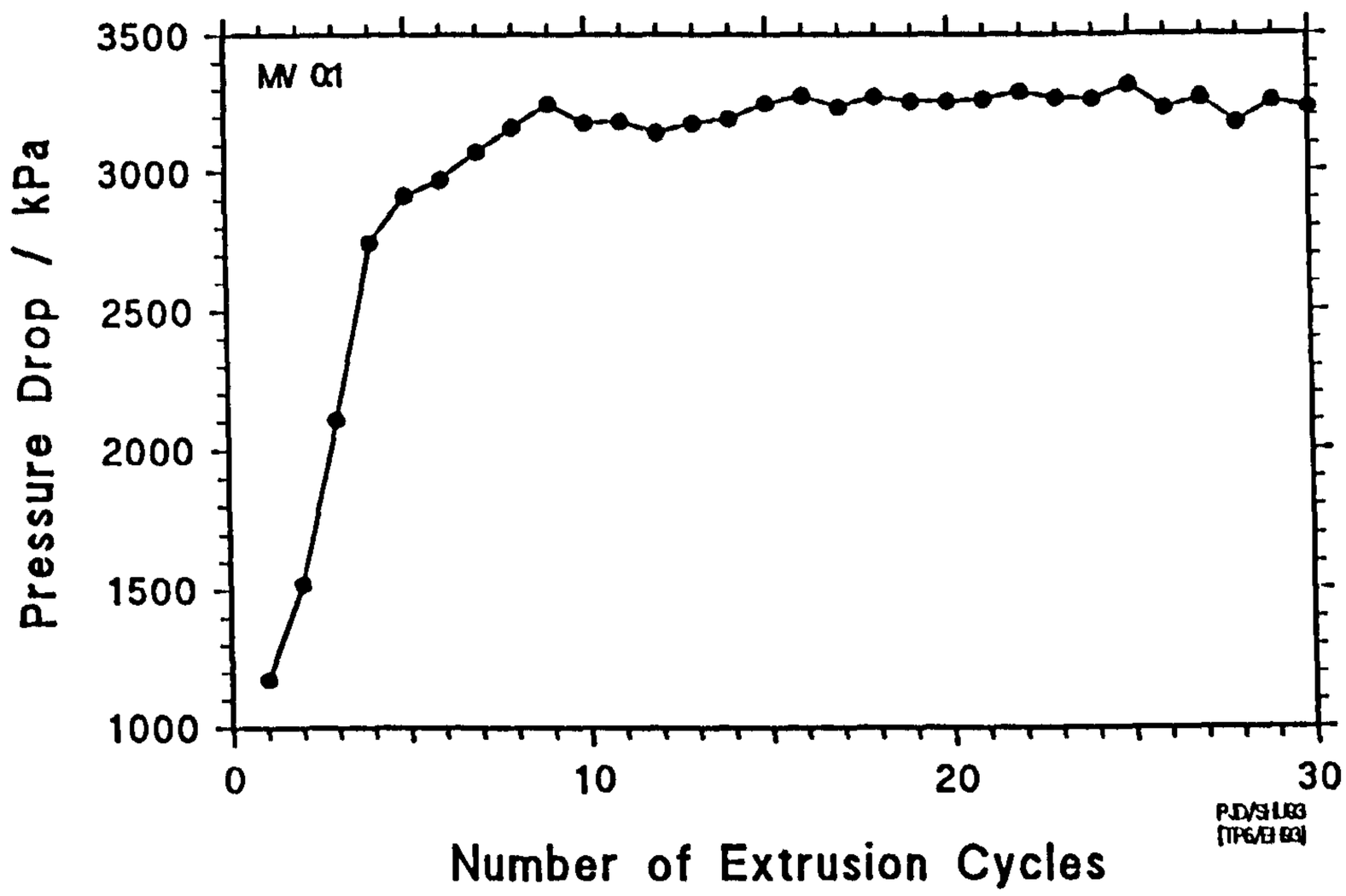

▲ : HV100 1:2
■ : HV100 1:1
● : HV100 2:1
Time / s
6000
5000
4000
3000
2000
1000
0
0
10
20
30
No. Extrusion Cycle
PJD/SHU93
[TP5/EH92]

Figure 71(a) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for pure LV medium.

Figure 71(b) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for pure MV medium.

Figure 71(c) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for pure HV medium.


LV α1
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles


MV α1
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles

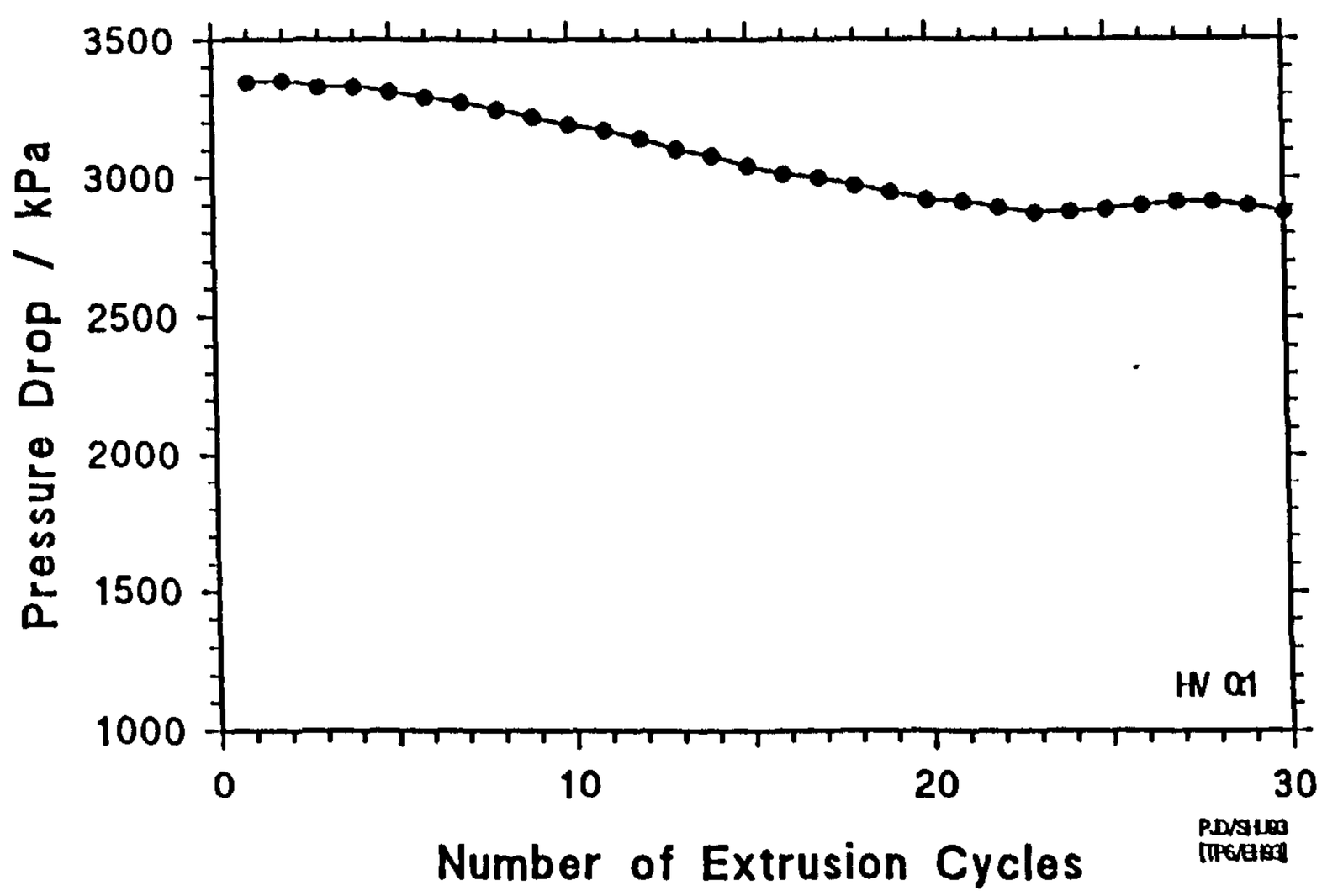
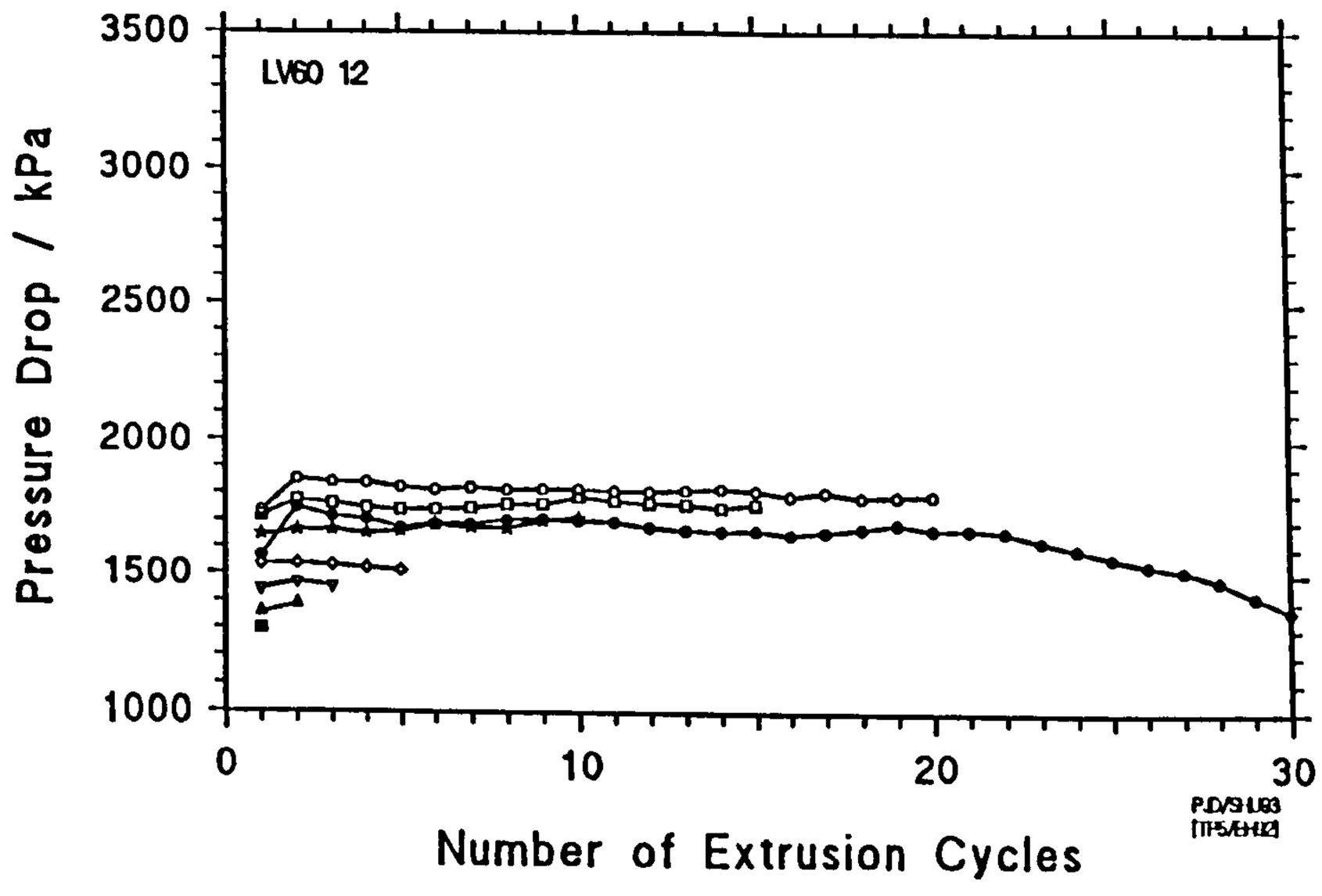
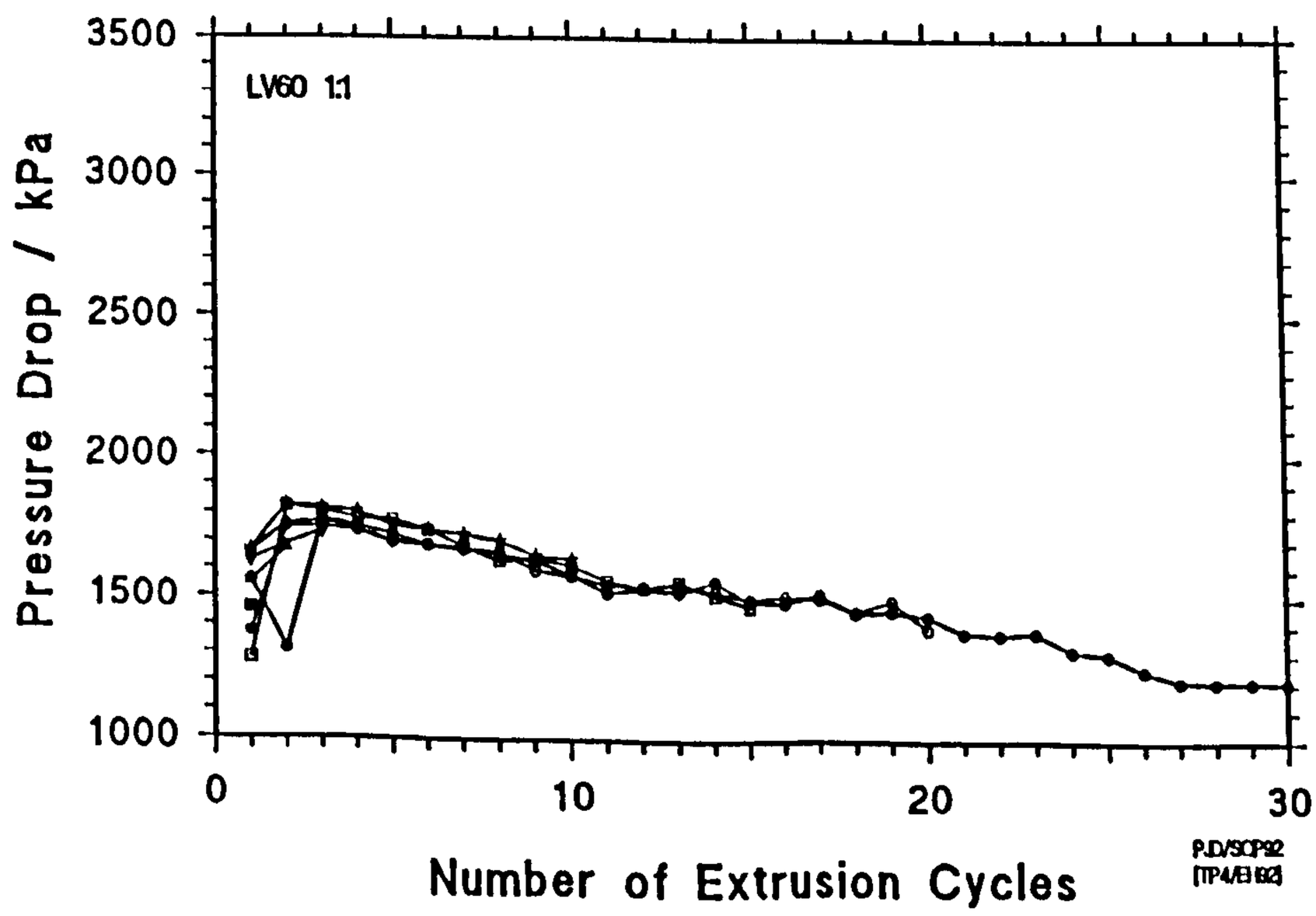

HV α1
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles

Figure 72(a) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 72(b) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 72(c) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using LV medium and 60 Mesh grit with a grit to polymer ratio of 2.


LV60 12
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles


LV60 1:1
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles

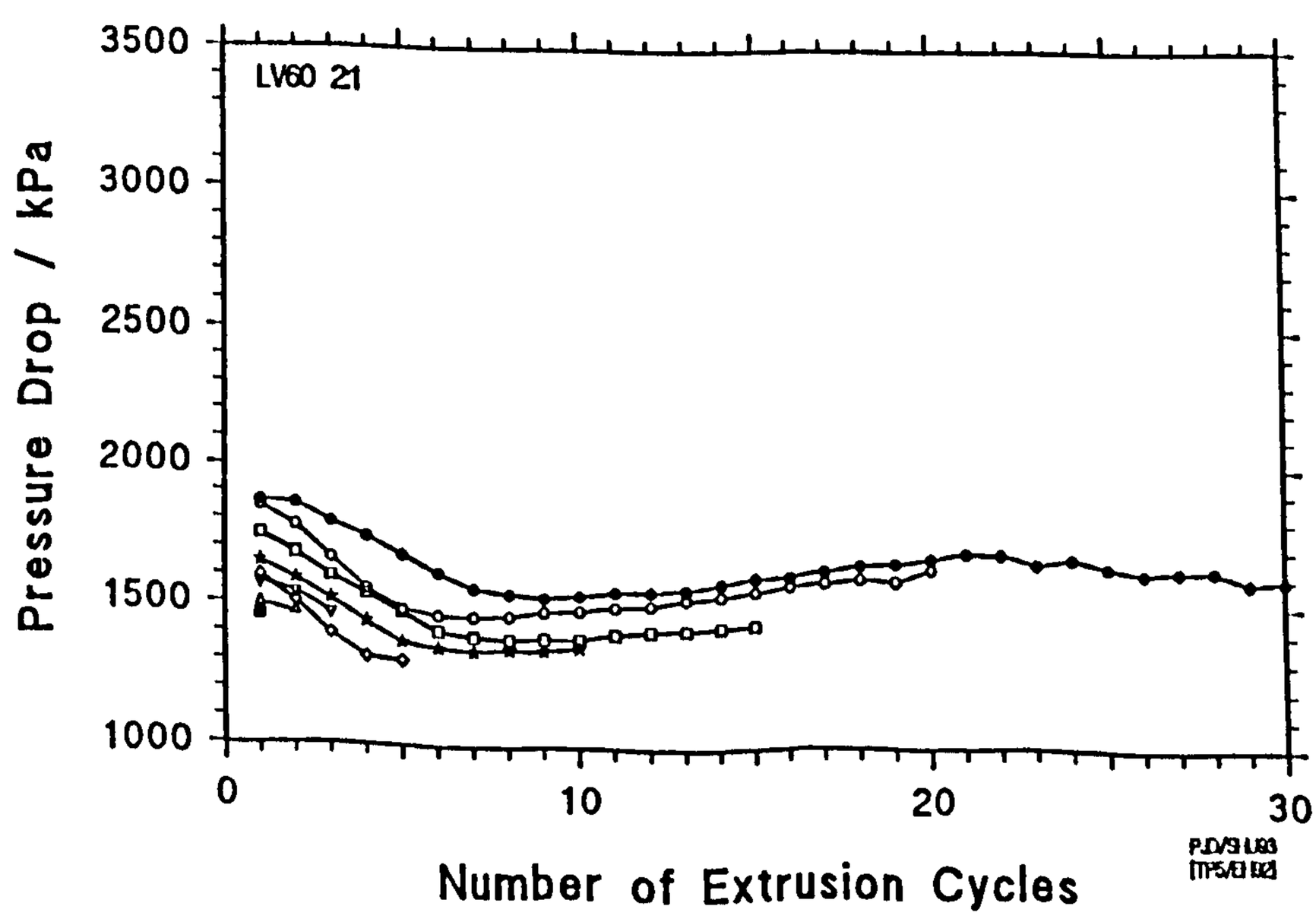
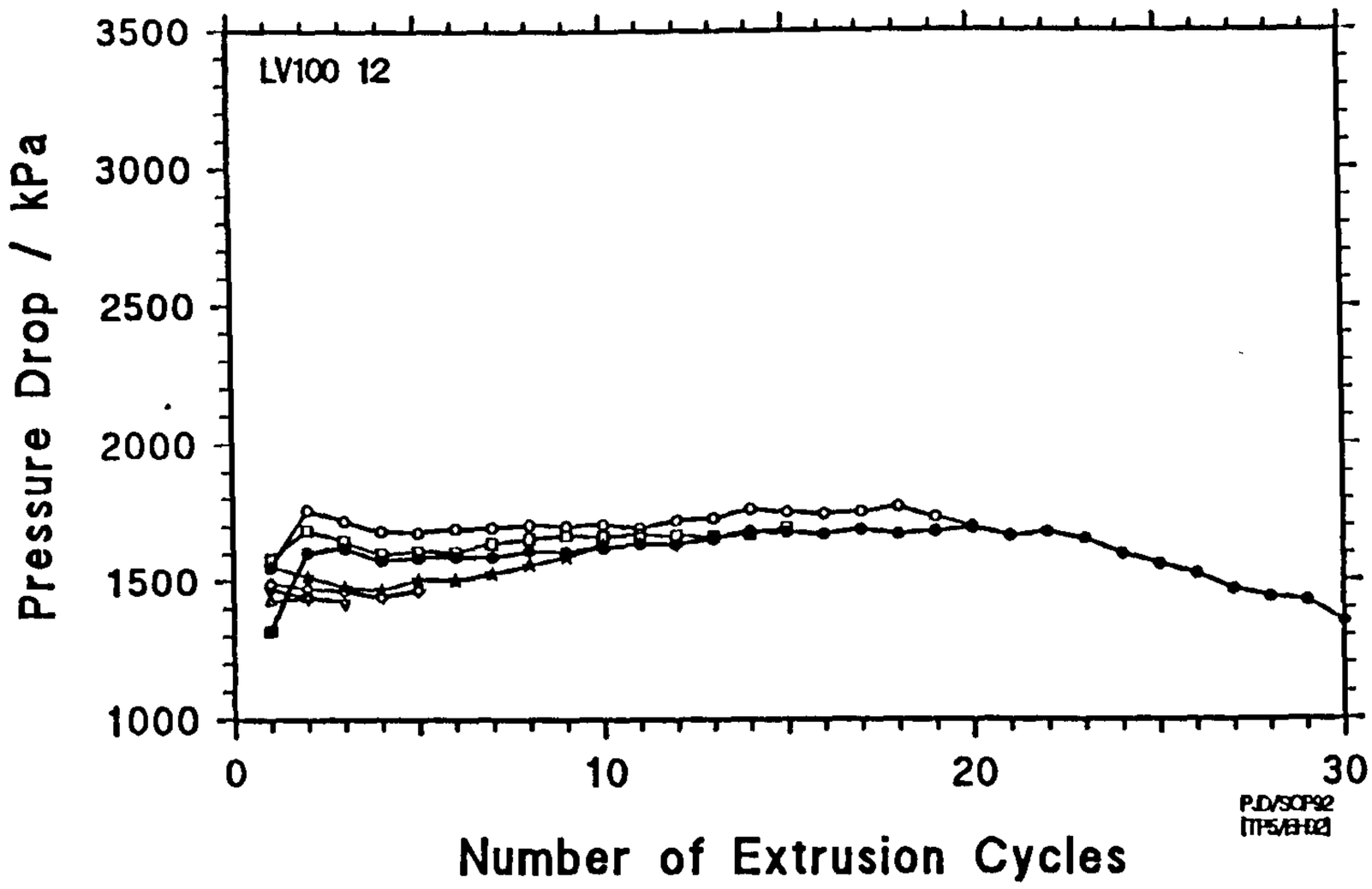
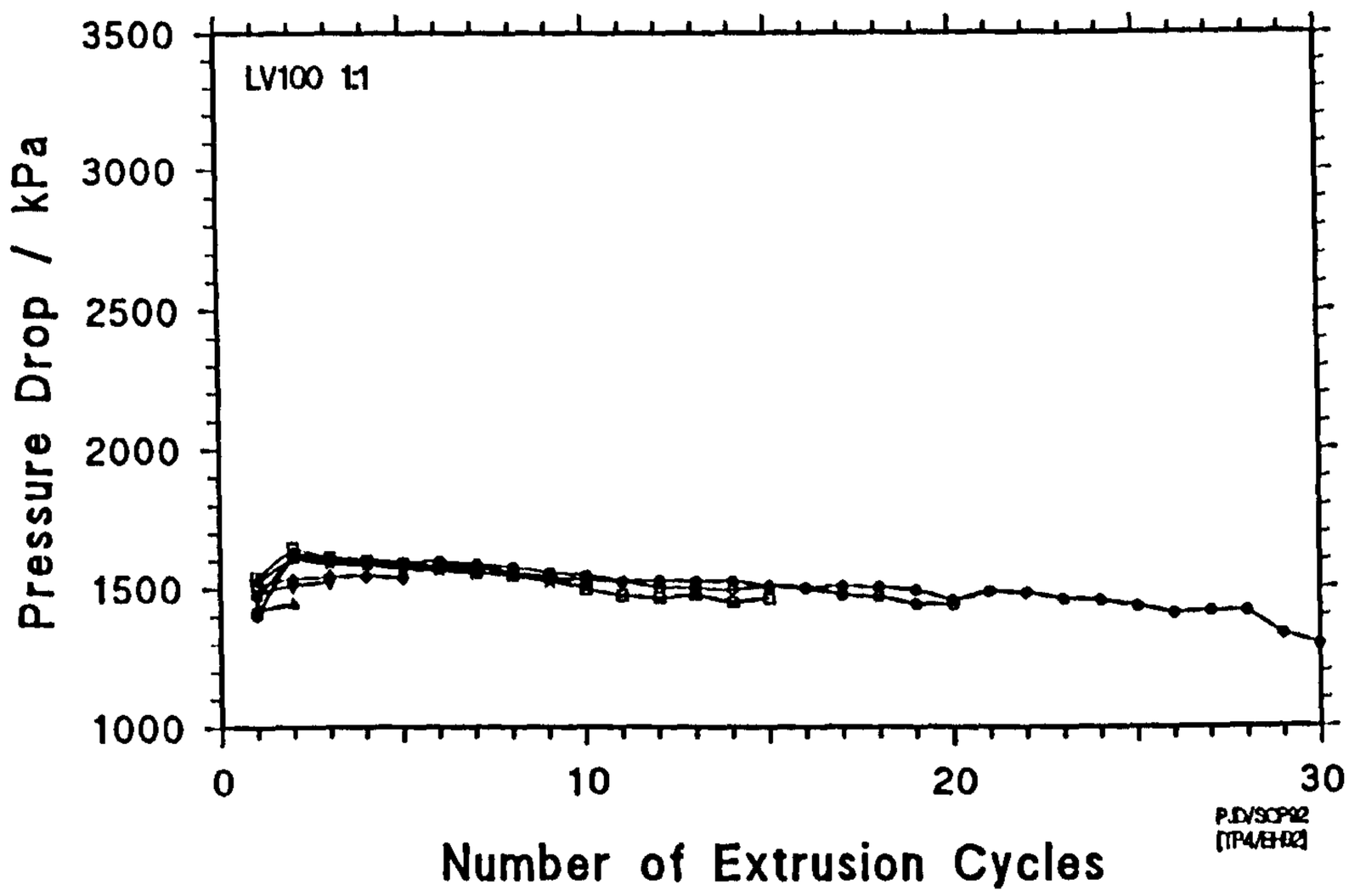

LV60 21
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles

Figure 73(a) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using LV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 73(b) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 73(c) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using LV medium and 100 Mesh grit with a grit to polymer ratio of 2.


LV100 12
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles


LV100 11
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles

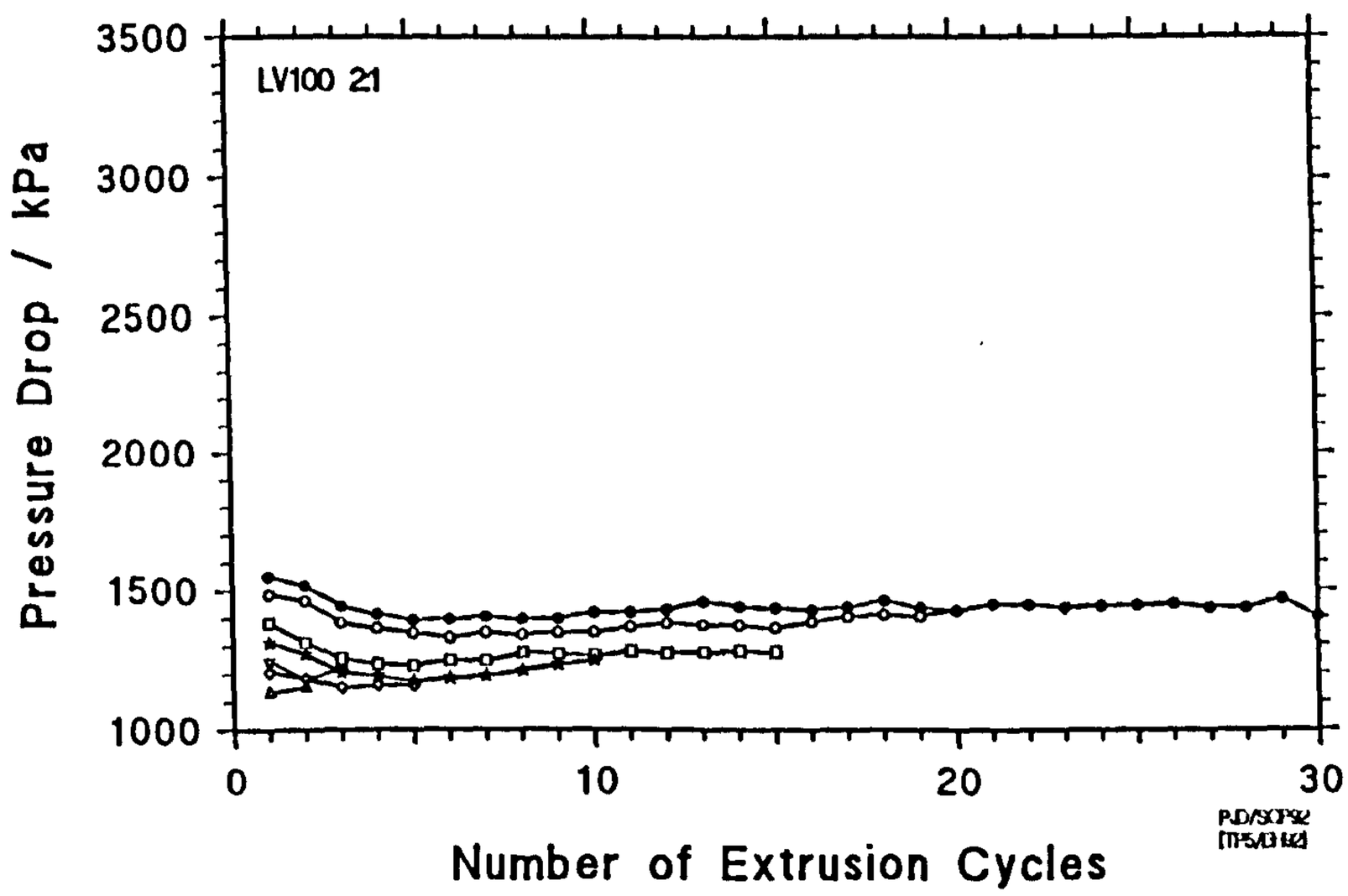
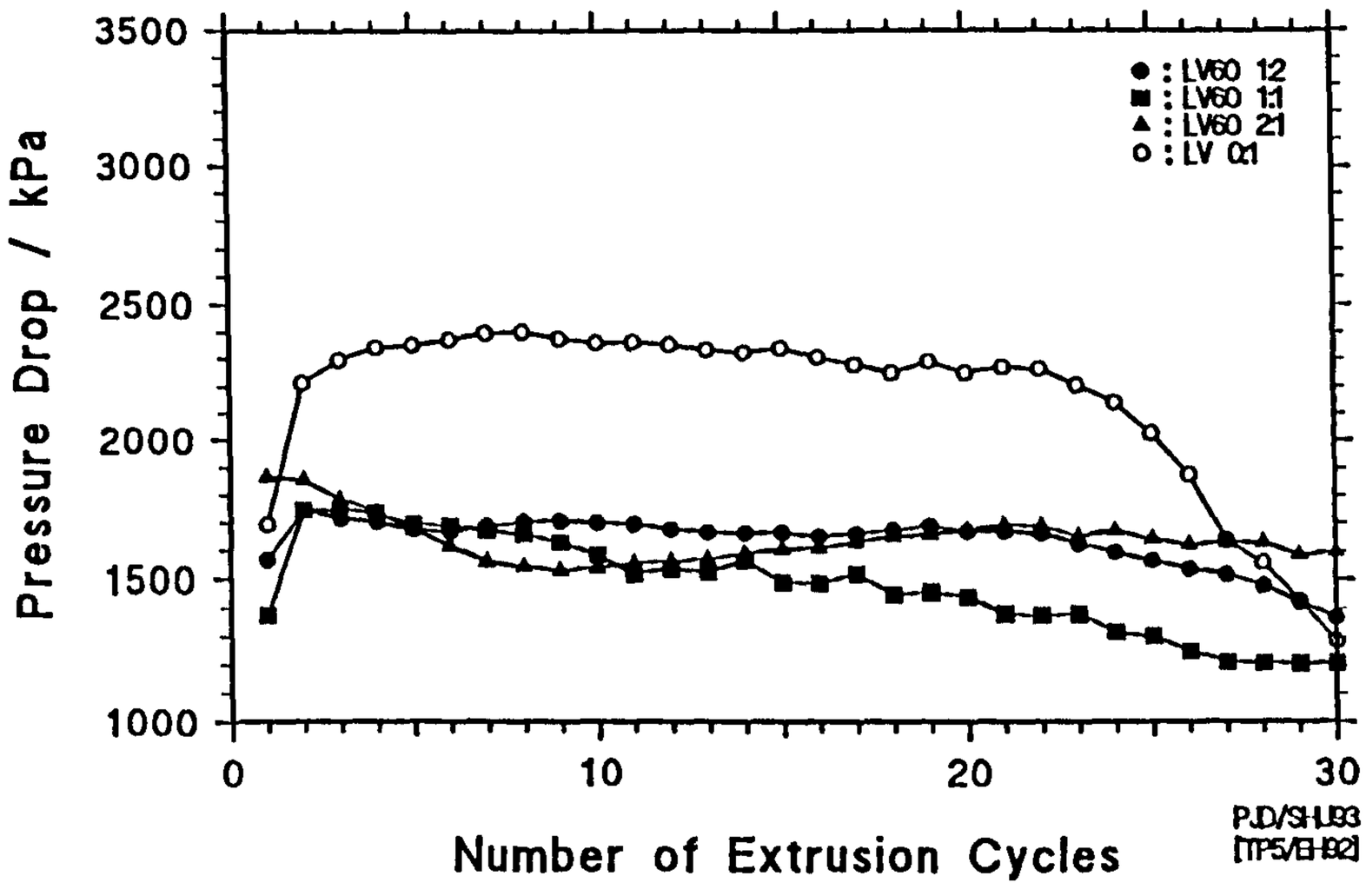

LV100 21
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles

Figure 74(a) : The illustration of the relationship between the number of extrusion cycles and the pressure drop across the die for the 30 extrusion cycle run with respect to all LV medium and 60 Mesh grit mixtures utilised, as well as the pure LV medium.

Figure 74(b) : The illustration of the relationship between the number of extrusion cycles and the pressure drop across the die for the 30 extrusion cycle run with respect to all LV medium and 100 Mesh grit mixtures utilised, as well as the pure LV medium.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
● : LV60 1:2
■ : LV60 1:1
▲ : LV60 2:1
○ : LV 0:1
P.J.D/SHU93
[TP5/EH92]

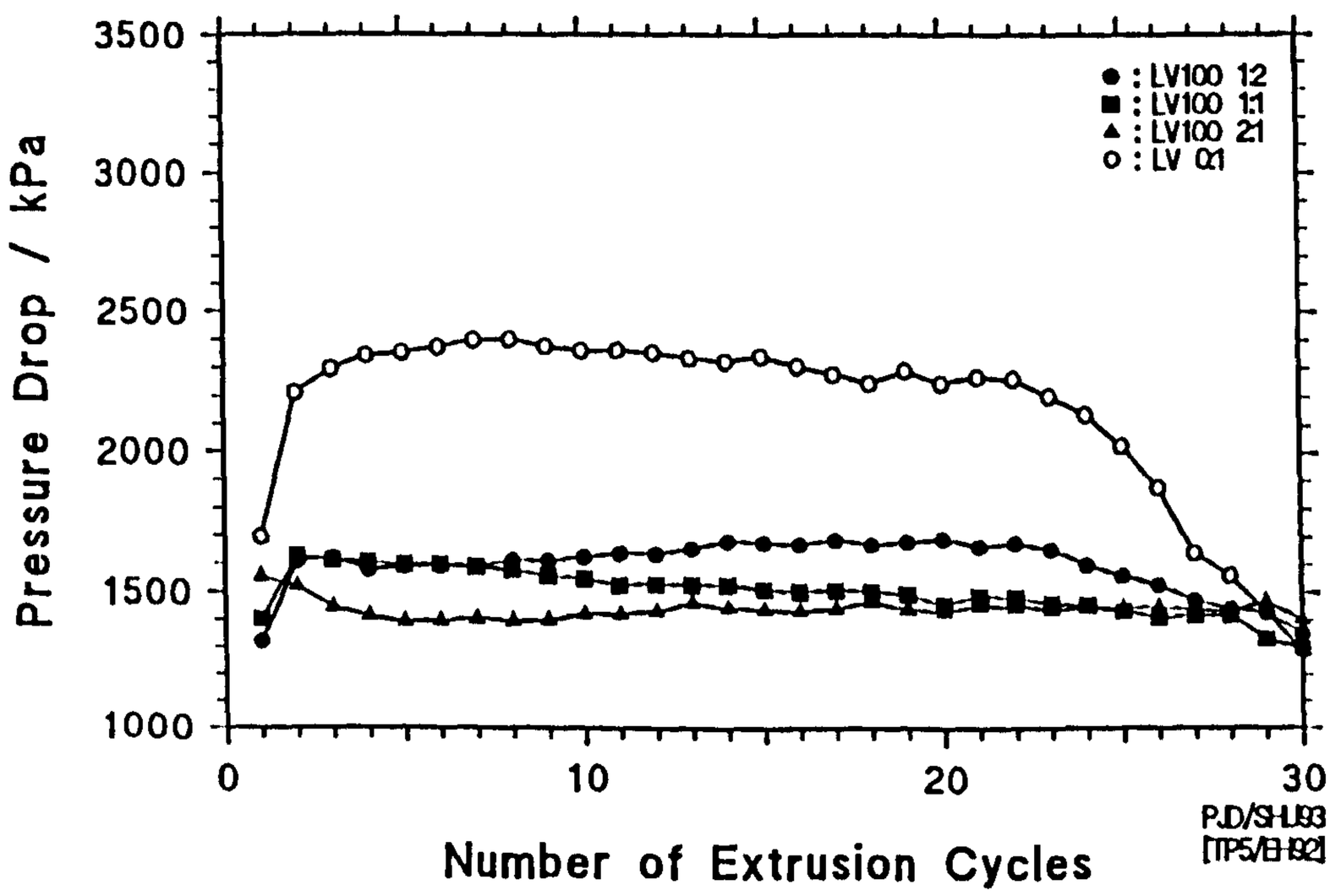
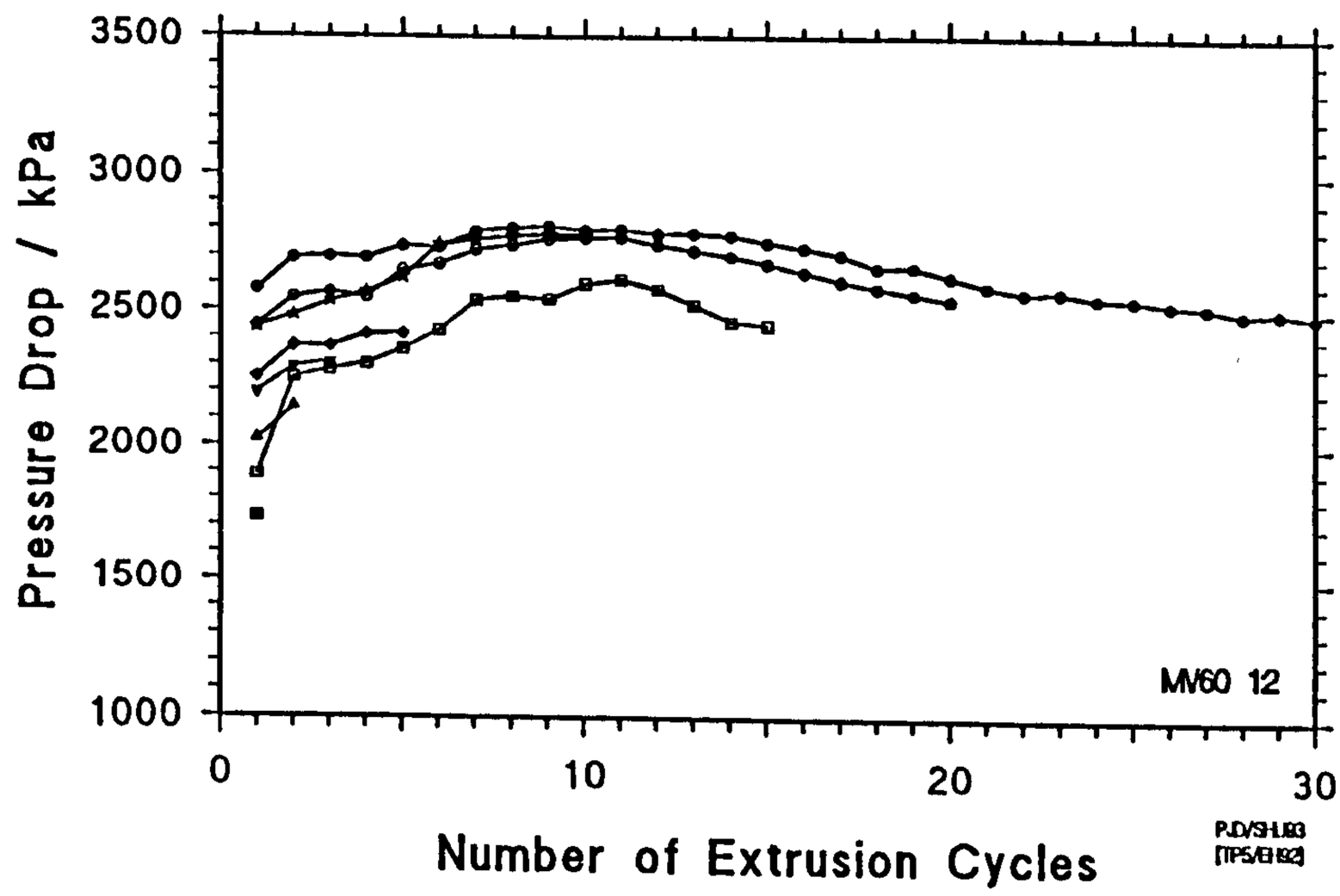
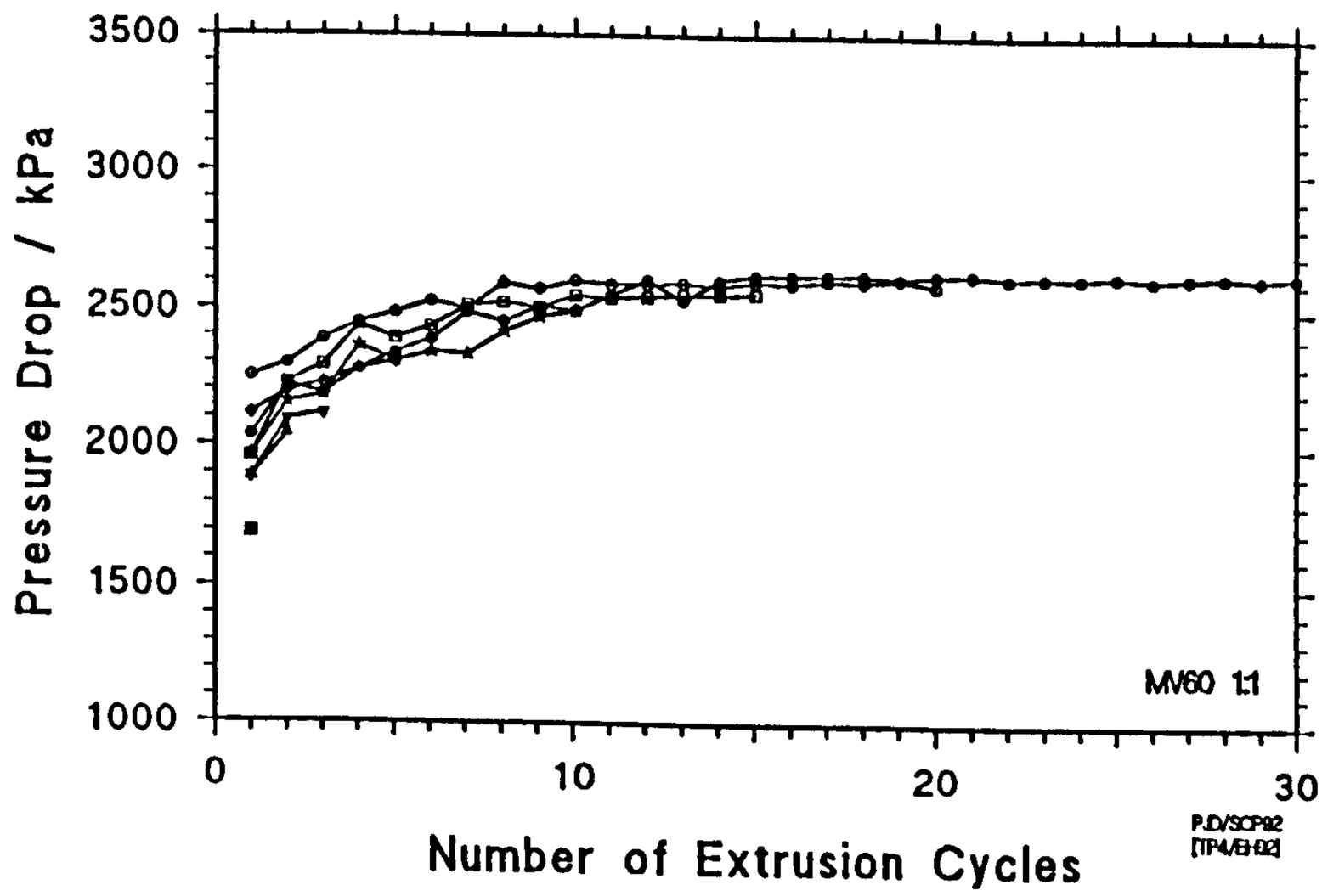

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
● : LV100 1:2
■ : LV100 1:1
▲ : LV100 2:1
○ : LV 0:1
P.J.D/SHU93
[TP5/EH92]

Figure 75(a) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 75(b) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 75(c) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using MV medium and 60 Mesh grit with a grit to polymer ratio of 2.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
MV60 12


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
MV60 11

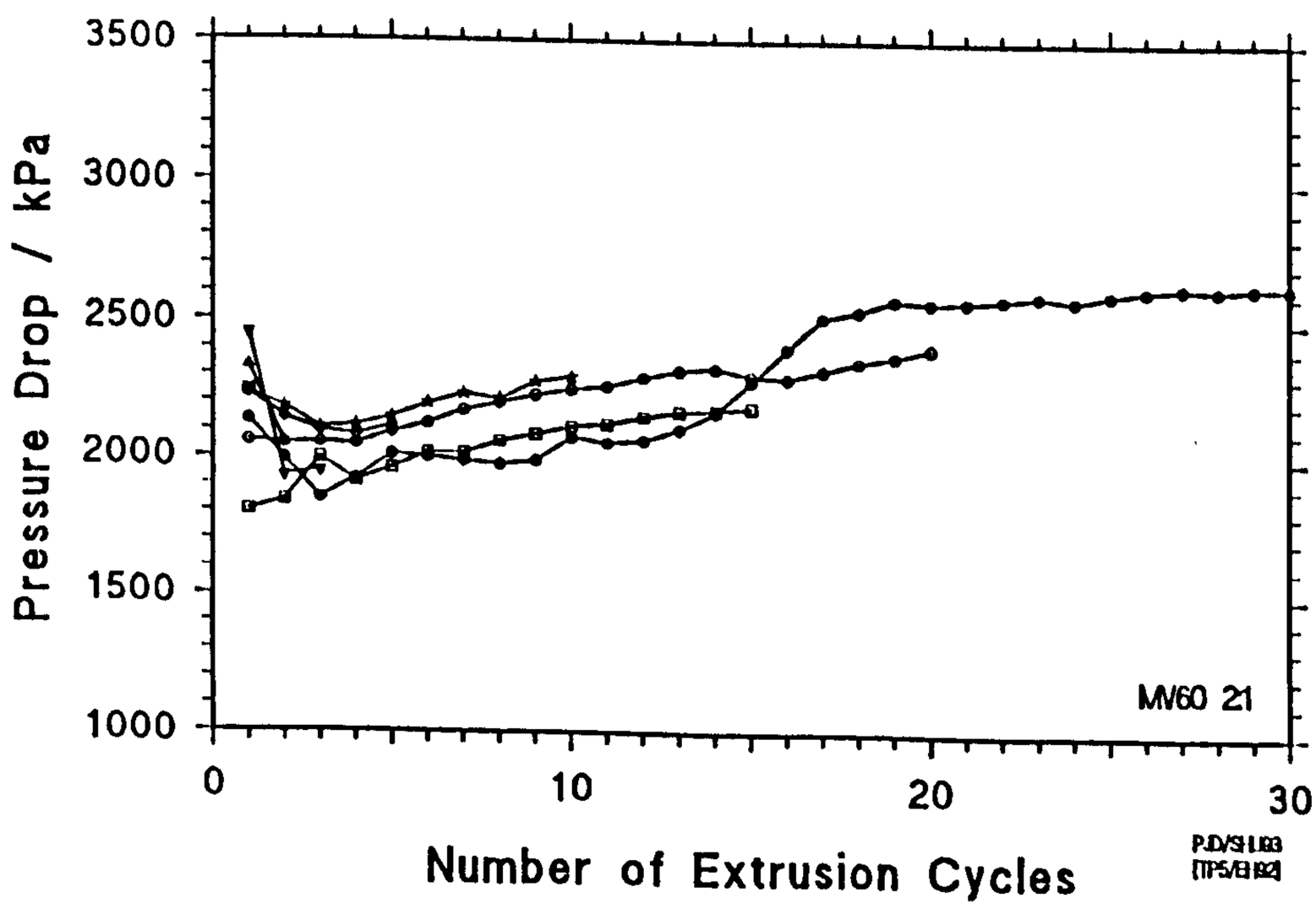
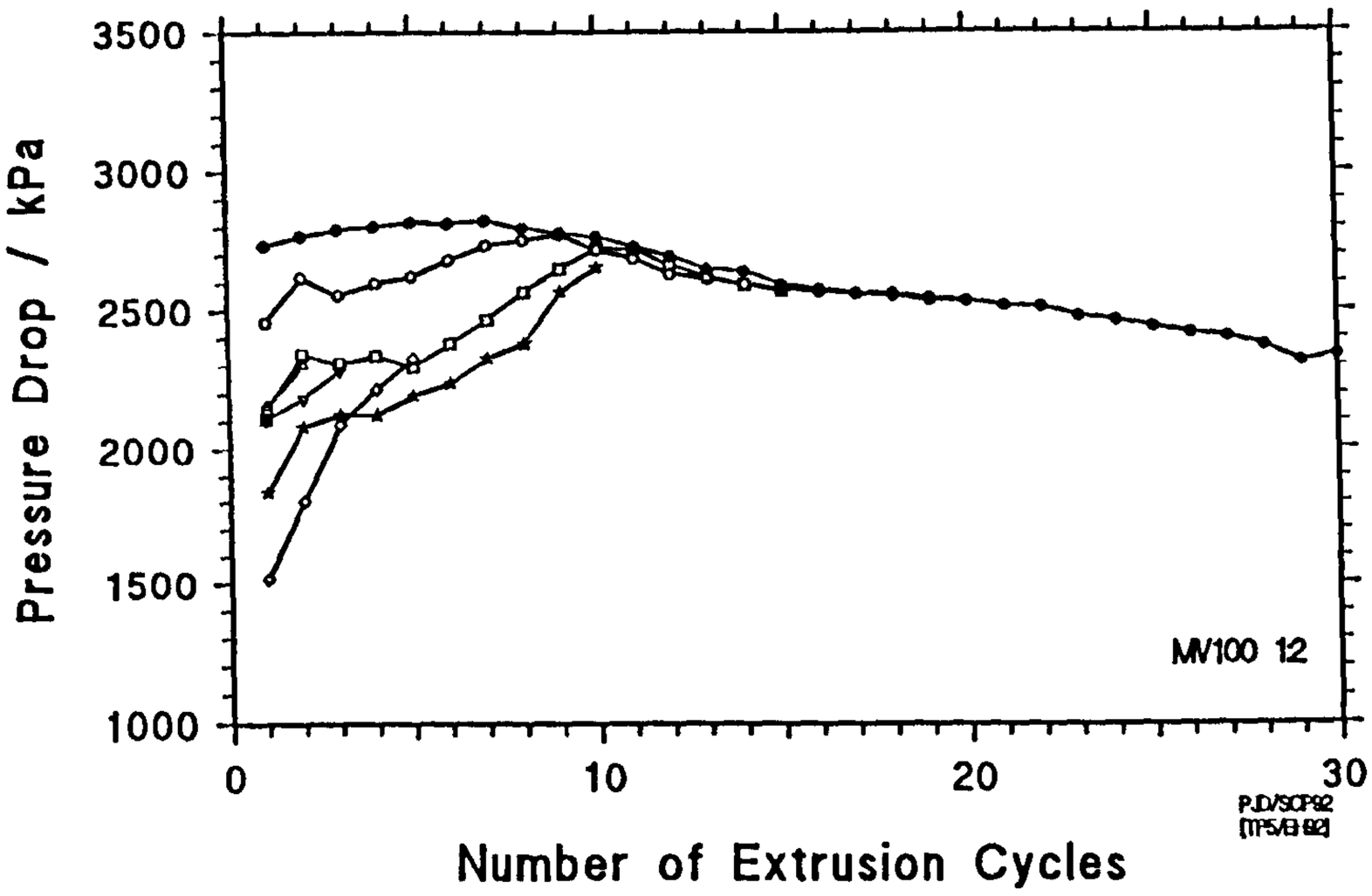
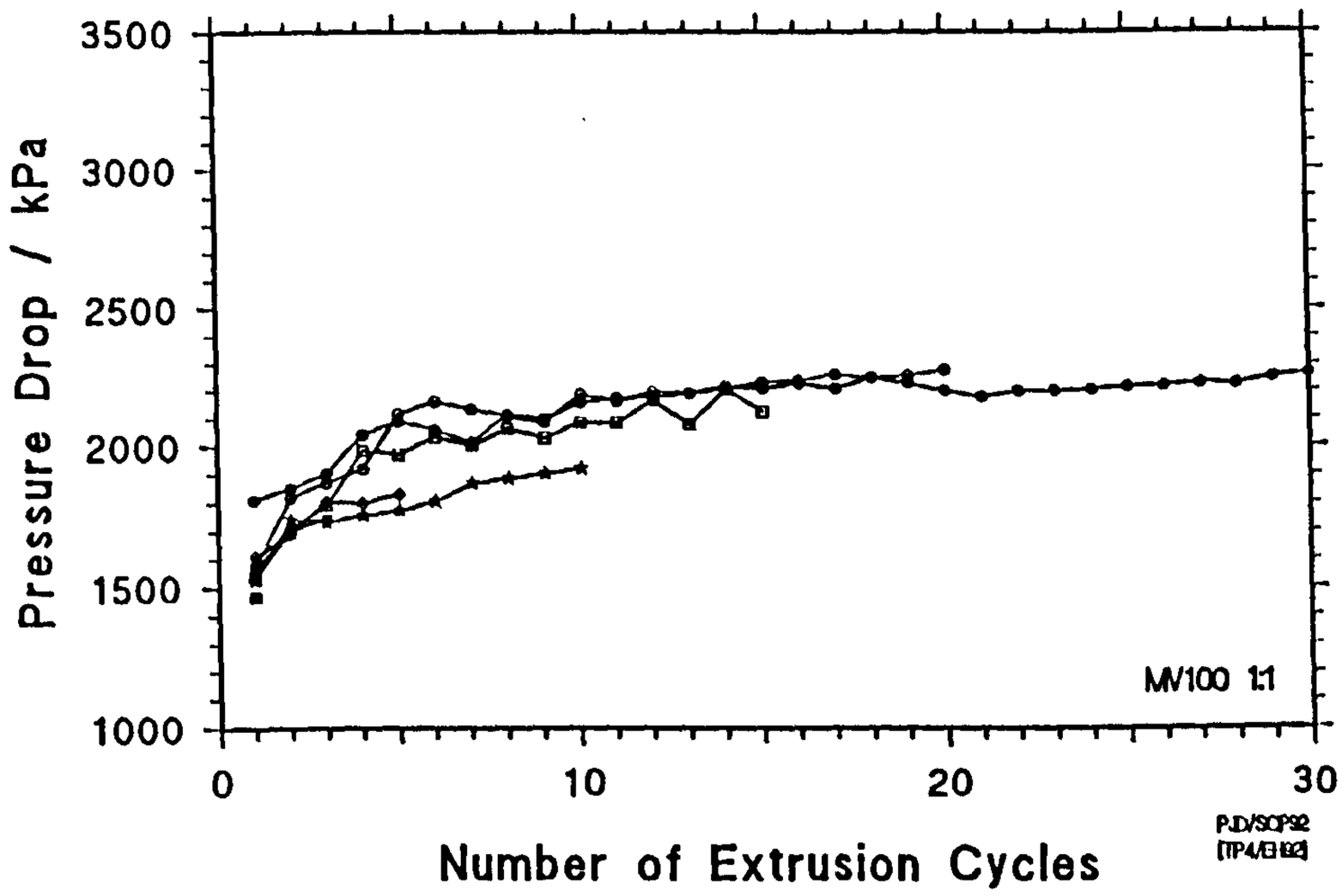

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
MV60 21

Figure 76(a) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 76(b) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 76(c) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using MV medium and 100 Mesh grit with a grit to polymer ratio of 2.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
MV100 12
Number of Extrusion Cycles


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
MV100 11
Number of Extrusion Cycles

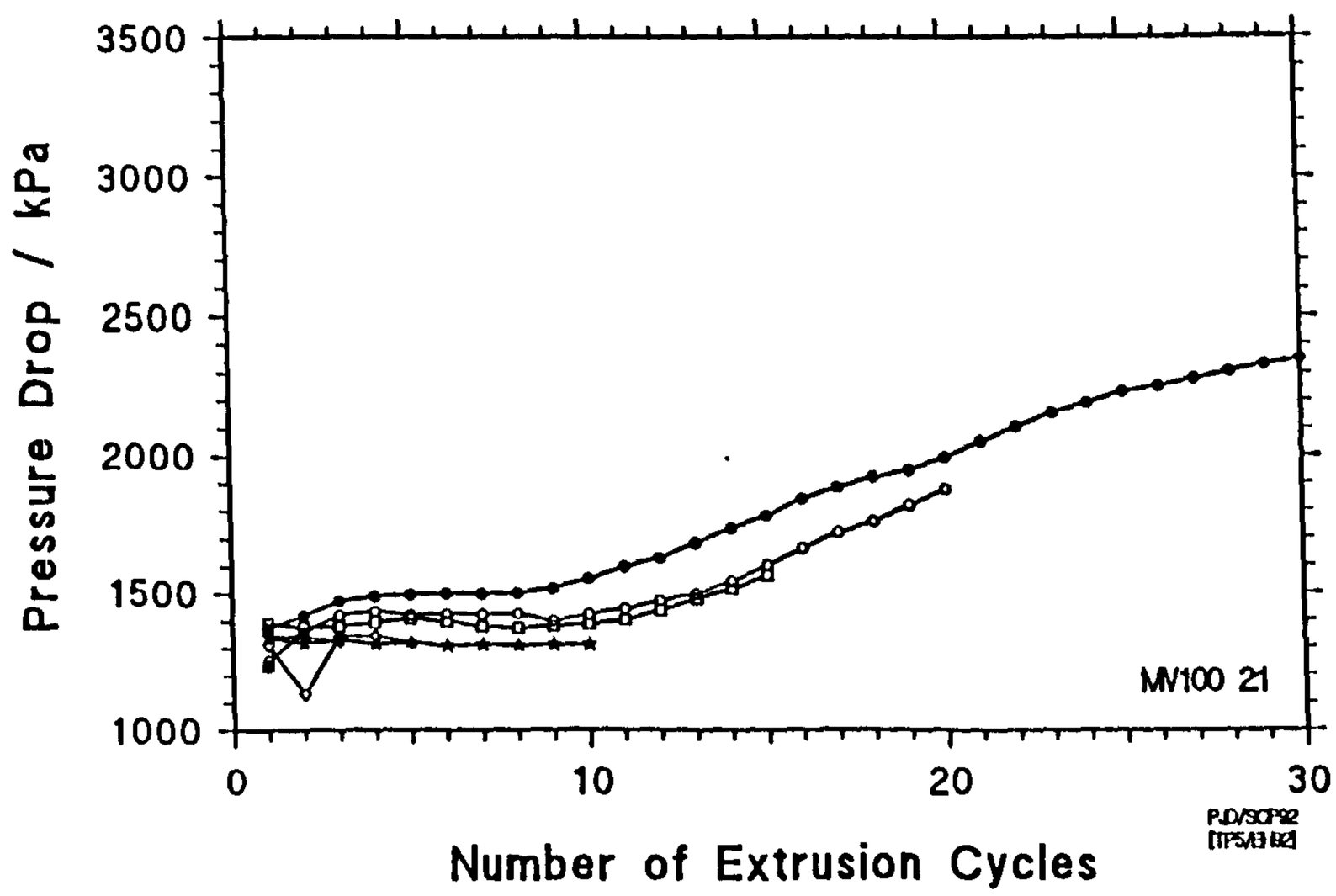
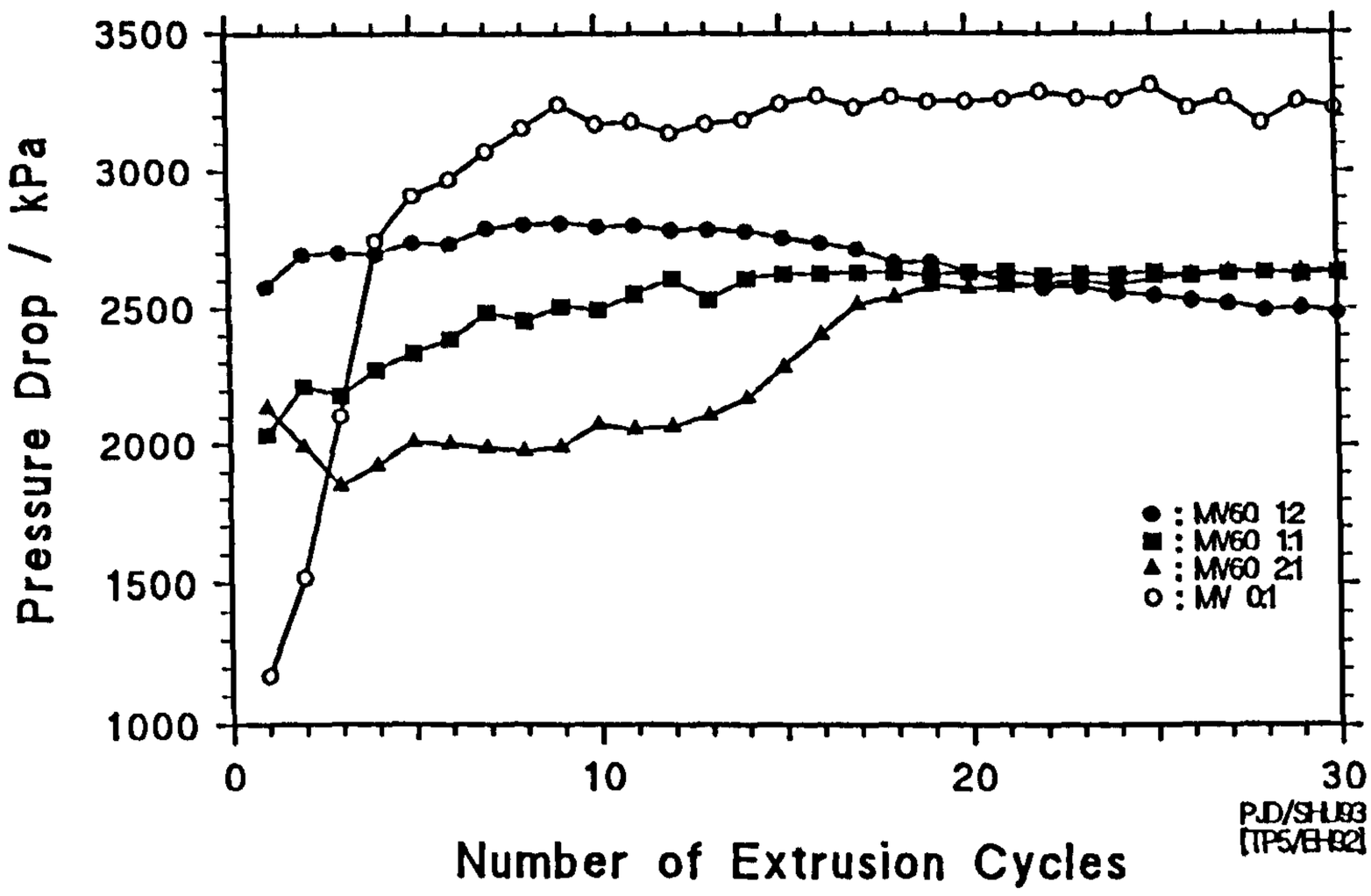

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
MV100 21
Number of Extrusion Cycles

Figure 77(a) : The illustration of the relationship between the number of extrusion cycles and the pressure drop across the die for the 30 extrusion cycle run with respect to all MV medium and 60 Mesh grit mixtures utilised, as well as the pure MV medium.

Figure 77(b) : The illustration of the relationship between the number of extrusion cycles and the pressure drop across the die for the 30 extrusion cycle run with respect to all MV medium and 100 Mesh grit mixtures utilised, as well as the pure MV medium.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
● : MV60 1:2
■ : MV60 1:1
▲ : MV60 2:1
○ : MV 0:1
P.D/SHU93
[TP5/EH92]

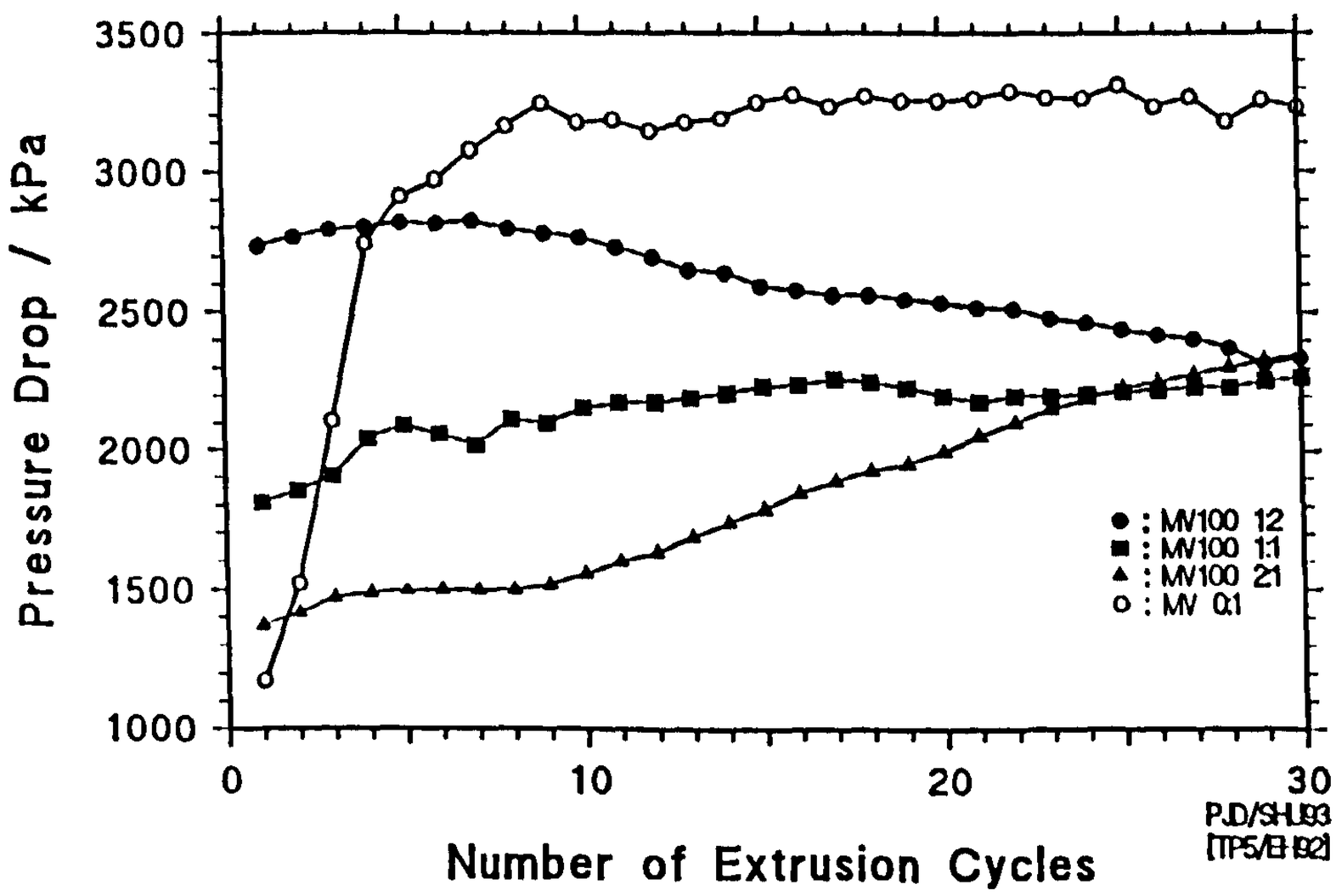
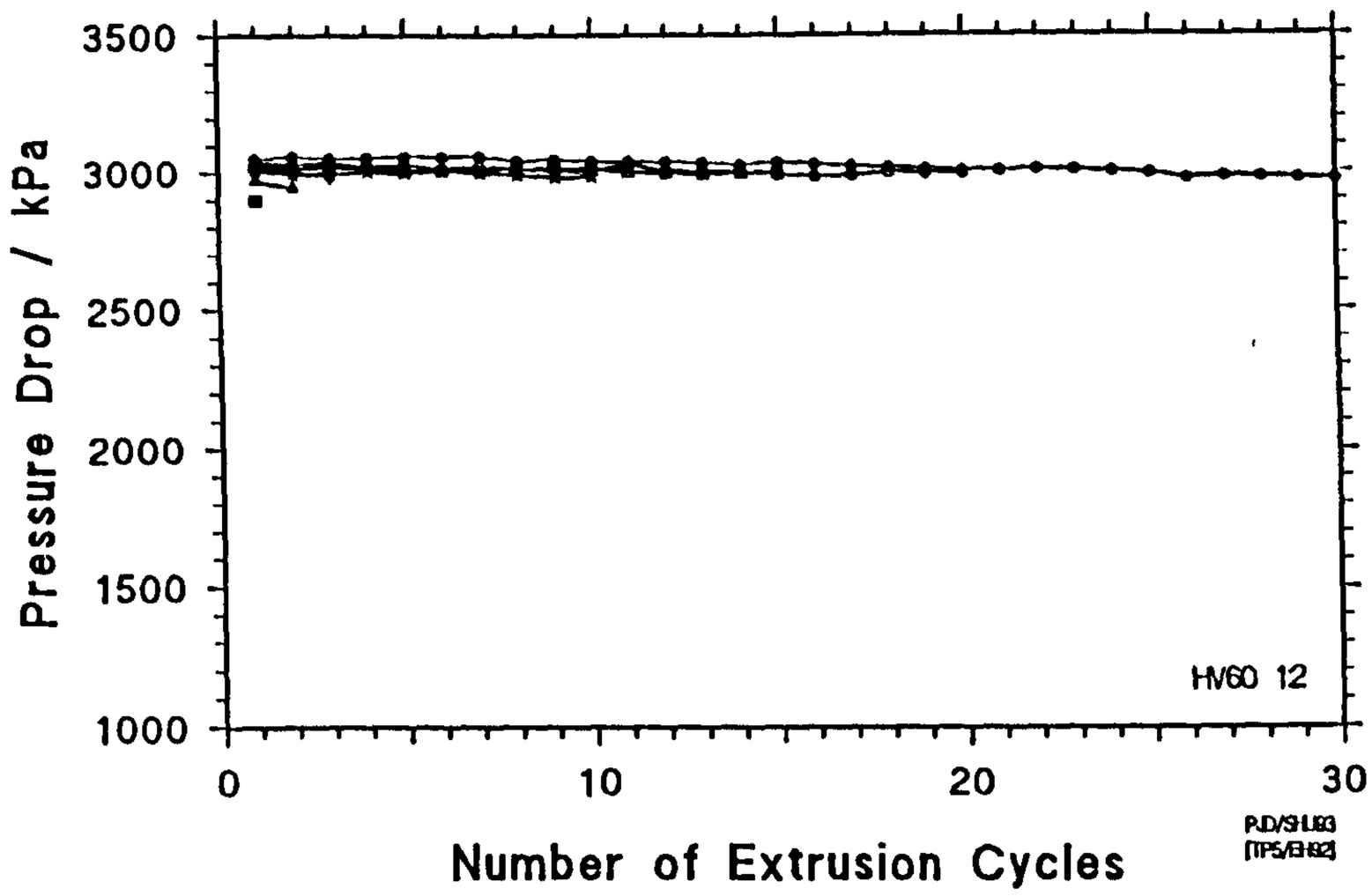
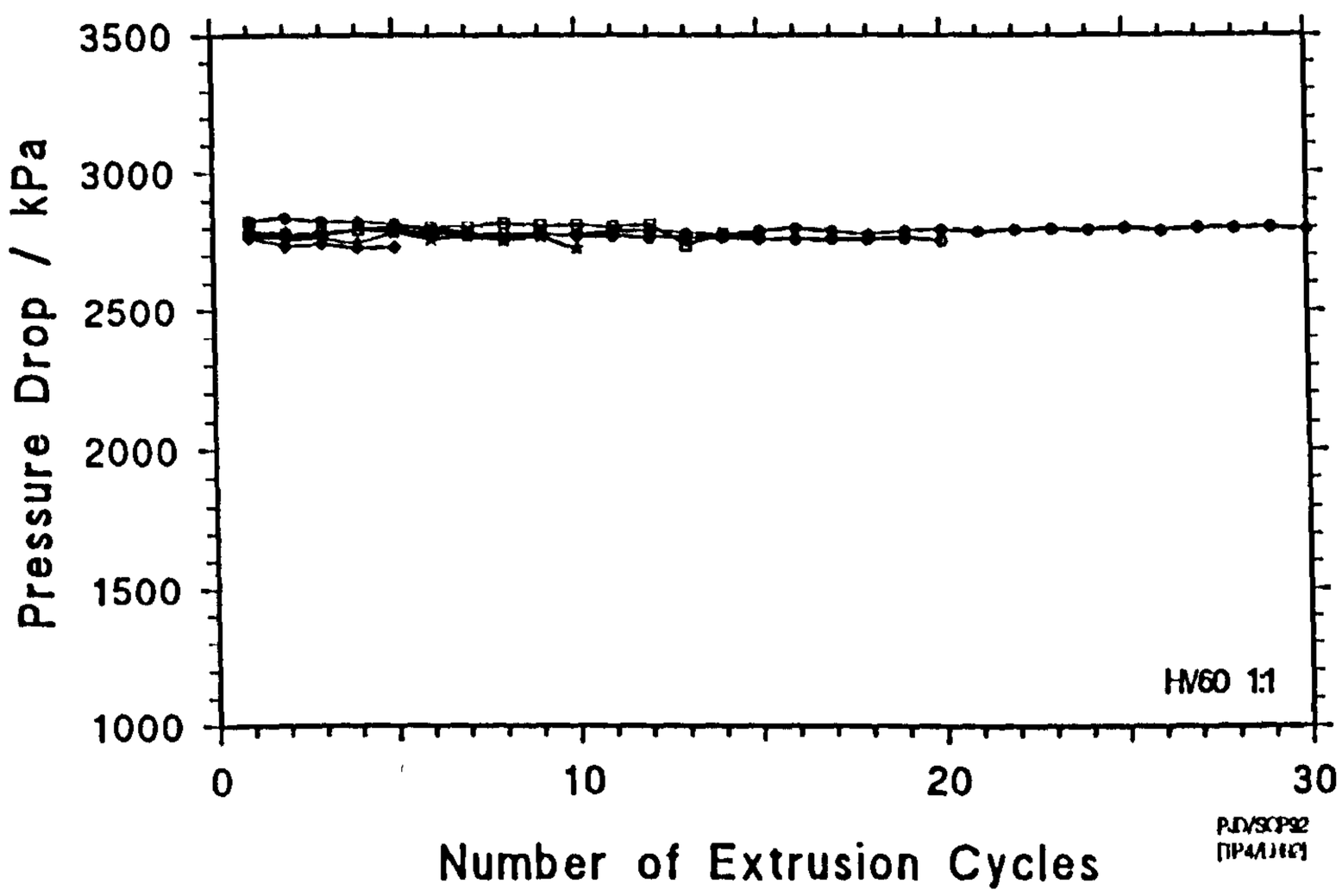

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
● : MV100 1:2
■ : MV100 1:1
▲ : MV100 2:1
○ : MV 0:1
P.D/SHU93
[TP5/EH92]

Figure 78(a) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using HV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 78(b) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 78(c) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using HV medium and 60 Mesh grit with a grit to polymer ratio of 2.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
HV60 12


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
HV60 1.1

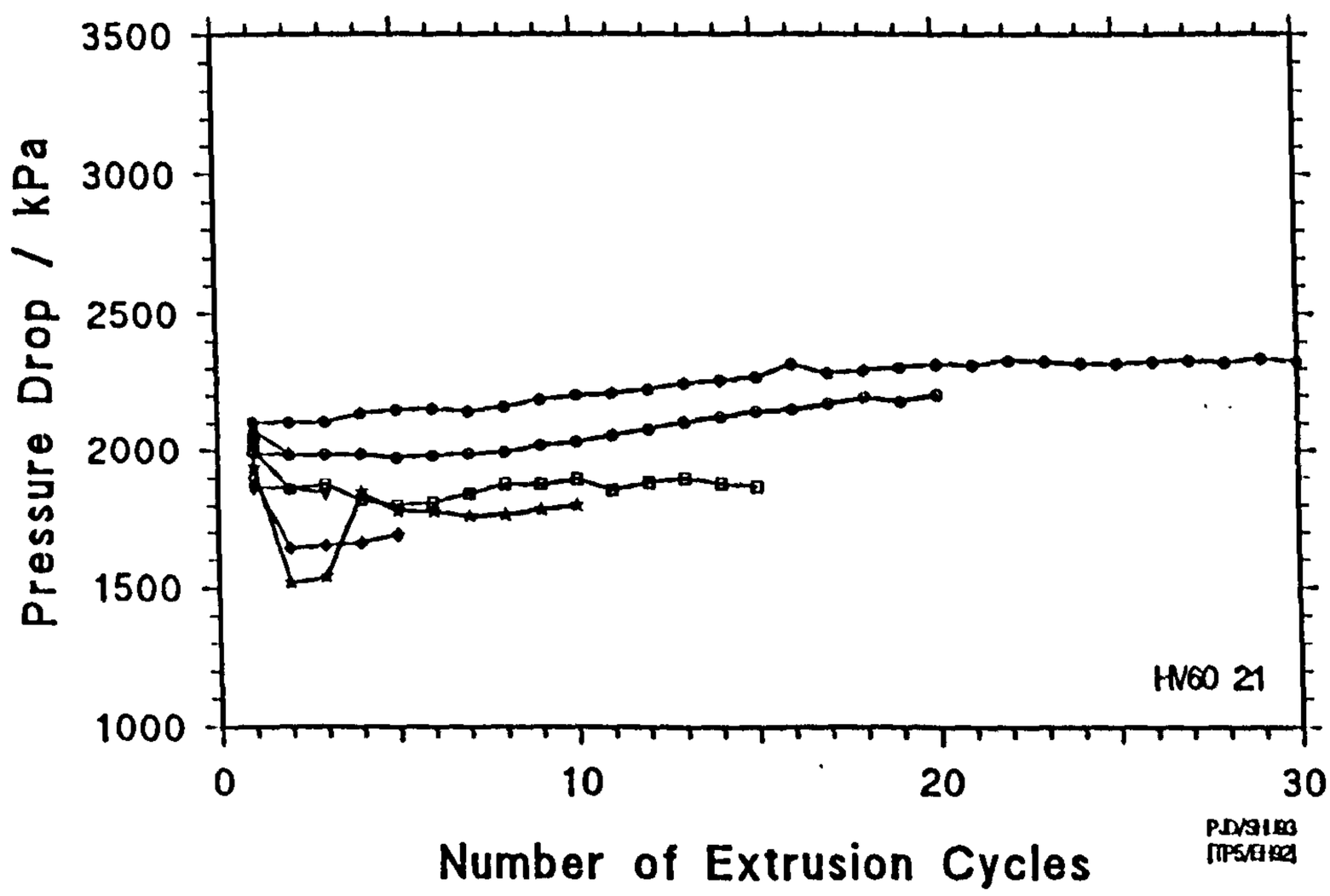
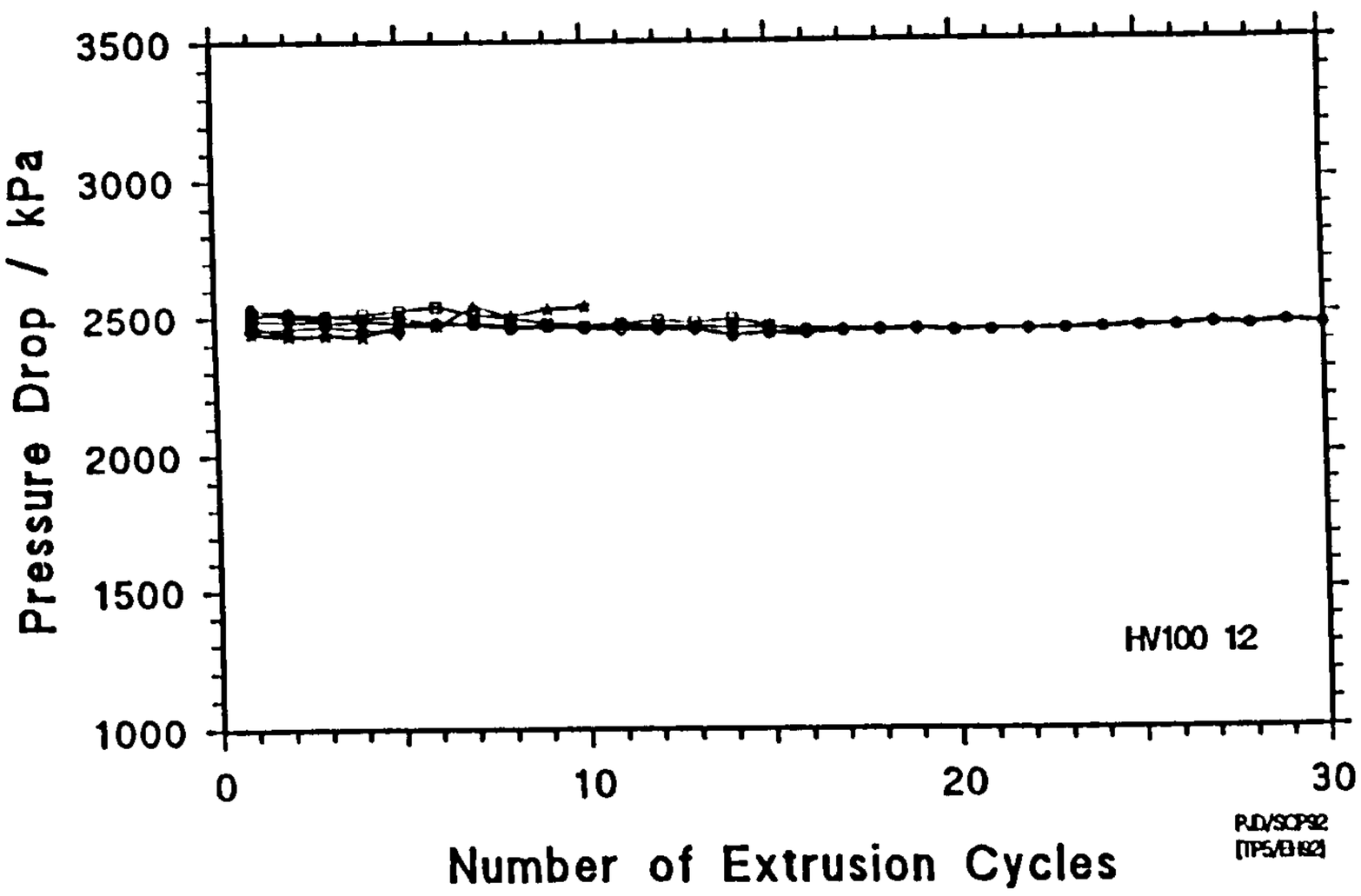
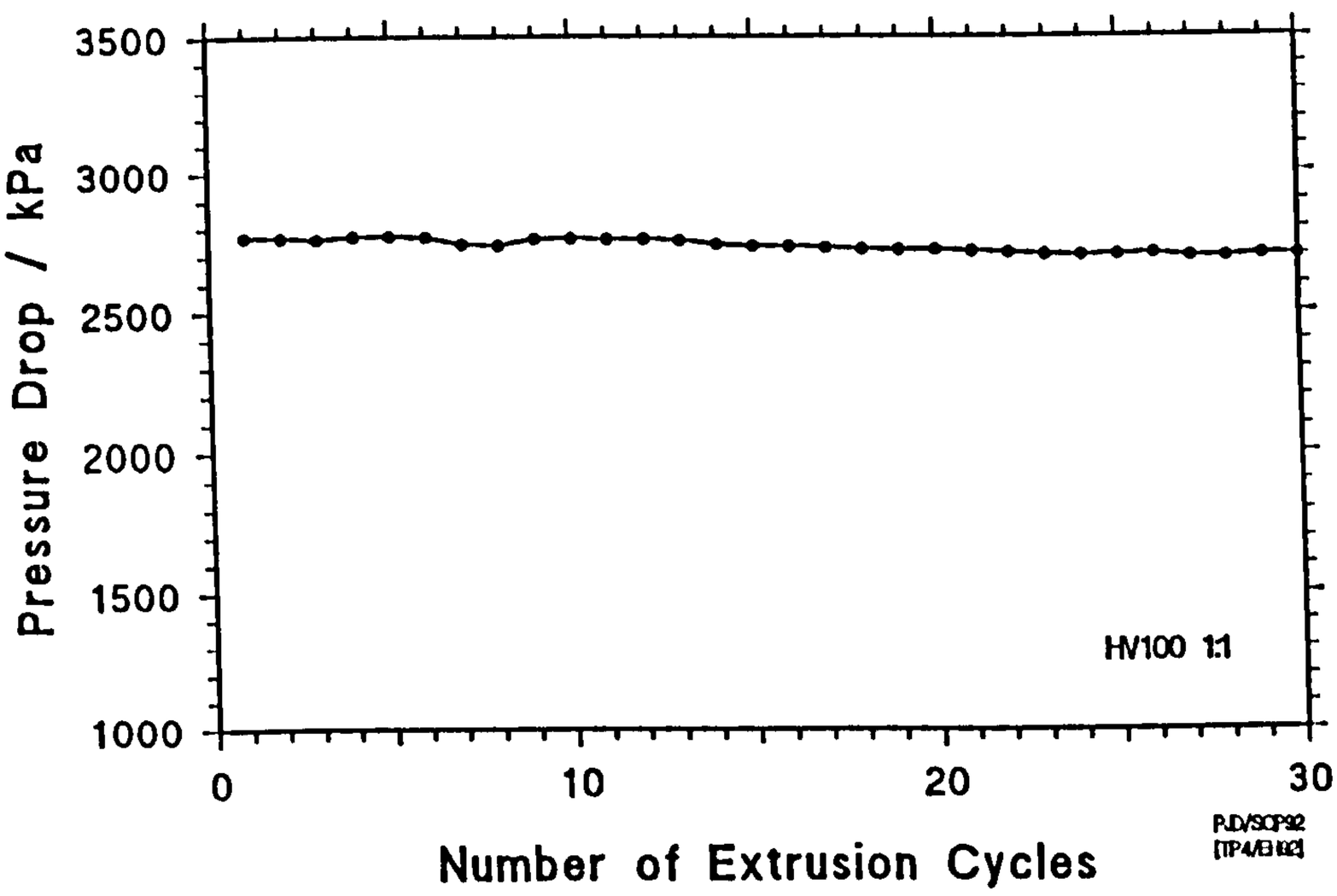

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
HV60 21

Figure 79(a) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using HV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 79(b) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 79(c) : The relationship between the number of extrusion cycles and the corresponding pressure drop across the die for all runs conducted using HV medium and 100 Mesh grit with a grit to polymer ratio of 2.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
HV100 12
0
10
20
30
Number of Extrusion Cycles


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
HV100 11
0
10
20
30
Number of Extrusion Cycles

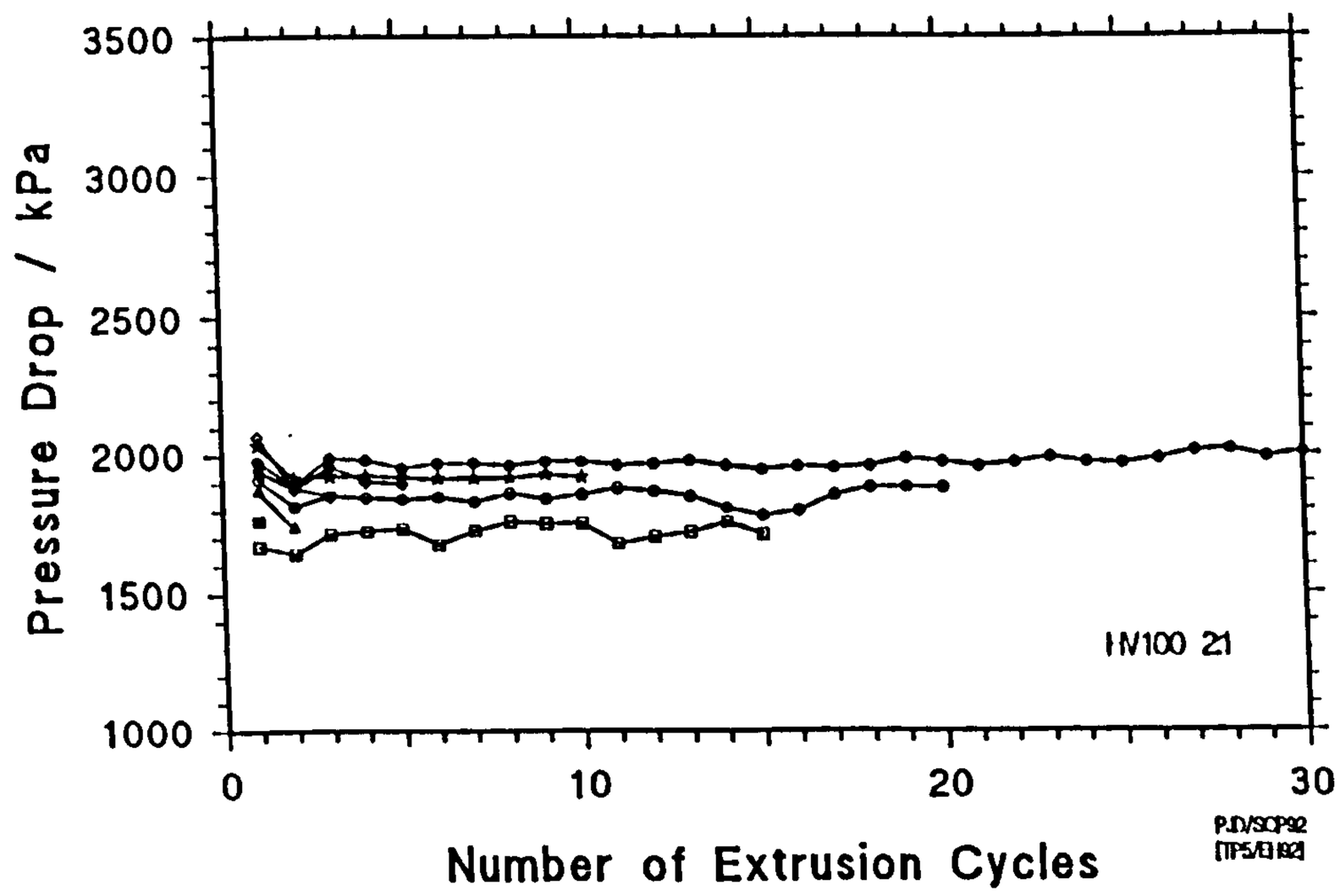
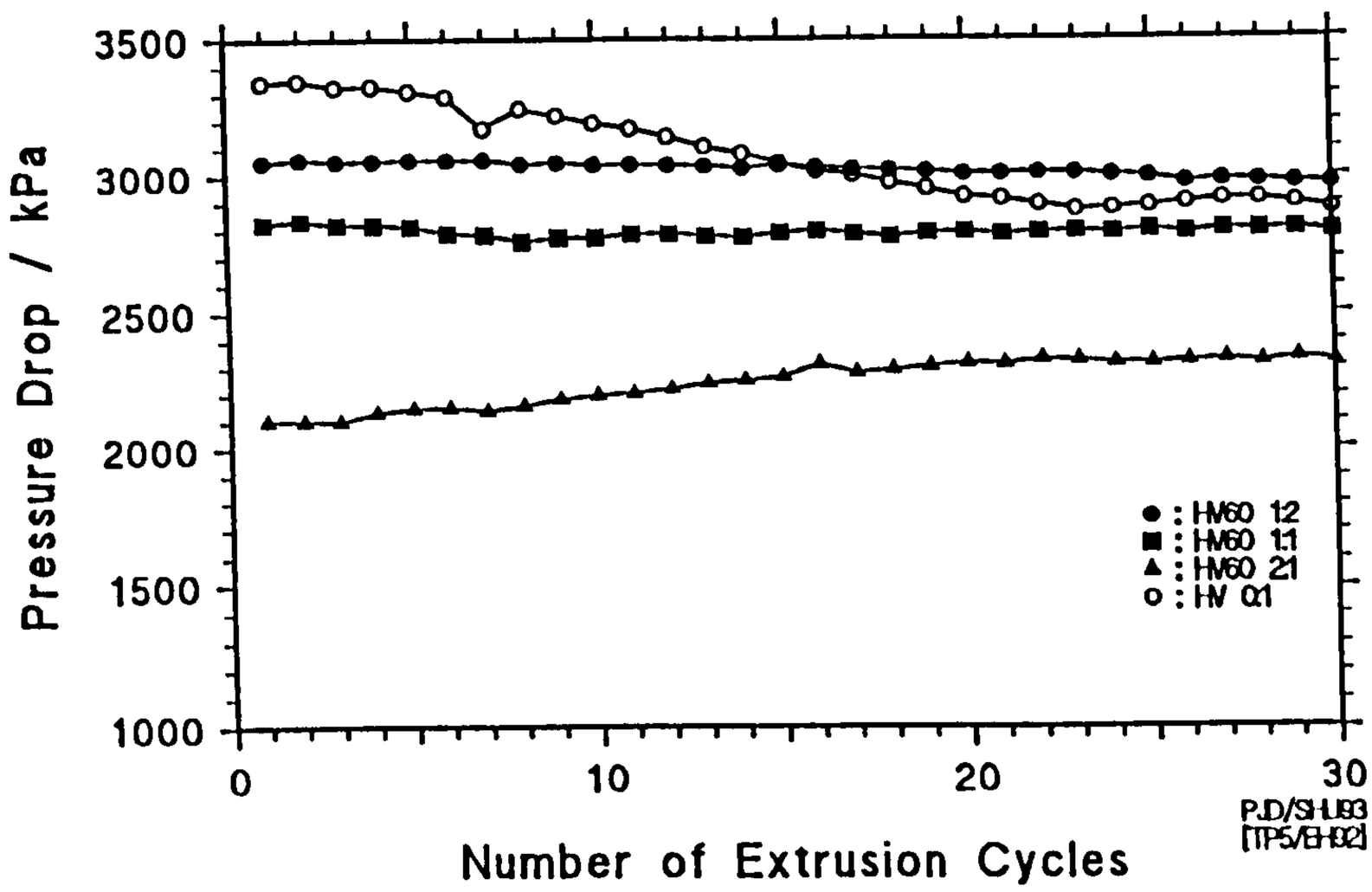

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
HV100 21
0
10
20
30
Number of Extrusion Cycles

Figure 80(a) : The illustration of the relationship between the number of extrusion cycles and the pressure drop across the die for the 30 extrusion cycle run with respect to all HV medium and 60 Mesh grit mixtures utilised, as well as the pure HV medium.

Figure 80(b) : The illustration of the relationship between the number of extrusion cycles and the pressure drop across the die for the 30 extrusion cycle run with respect to all HV medium and 100 Mesh grit mixtures utilised, as well as the pure HV medium.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
● : HV60 1:2
■ : HV60 1:1
▲ : HV60 2:1
o : HV 0:1
P.J.D/SHU93
[TP5/EH92]

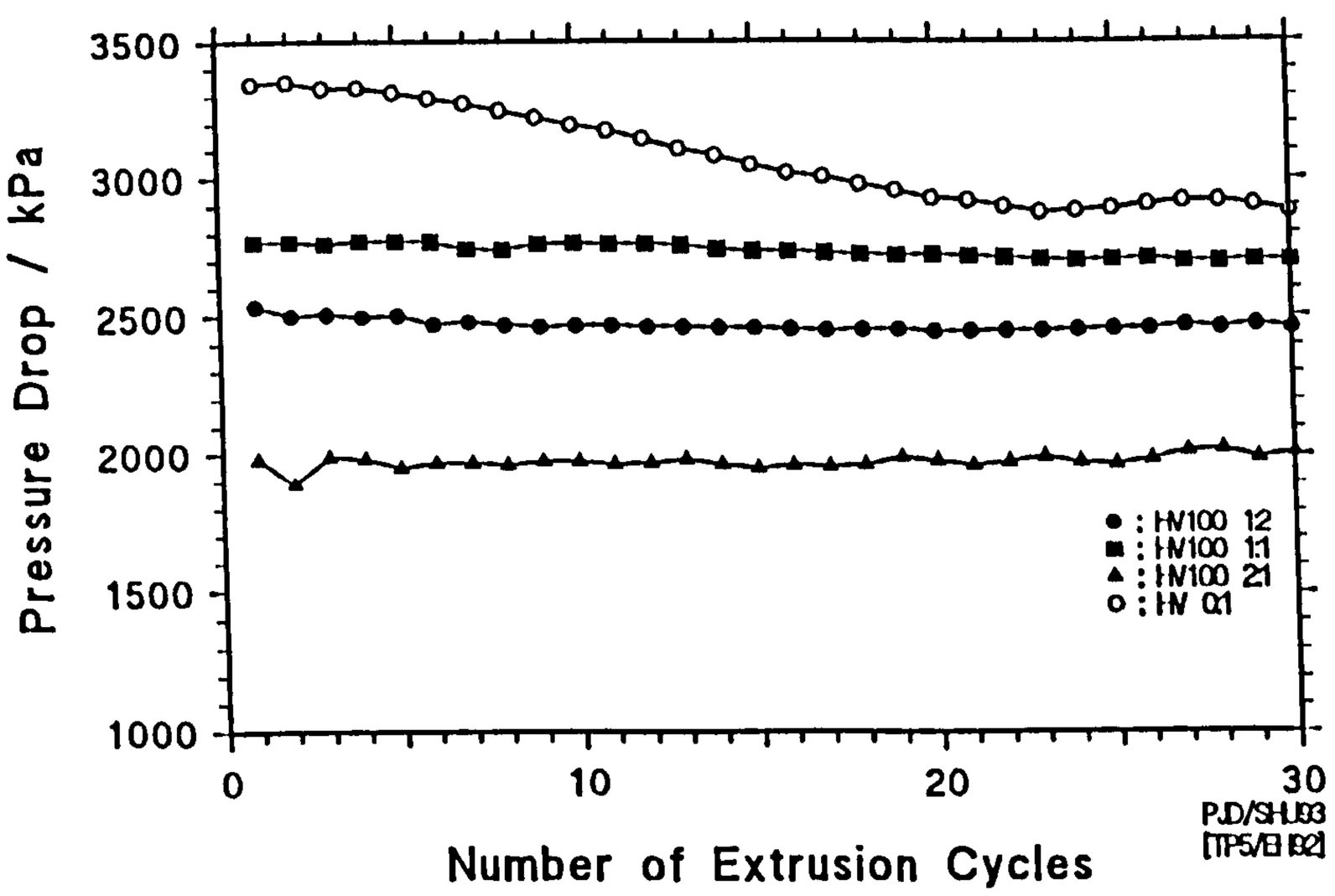

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
● : HV100 1:2
■ : HV100 1:1
▲ : HV100 2:1
o : HV 0:1
P.J.D/SHU93
[TP5/EH92]

Figure 81 : The relationship between the number of extrusion cycles and the average pressure drops obtained in relation to all LV medium and 60 Mesh grit mixtures.

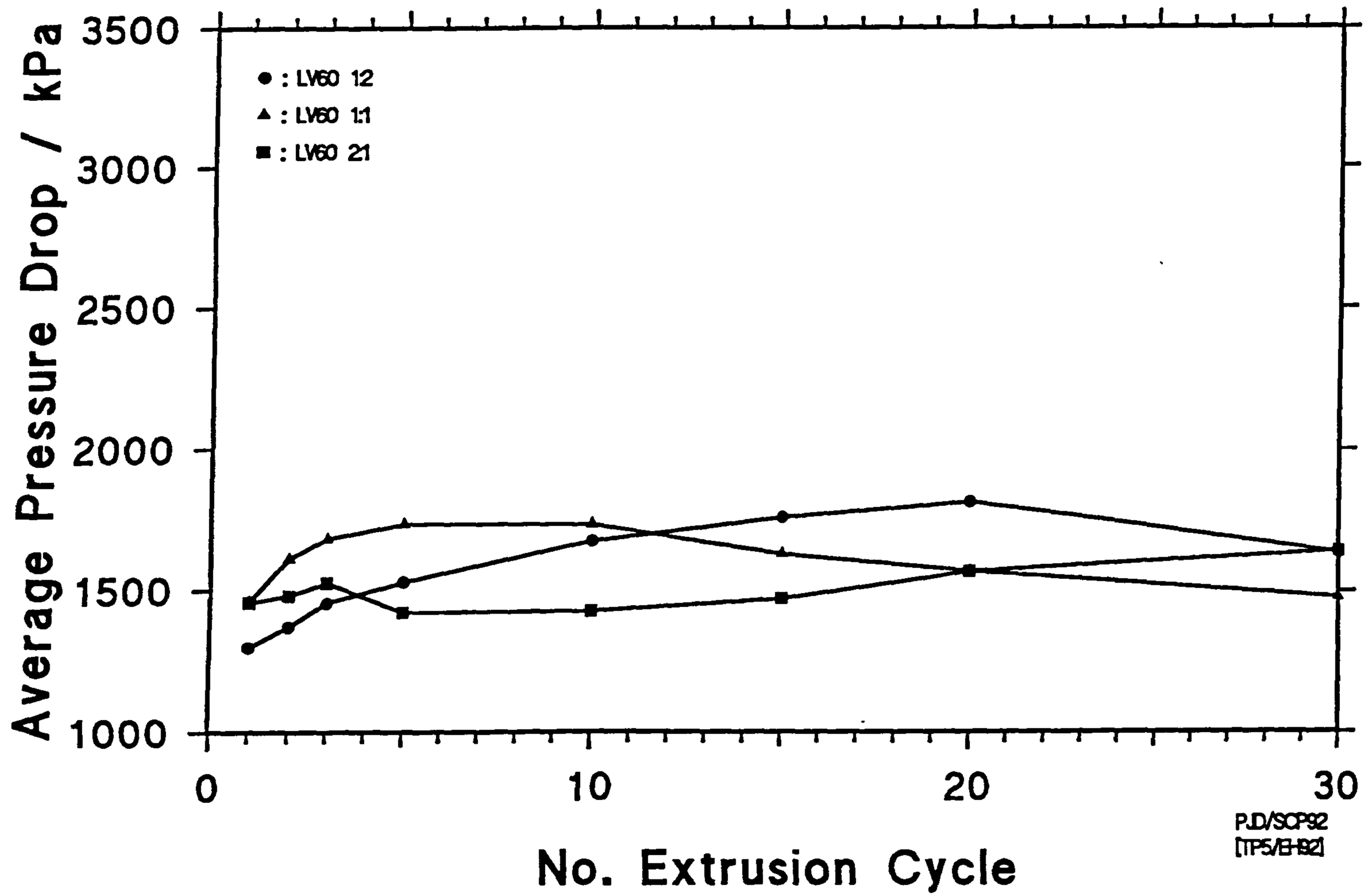

Average Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
● : LV60 12
▲ : LV60 1:1
■ : LV60 21
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 82 : The relationship between the number of extrusion cycles and the average pressure drops obtained in relation to all LV medium and 100 Mesh grit mixtures.

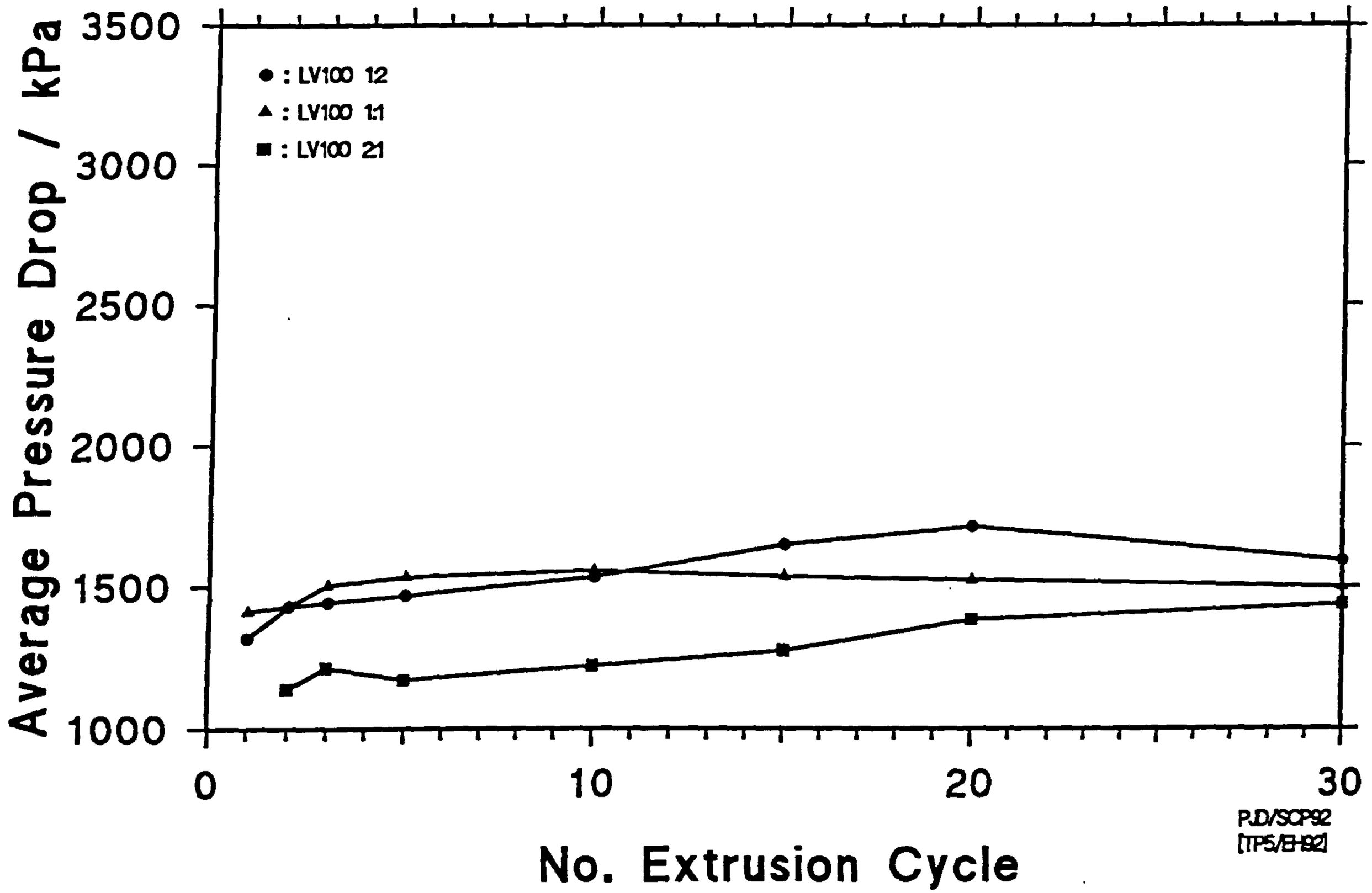

Average Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
● : LV100 12
▲ : LV100 11
■ : LV100 21
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 83 : The relationship between the number of extrusion cycles and the average pressure drops obtained in relation to all MV medium and 60 Mesh grit mixtures.

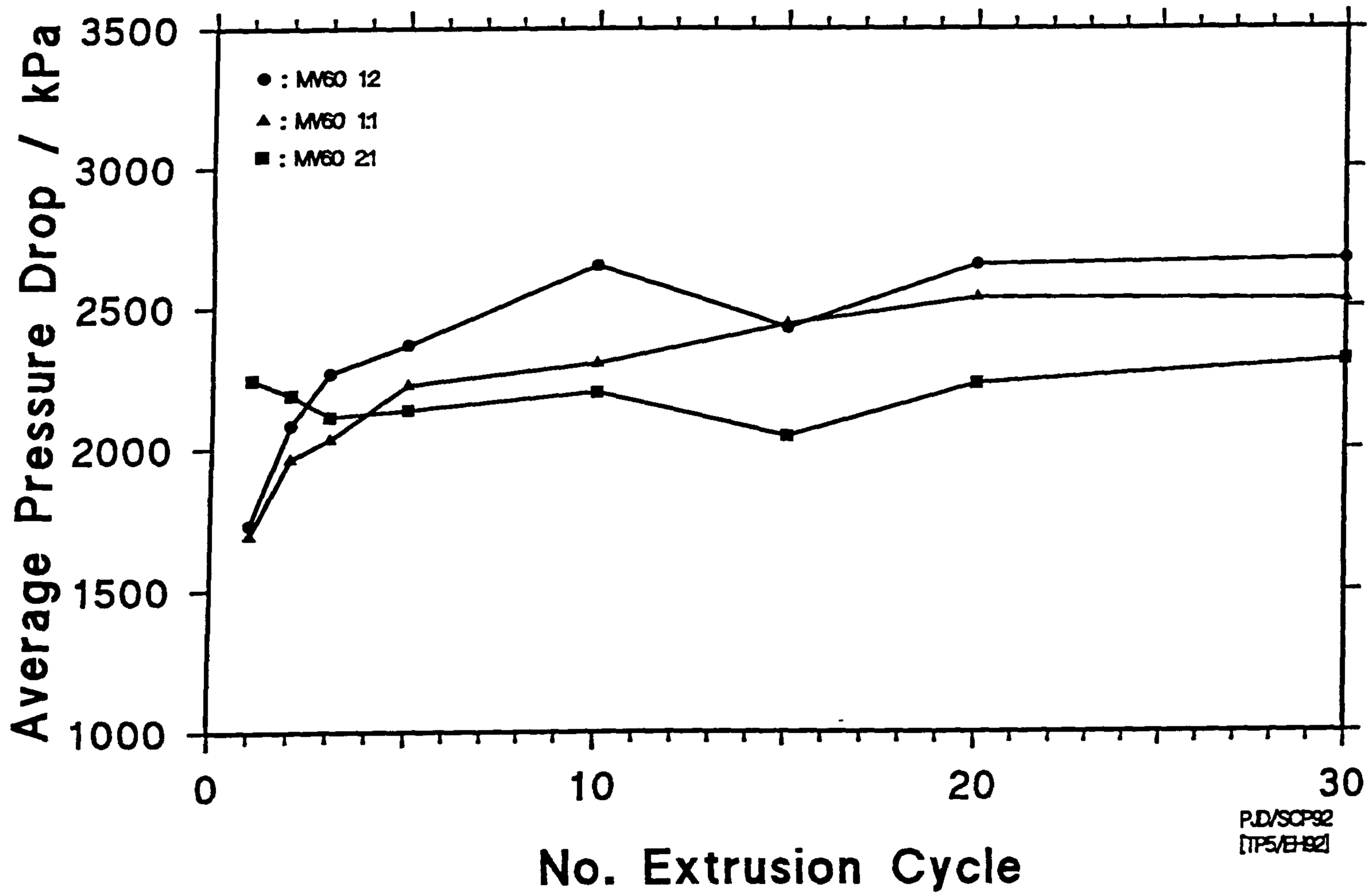

Average Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
● : MV60 1:2
▲ : MV60 1:1
■ : MV60 2:1
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 84 : The relationship between the number of extrusion cycles and the average pressure drops obtained in relation to all MV medium and 100 Mesh grit mixtures.

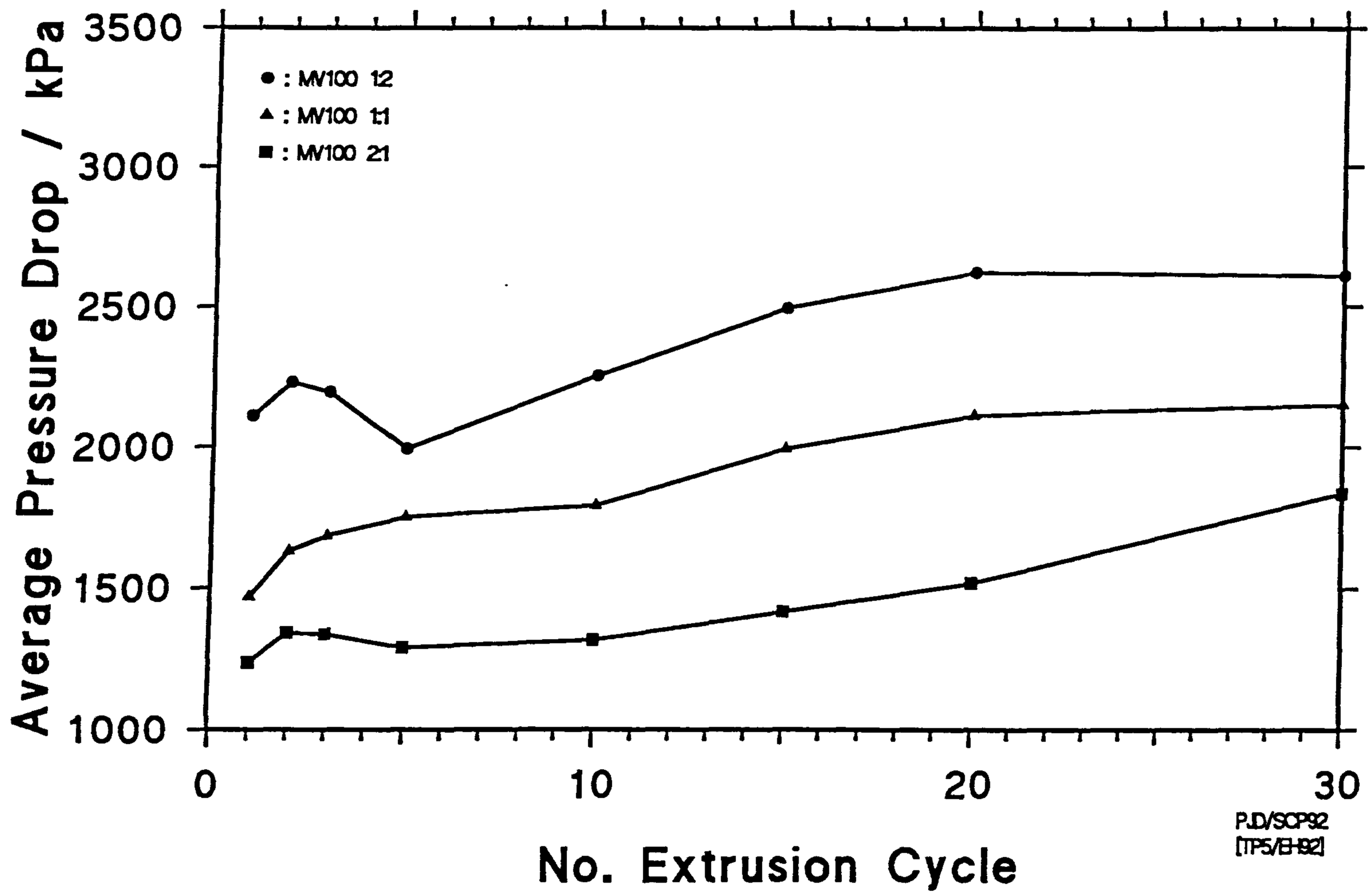

Average Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
● : MV100 12
▲ : MV100 11
■ : MV100 21
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 85 : The relationship between the number of extrusion cycles and the average pressure drops obtained in relation to all HV medium and 60 Mesh grit mixtures.

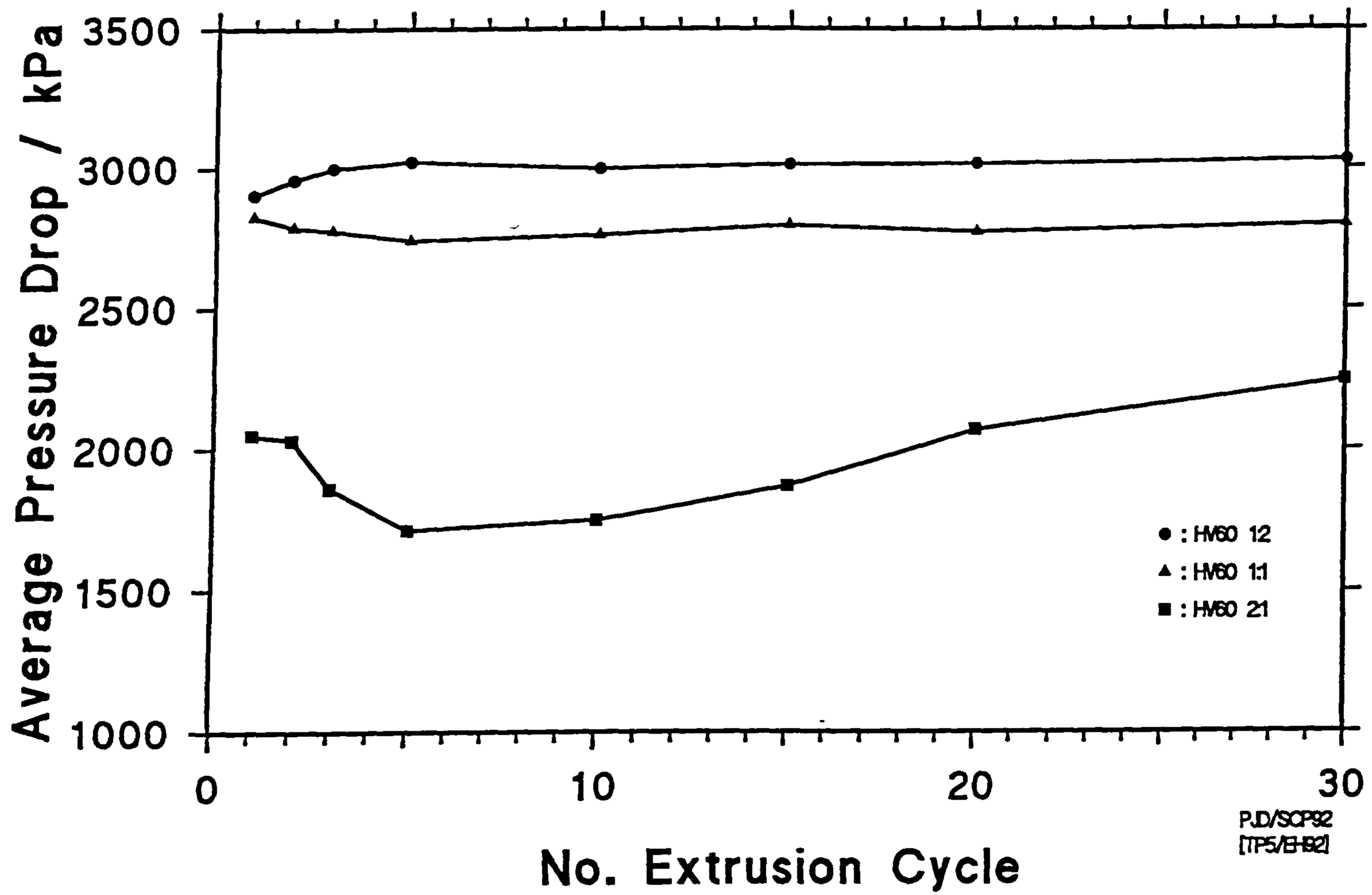

Average Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
No. Extrusion Cycle
● : HV60 12
▲ : HV60 1:1
■ : HV60 21
PJD/SCP92
[TP5/EH92]

Figure 86 : The relationship between the number of extrusion cycles and the average pressure drops obtained in relation to all HV medium and 100 Mesh grit mixtures.

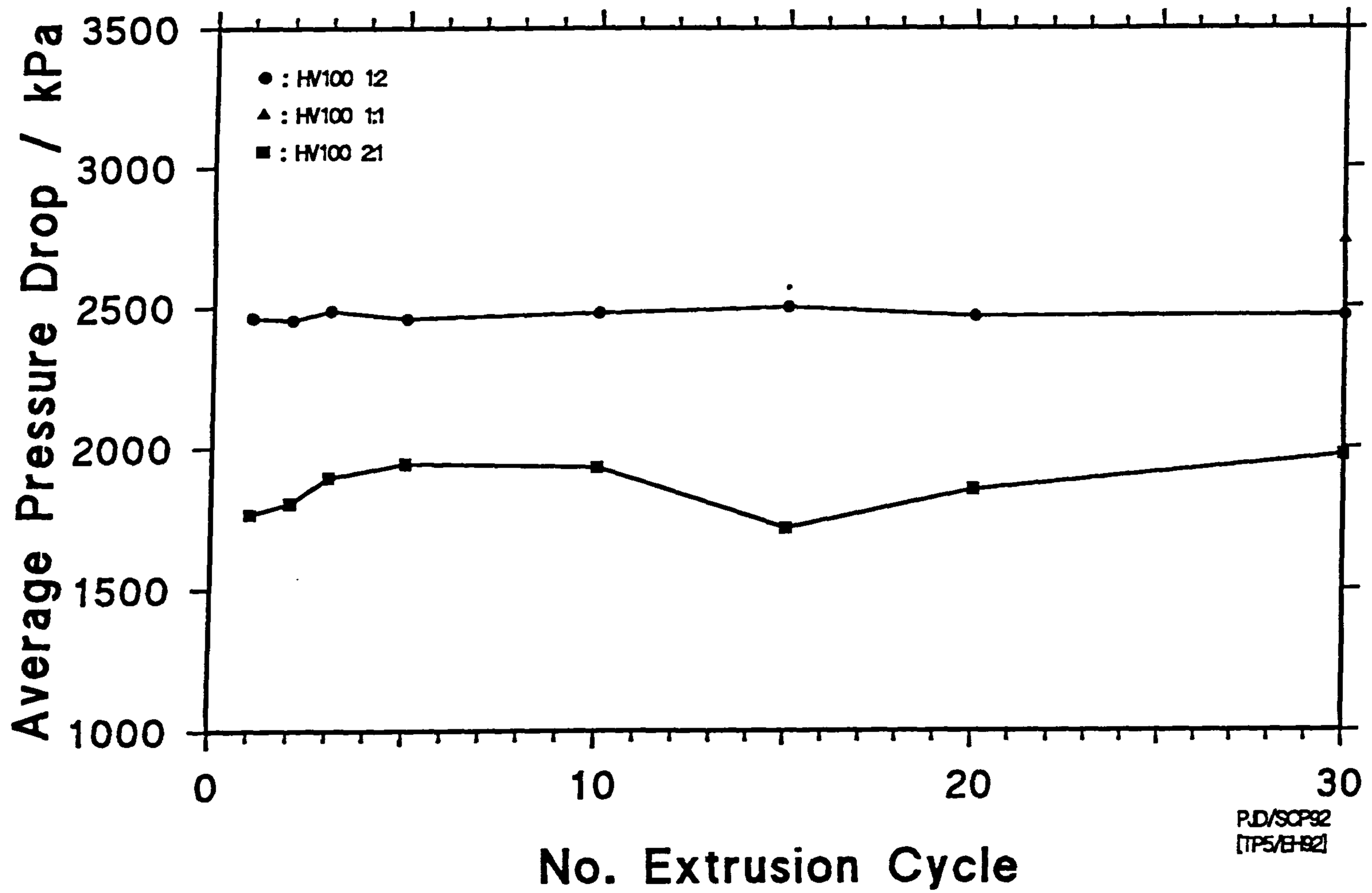

Average Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
● : HV100 1:2
▲ : HV100 1:1
■ : HV100 2:1
0
10
20
30
No. Extrusion Cycle
PJD/SCP92
[TP5/EH92]

Figure 87 : The relationship between the number of extrusion cycles and the viscosity of the medium for all LV medium and 60 Mesh grit mixtures.

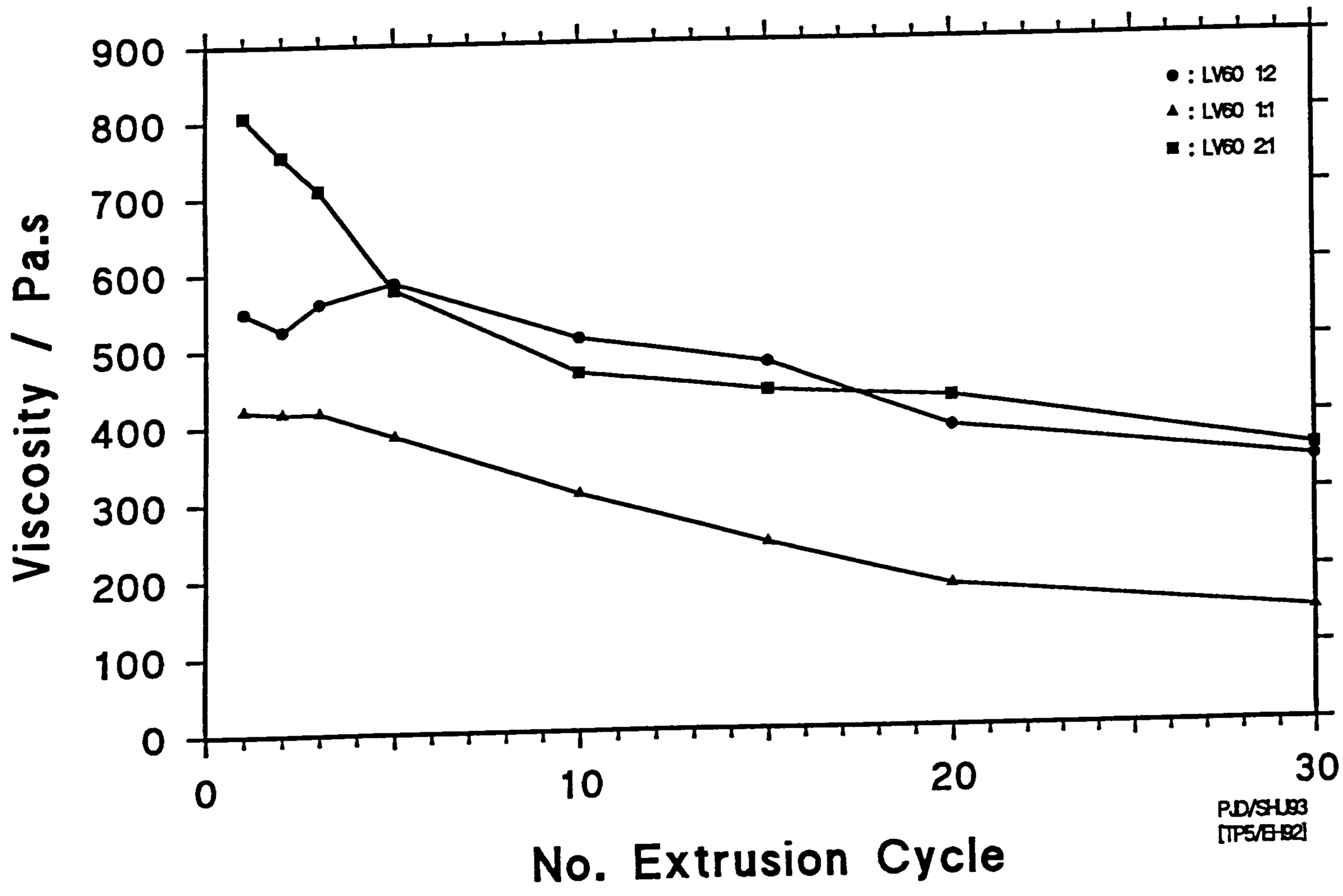

900
800
700
600
500
400
300
200
100
0
Viscosity / Pa.s
0
10
20
30
No. Extrusion Cycle
● : LV60 12
▲ : LV60 11
■ : LV60 21
PJD/SHU93
[TP5/EH92]

Figure 88 : The relationship between the number of extrusion cycles and the viscosity of the medium for all LV medium and 100 Mesh grit mixtures.

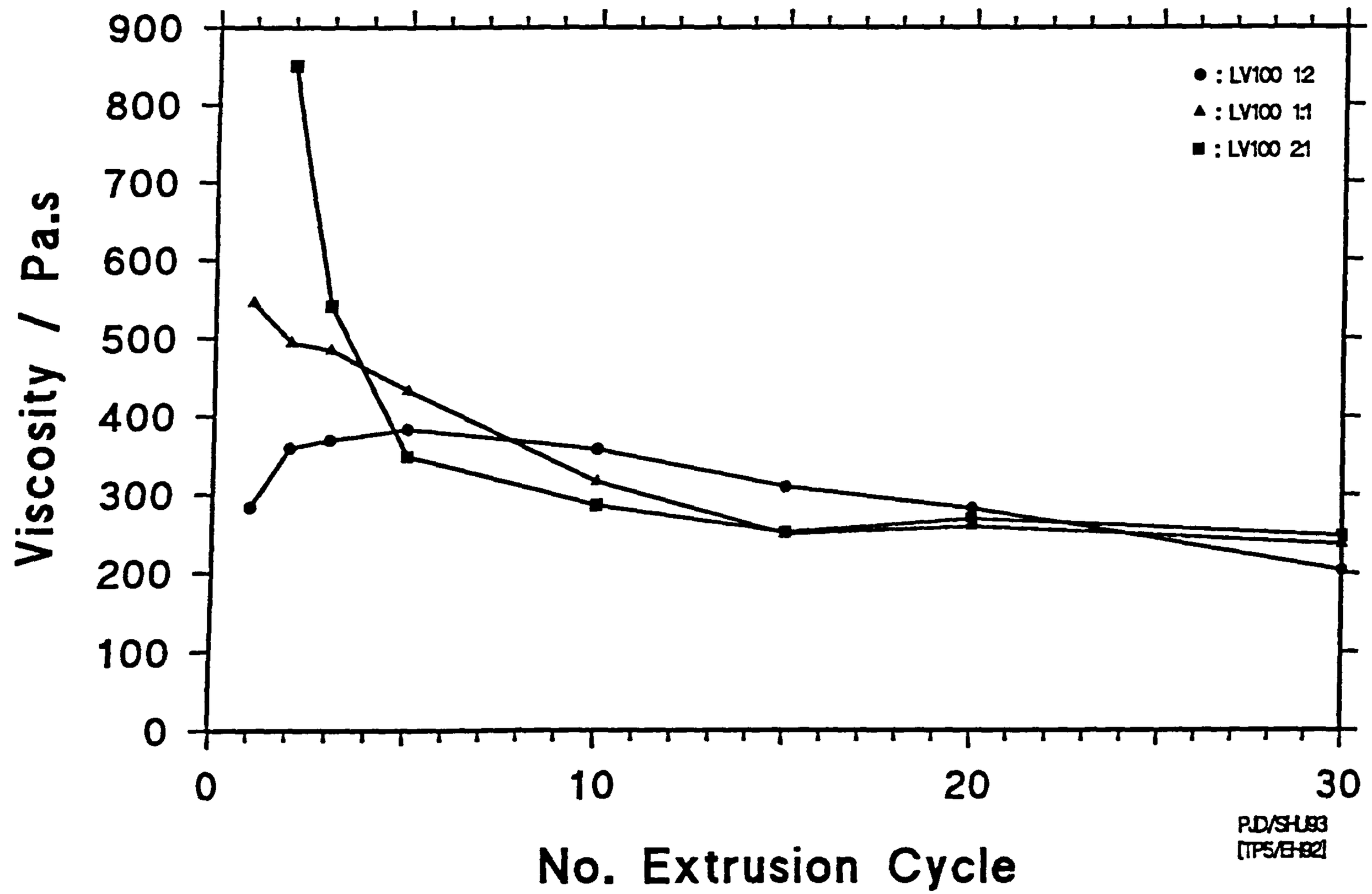

900
800
700
600
500
400
300
200
100
0
Viscosity / Pa.s
0
10
20
30
No. Extrusion Cycle
● : LV100 1:2
▲ : LV100 1:1
■ : LV100 2:1
P.D/SHU93
[TP5/EH92]

Figure 89 : The relationship between the number of extrusion cycles and the viscosity of the medium for all MV medium and 60 Mesh grit mixtures.

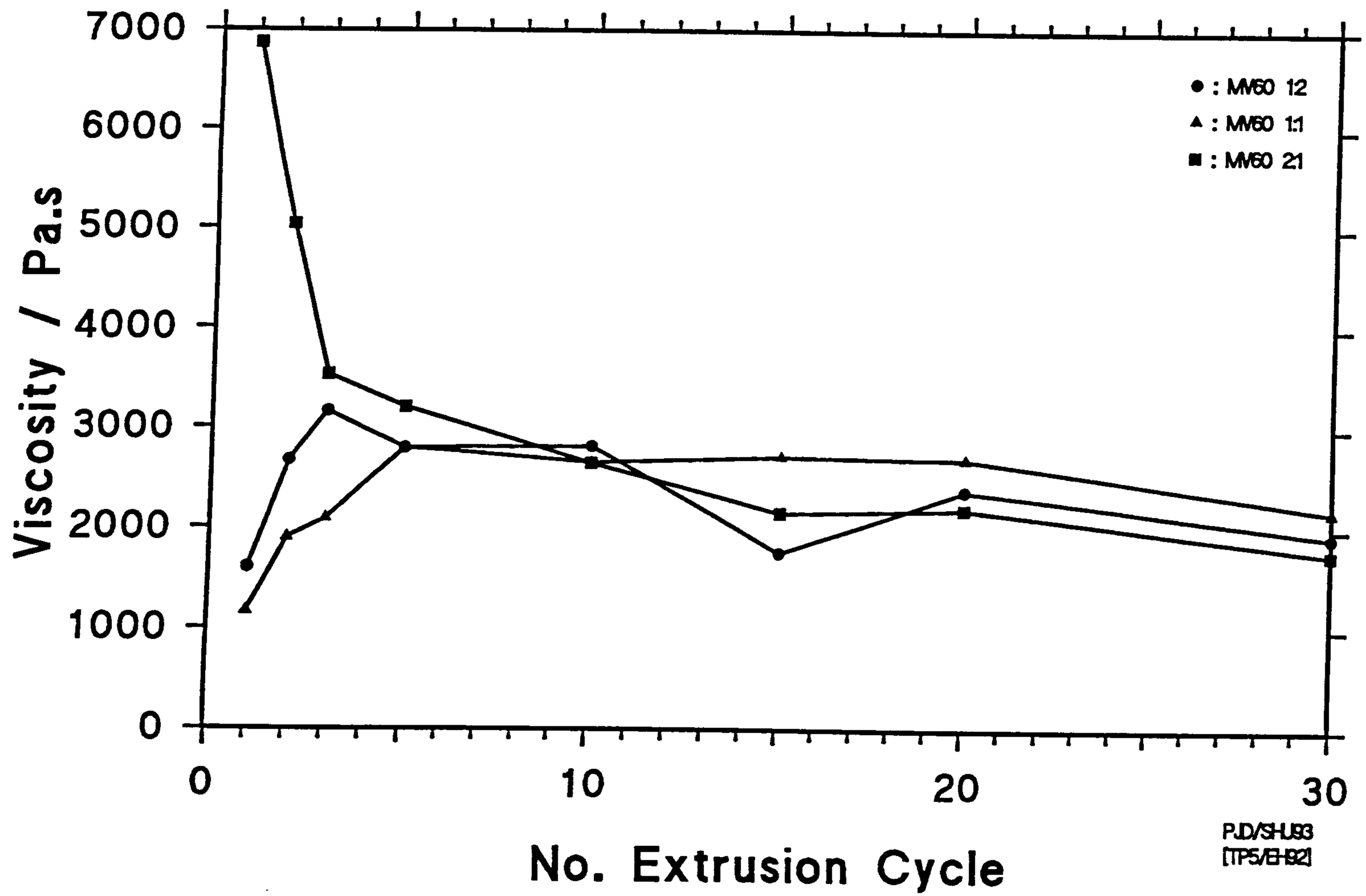

7000
6000
5000
4000
3000
2000
1000
0
Viscosity / Pa.s
0
10
20
30
No. Extrusion Cycle
● : MV60 1:2
▲ : MV60 1:1
■ : MV60 2:1
PJD/SHU93
[TP5/EH92]

Figure 90 : The relationship between the number of extrusion cycles and the viscosity of the medium for all MV medium and 100 Mesh grit mixtures.

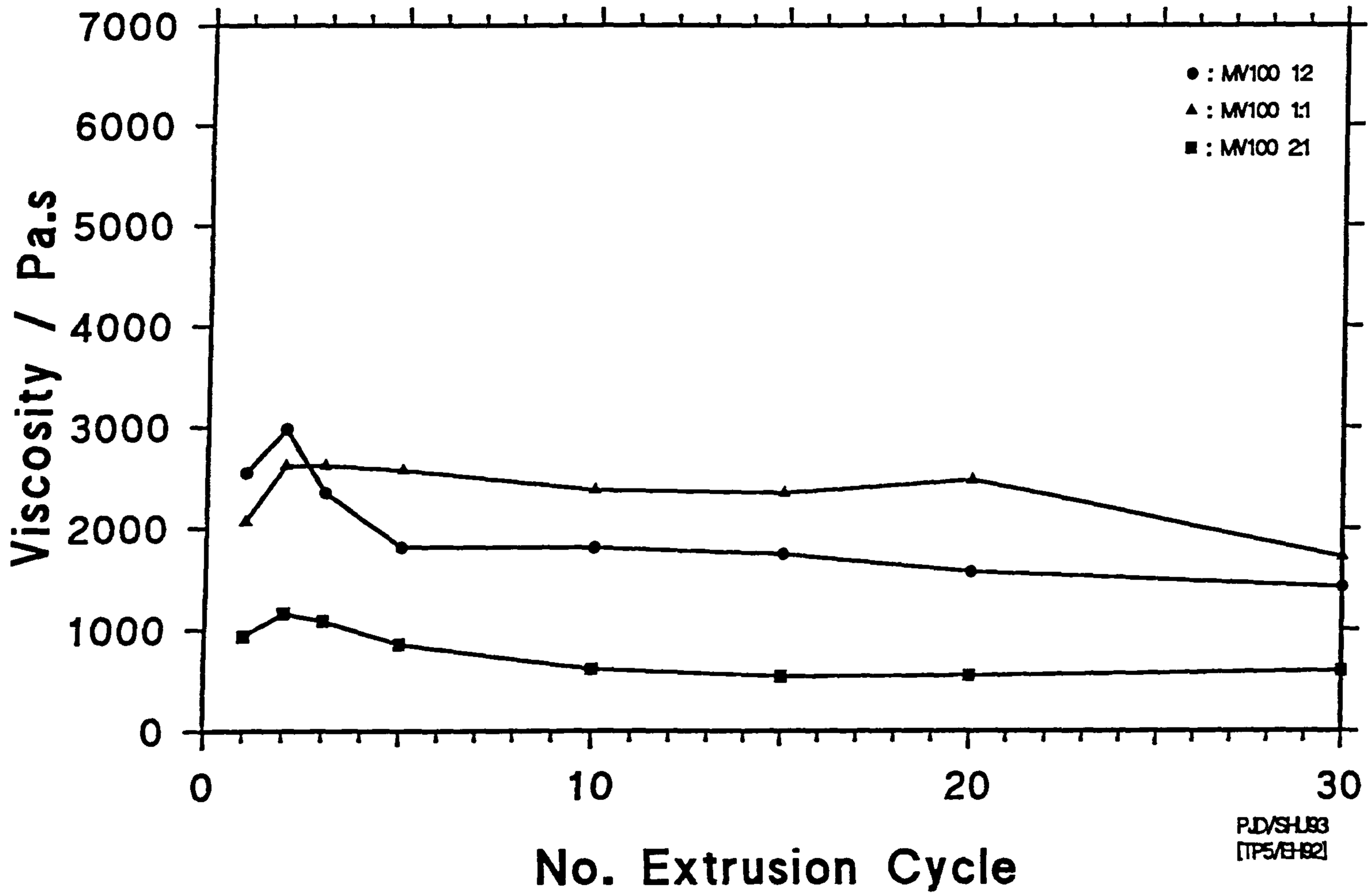

7000
6000
5000
4000
3000
2000
1000
0
Viscosity / Pa.s
0
10
20
30
No. Extrusion Cycle
● : MV100 1:2
▲ : MV100 1:1
■ : MV100 2:1
PJD/SHU93
[TP5/EH92]

Figure 91 : The relationship between the number of extrusion cycles and the viscosity of the medium for all HV medium and 60 Mesh grit mixtures.

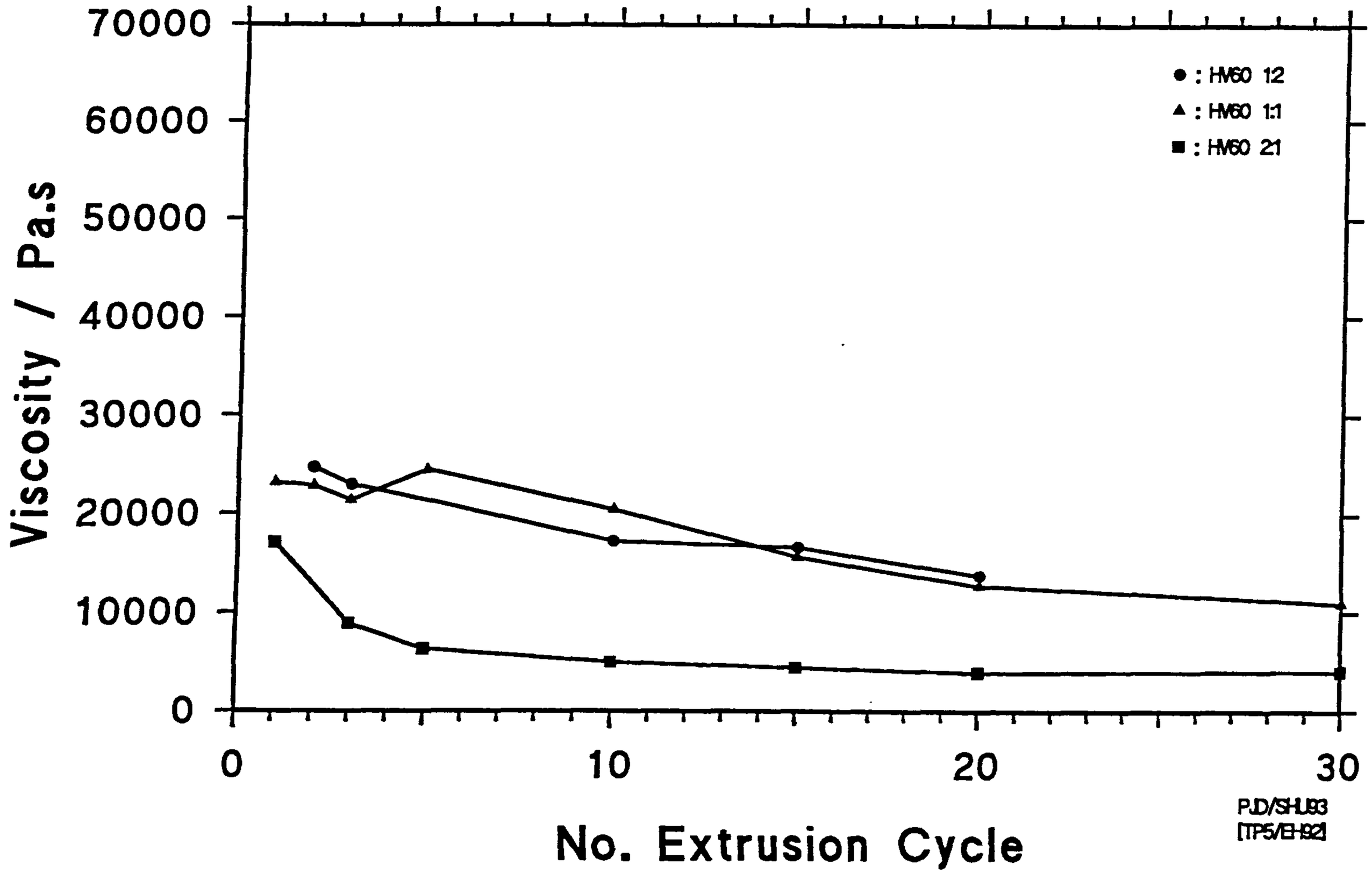

70000
60000
50000
40000
30000
20000
10000
0
Viscosity / Pa.s
0
10
20
30
No. Extrusion Cycle
● : HV60 1:2
▲ : HV60 1:1
■ : HV60 2:1
PJD/SHU93
[TP5/EH92]

Figure 92 : The relationship between the number of extrusion cycles and the viscosity of the medium for all HV medium and 100 Mesh grit mixtures.

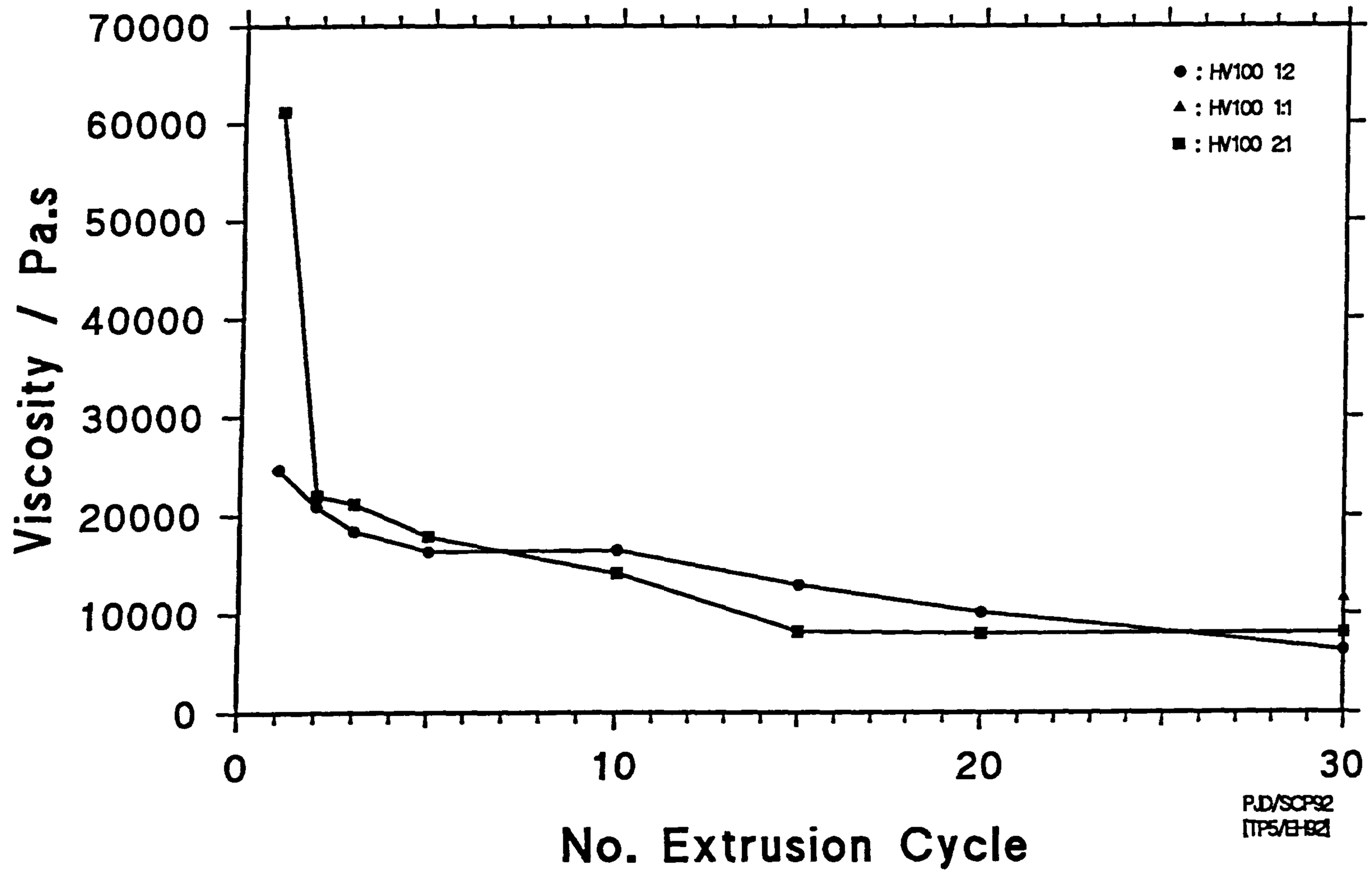
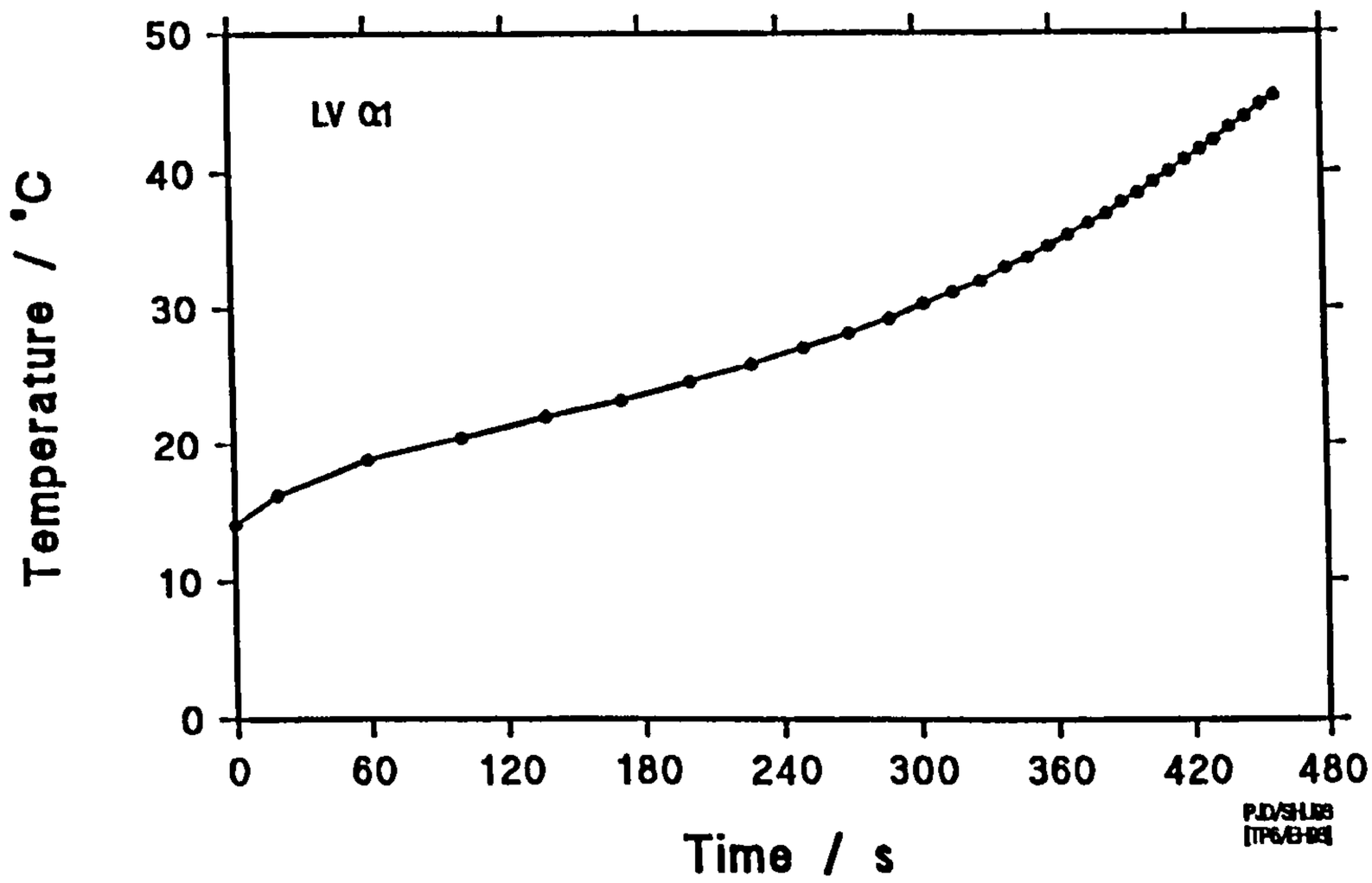
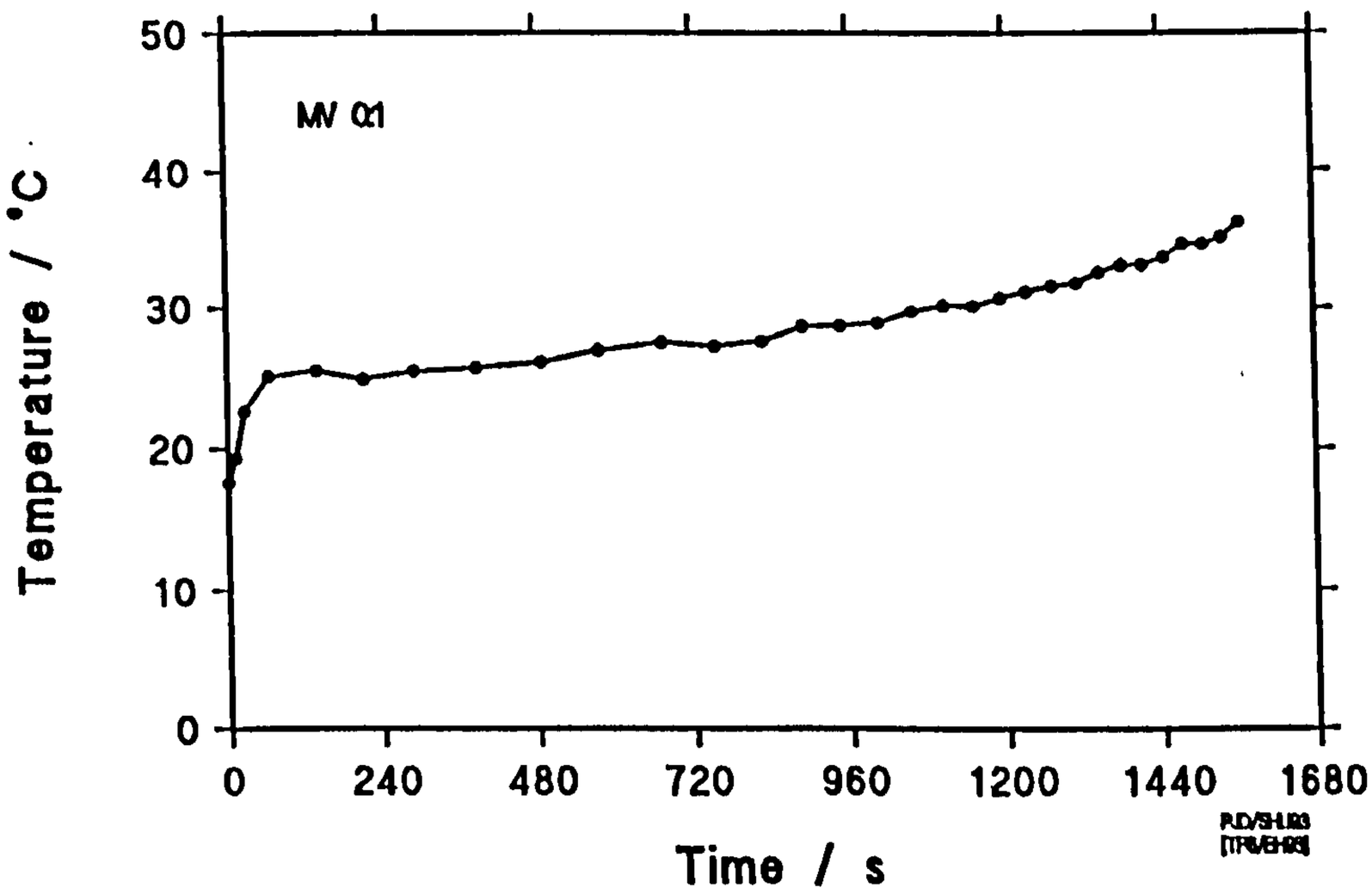

70000
60000
50000
40000
30000
20000
10000
0
Viscosity / Pa.s
0
10
20
30
No. Extrusion Cycle
● : HV100 1:2
▲ : HV100 1:1
■ : HV100 2:1
PJD/SCP92
[TP5/EH92]

Figure 93(a) : The relationship between processing time and temperature of the pure LV medium.

Figure 93(b) : The relationship between processing time and temperature of the pure MV medium.

Figure 93(c) : The relationship between processing time and temperature of the pure HV medium.


LV 01
Temperature / °C
Time / s
0
10
20
30
40
50
0
60
120
180
240
300
360
420
480


MV 01
Temperature / °C
Time / s
0
10
20
30
40
50
0
240
480
720
960
1200
1440
1680

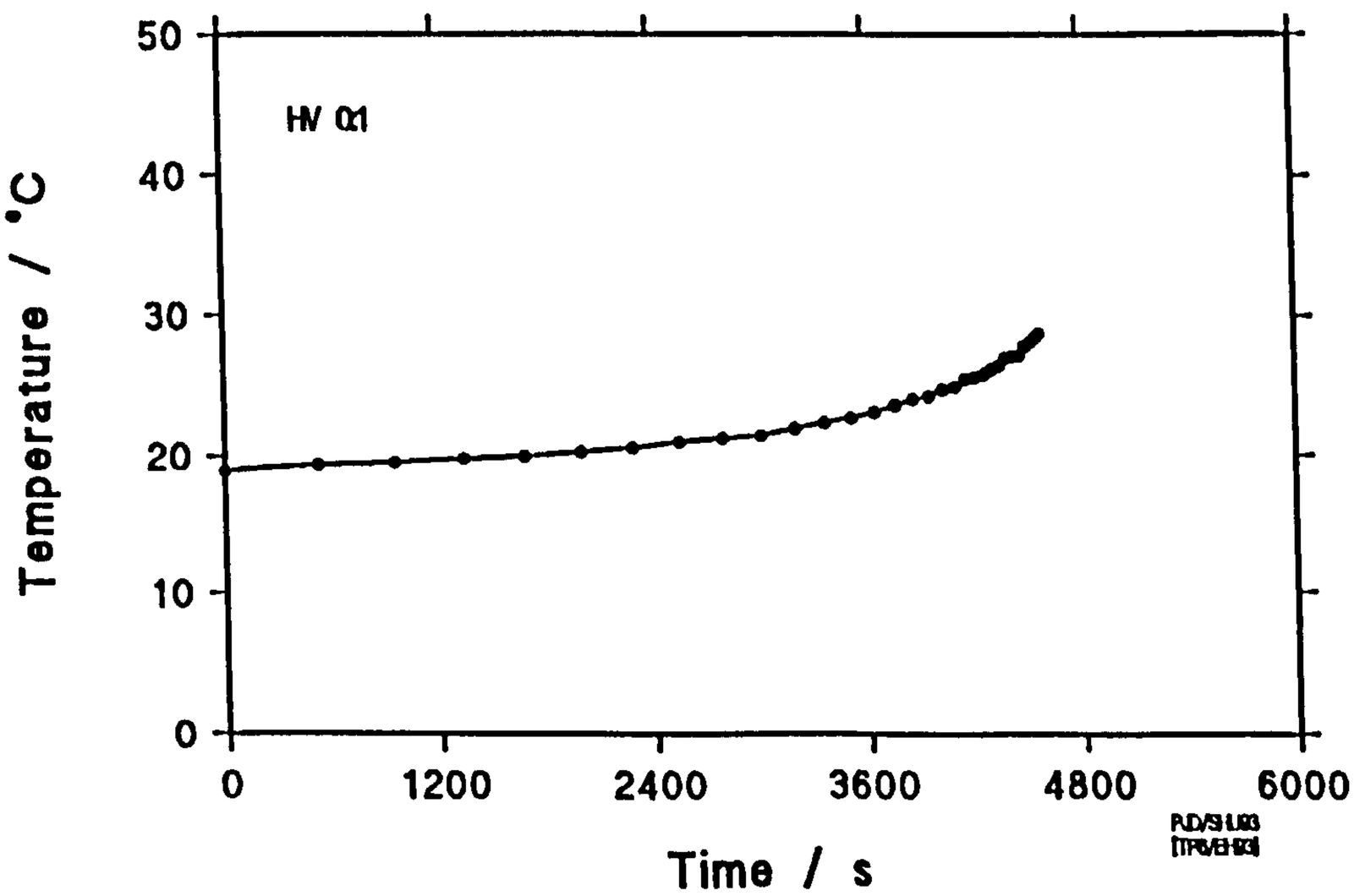
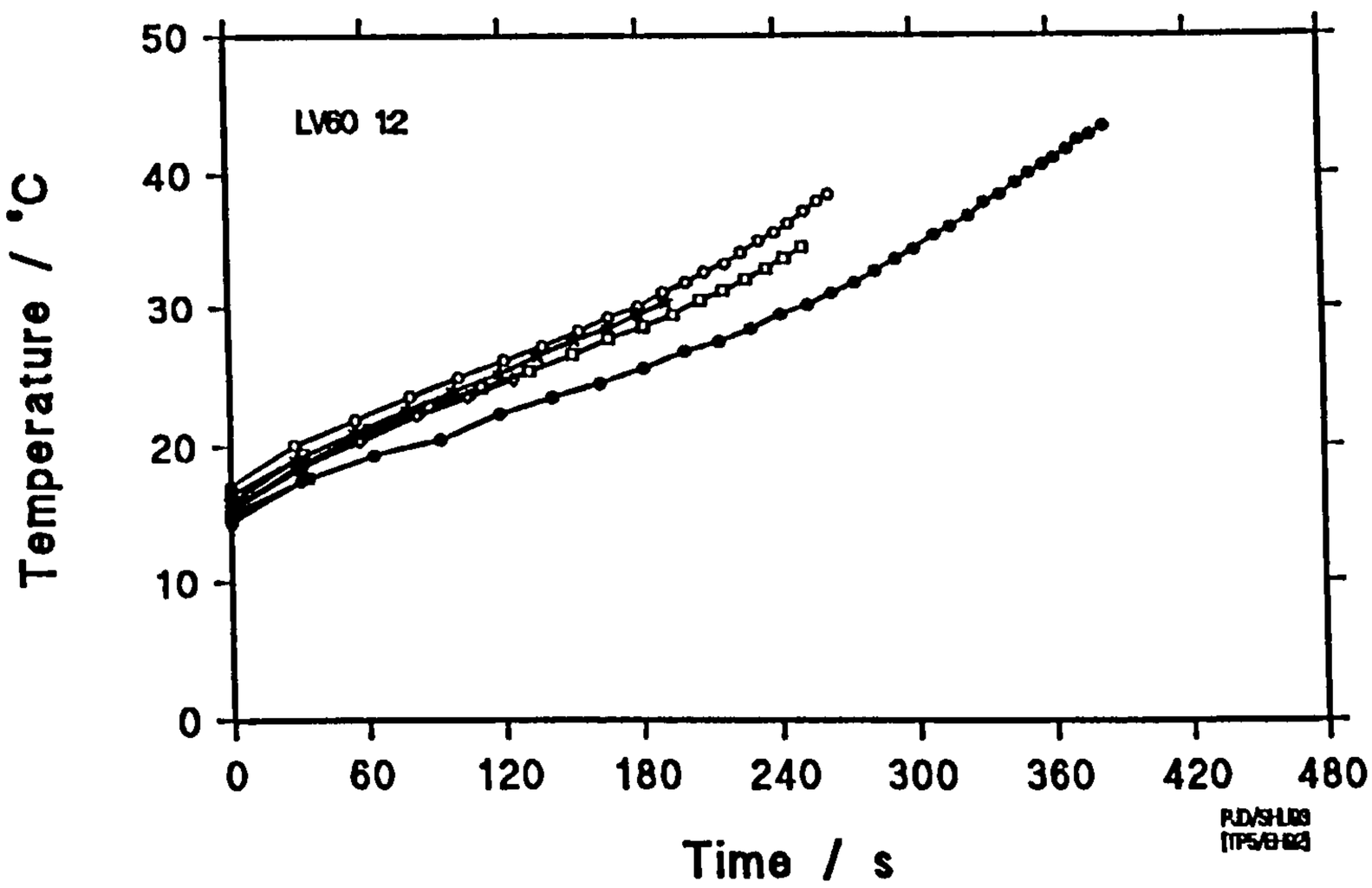
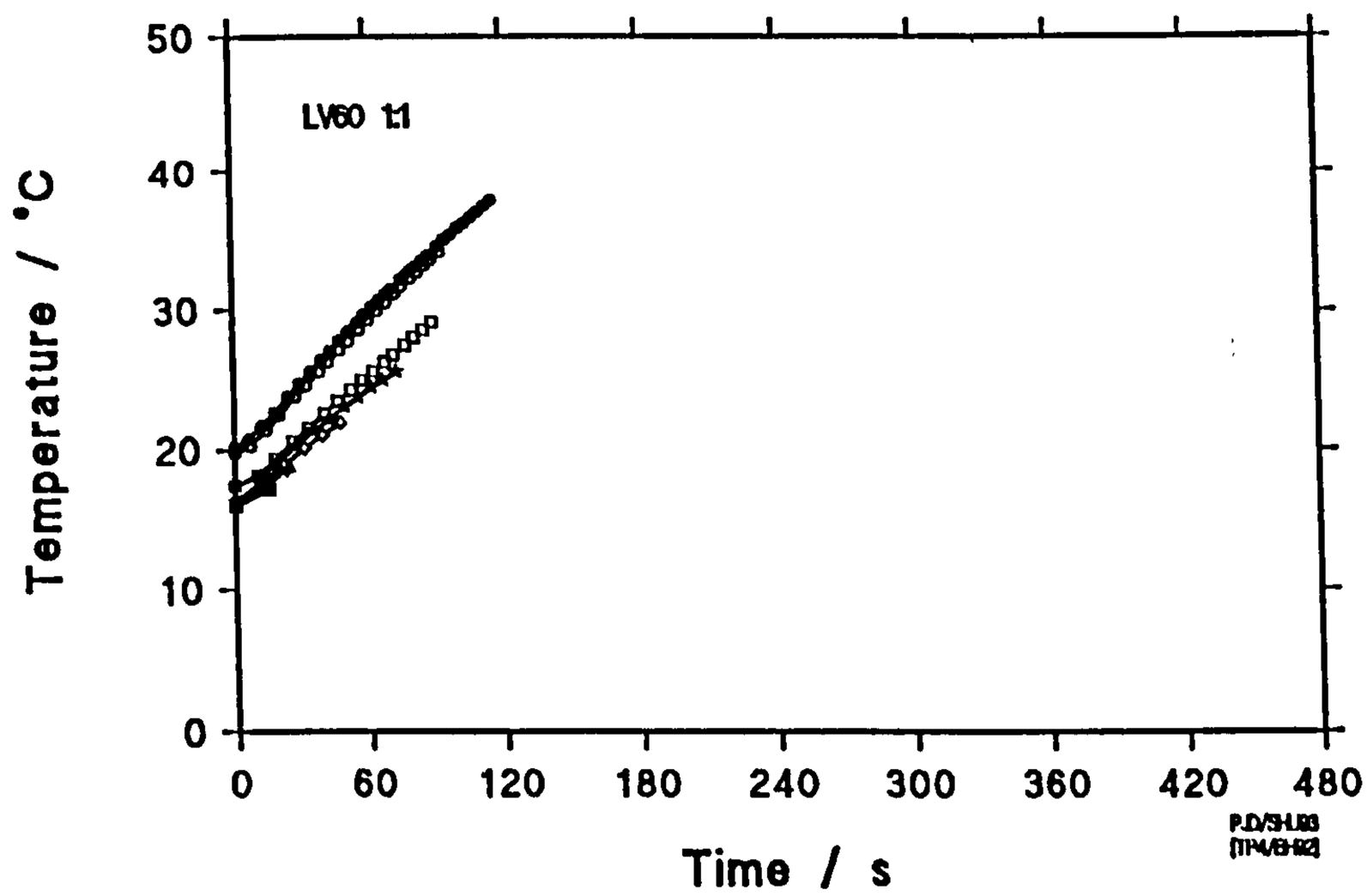

HV 01
Temperature / °C
Time / s
0
10
20
30
40
50
0
1200
2400
3600
4800
6000

Figure 94(a) : The relationship between processing time and temperature for all runs conducted using LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 94(b) : The relationship between processing time and temperature for all runs conducted using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 94(c) : The relationship between processing time and temperature for all runs conducted using LV medium and 60 Mesh grit with a grit to polymer ratio of 2.


LV60 12
Temperature / °C
Time / s
0
10
20
30
40
50
0
60
120
180
240
300
360
420
480


LV60 11
Temperature / °C
Time / s
0
10
20
30
40
50
0
60
120
180
240
300
360
420
480

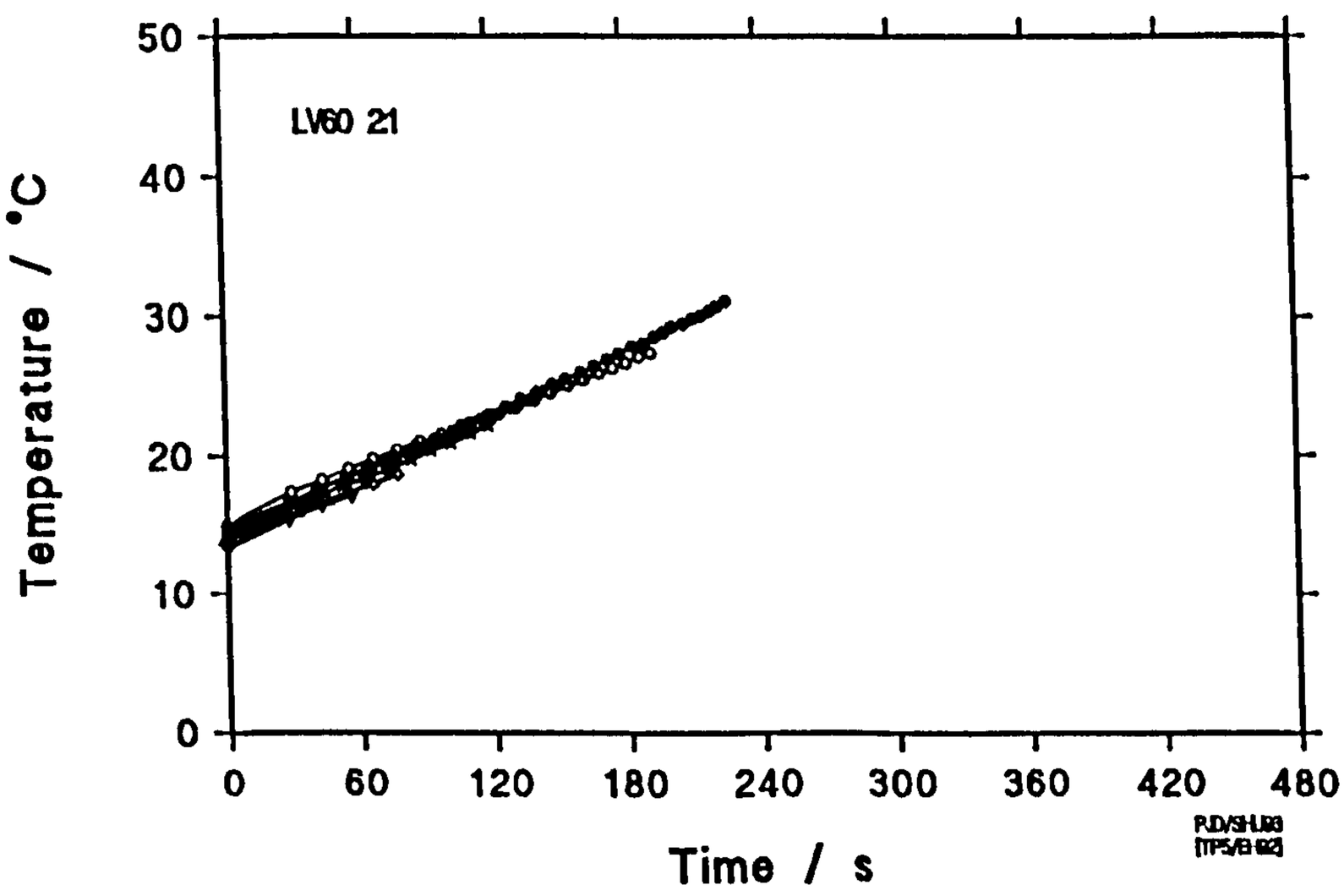
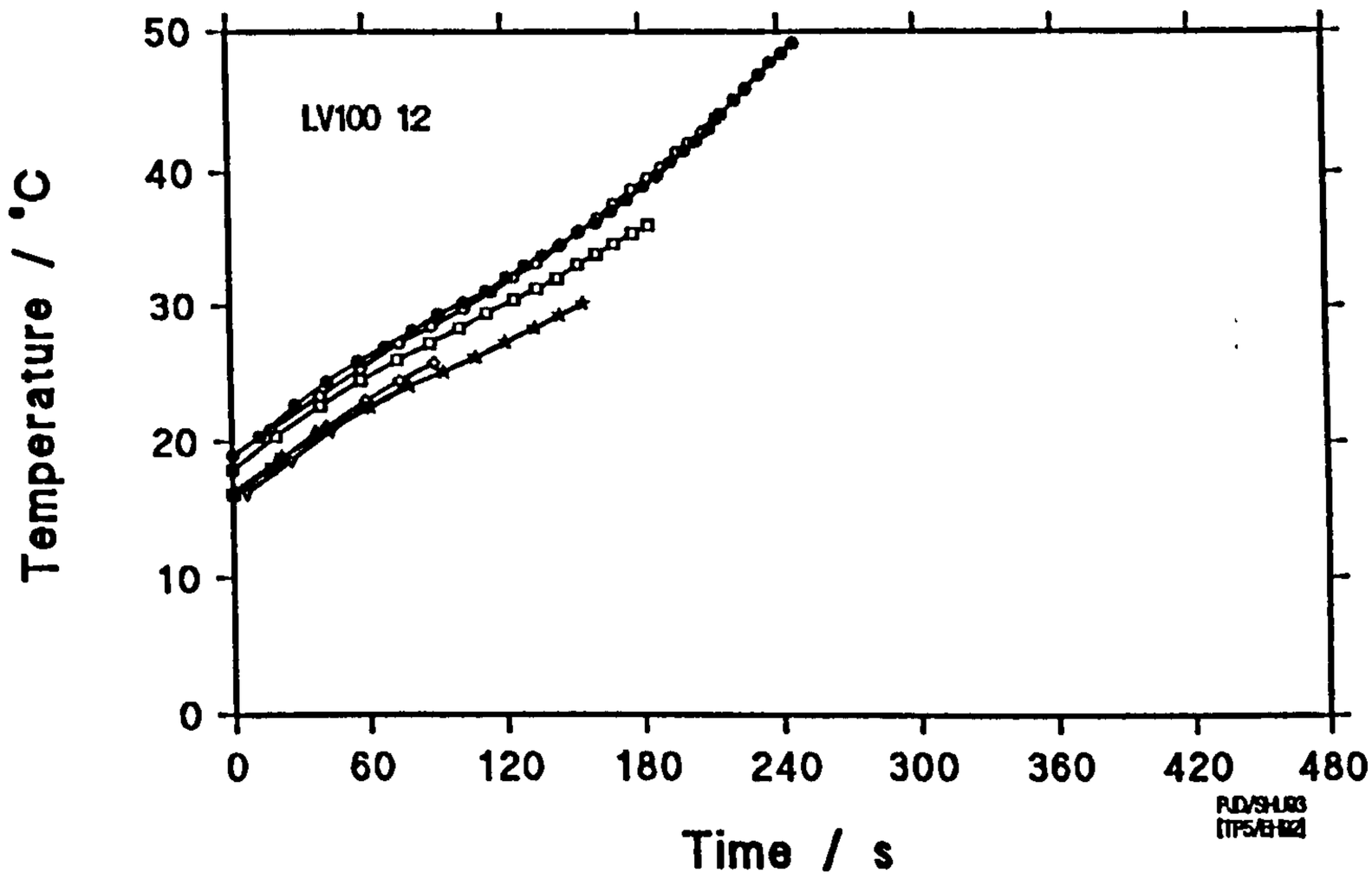
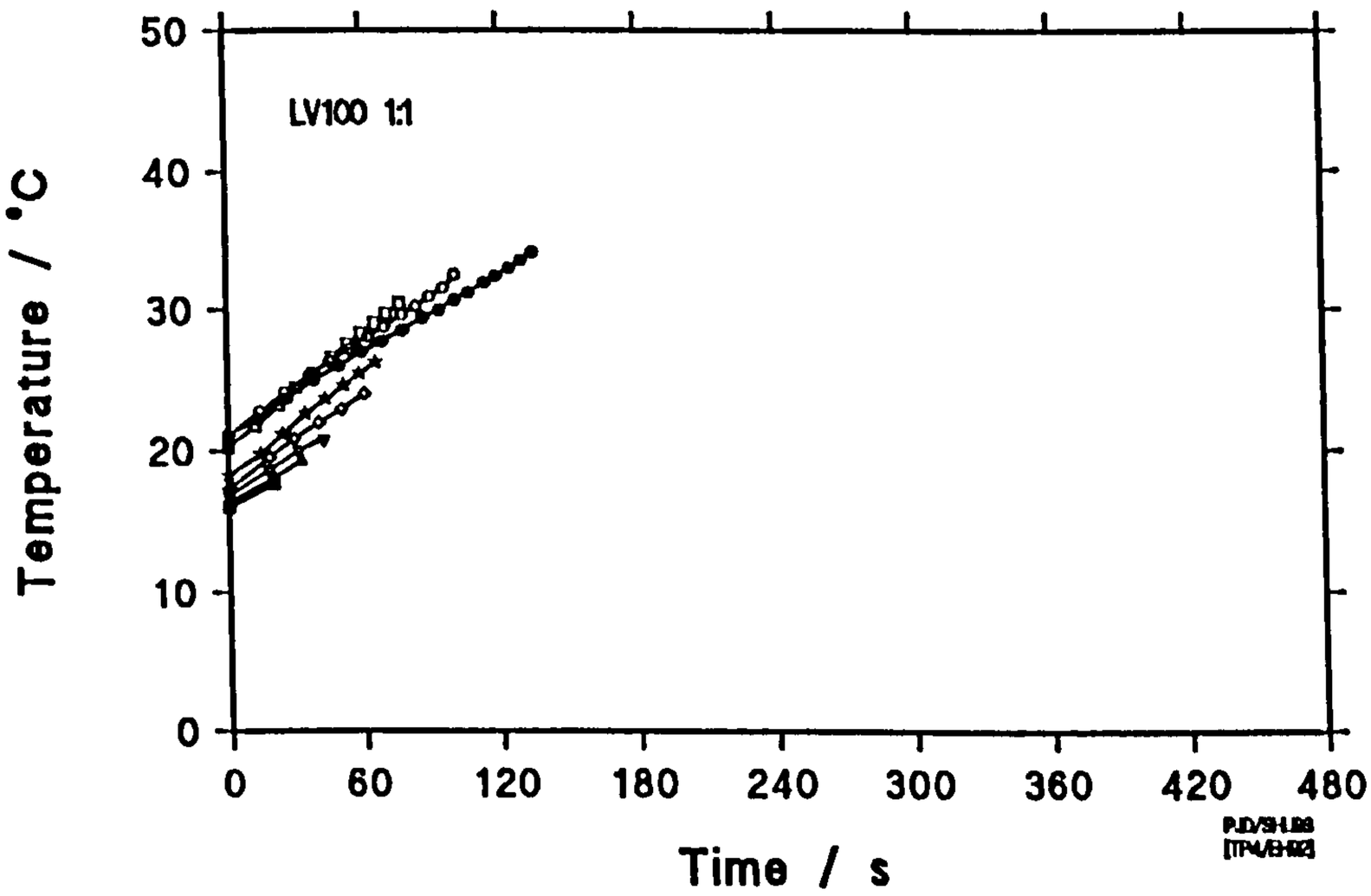

LV60 21
Temperature / °C
Time / s
0
10
20
30
40
50
0
60
120
180
240
300
360
420
480

Figure 95(a) : The relationship between processing time and temperature for all runs conducted using LV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 95(b) : The relationship between processing time and temperature for all runs conducted using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 95(c) : The relationship between processing time and temperature for all runs conducted using LV medium and 100 Mesh grit with a grit to polymer ratio of 2.


LV100 12
Temperature / °C
Time / s
0
10
20
30
40
50
0
60
120
180
240
300
360
420
480


LV100 1:1
Temperature / °C
Time / s
0
10
20
30
40
50
0
60
120
180
240
300
360
420
480

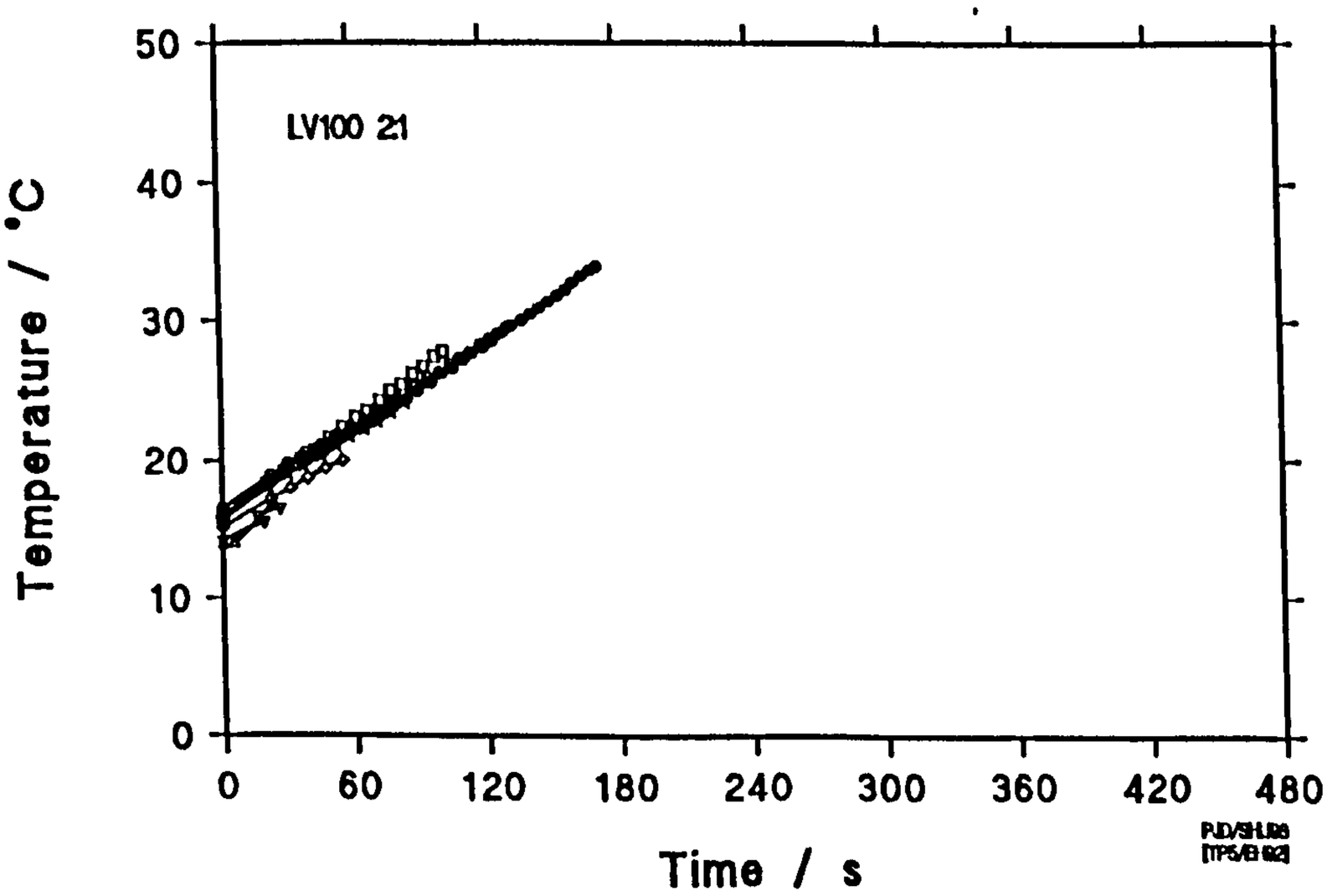
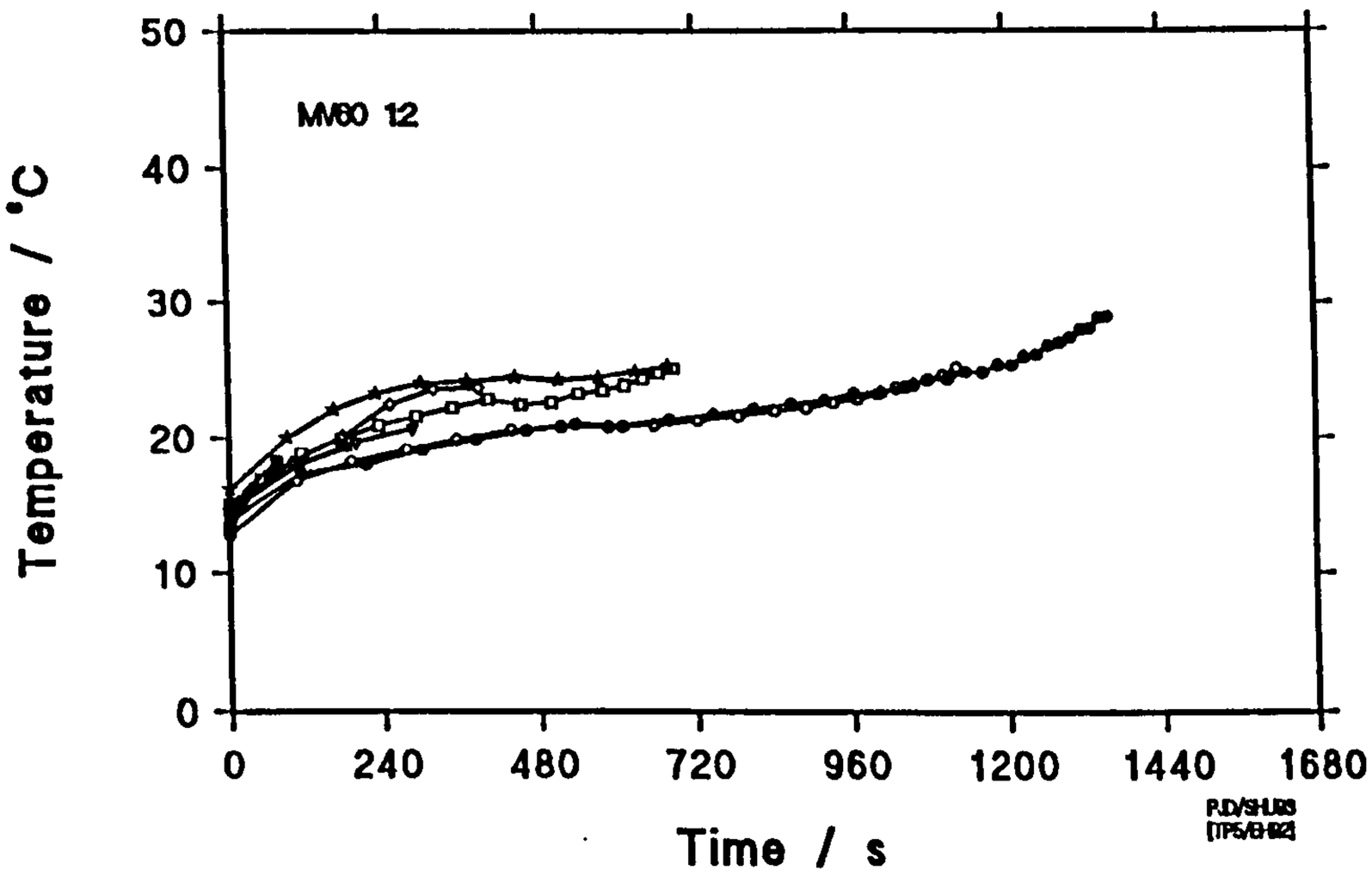
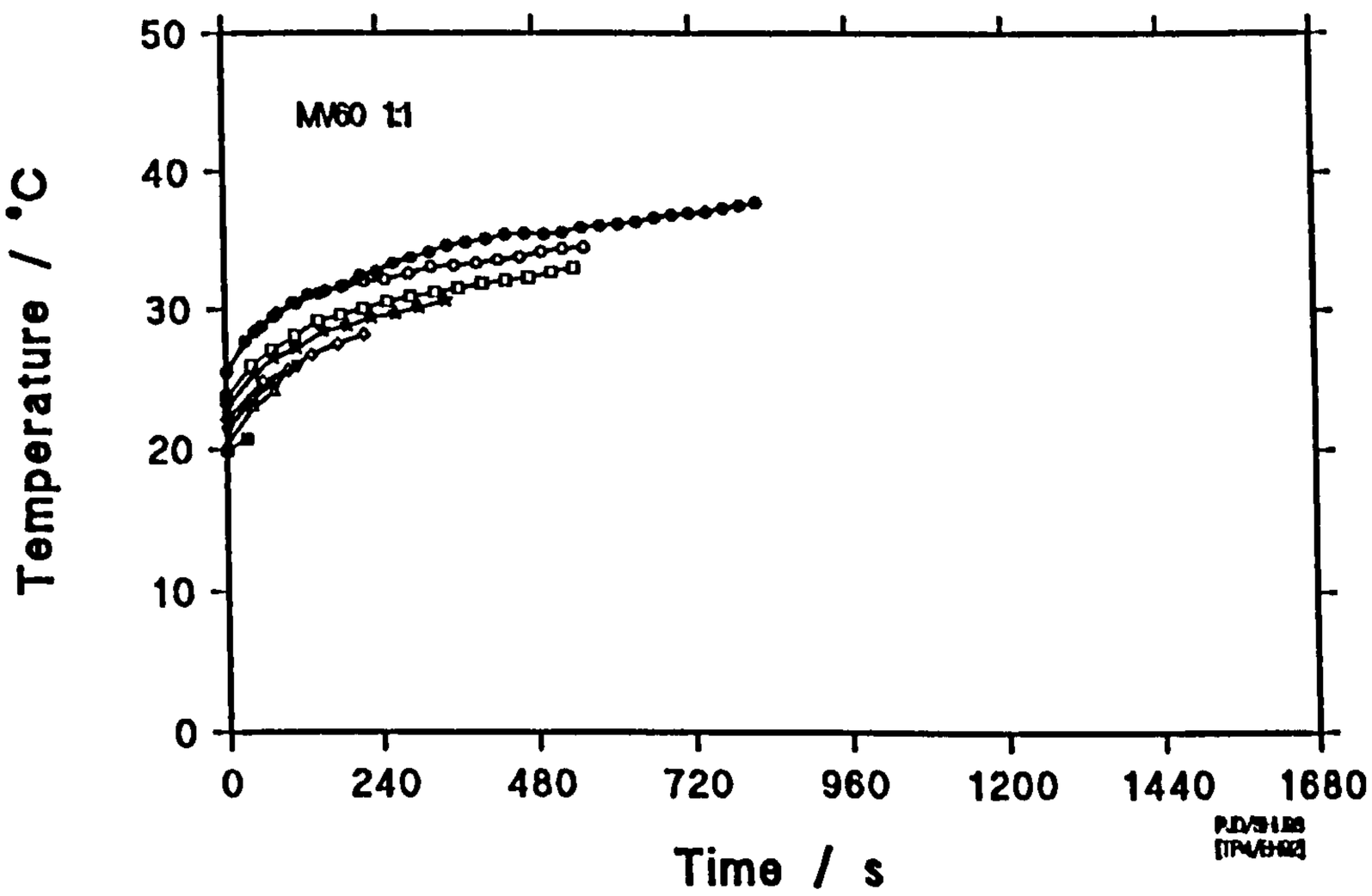

LV100 21
Temperature / °C
Time / s
0
10
20
30
40
50
0
60
120
180
240
300
360
420
480

Figure 96(a) : The relationship between processing time and temperature for all runs conducted using MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 96(b) : The relationship between processing time and temperature for all runs conducted using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 96(c) : The relationship between processing time and temperature for all runs conducted using MV medium and 60 Mesh grit with a grit to polymer ratio of 2.


MV60 12
Temperature / °C
Time / s
0
10
20
30
40
50
0
240
480
720
960
1200
1440
1680


MV60 11
Temperature / °C
Time / s
0
10
20
30
40
50
0
240
480
720
960
1200
1440
1680

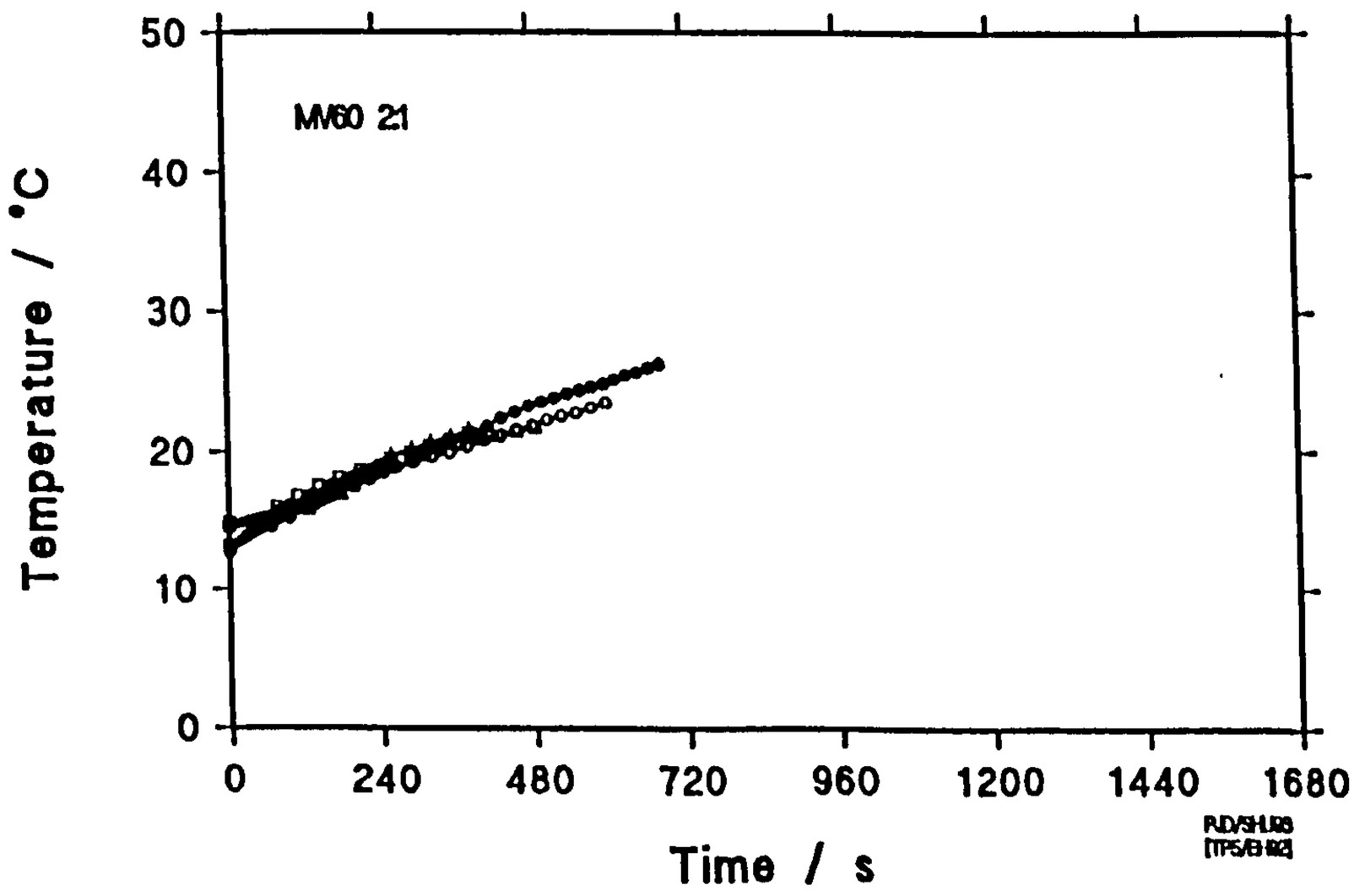
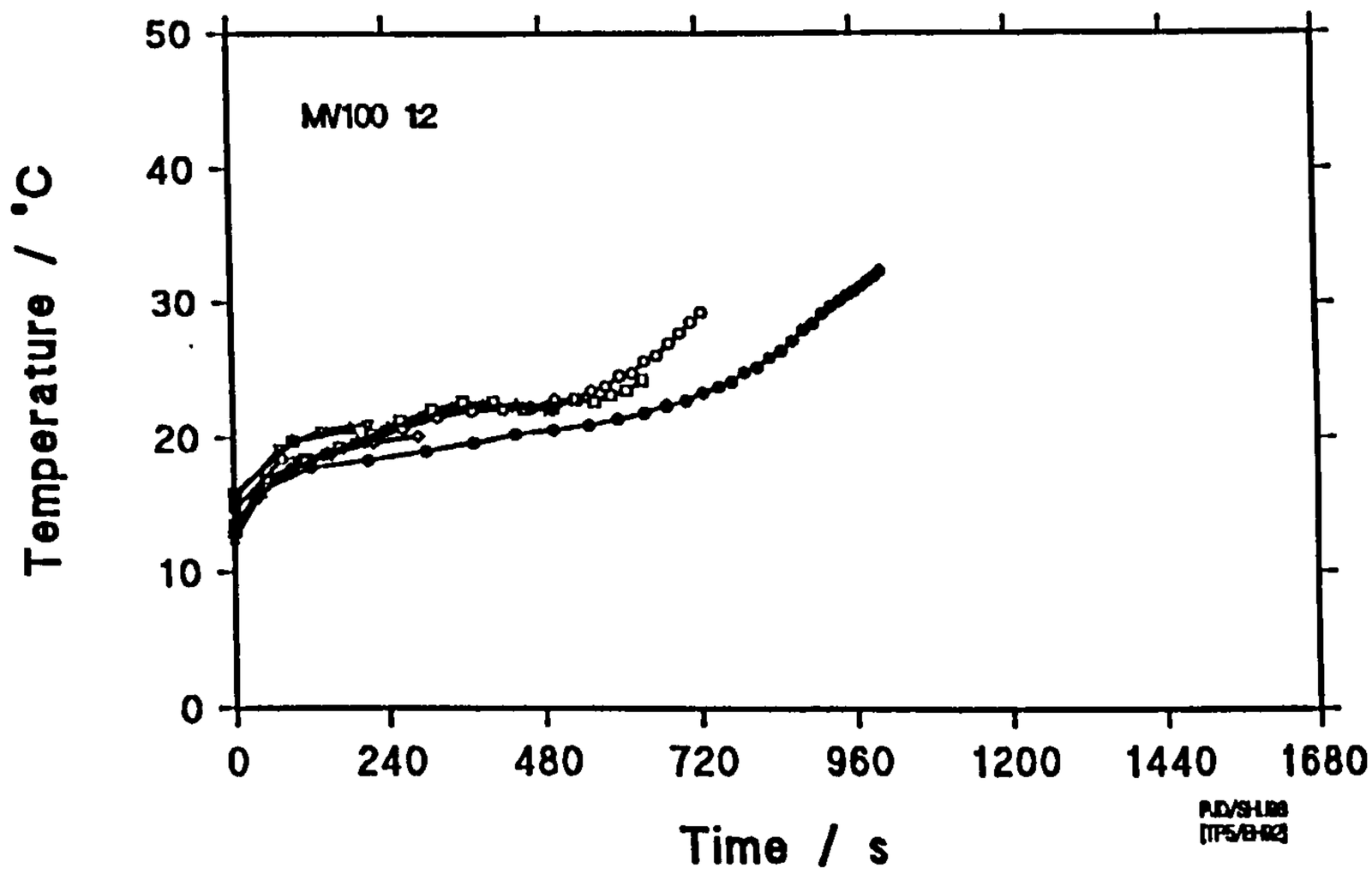
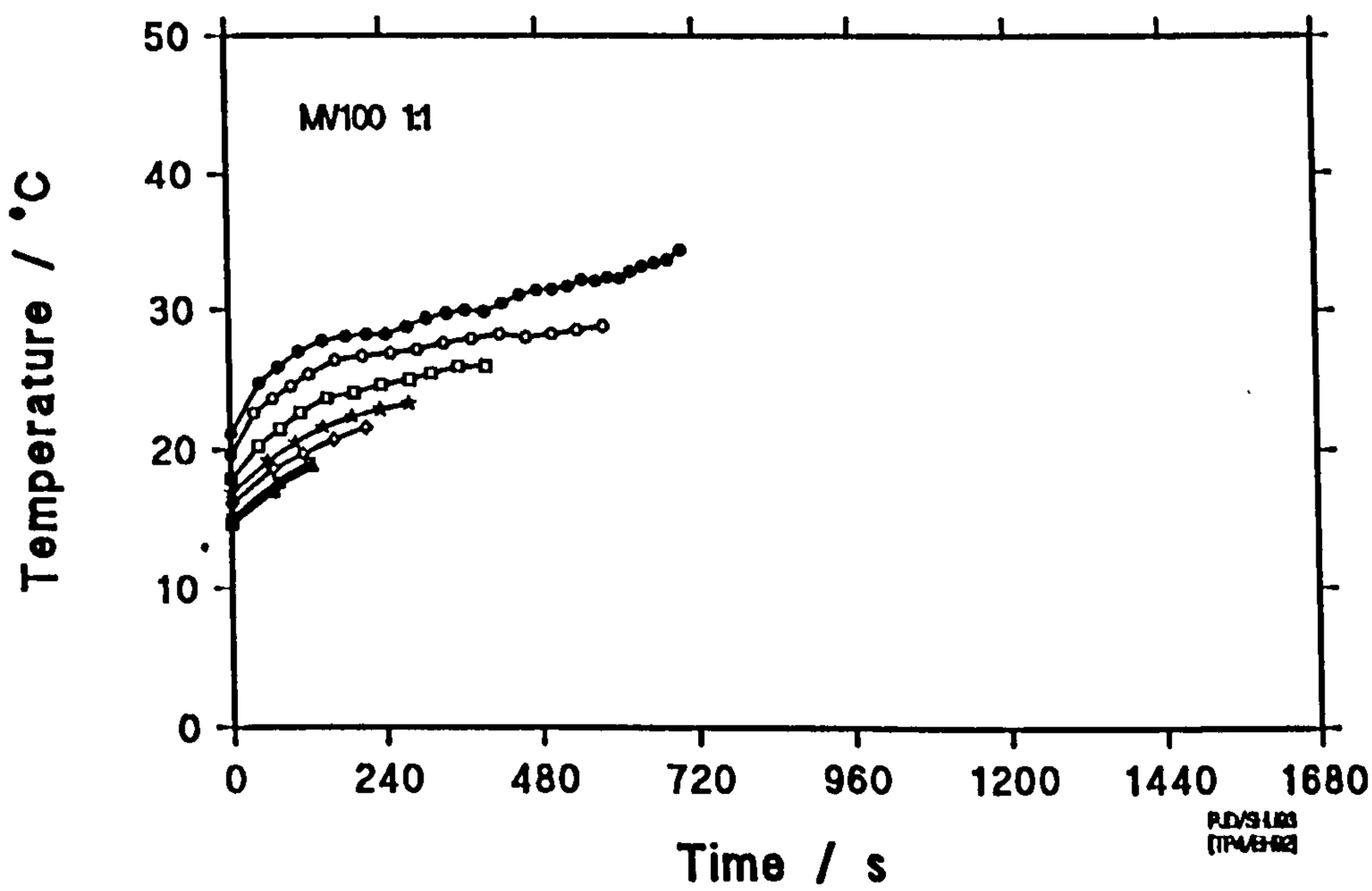

MV60 21
Temperature / °C
Time / s
0
10
20
30
40
50
0
240
480
720
960
1200
1440
1680

Figure 97(a) : The relationship between processing time and temperature for all runs conducted using MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 97(b) : The relationship between processing time and temperature for all runs conducted using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 97(c) : The relationship between processing time and temperature for all runs conducted using MV medium and 100 Mesh grit with a grit to polymer ratio of 2.


MV100 12
Temperature / °C
Time / s
0
10
20
30
40
50
0
240
480
720
960
1200
1440
1680


MV100 11
Temperature / °C
Time / s
0
10
20
30
40
50
0
240
480
720
960
1200
1440
1680

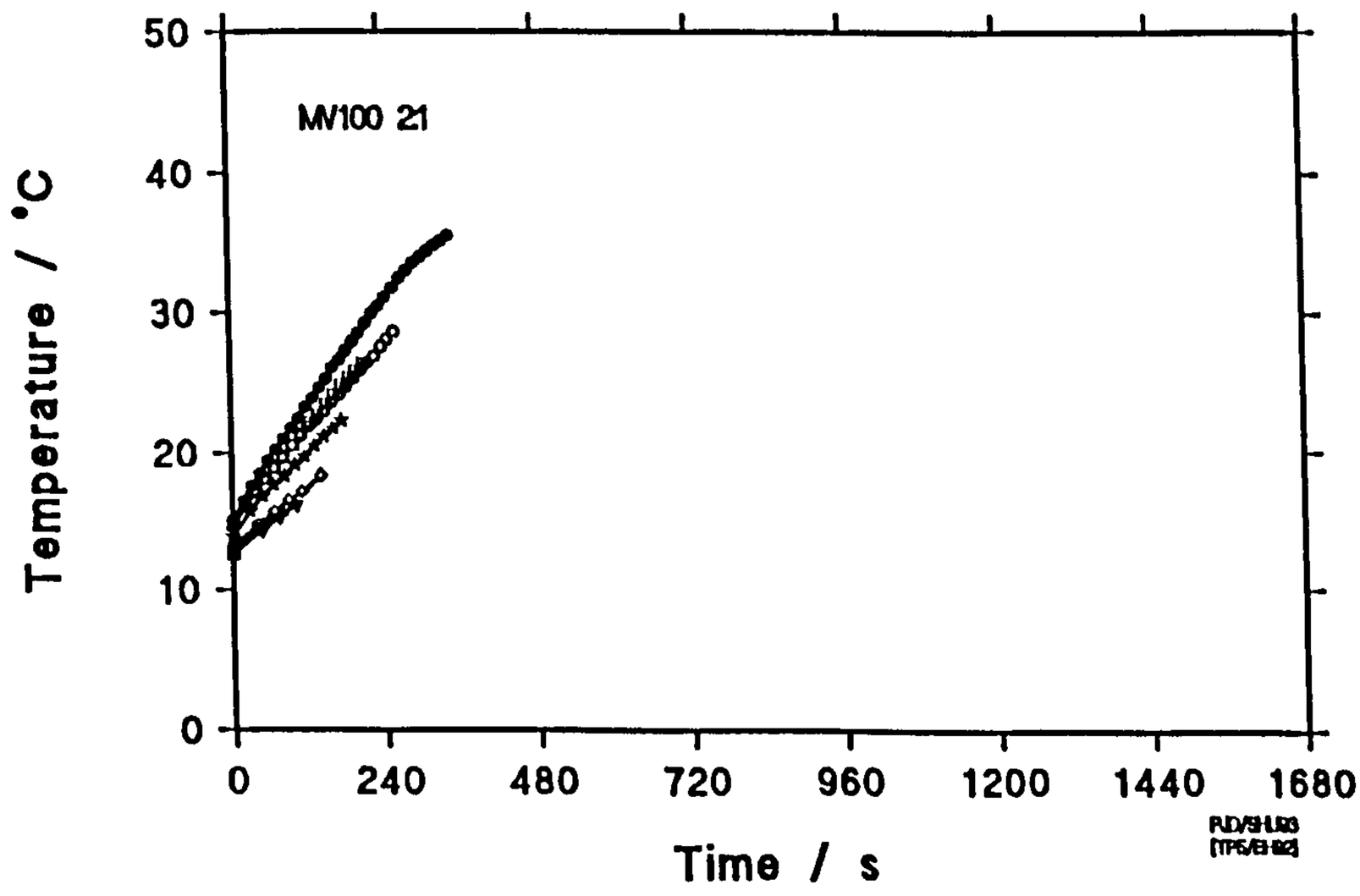
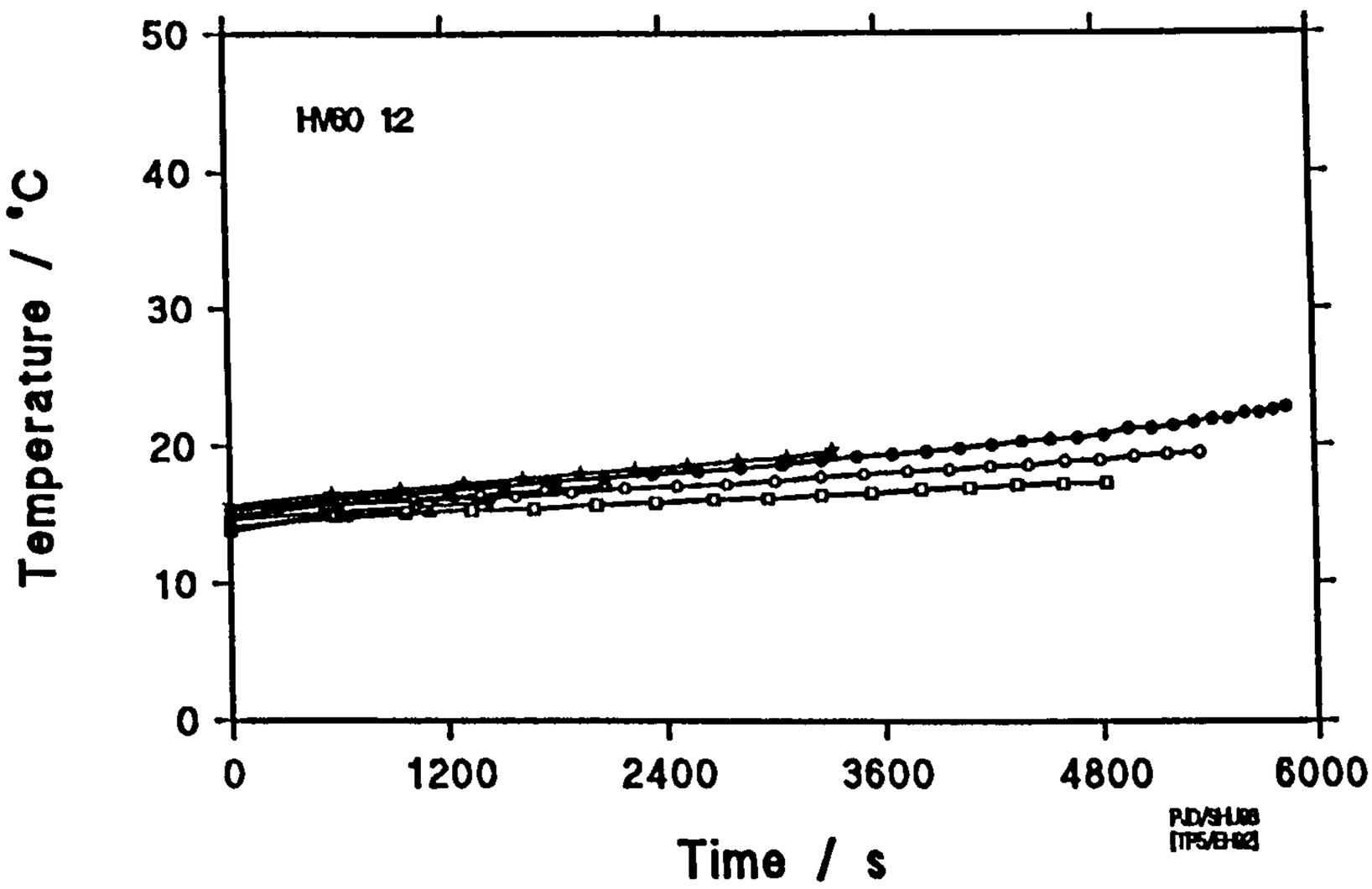
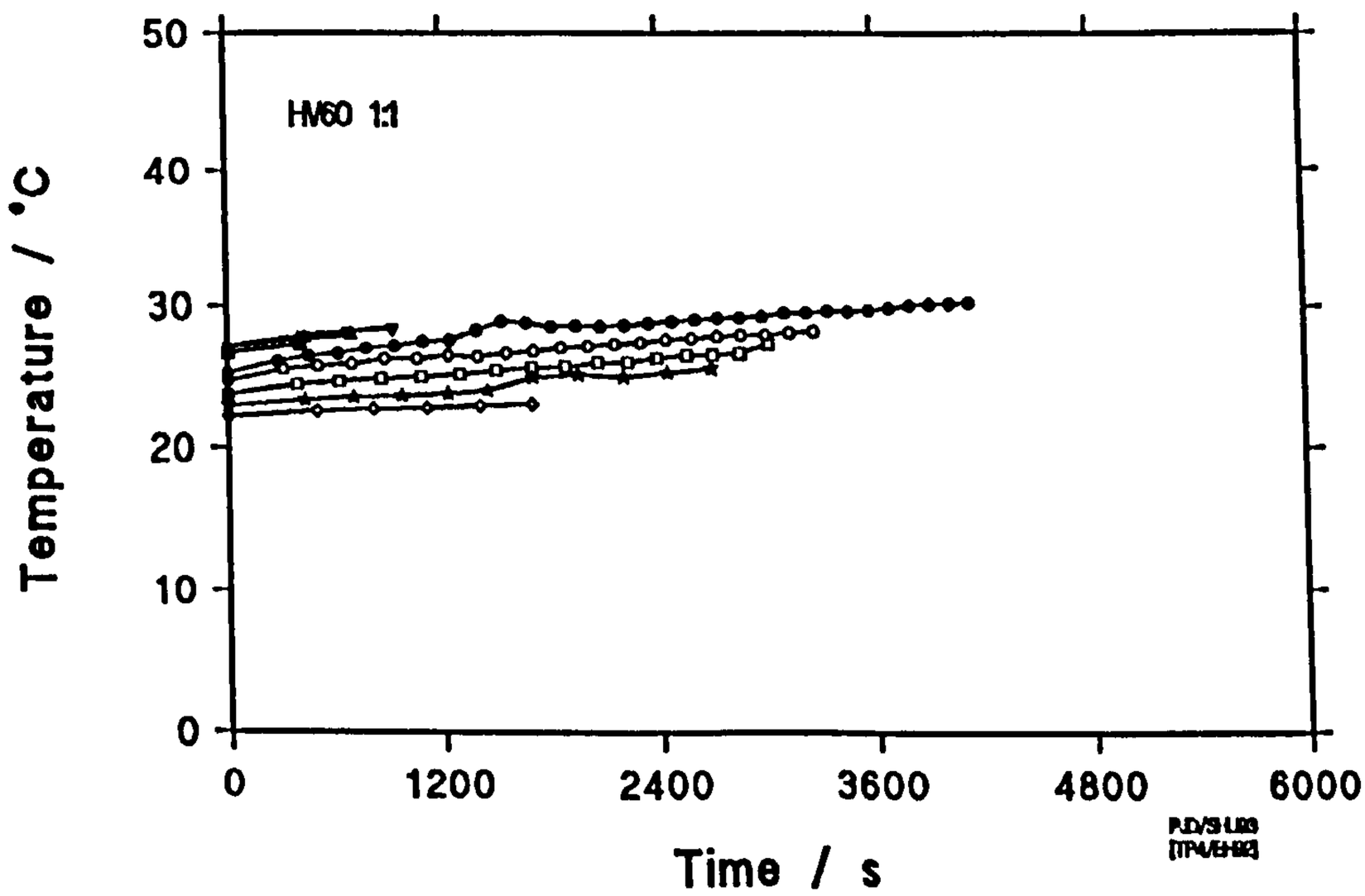

MV100 21
Temperature / °C
Time / s
0
10
20
30
40
50
0
240
480
720
960
1200
1440
1680

Figure 98(a) : The relationship between processing time and temperature for all runs conducted using HV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 98(b) : The relationship between processing time and temperature for all runs conducted using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 98(c) : The relationship between processing time and temperature for all runs conducted using HV medium and 60 Mesh grit with a grit to polymer ratio of 2.


HV60 12
Temperature / °C
Time / s
0
10
20
30
40
50
0
1200
2400
3600
4800
6000


HV60 11
Temperature / °C
Time / s
0
10
20
30
40
50
0
1200
2400
3600
4800
6000

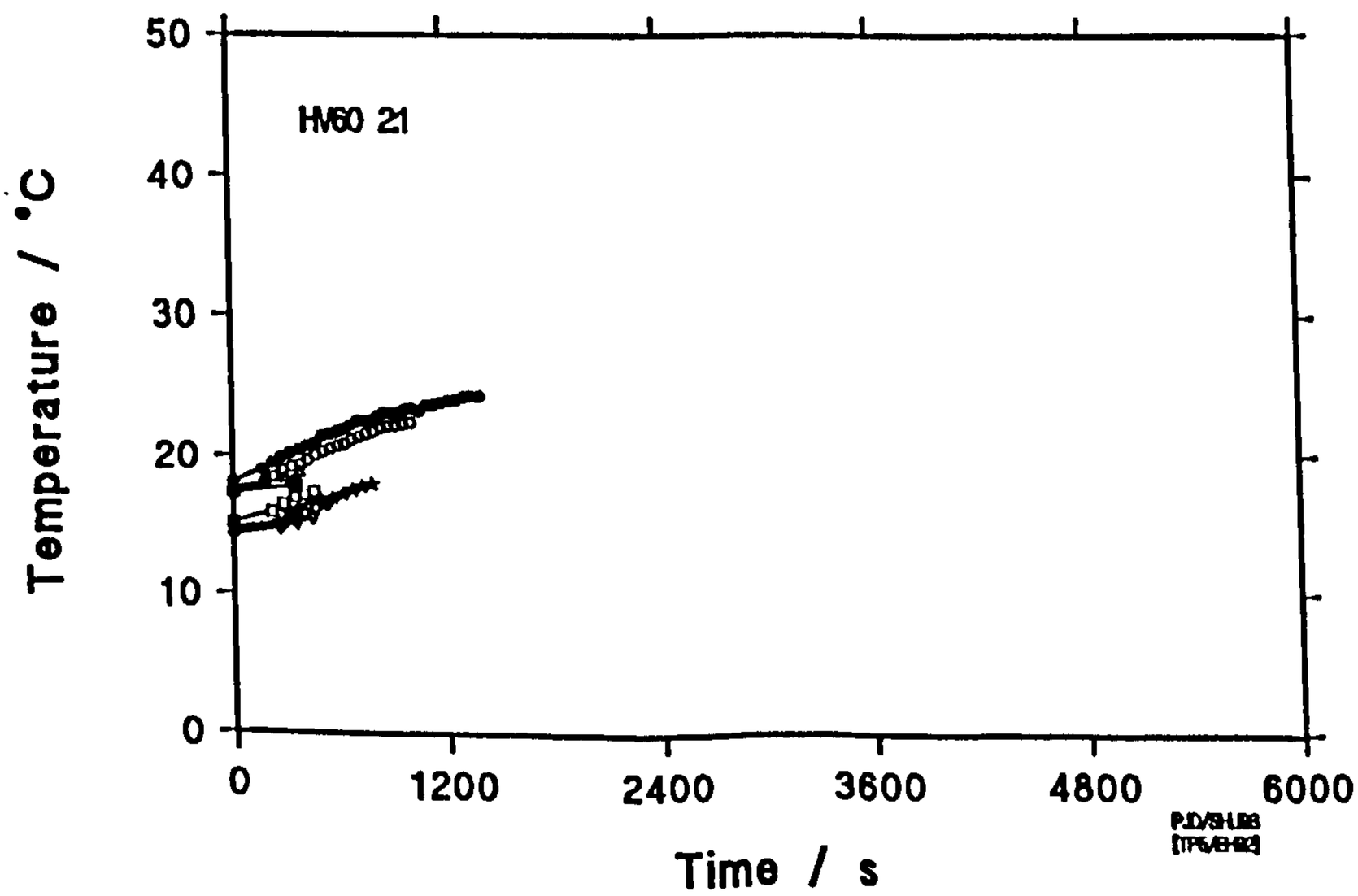
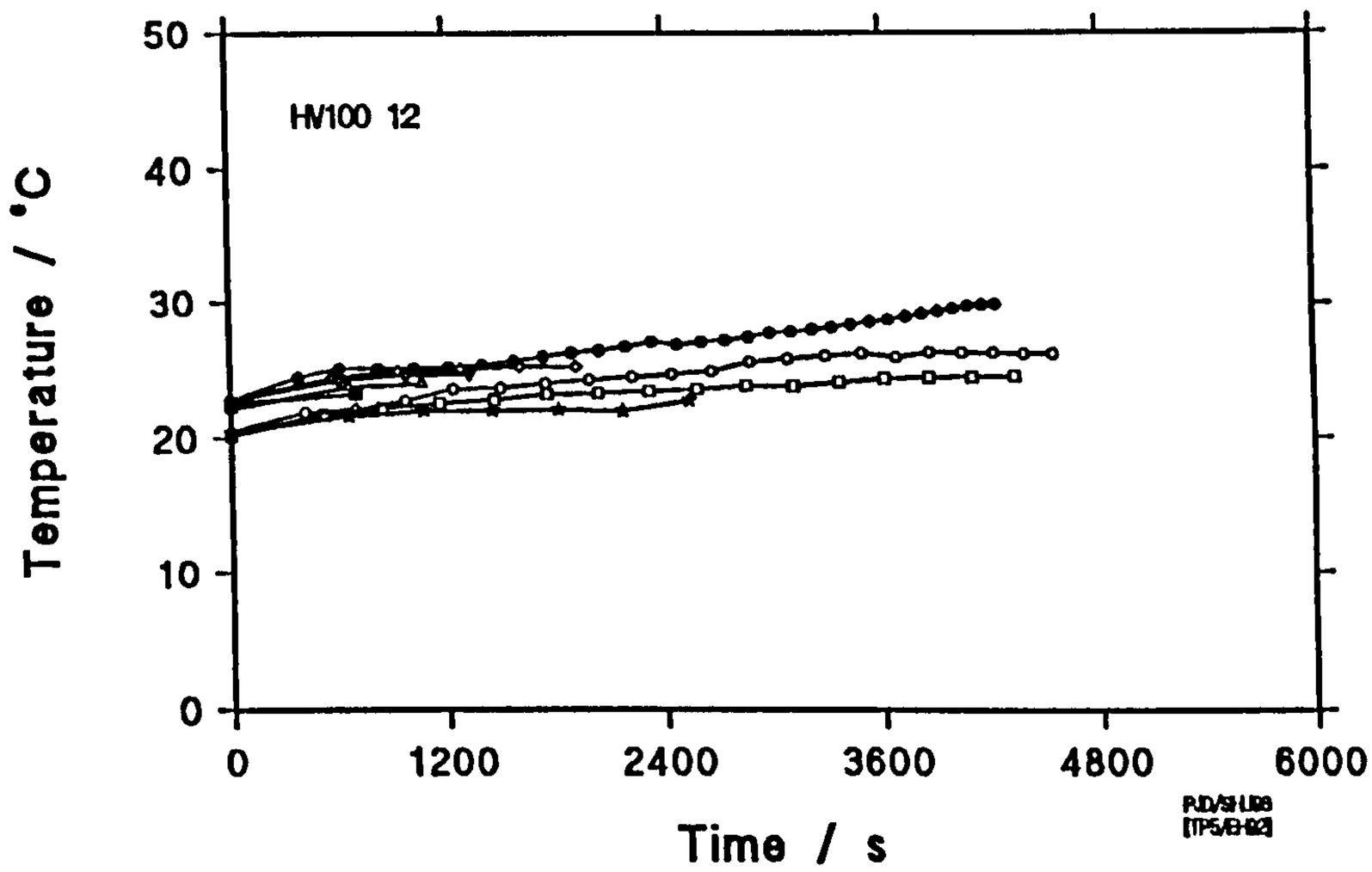
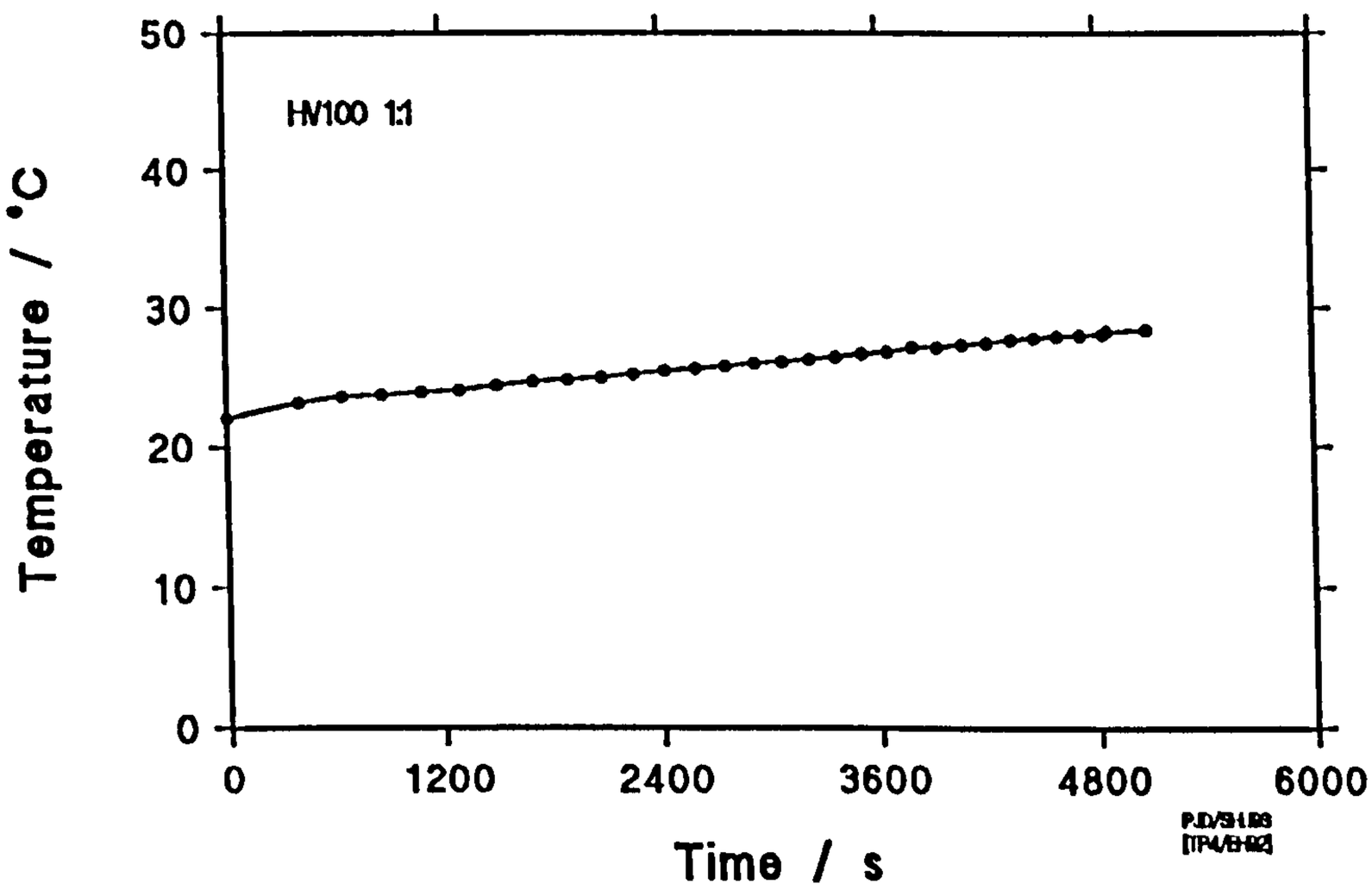

HV60 21
Temperature / °C
Time / s
0
10
20
30
40
50
0
1200
2400
3600
4800
6000

Figure 99(a) : The relationship between processing time and temperature for all runs conducted using HV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 99(b) : The relationship between processing time and temperature for all runs conducted using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 99(c) : The relationship between processing time and temperature for all runs conducted using HV medium and 100 Mesh grit with a grit to polymer ratio of 2.


HV100 12
Temperature / °C
Time / s
0
10
20
30
40
50
0
1200
2400
3600
4800
6000


HV100 11
Temperature / °C
Time / s
0
10
20
30
40
50
0
1200
2400
3600
4800
6000

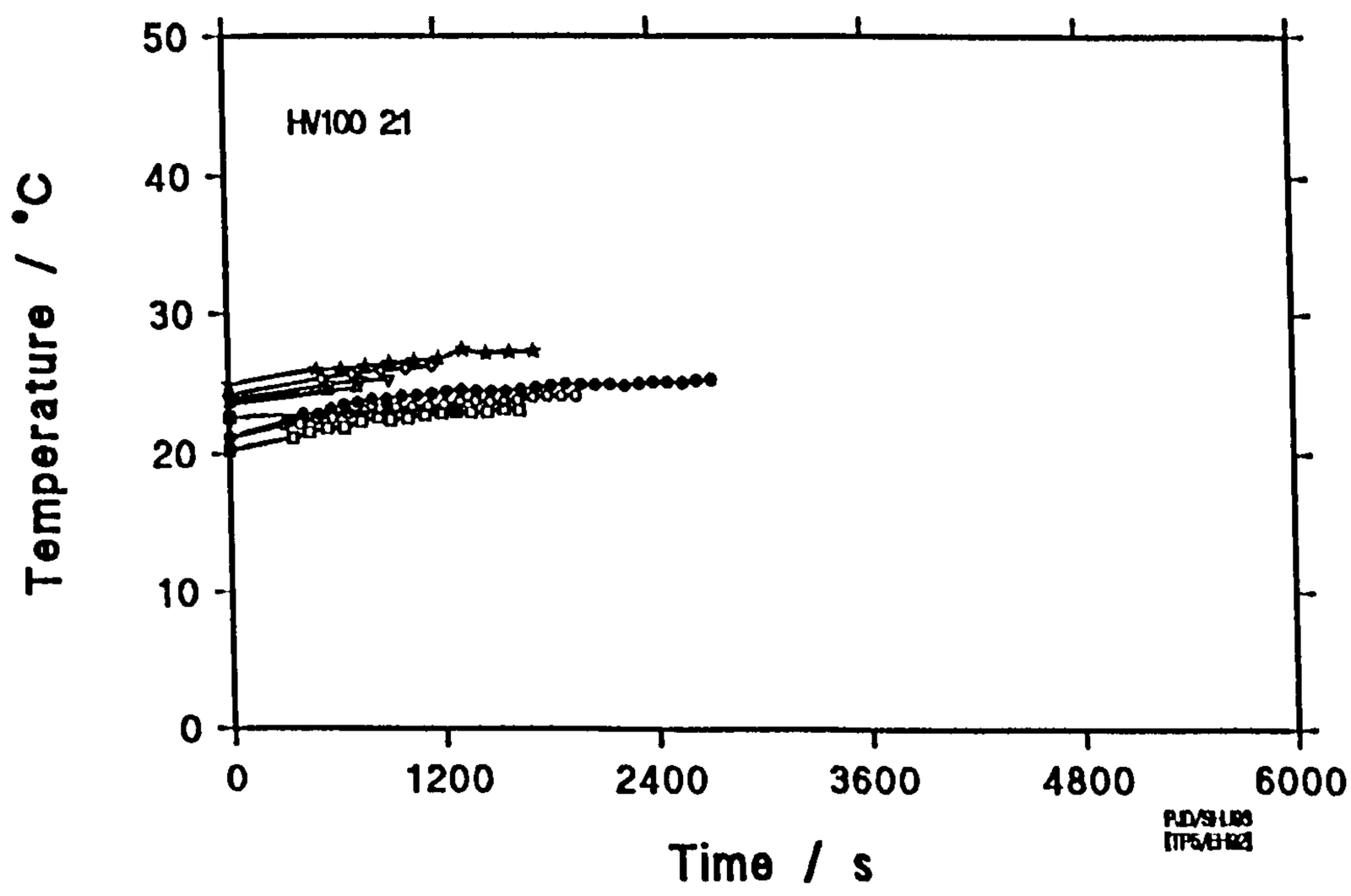
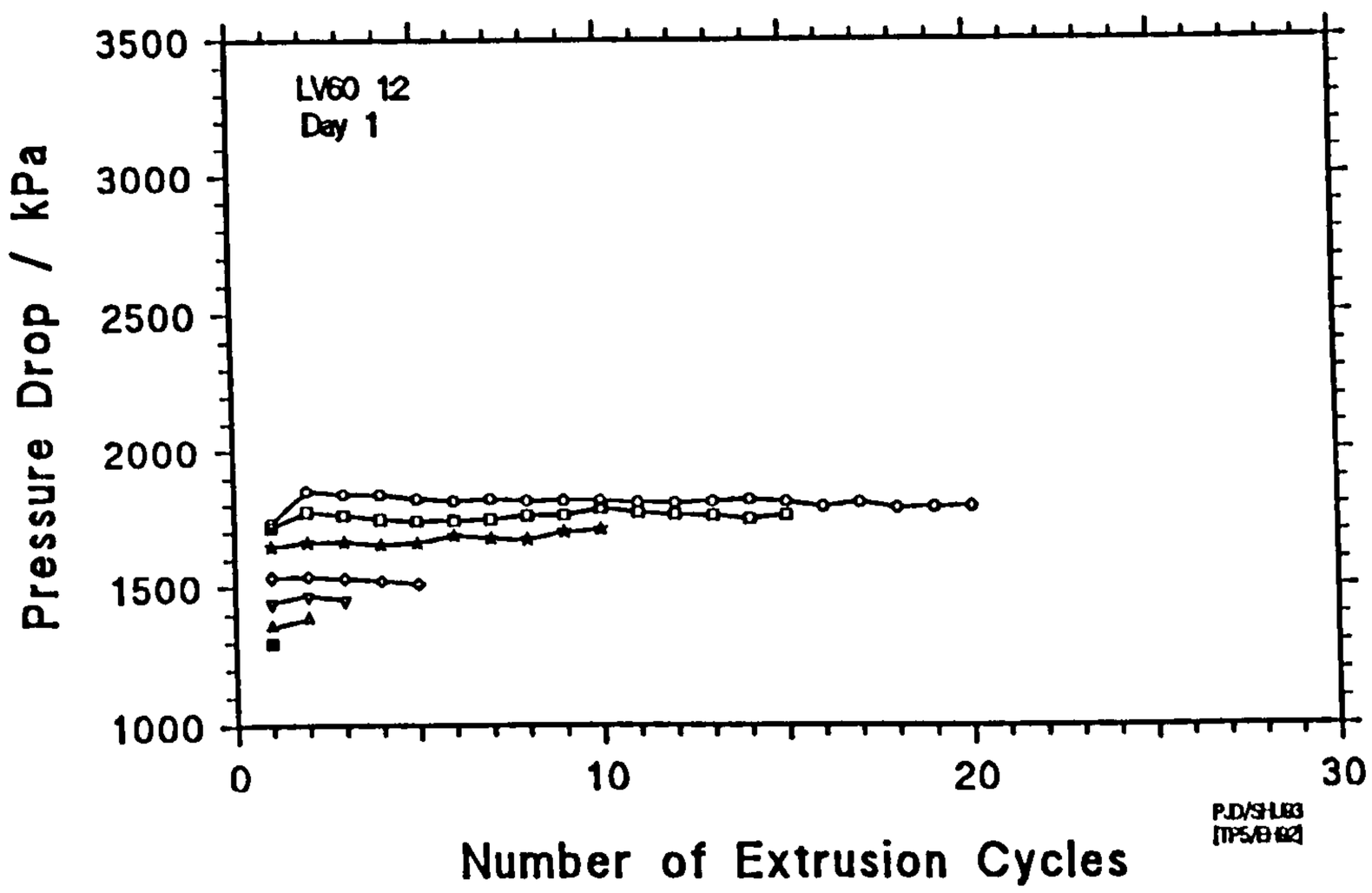

HV100 21
Temperature / °C
Time / s
0
10
20
30
40
50
0
1200
2400
3600
4800
6000

Figure 100(a) : The relationship between the number of extrusion cycles and the pressure drop across the die for all runs completed on day 1 (23/11/92) using LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 100(b) : The relationship between the number of extrusion cycles and the pressure drop across the die for all runs completed on day 2 (24/11/92) using LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.


LV60 12
Day 1
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles

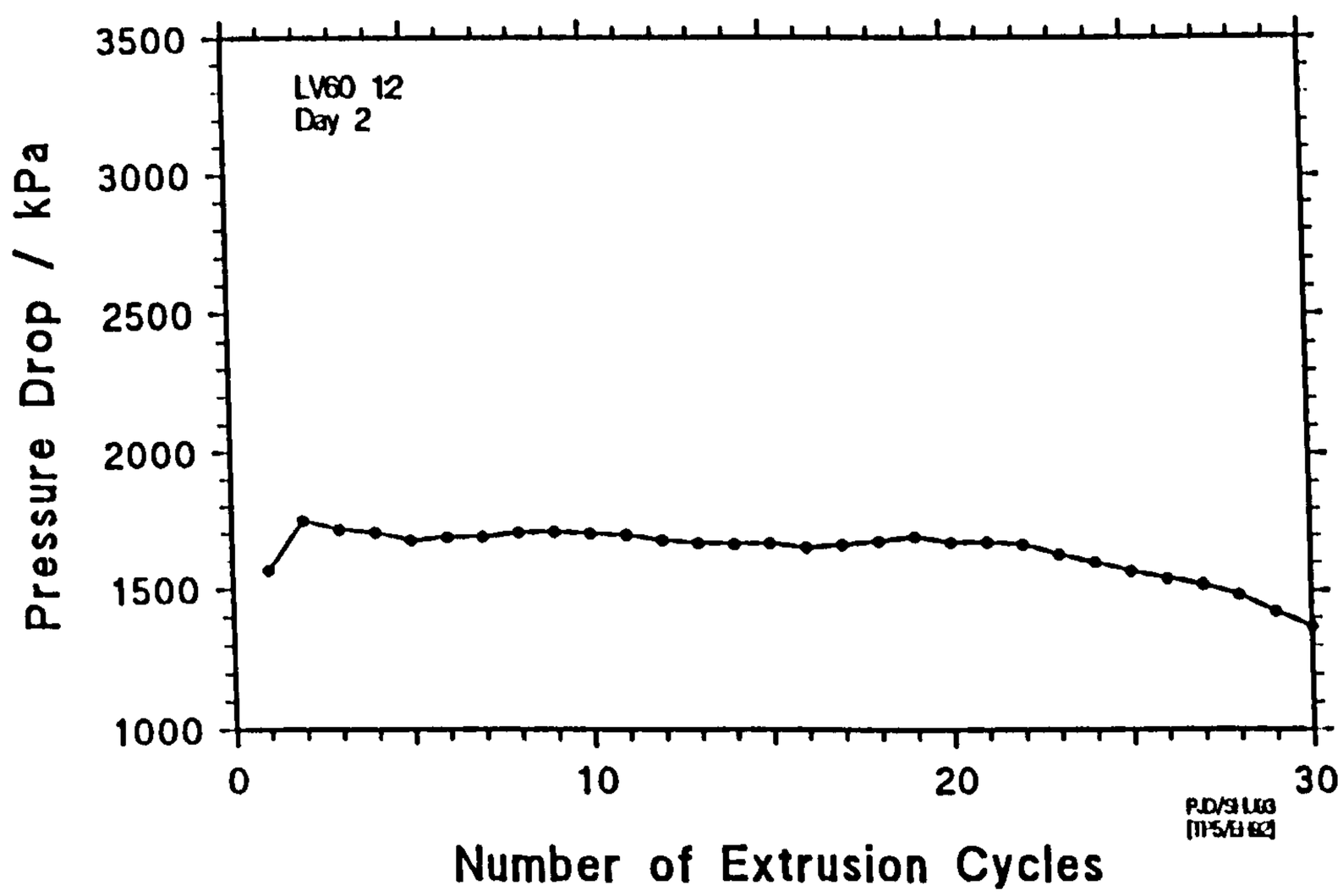
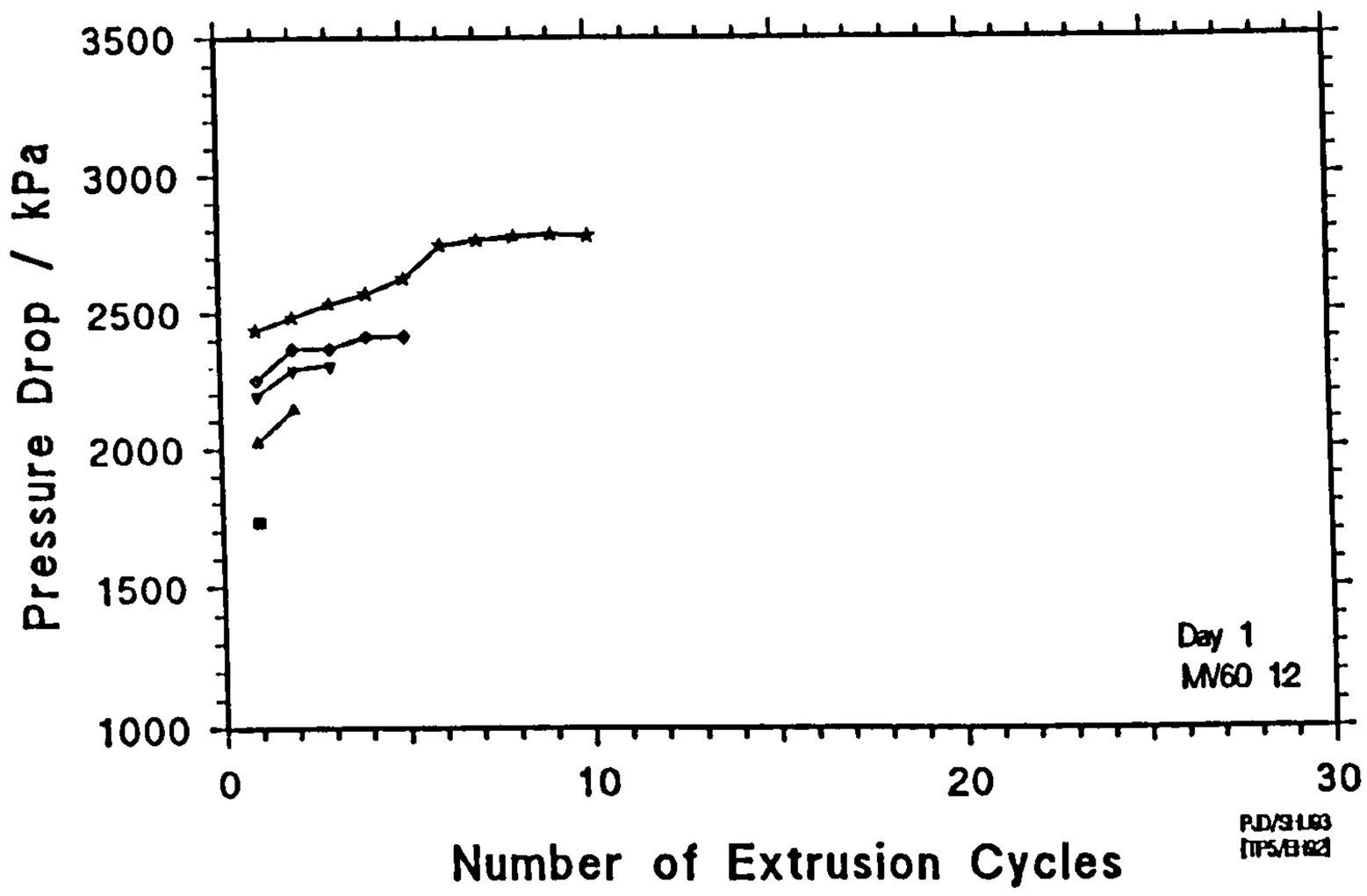

LV60 12
Day 2
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
Number of Extrusion Cycles

Figure 101(a) : The relationship between the number of extrusion cycles and the pressure drop across the die for all runs completed on day 1 (24/11/92) using MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 101(b) : The relationship between the number of extrusion cycles and the pressure drop across the die for all runs completed on day 2 (25/11/92) using MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
Day 1
MV60 12

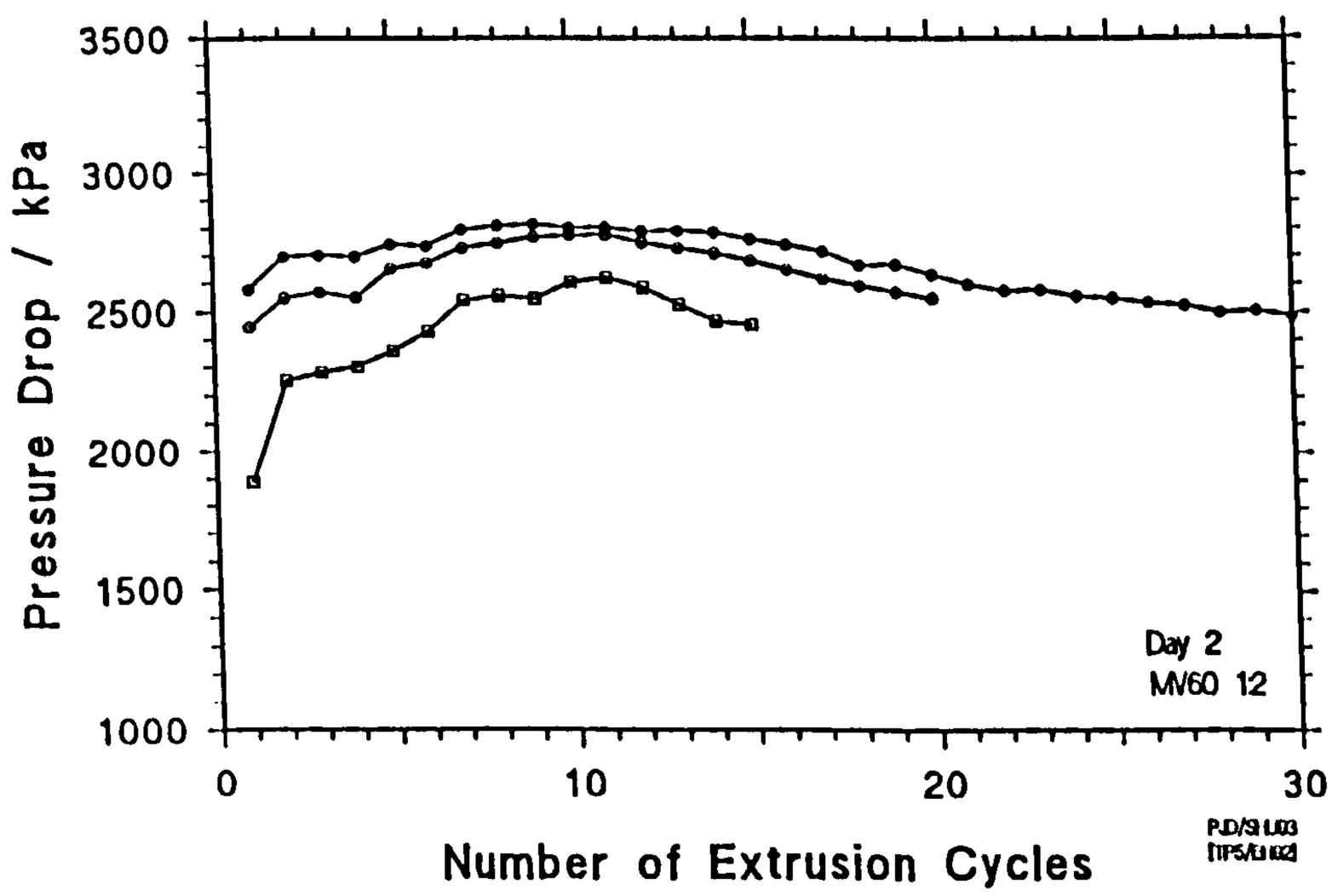
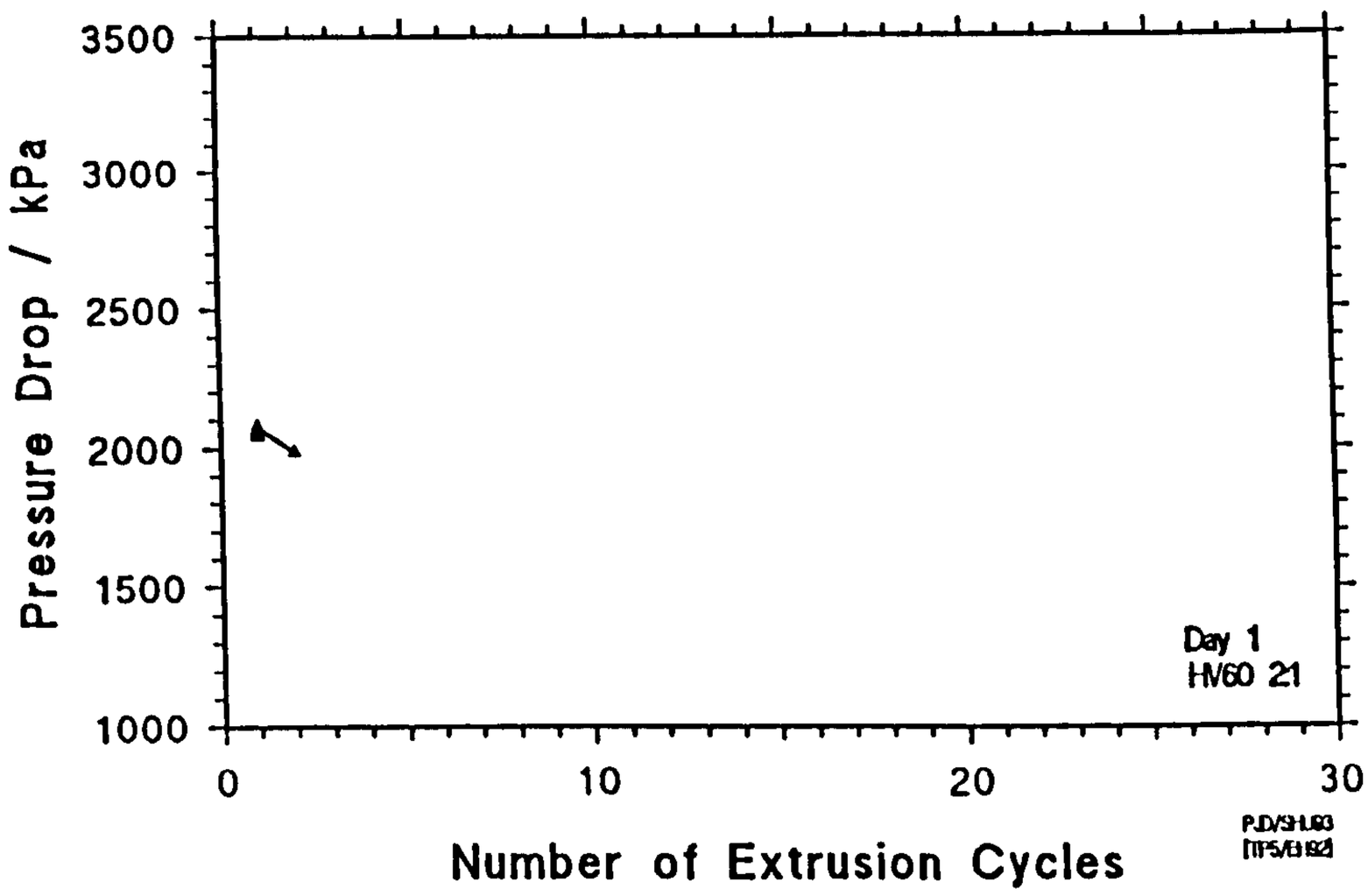

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
Day 2
MV60 12

Figure 102(a) : The relationship between the number of extrusion cycles and the pressure drop across the die for all runs completed on day 1 (15/12/92) using HV medium and 60 Mesh grit with a grit to polymer ratio of 2.

Figure 102(b) : The relationship between the number of extrusion cycles and the pressure drop across the die for all runs completed on day 2 (16/12/92) using HV medium and 60 Mesh grit with a grit to polymer ratio of 2.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
Day 1
HV60 21

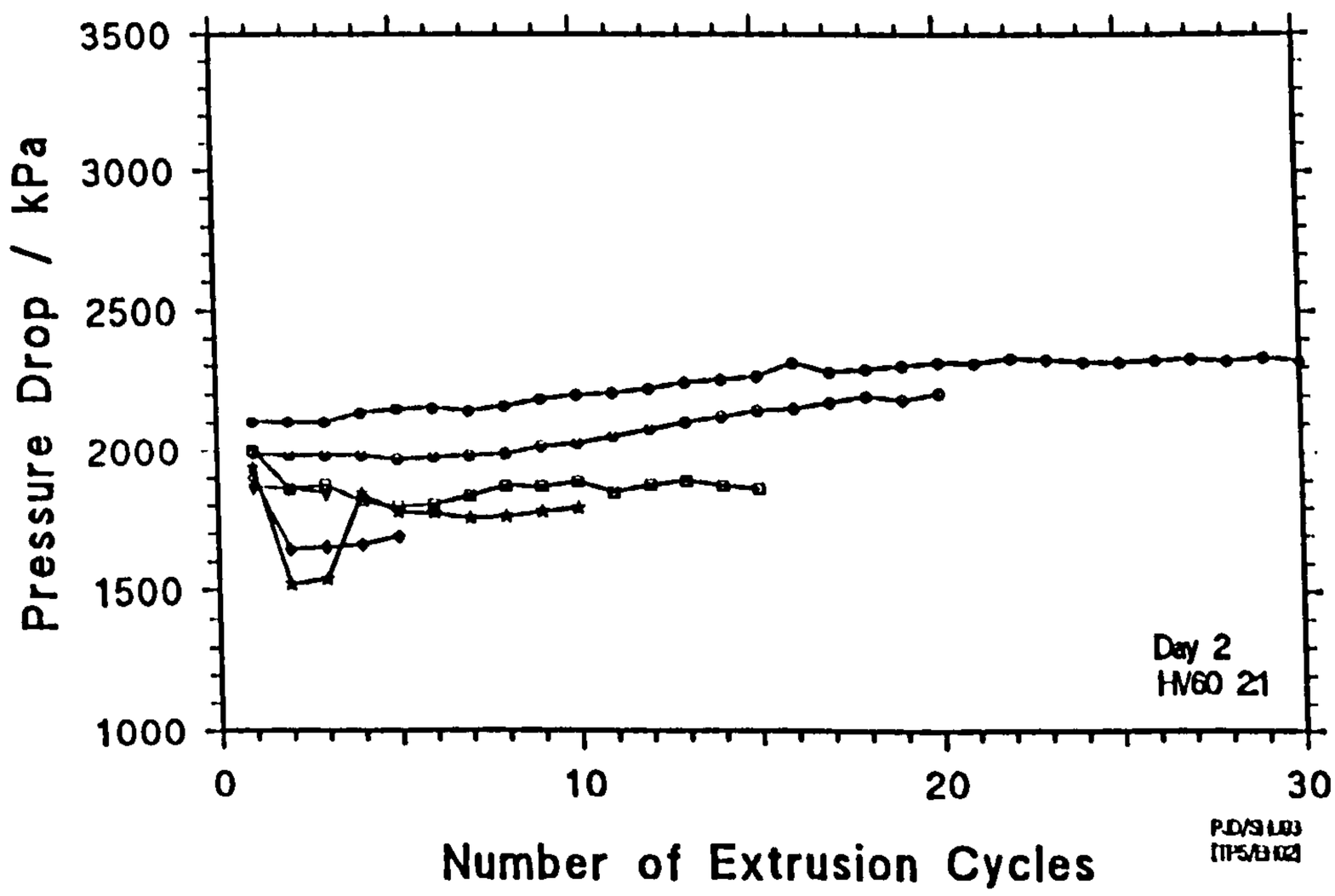
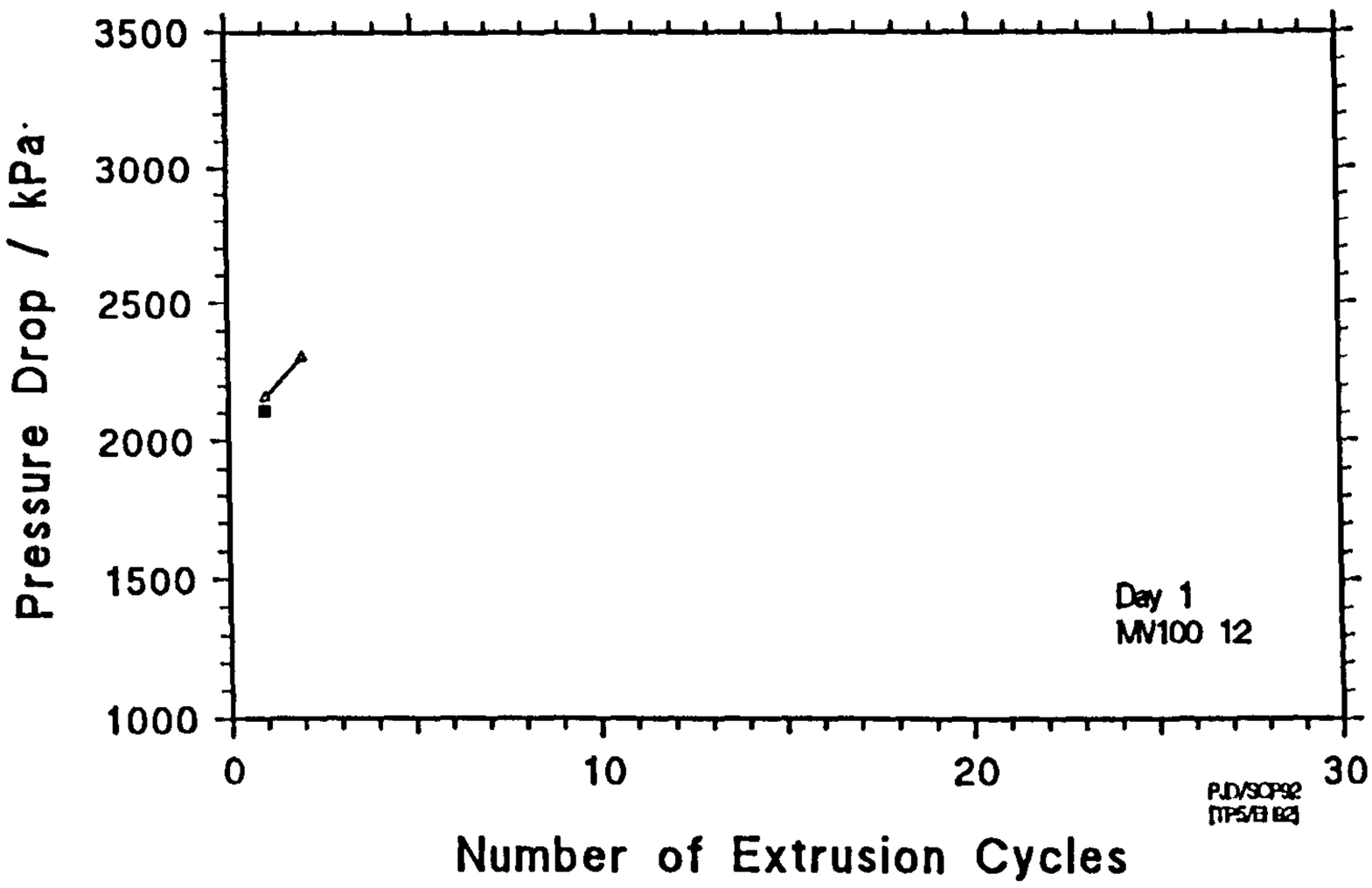

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
Day 2
HV60 21

Figure 103(a) : The relationship between the increase in the number of extrusion cycles and the decrease in the rate of pressure drop increase for all runs completed on day 1 (03/11/92) using MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 103(b) : The relationship between the increase in the number of extrusion cycles and the decrease in the rate of pressure drop increase for all runs completed on day 2 (04/11/92) using MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.


3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
Day 1
MV100 12

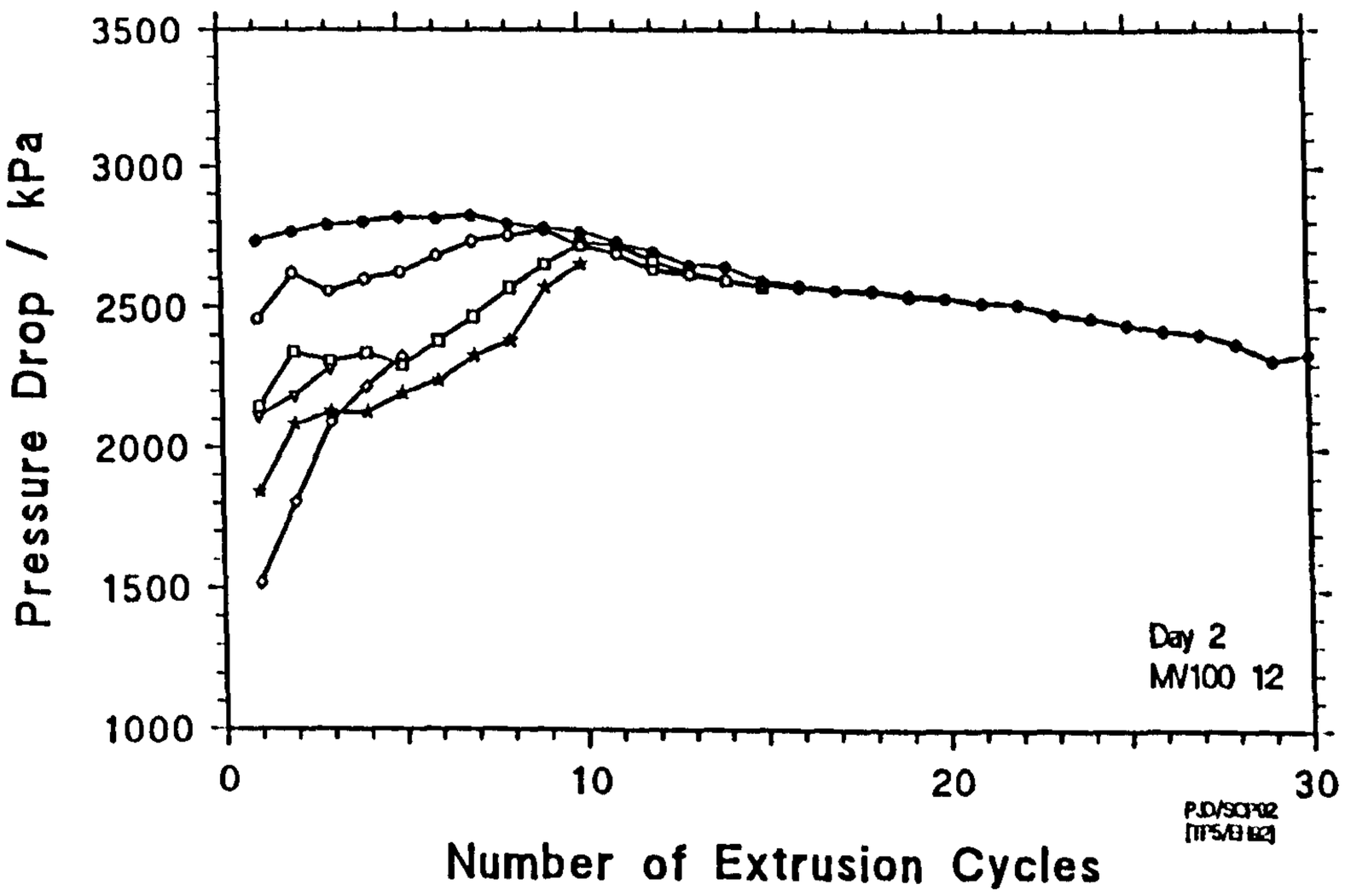
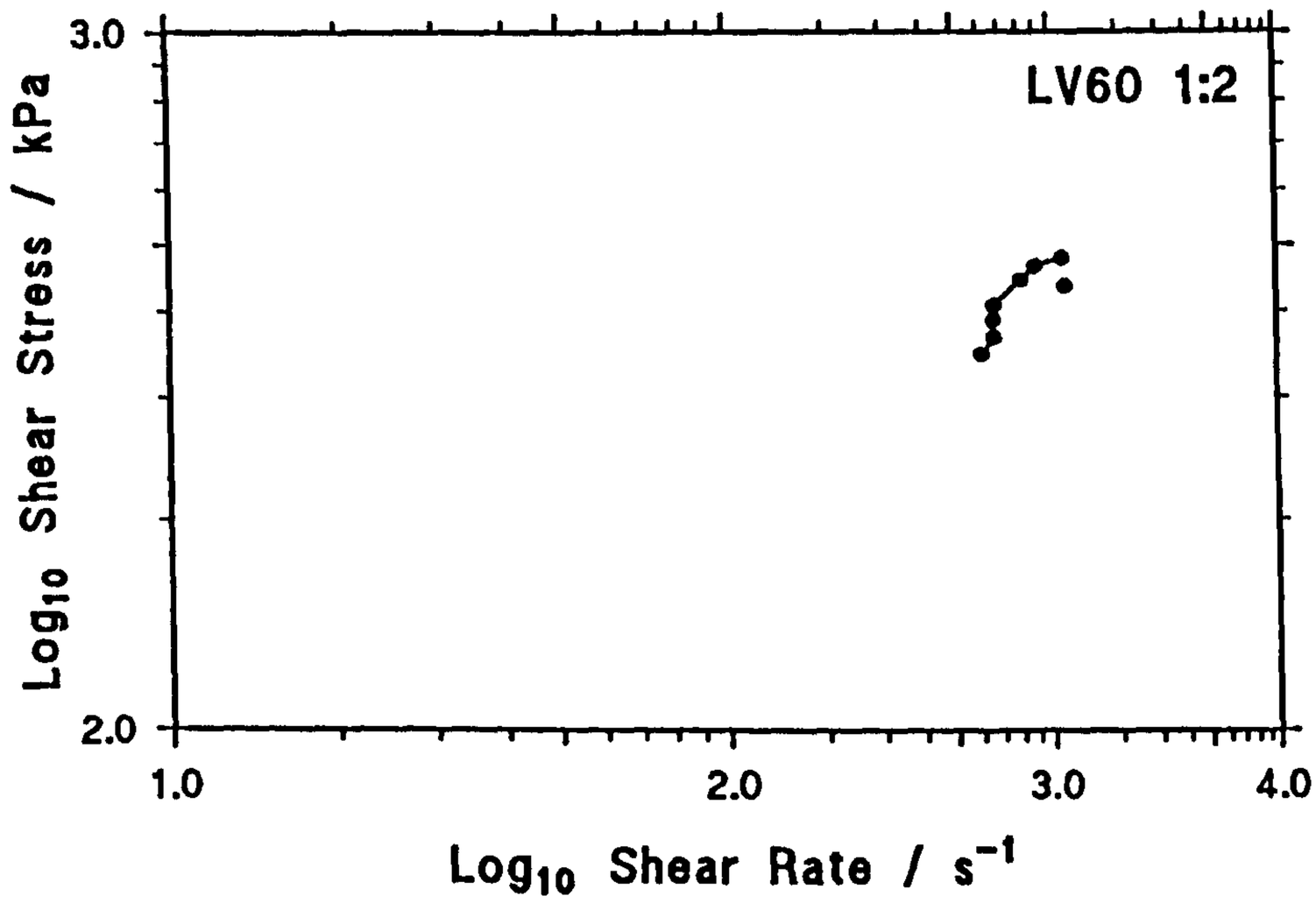
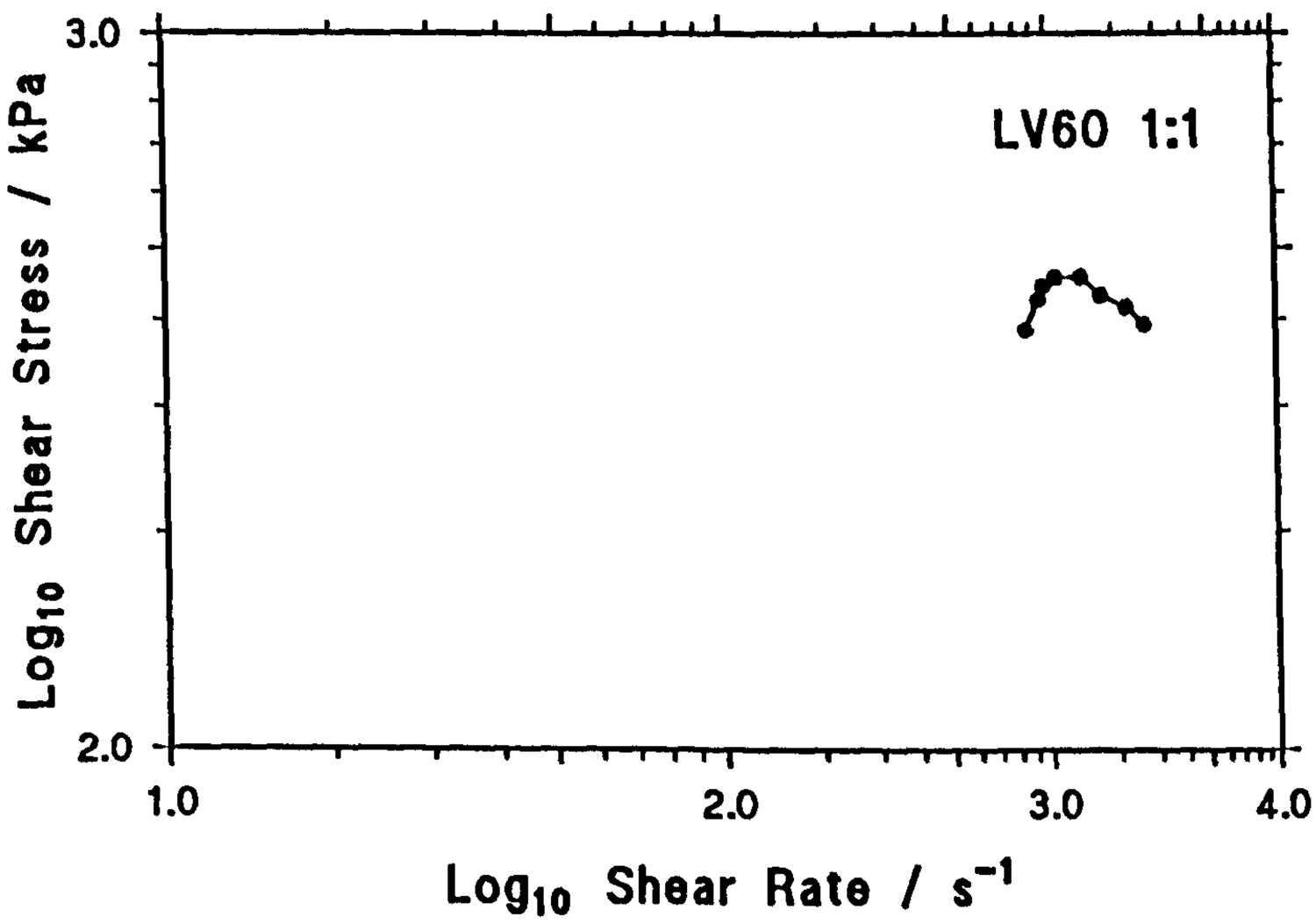

3500
3000
2500
2000
1500
1000
Pressure Drop / kPa
0
10
20
30
Number of Extrusion Cycles
Day 2
MV100 12

Figure 104(a) : The relationship between log shear rate and log shear stress obtained using LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 104(b) : The relationship between log shear rate and log shear stress obtained using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 104(c) : The relationship between log shear rate and log shear stress obtained using LV medium and 60 Mesh grit with a grit to polymer ratio of 2.


LV60 1:2
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1


LV60 1:1
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

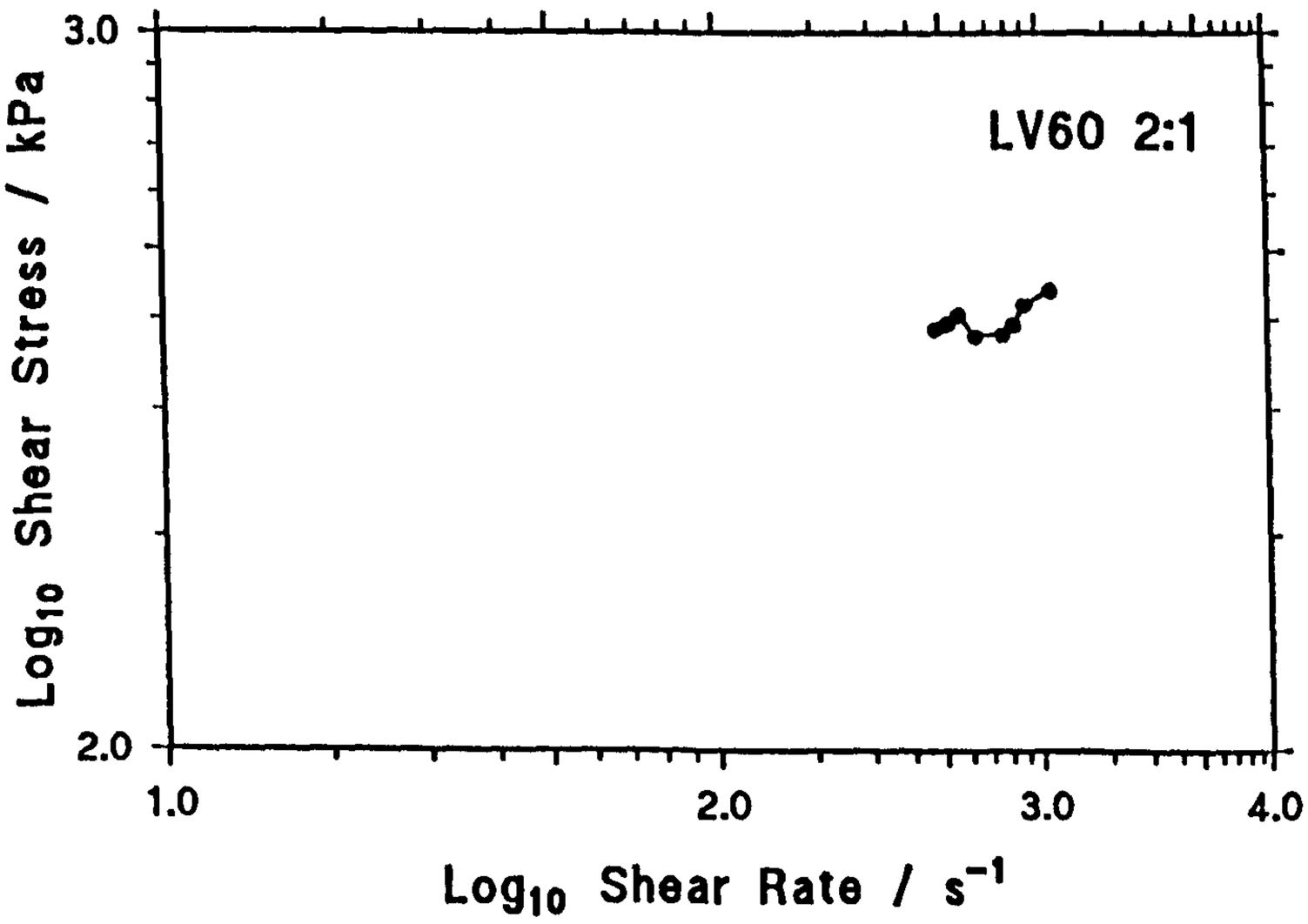
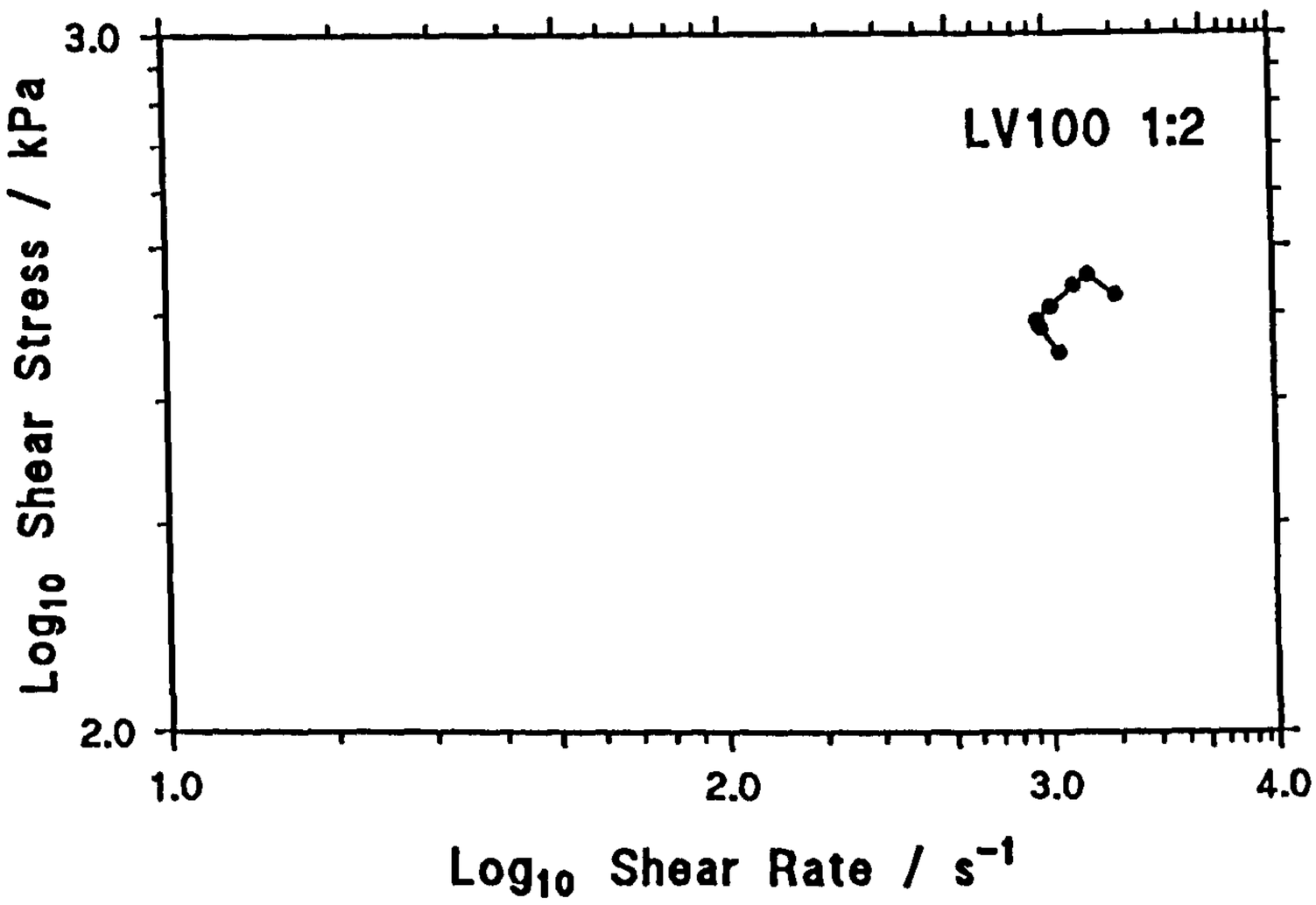
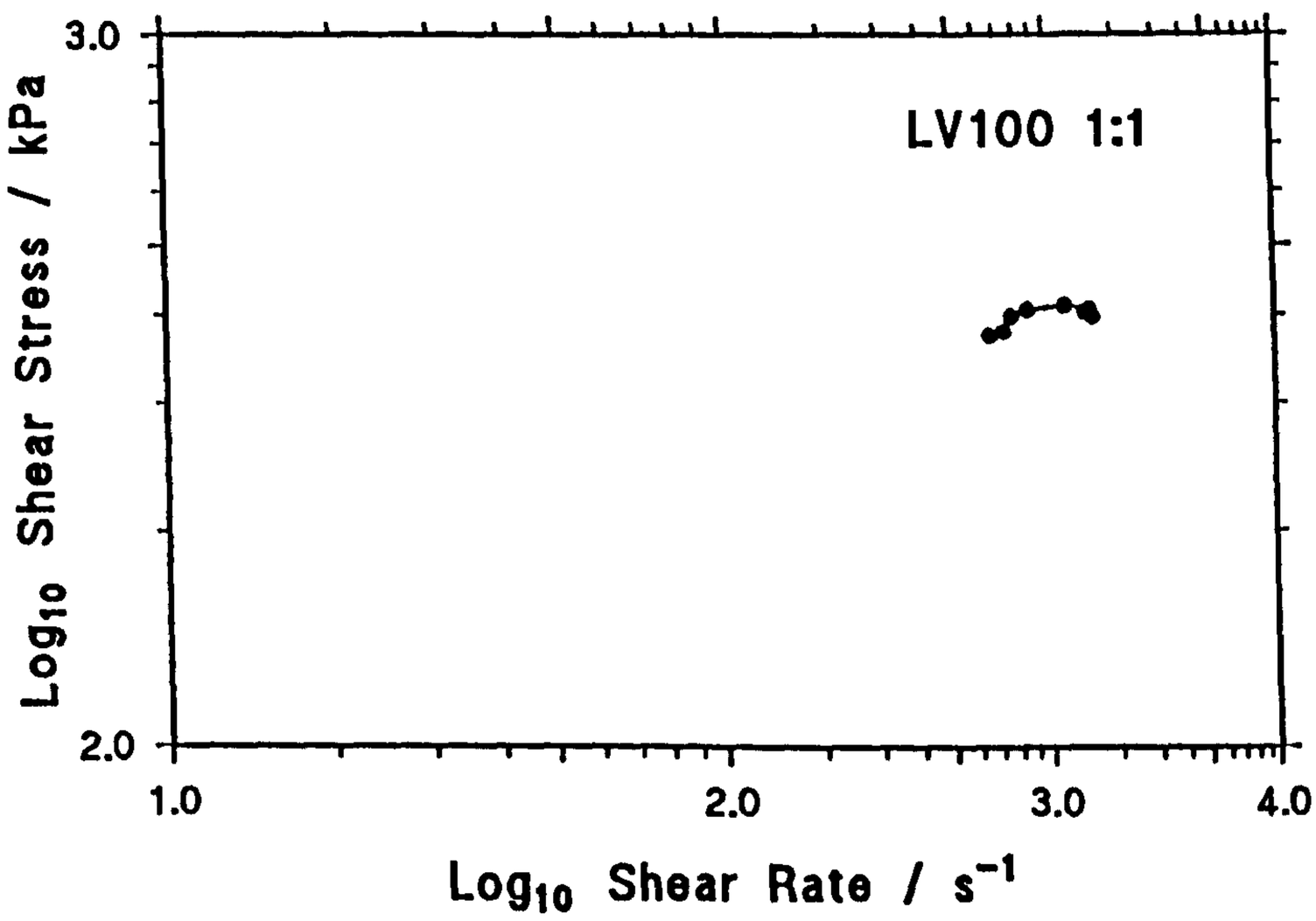

LV60 2:1
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

Figure 105(a) : The relationship between log shear rate and log shear stress obtained using LV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 105(b) : The relationship between log shear rate and log shear stress obtained using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 105(c) : The relationship between log shear rate and log shear stress obtained using LV medium and 100 Mesh grit with a grit to polymer ratio of 2.


LV100 1:2
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1


LV100 1:1
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

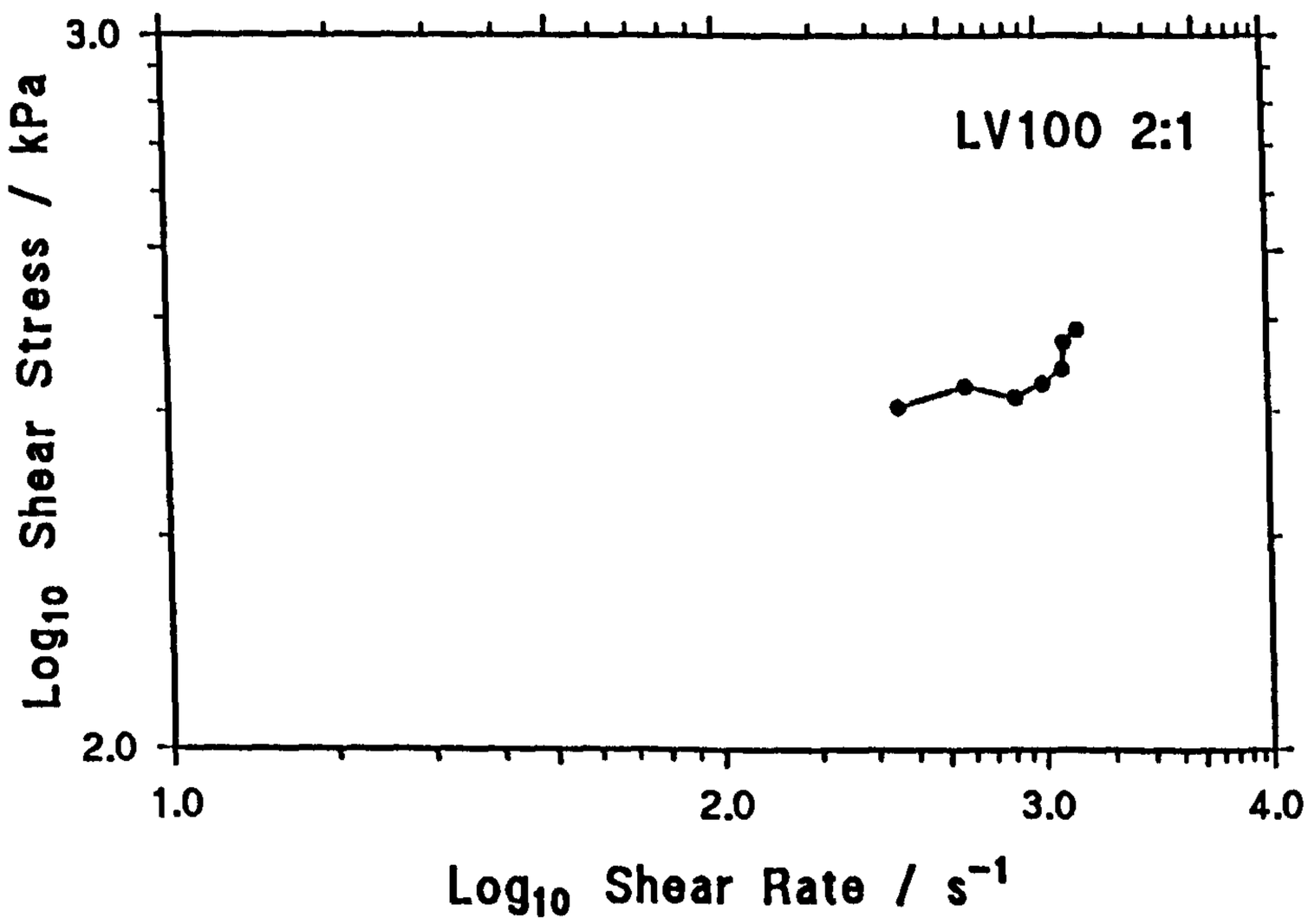
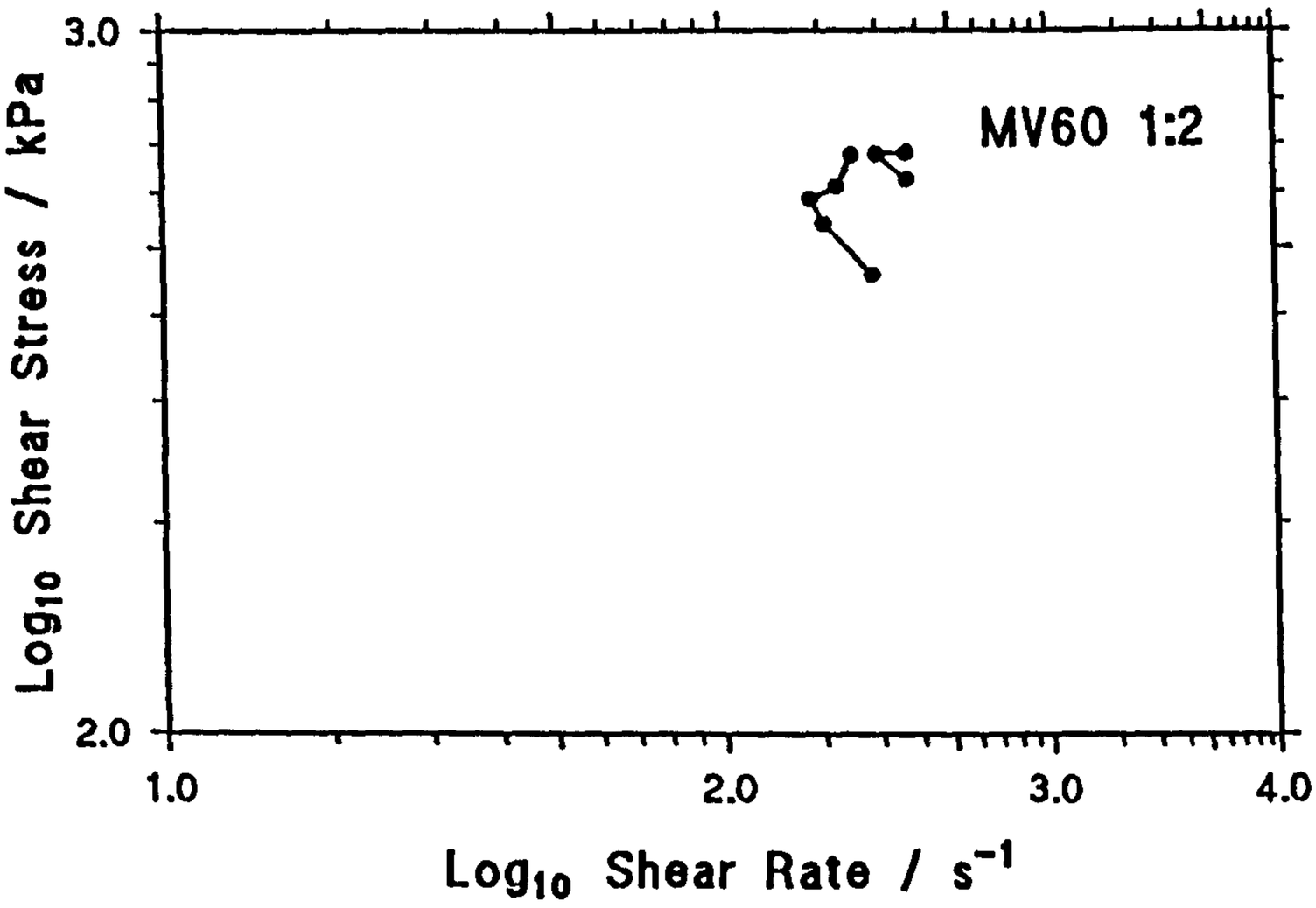
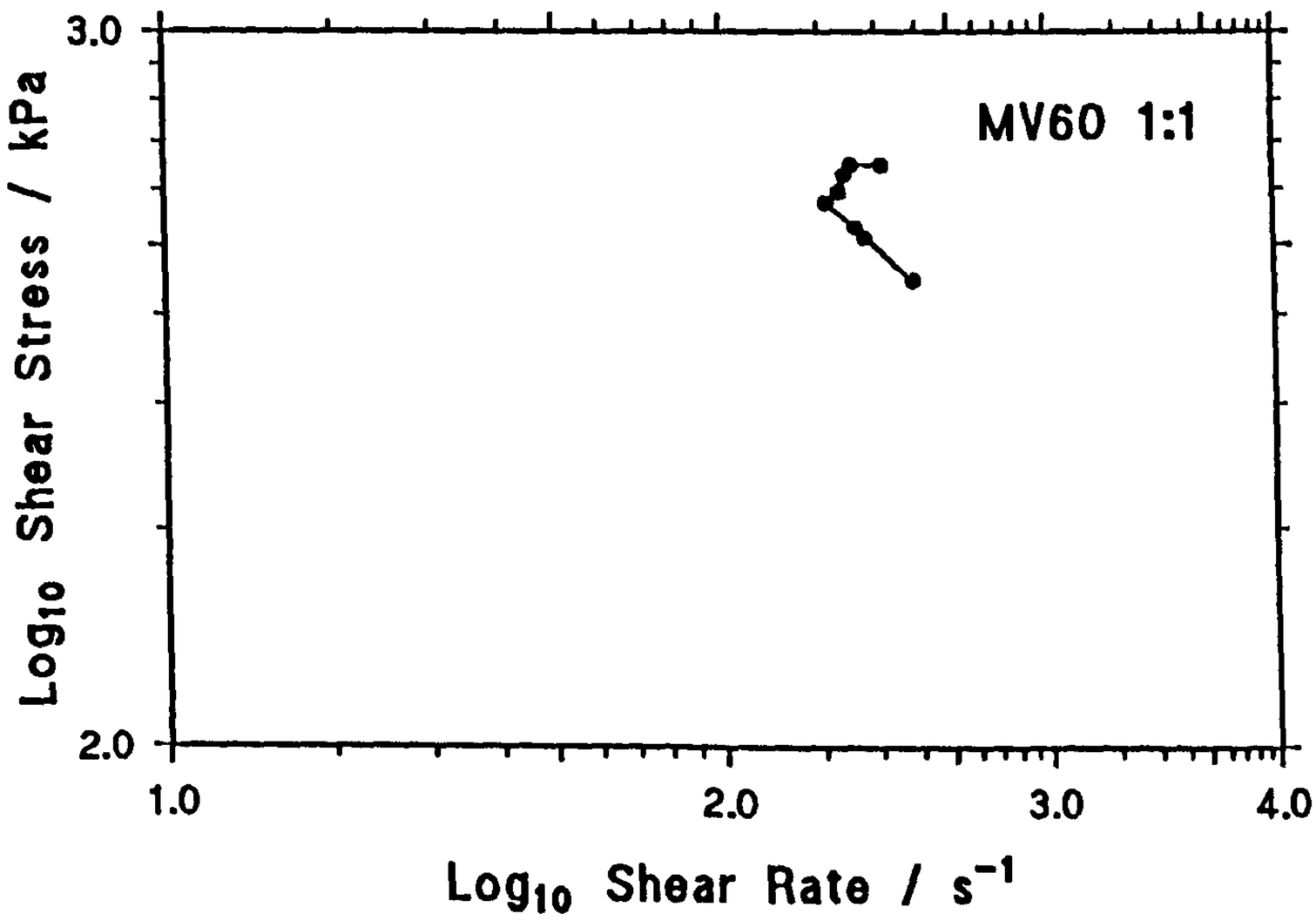

LV100 2:1
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

Figure 106(a) : The relationship between log shear rate and log shear stress obtained using MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 106(b) : The relationship between log shear rate and log shear stress obtained using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 106(c) : The relationship between log shear rate and log shear stress obtained using MV medium and 60 Mesh grit with a grit to polymer ratio of 2.


MV60 1:2
Log10 Shear Stress / kPa
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Rate / s-1


MV60 1:1
Log10 Shear Stress / kPa
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Rate / s-1

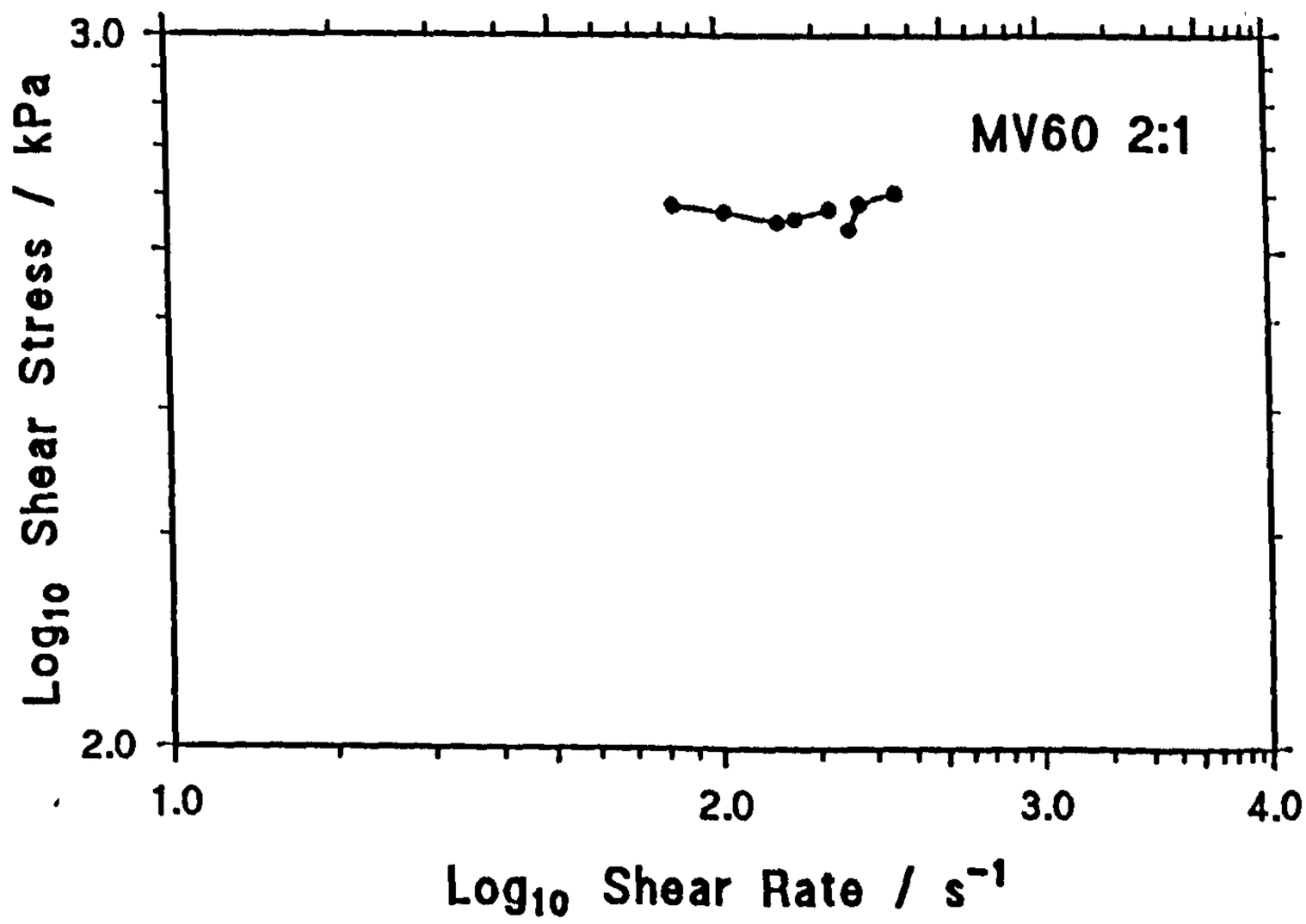
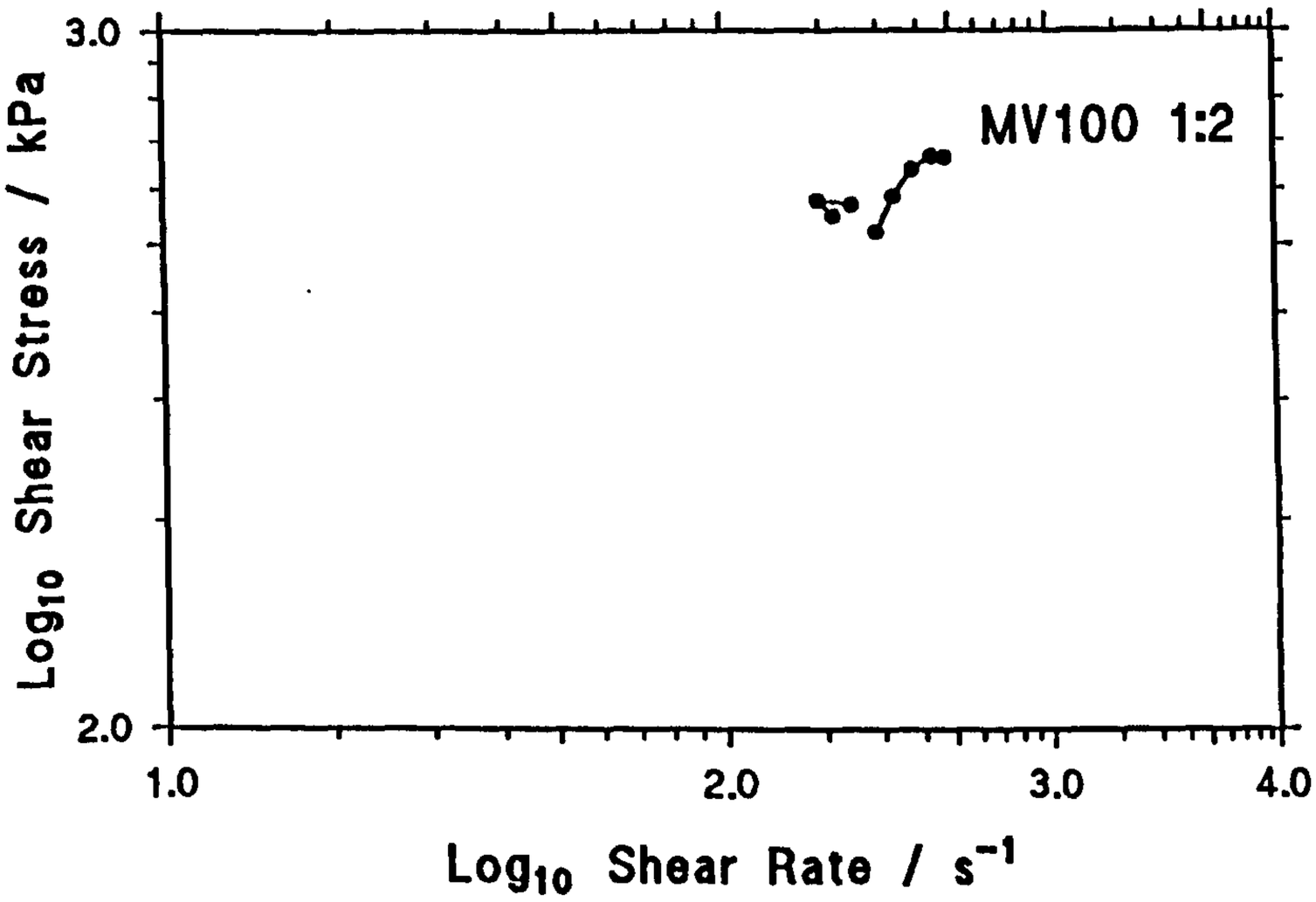
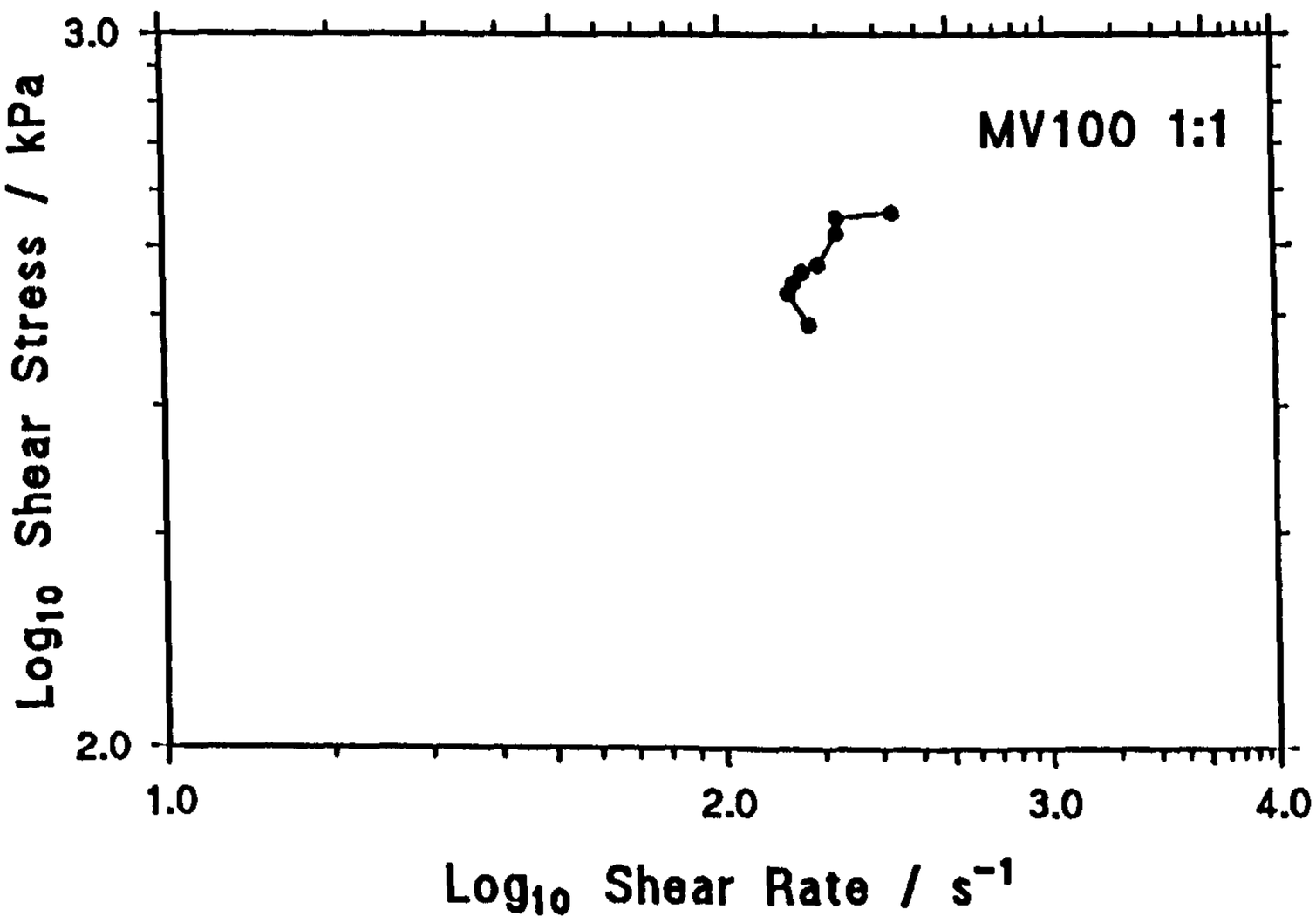

MV60 2:1
Log10 Shear Stress / kPa
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Rate / s-1

Figure 107(a) : The relationship between log shear rate and log shear stress obtained using MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 107(b) : The relationship between log shear rate and log shear stress obtained using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 107(c) : The relationship between log shear rate and log shear stress obtained using MV medium and 100 Mesh grit with a grit to polymer ratio of 2.


MV100 1:2
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1


MV100 1:1
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

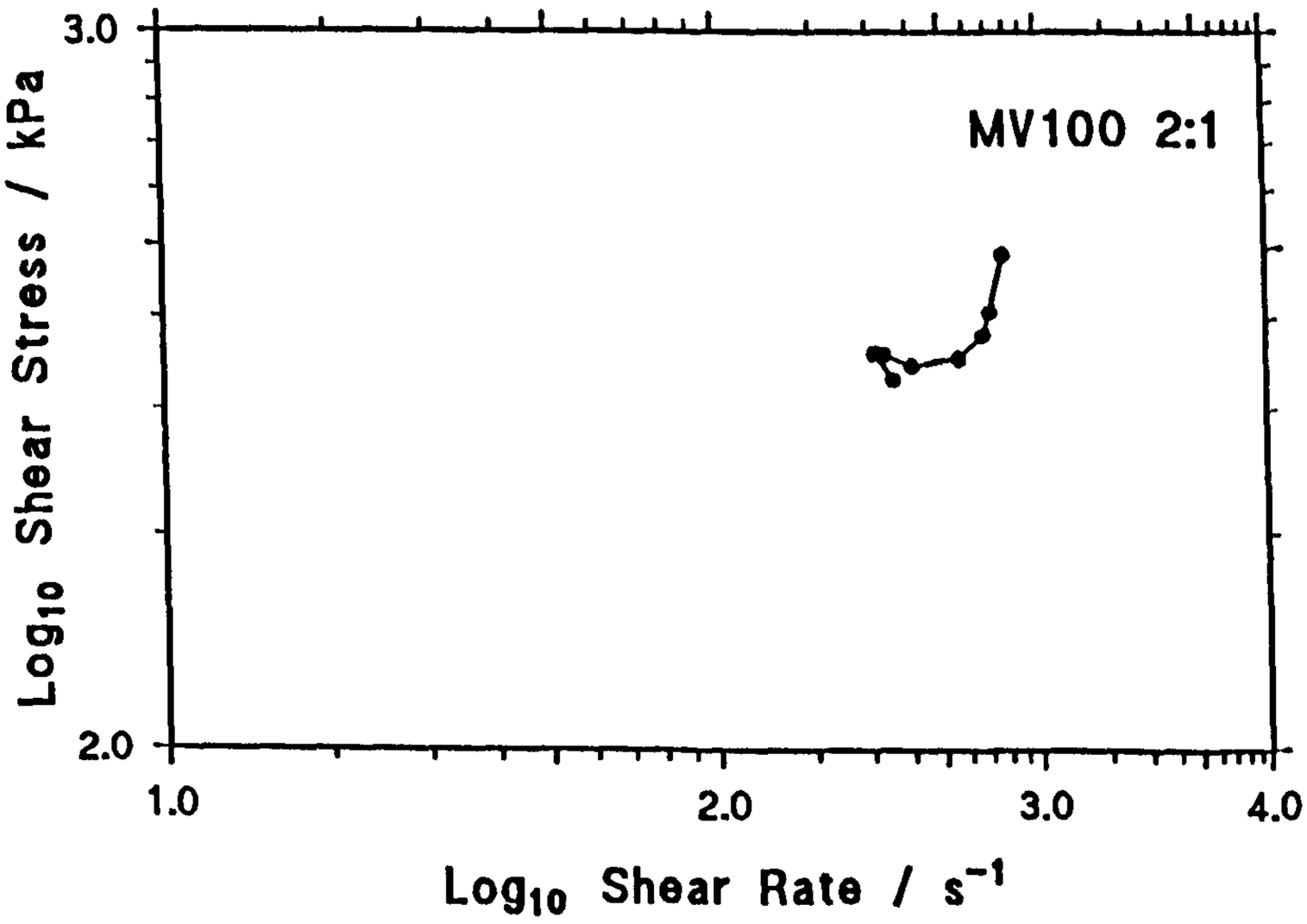
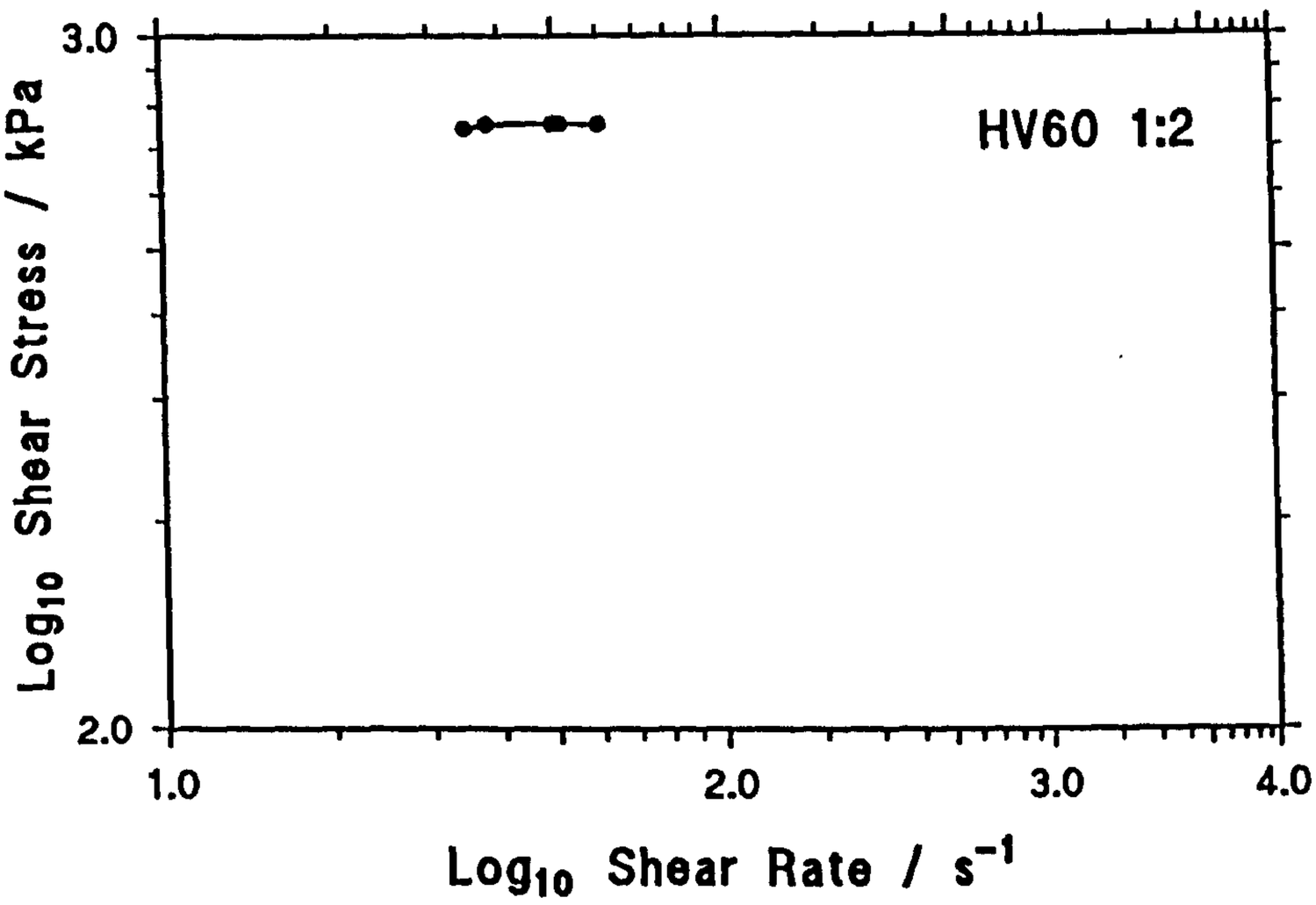
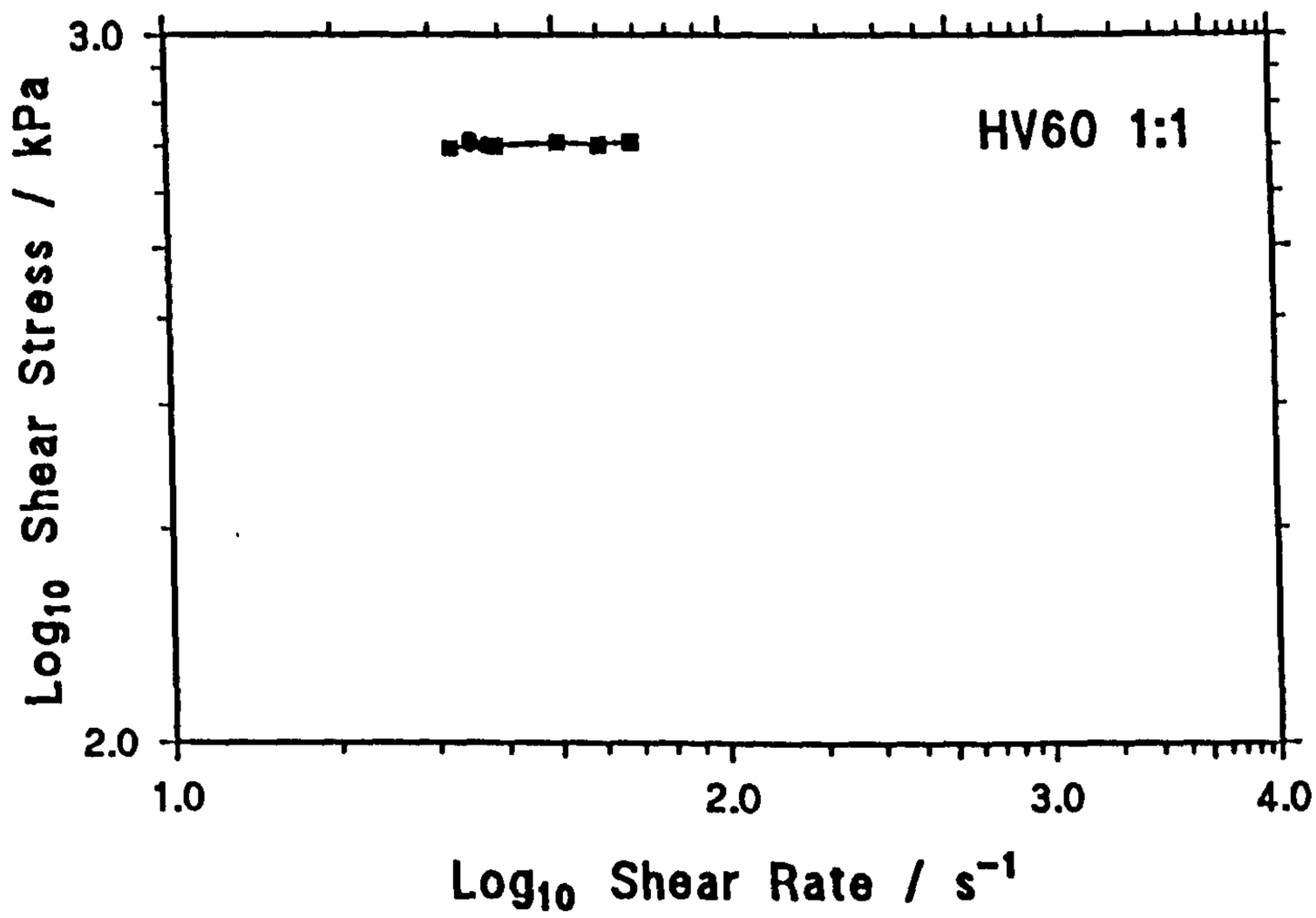

MV100 2:1
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

Figure 108(a) : The relationship between log shear rate and log shear stress obtained using HV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 108(b) : The relationship between log shear rate and log shear stress obtained using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 108(c) : The relationship between log shear rate and log shear stress obtained using HV medium and 60 Mesh grit with a grit to polymer ratio of 2.


HV60 1:2
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1


HV60 1:1
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

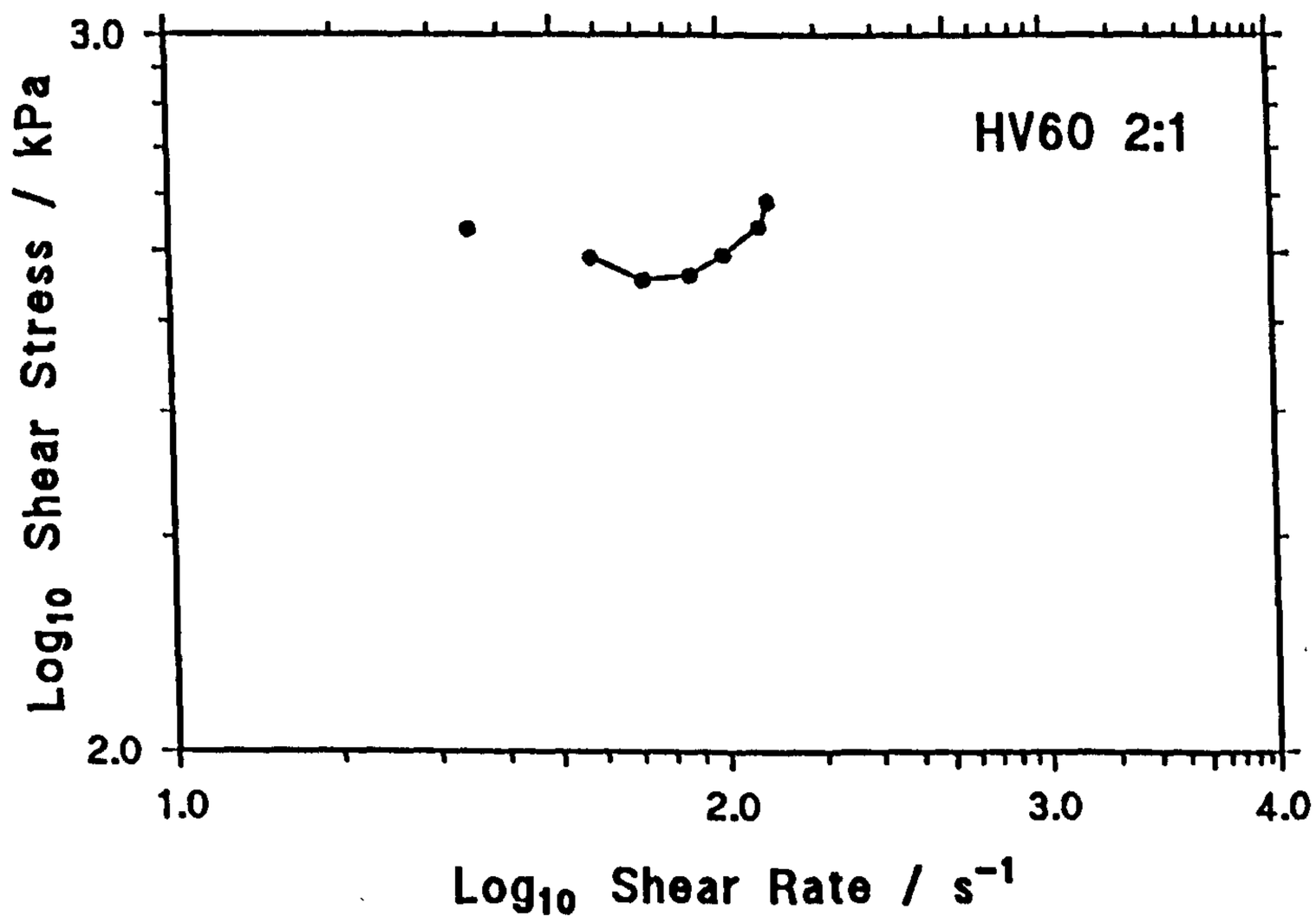
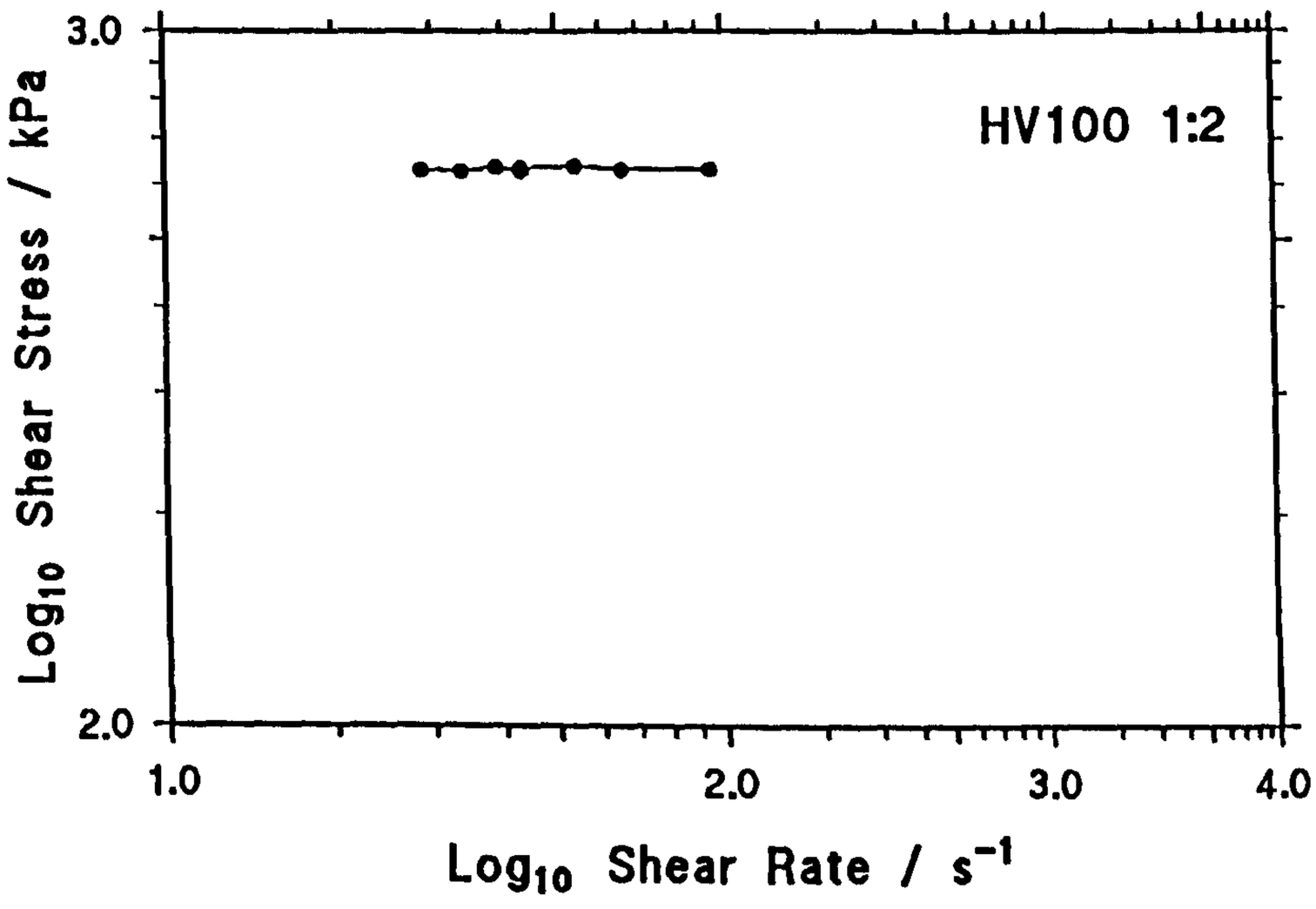

HV60 2:1
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

Figure 109(a) : The relationship between log shear rate and log shear stress obtained using HV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 109(b) : The relationship between log shear rate and log shear stress obtained using HV medium and 100 Mesh grit with a grit to polymer ratio of 2.


HV100 1:2
3.0
2.0
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

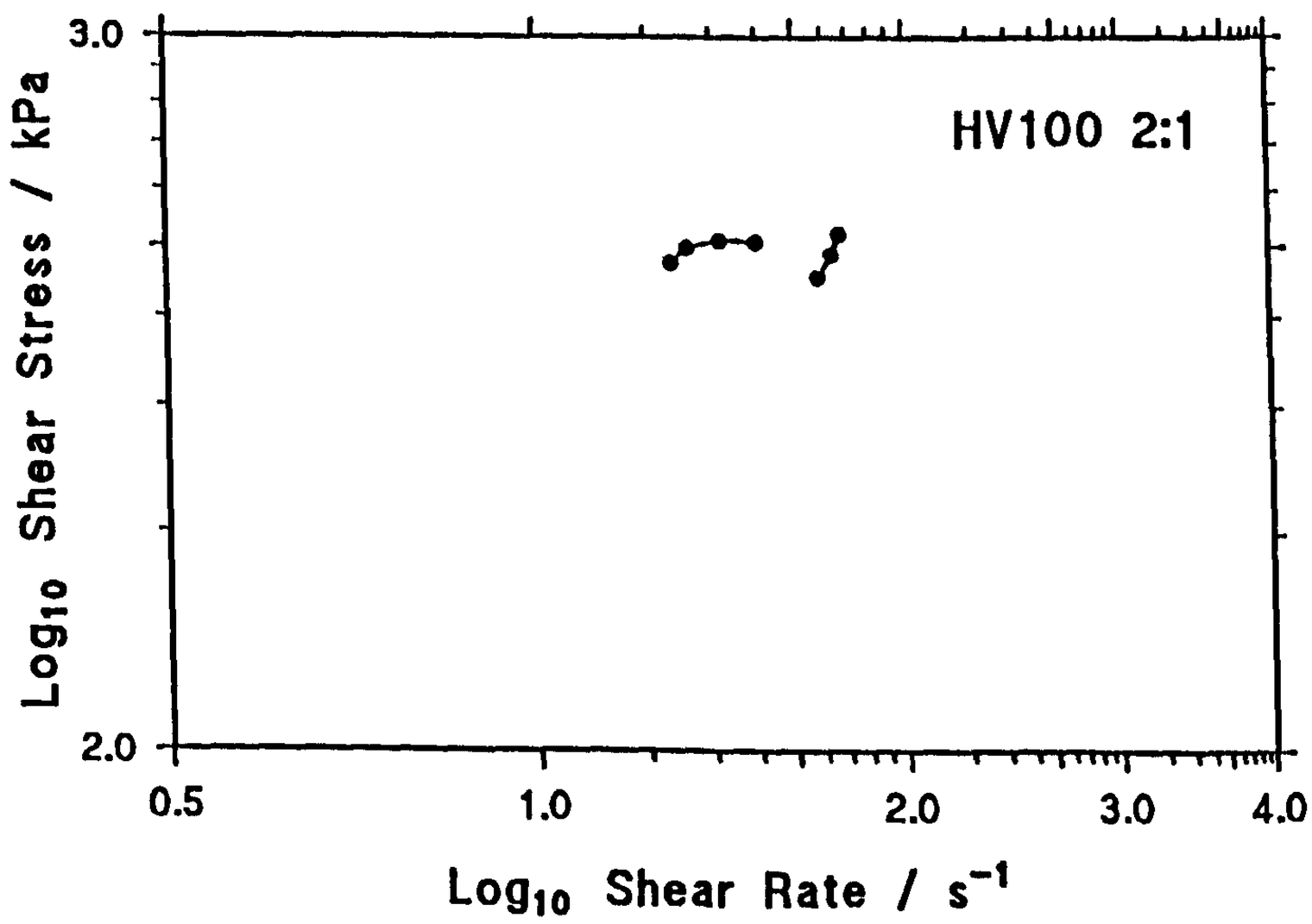
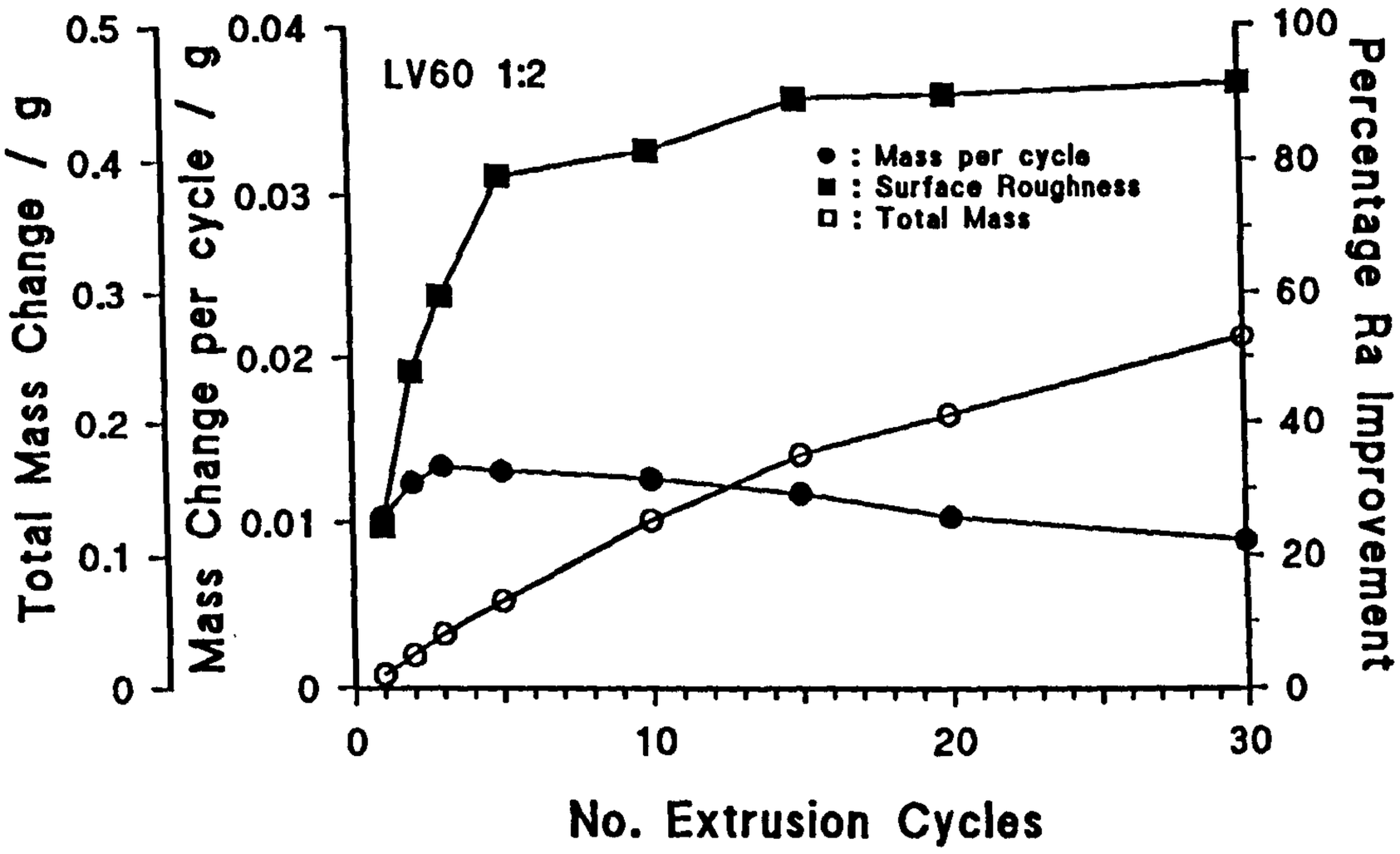
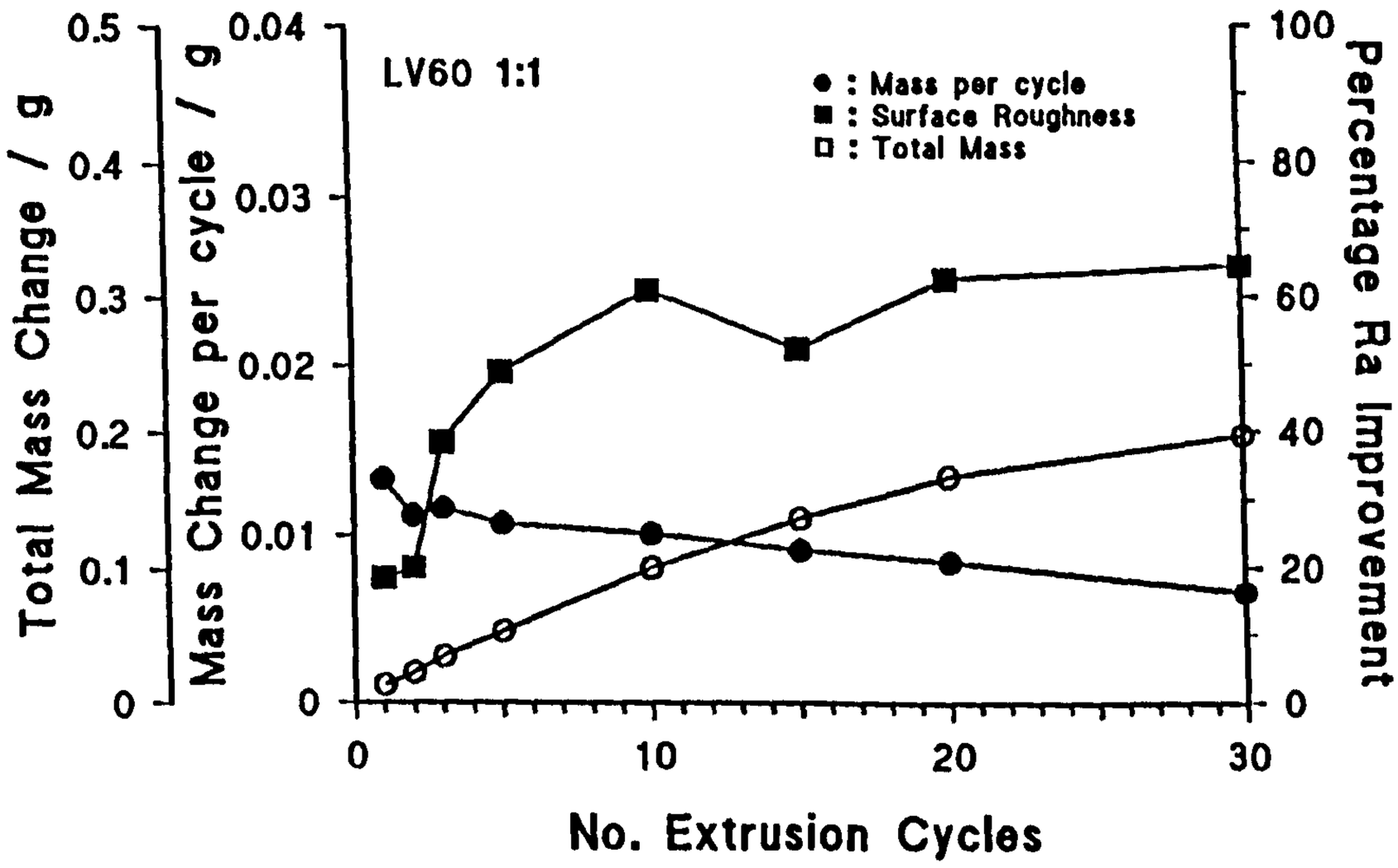

HV100 2:1
3.0
2.0
0.5
1.0
2.0
3.0
4.0
Log10 Shear Stress / kPa
Log10 Shear Rate / s-1

Figure 110(a) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 110(b) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 110(c) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using LV medium and 60 Mesh grit with a grit to polymer ratio of 2.


LV60 1:2
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles


LV60 1:1
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles

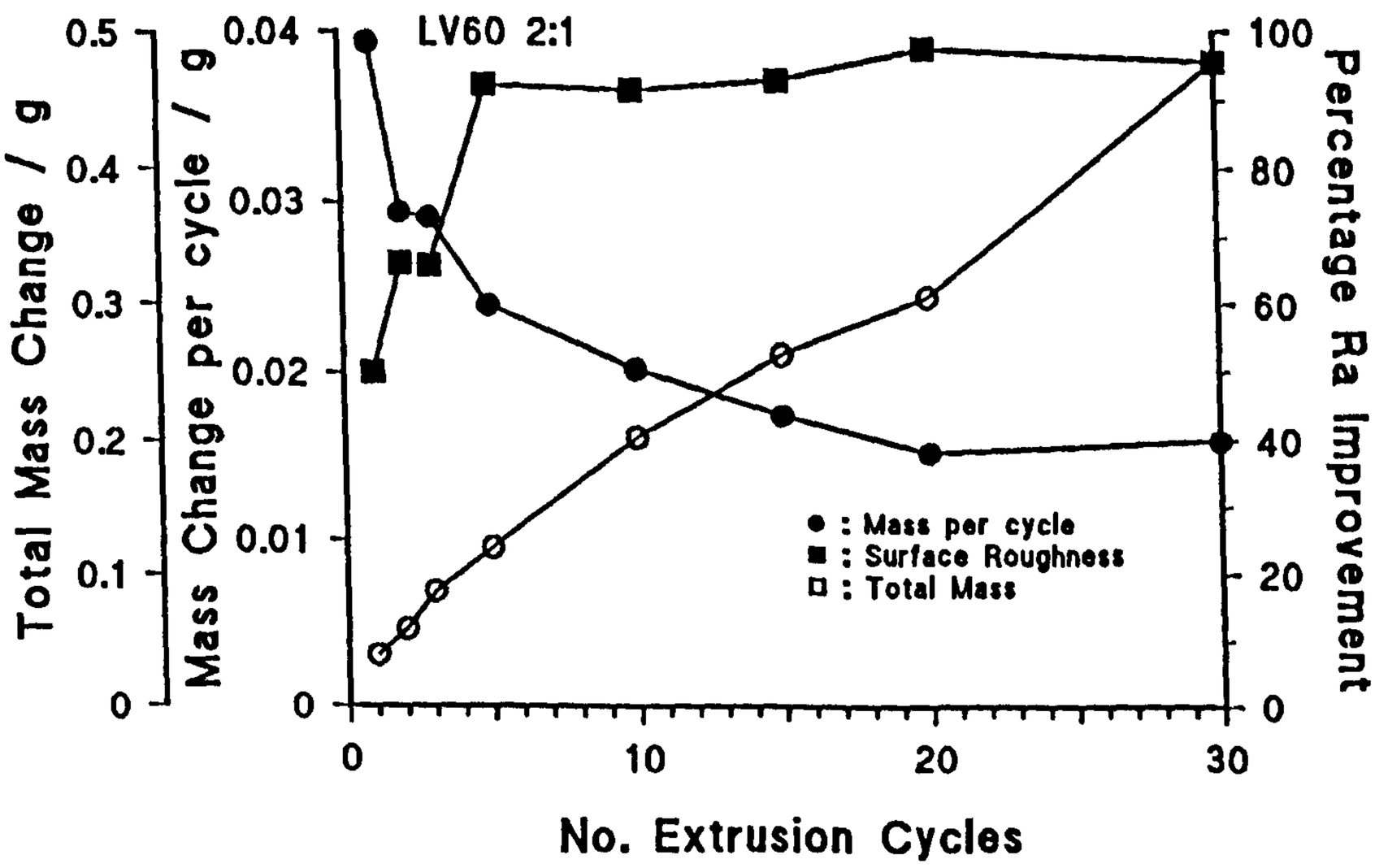
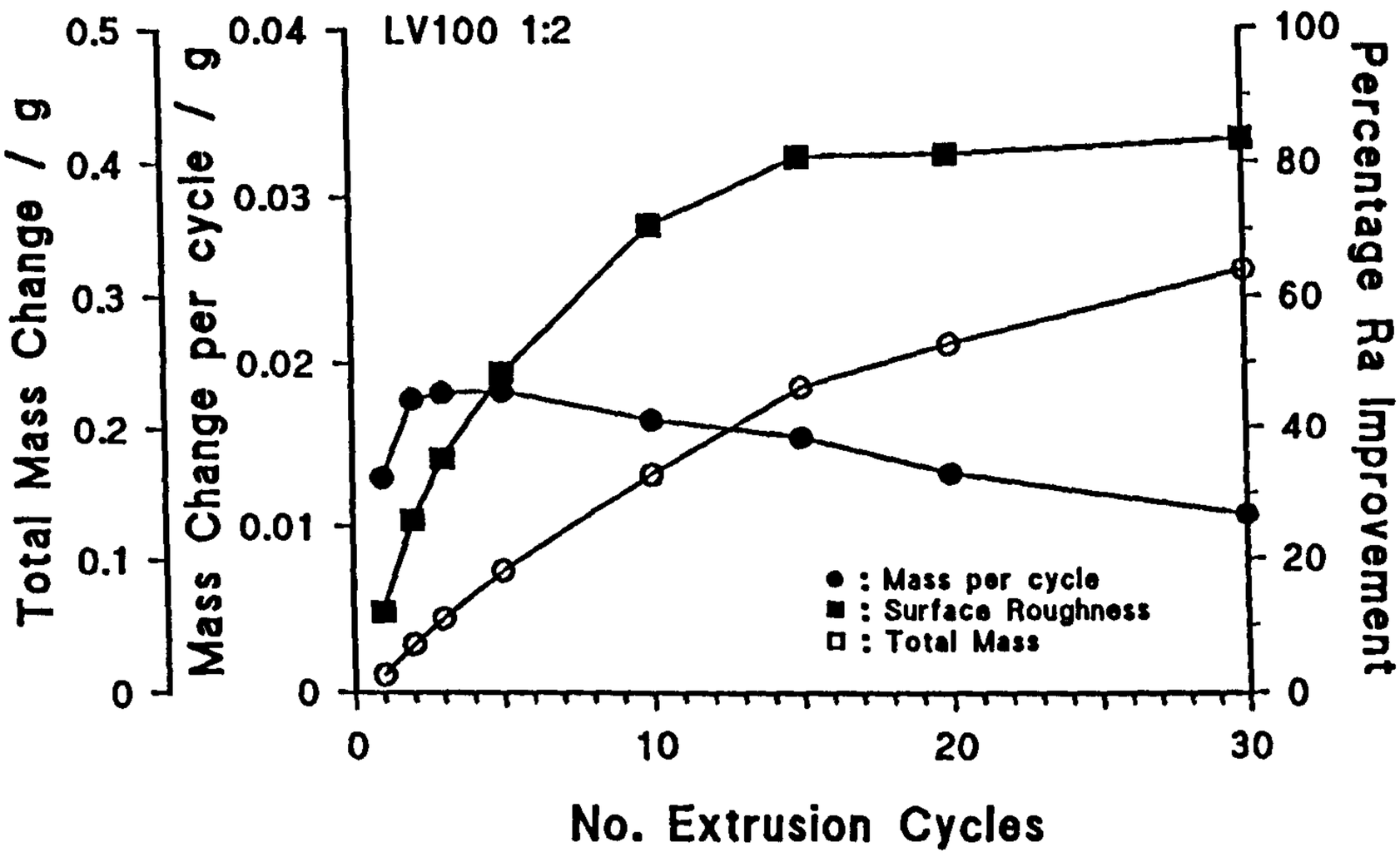
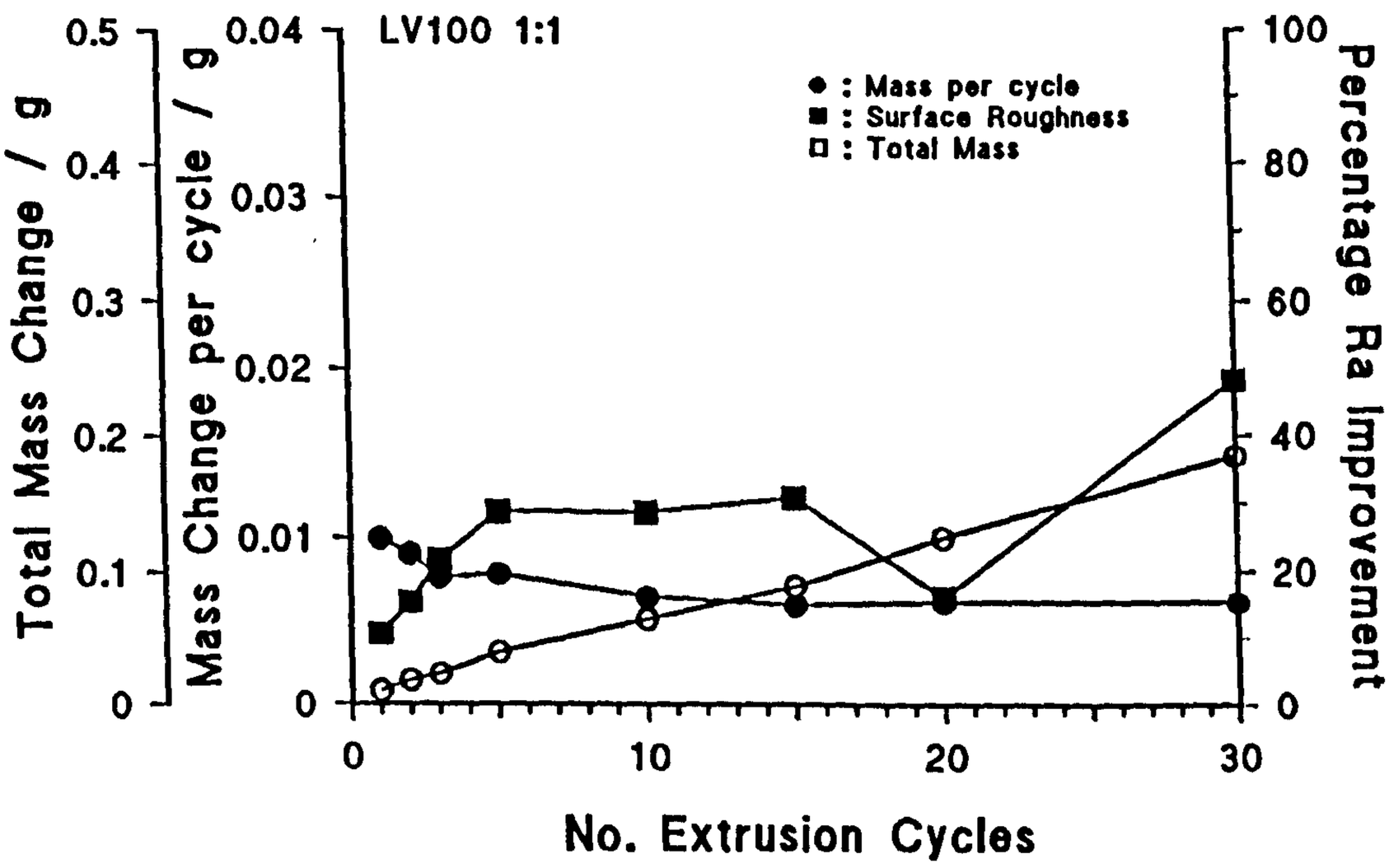

LV60 2:1
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles

Figure 111(a) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using LV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 111(b) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 111(c) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using LV medium and 100 Mesh grit with a grit to polymer ratio of 2.


LV100 1:2
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles


LV100 1:1
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles

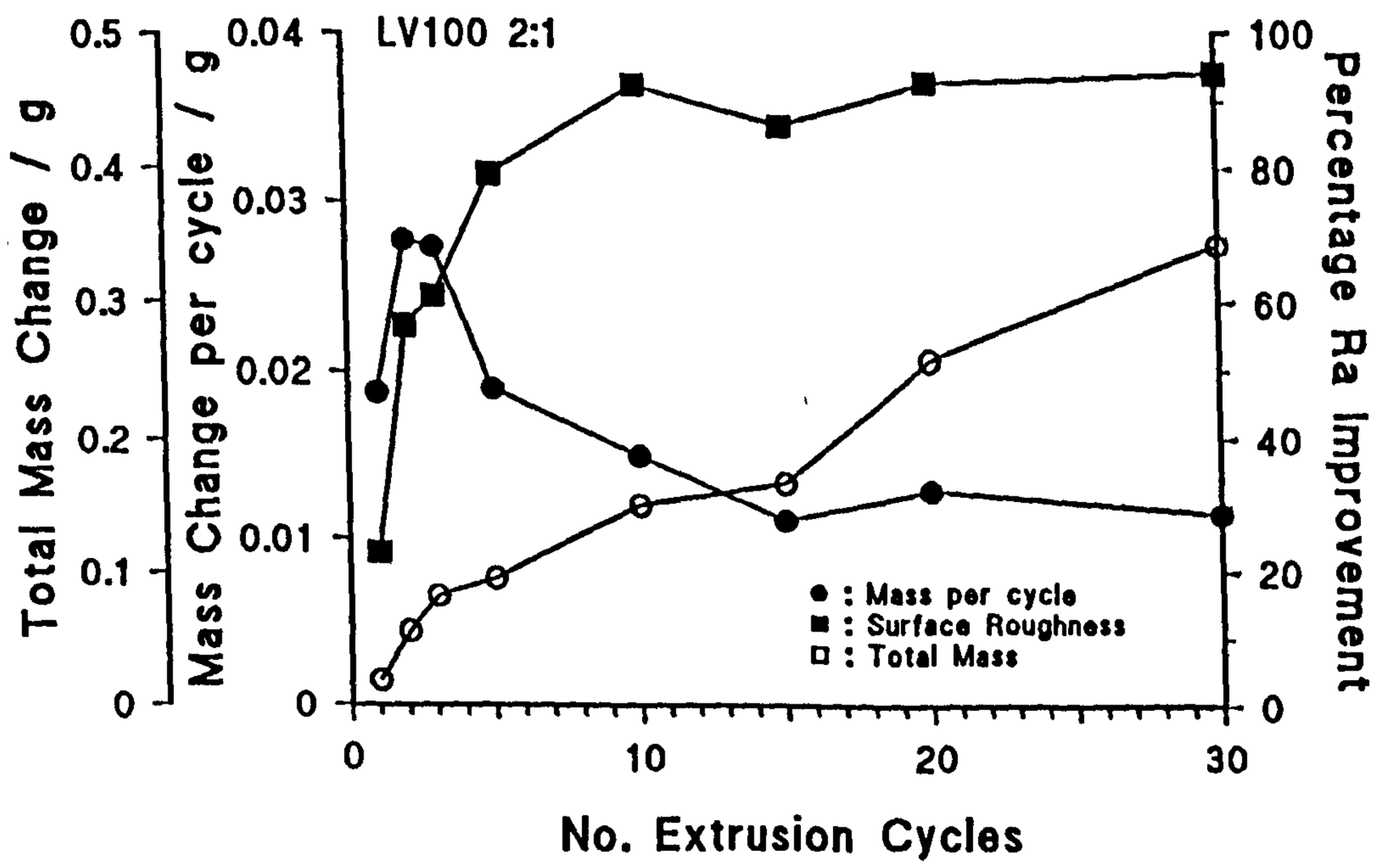
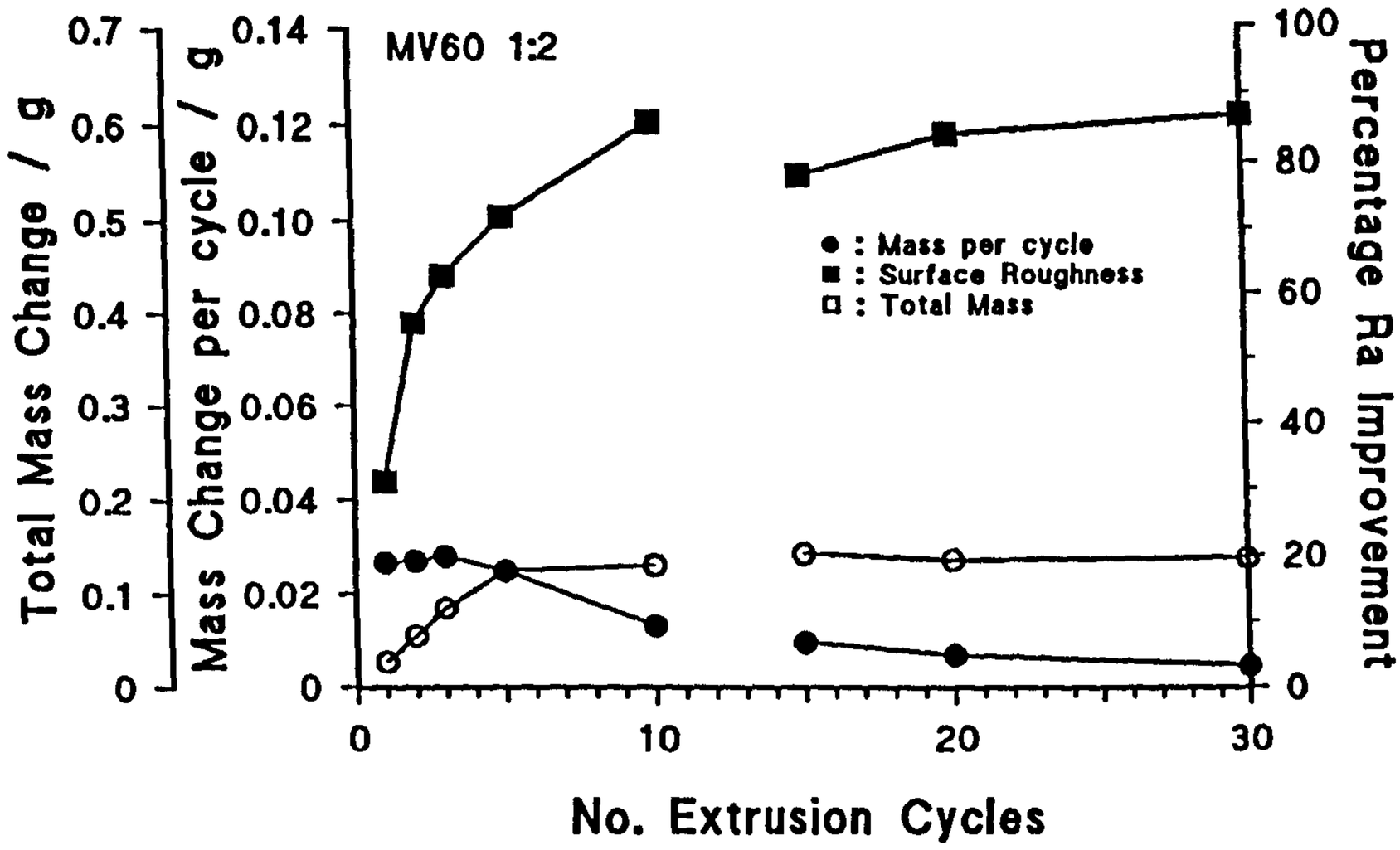
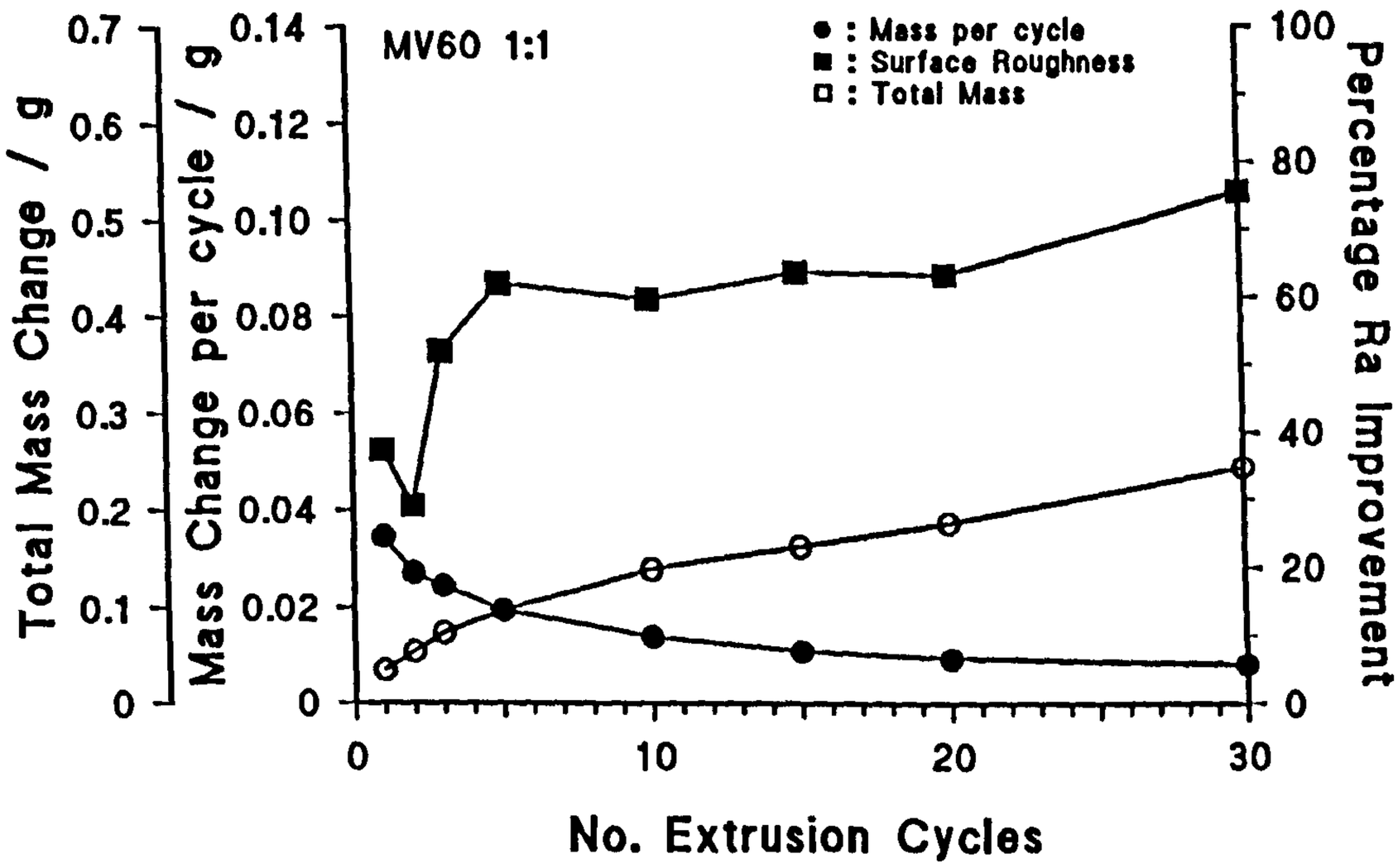

LV100 2:1
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles

Figure 112(a) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 112(b) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 112(c) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using MV medium and 60 Mesh grit with a grit to polymer ratio of 2.


MV60 1:2
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles


MV60 1:1
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles

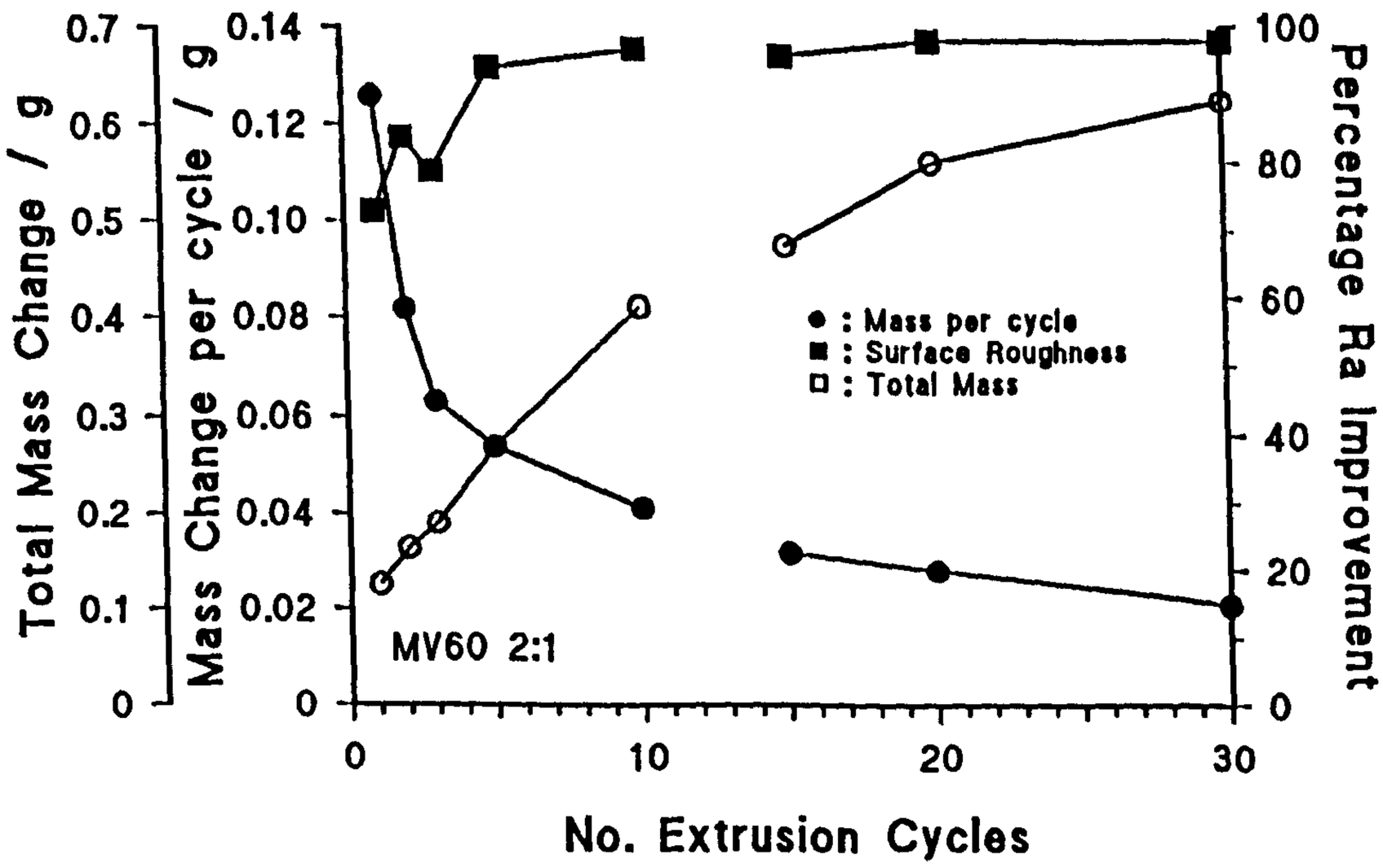
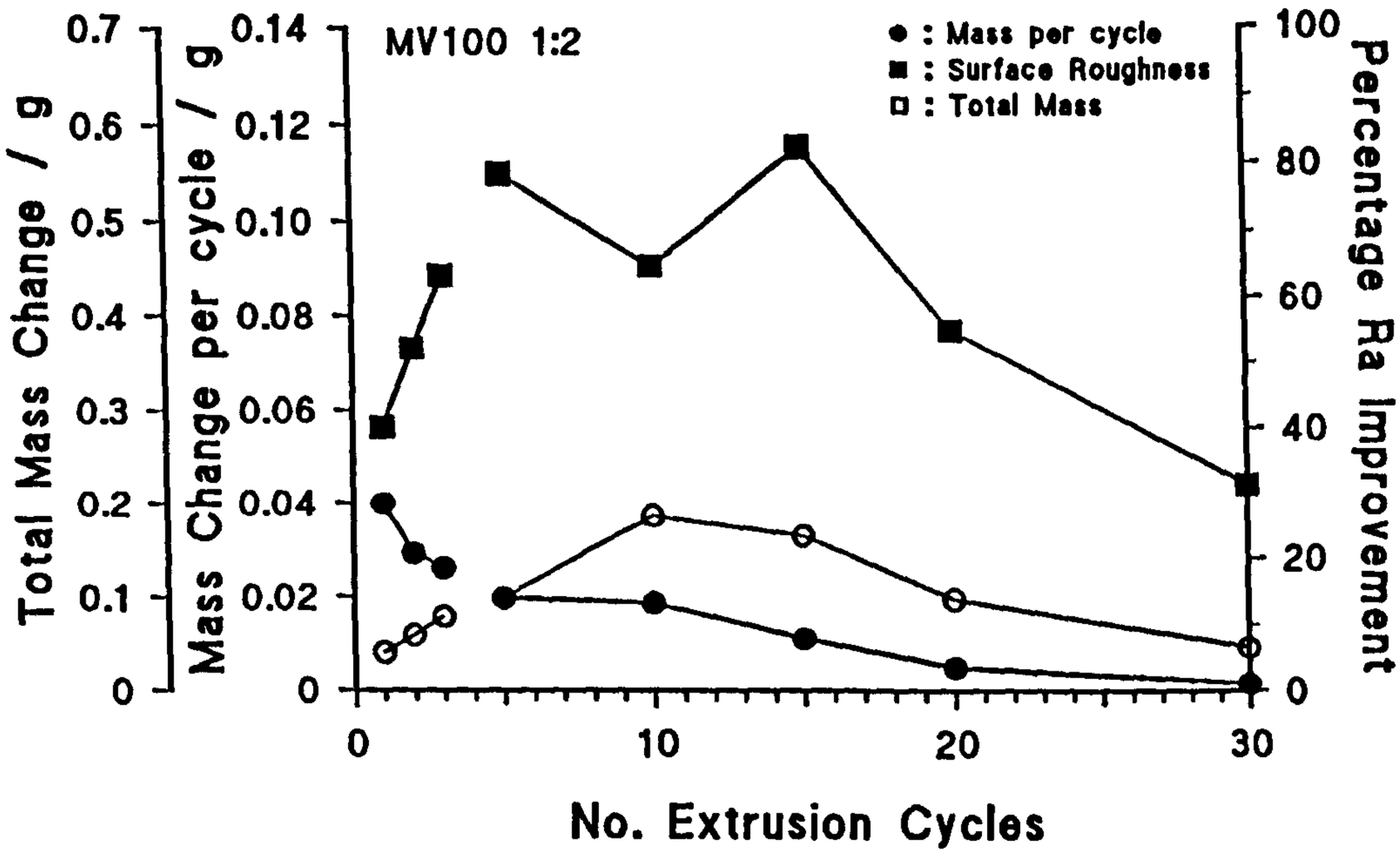
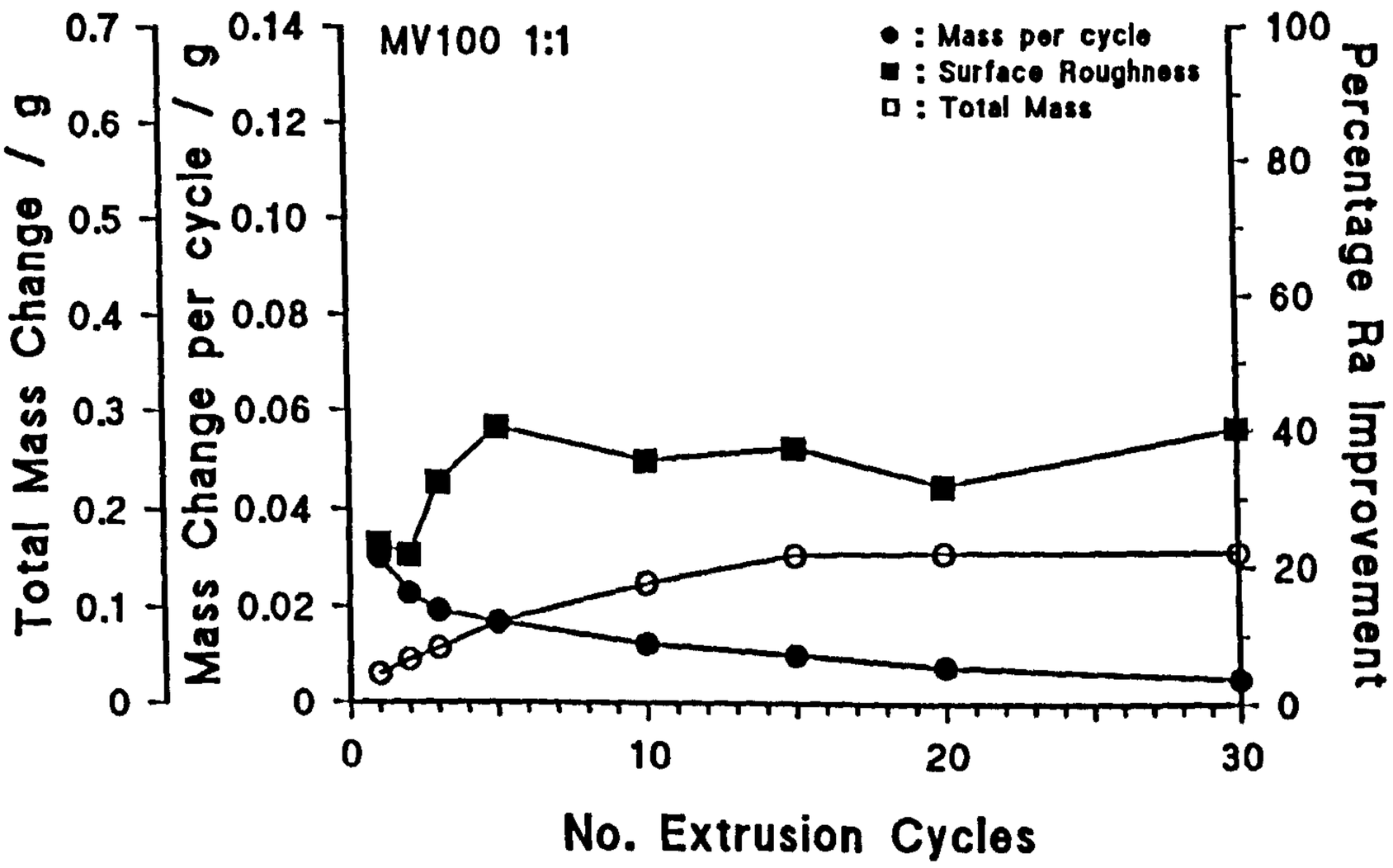

MV60 2:1
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles

Figure 113(a) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 113(b) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 113(c) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using MV medium and 100 Mesh grit with a grit to polymer ratio of 2.


MV100 1:2
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles


MV100 1:1
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles

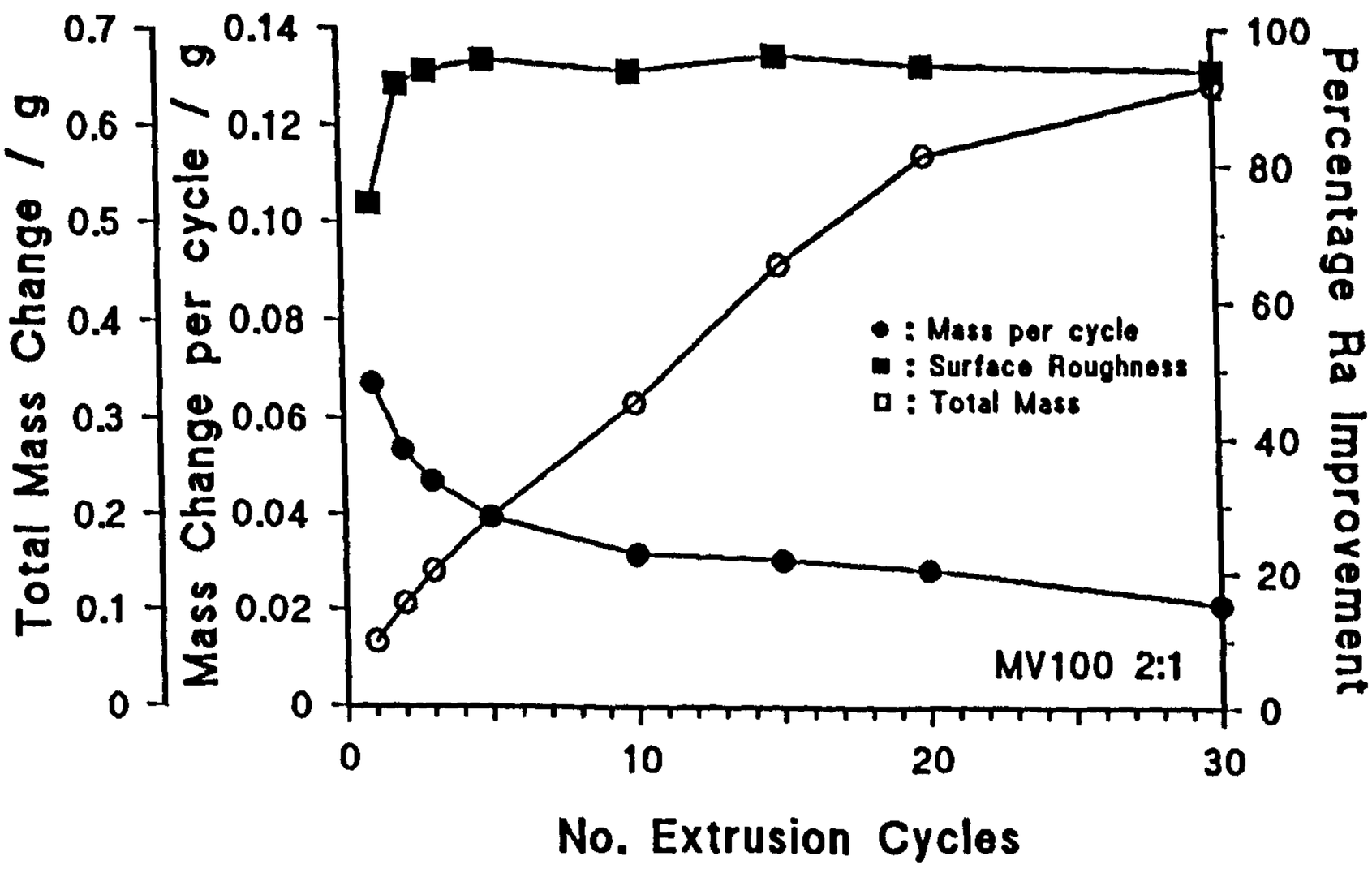
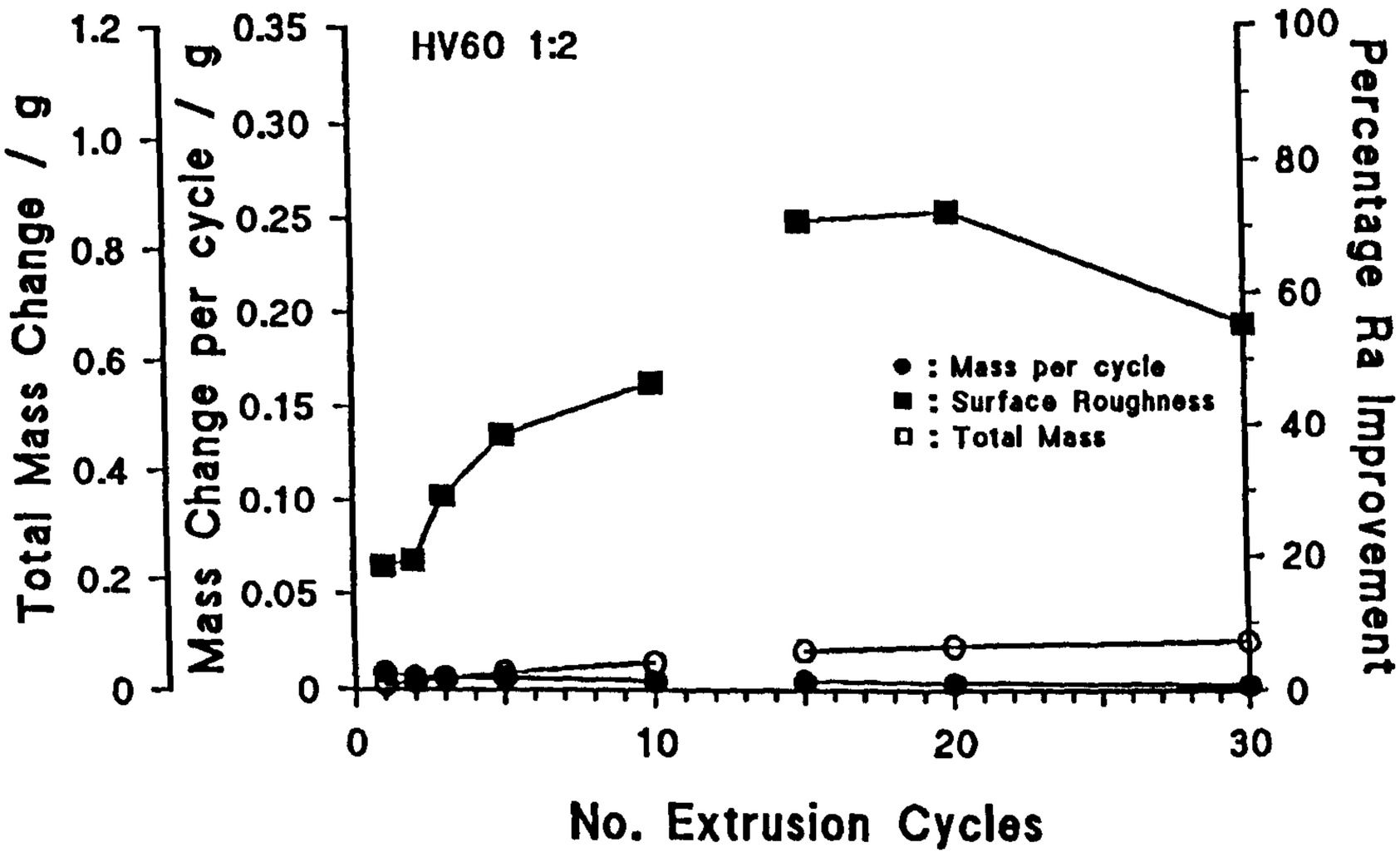
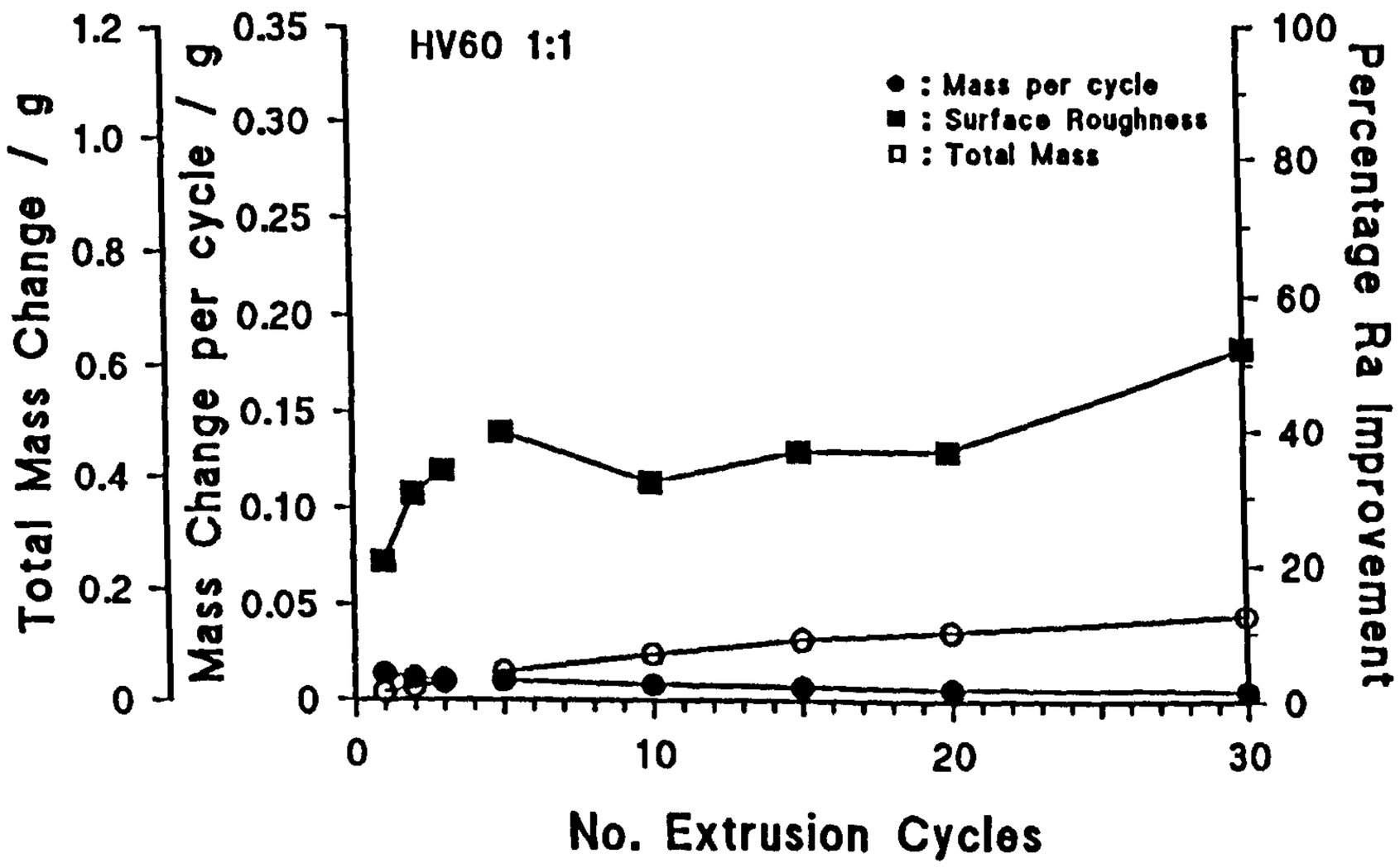

● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
MV100 2:1
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles

Figure 114(a) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using HV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 114(b) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 114(c) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using HV medium and 60 Mesh grit with a grit to polymer ratio of 2.


HV60 1:2
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles


HV60 1:1
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles

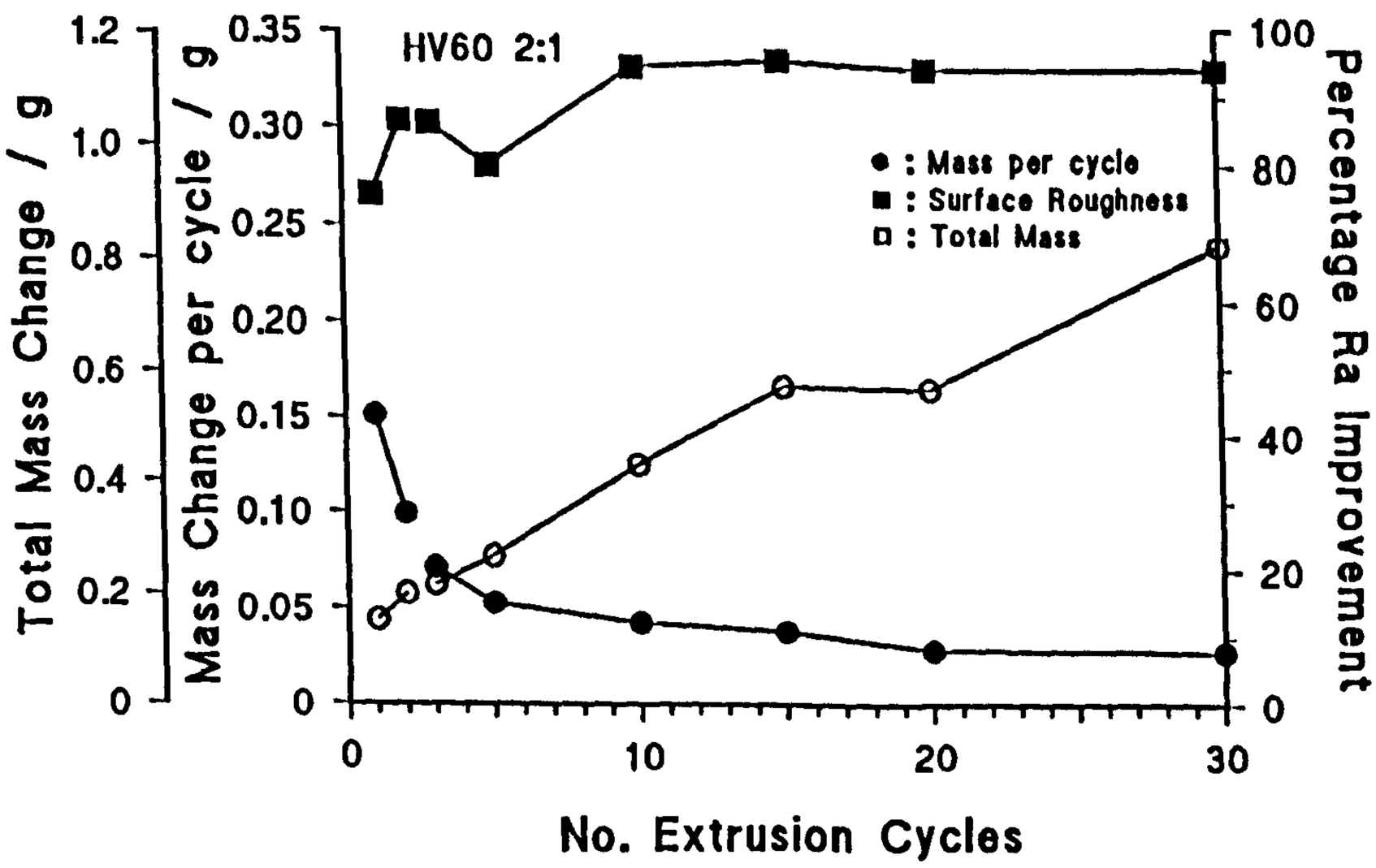
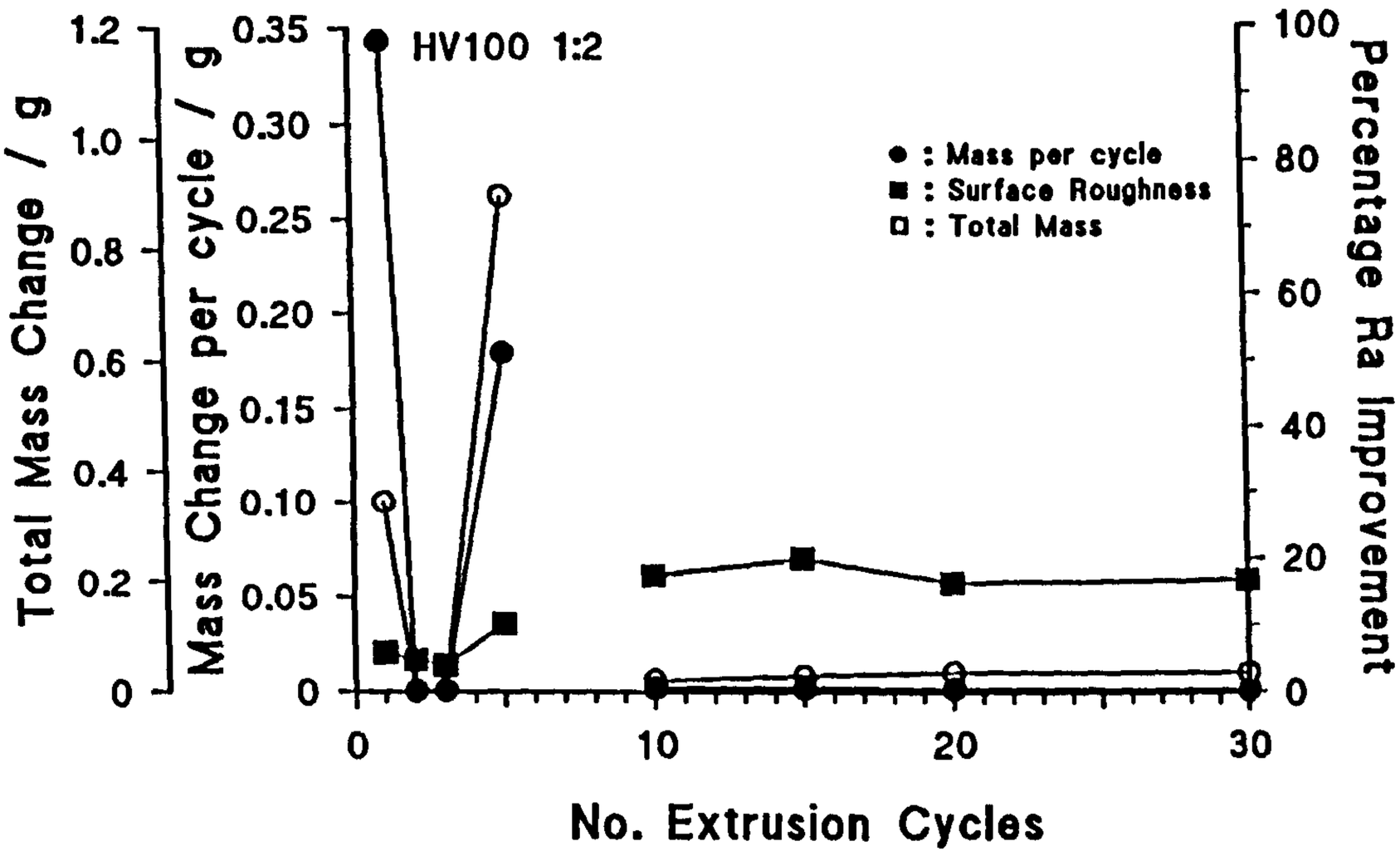
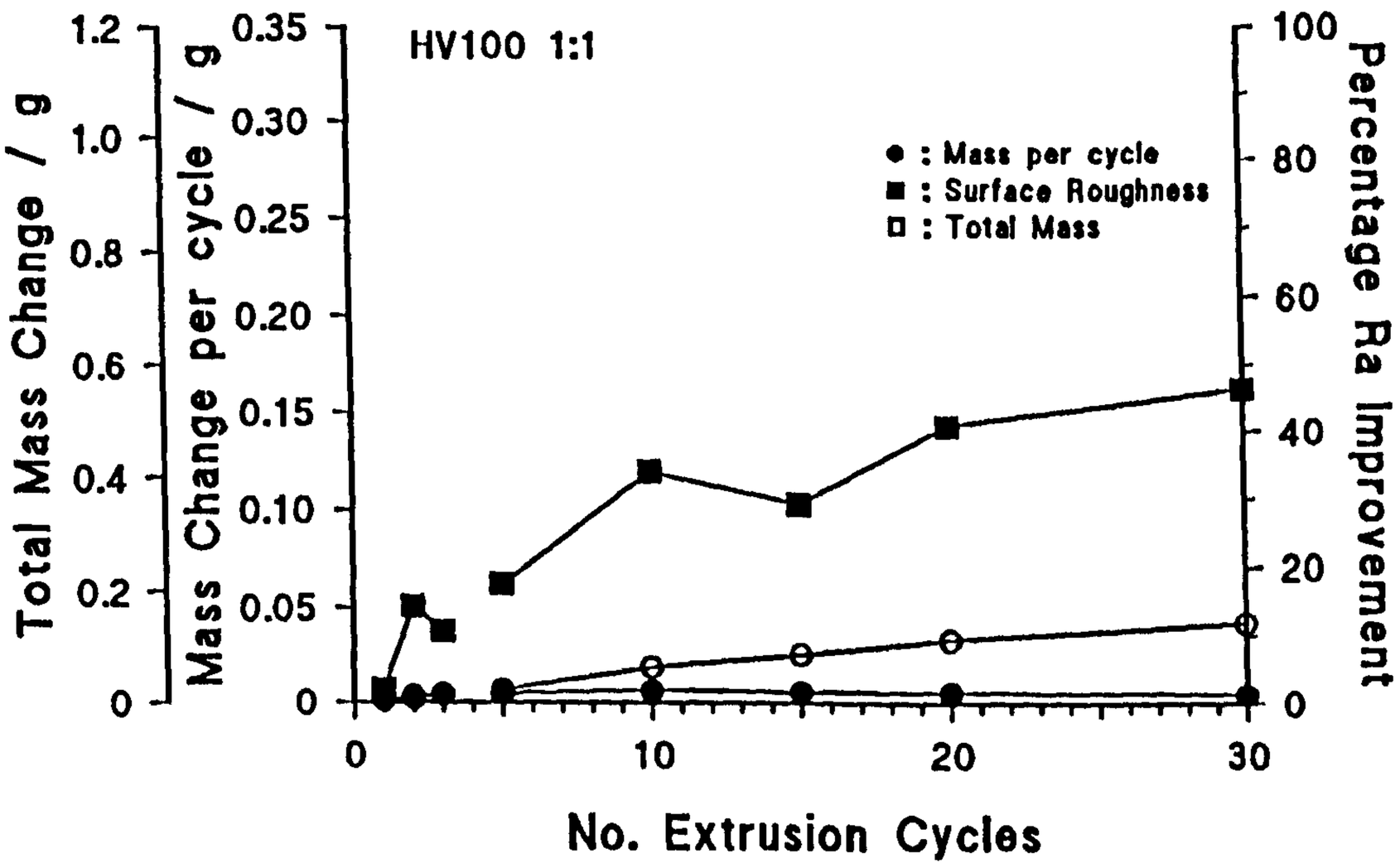

HV60 2:1
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
No. Extrusion Cycles

Figure 115(a) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using HV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 115(b) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 115(c) : The relationship between the number of extrusion cycles and (i) the mass change per cycle, (ii) the total mass change, and (iii) the percentage surface roughness improvement obtained using HV medium and 100 Mesh grit with a grit to polymer ratio of 2.


HV100 1:2
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles


HV100 1:1
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles

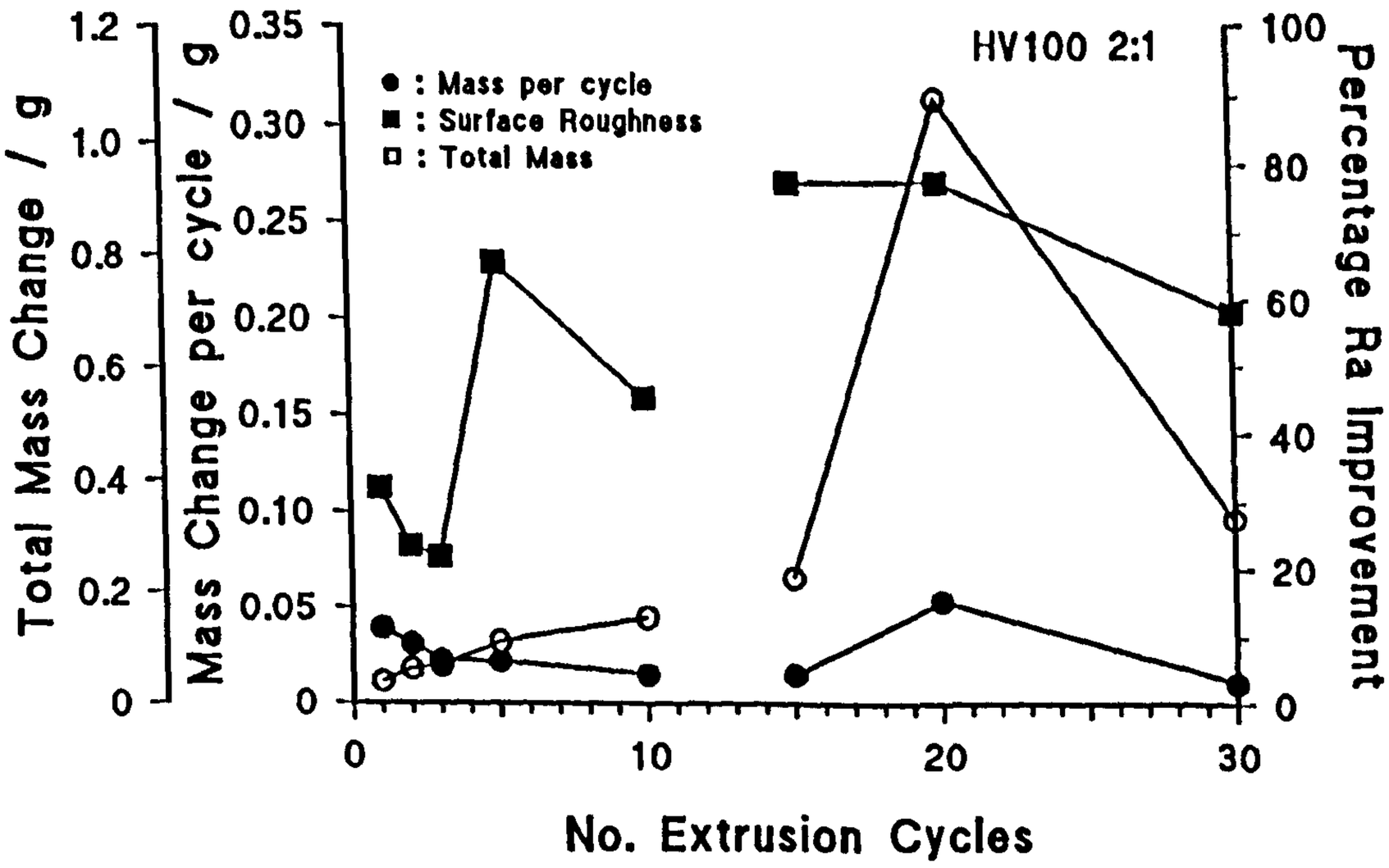
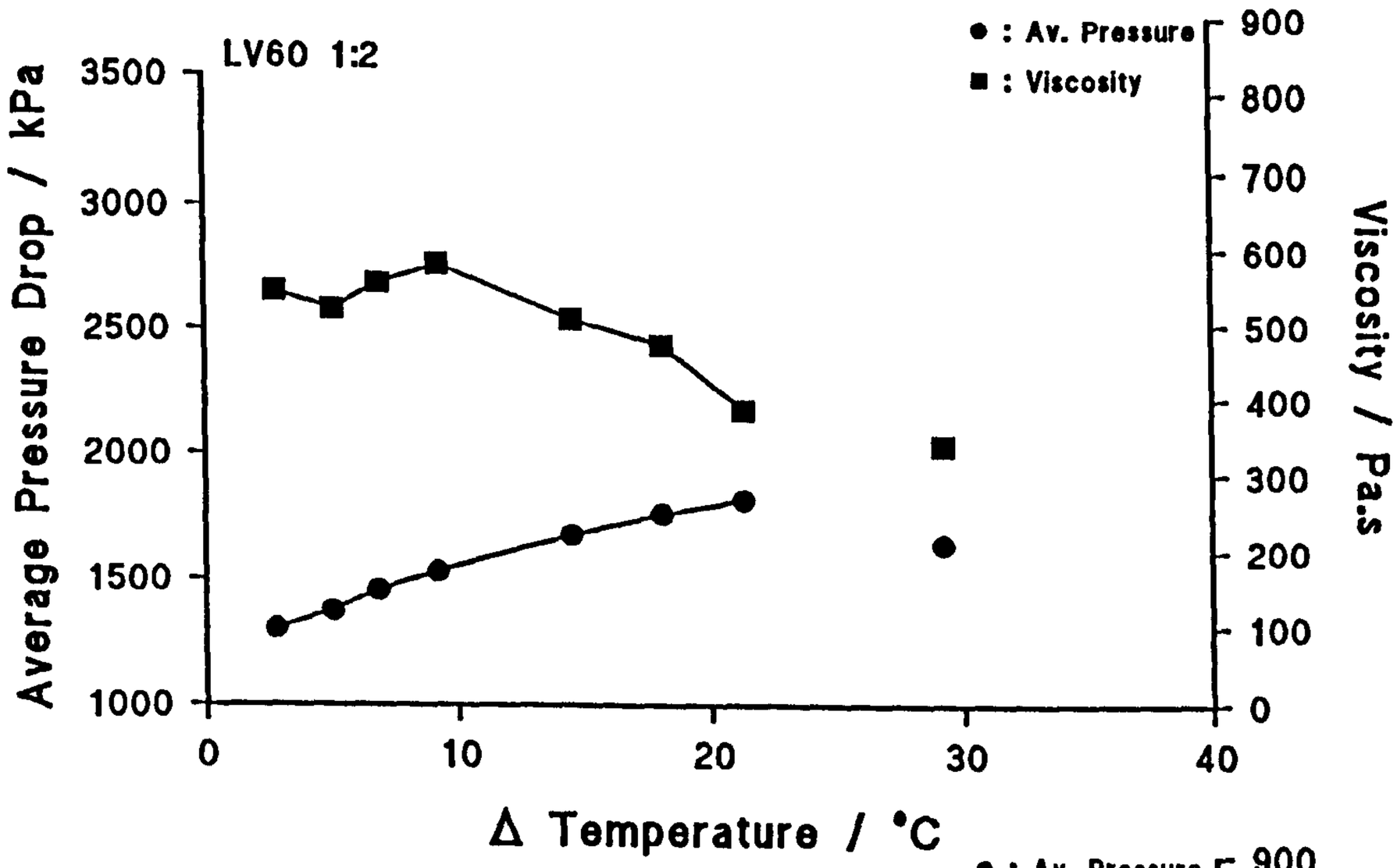
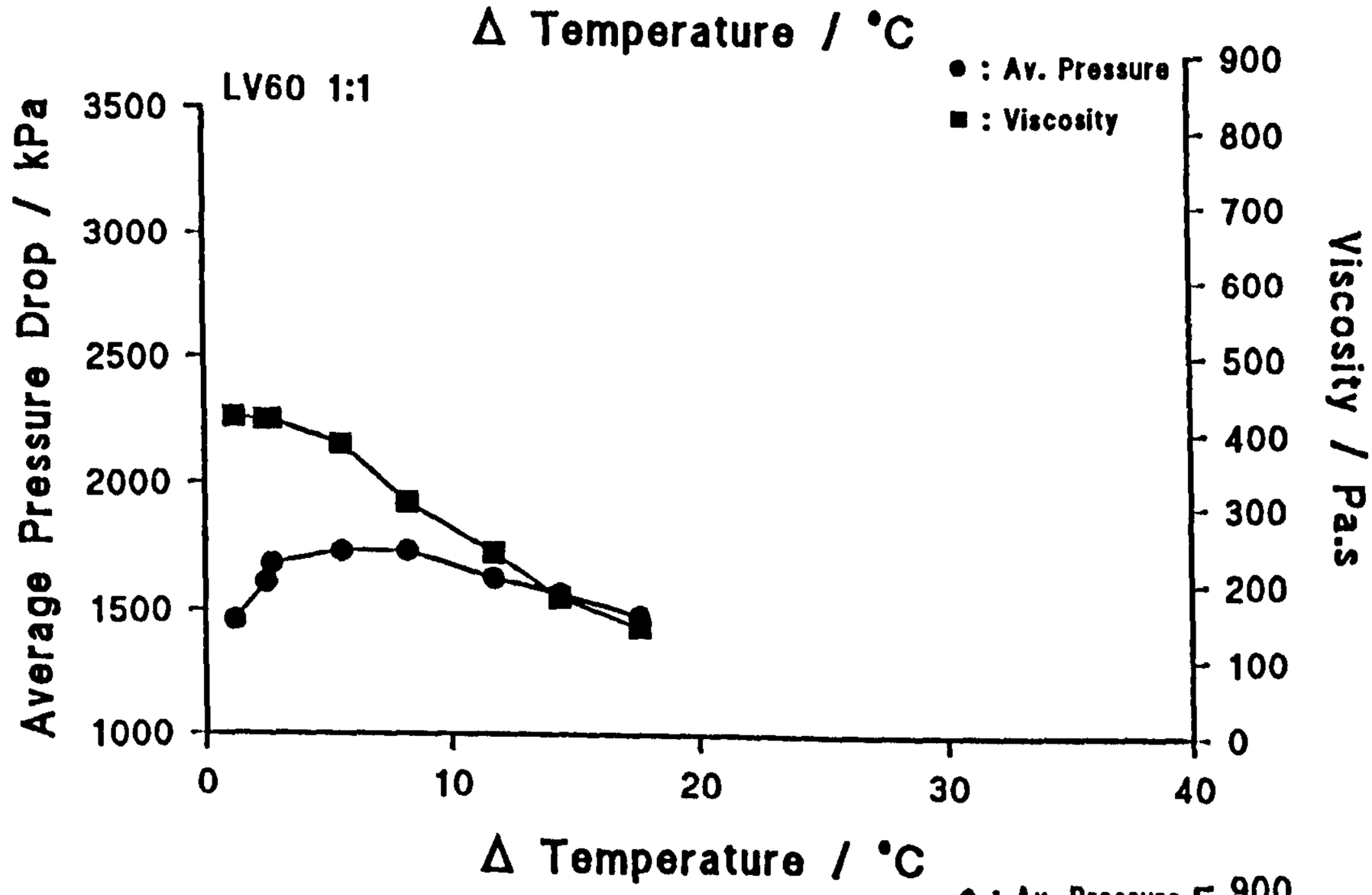

HV100 2:1
● : Mass per cycle
■ : Surface Roughness
□ : Total Mass
Total Mass Change / g
Mass Change per cycle / g
Percentage Ra Improvement
No. Extrusion Cycles

Figure 116(a) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 116(b) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 116(c) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the LV medium and 60 Mesh grit with a grit to polymer ratio of 2.


LV60 1:2
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
Δ Temperature / °C


LV60 1:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
Δ Temperature / °C

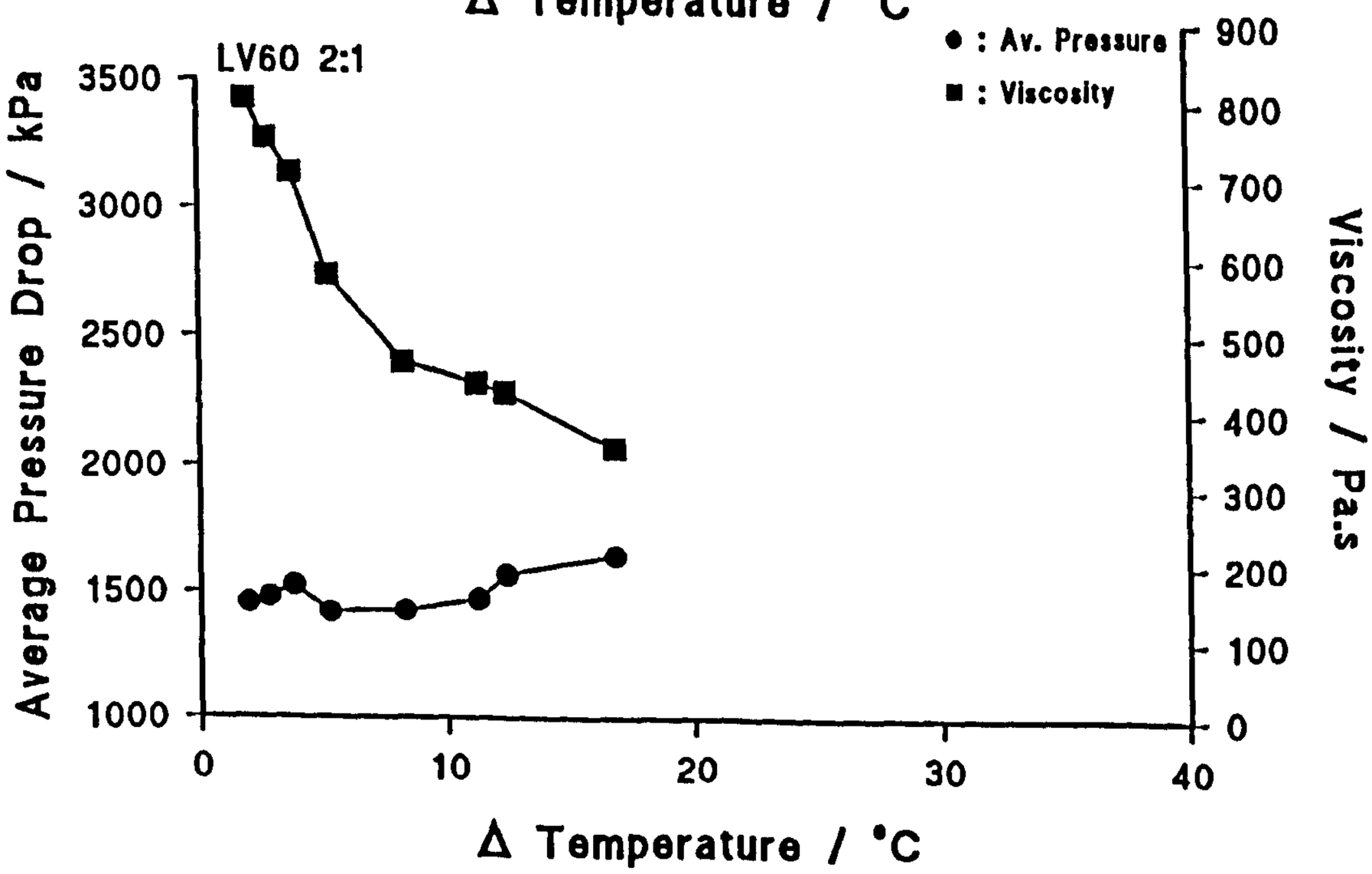
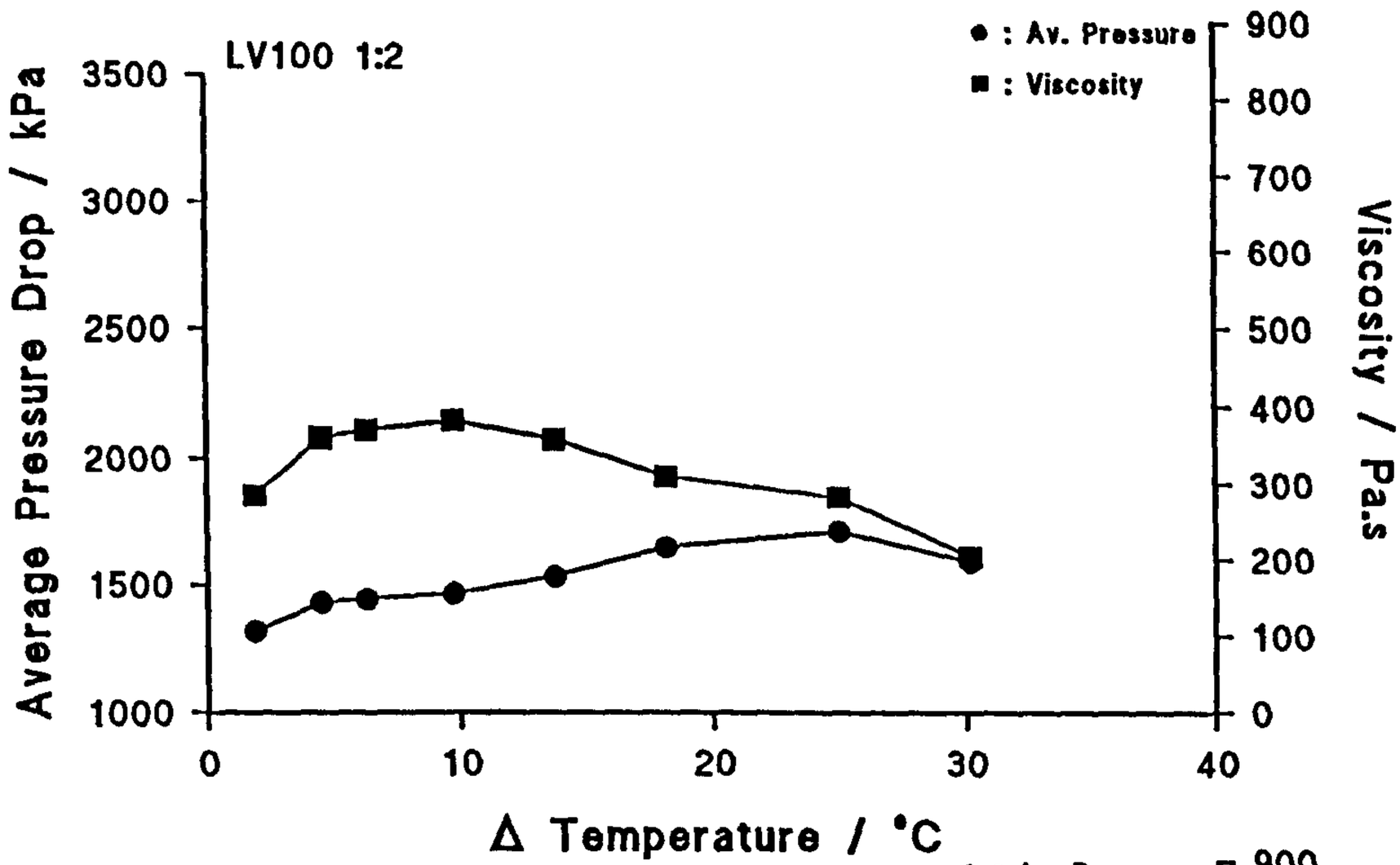
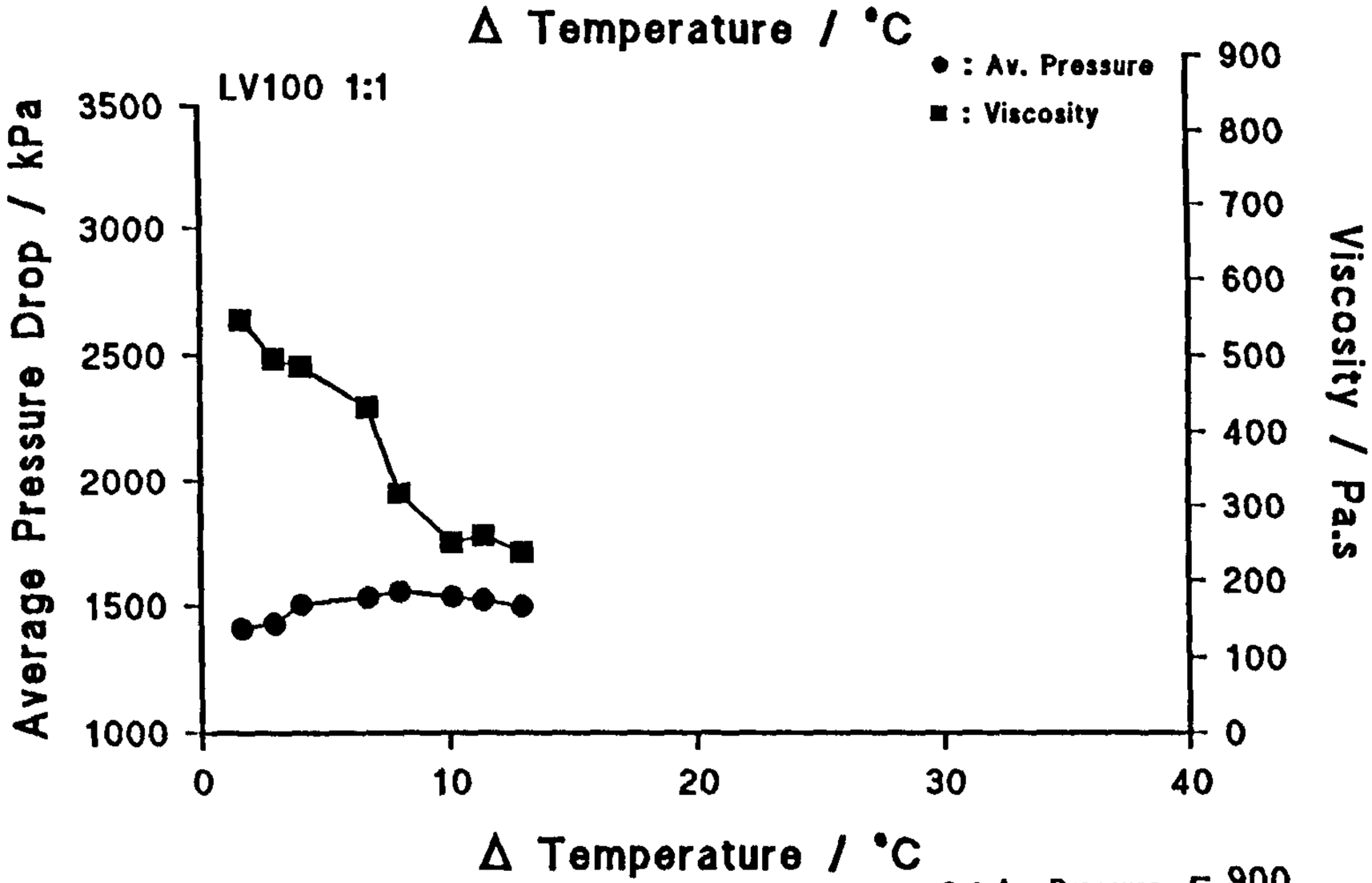

LV60 2:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
Δ Temperature / °C

Figure 117(a) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the LV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 117(b) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 117(c) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the LV medium and 100 Mesh grit with a grit to polymer ratio of 2.


LV100 1:2
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
Δ Temperature / °C


LV100 1:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
Δ Temperature / °C

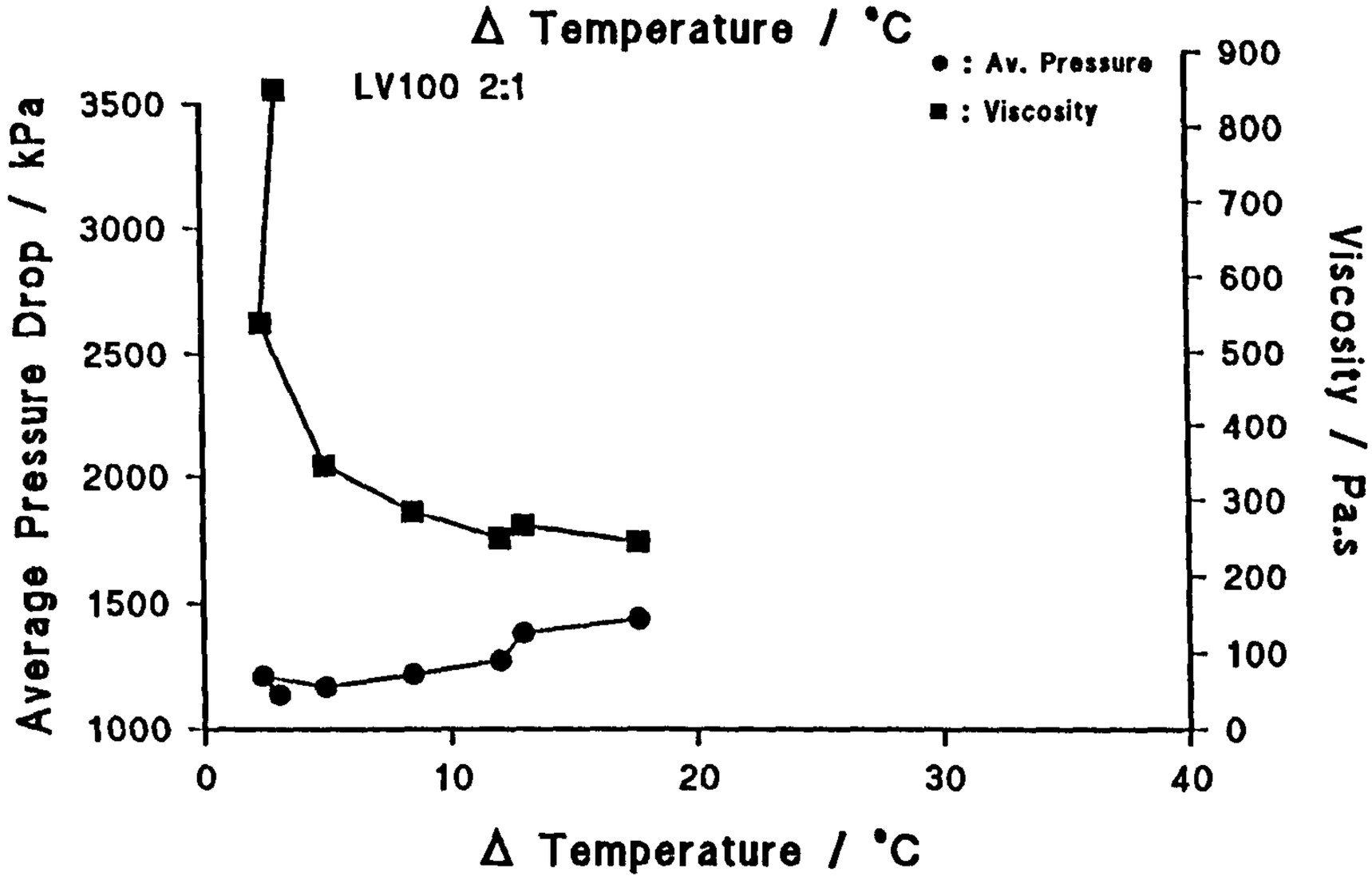
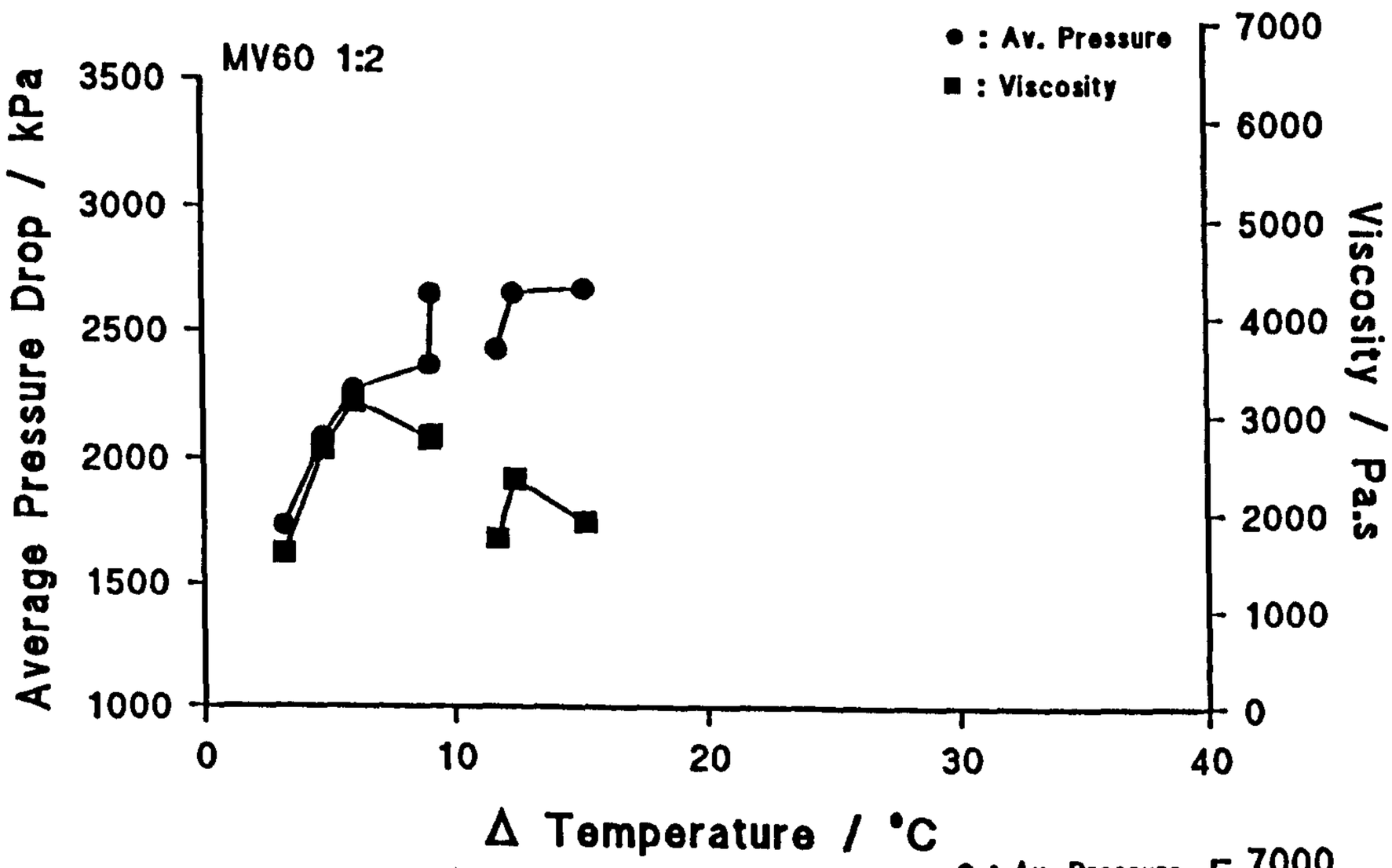
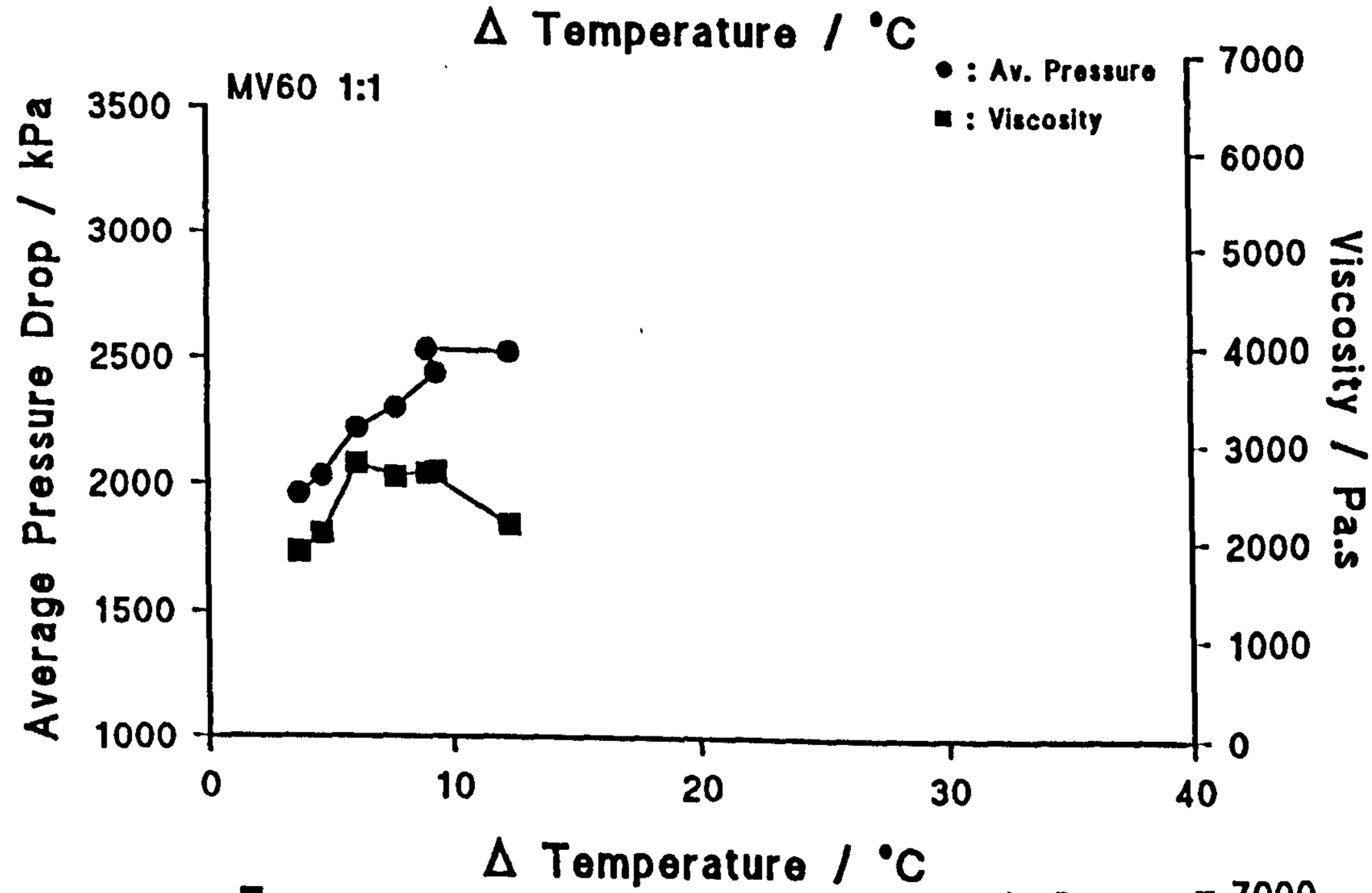

LV100 2:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
Δ Temperature / °C

Figure 118(a) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 118(b) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 118(c) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the MV medium and 60 Mesh grit with a grit to polymer ratio of 2.


MV60 1:2
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
Δ Temperature / °C


MV60 1:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
Δ Temperature / °C

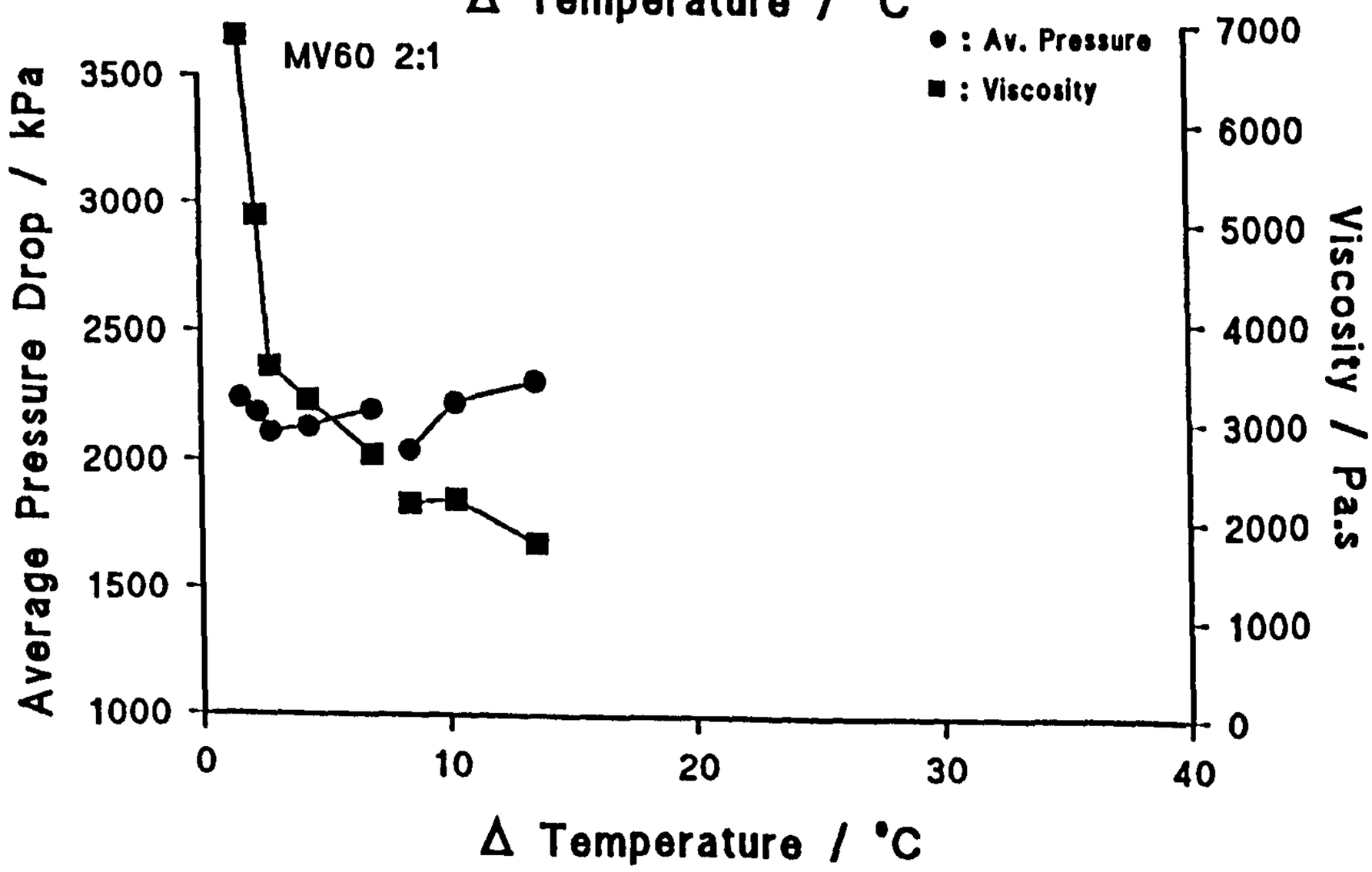
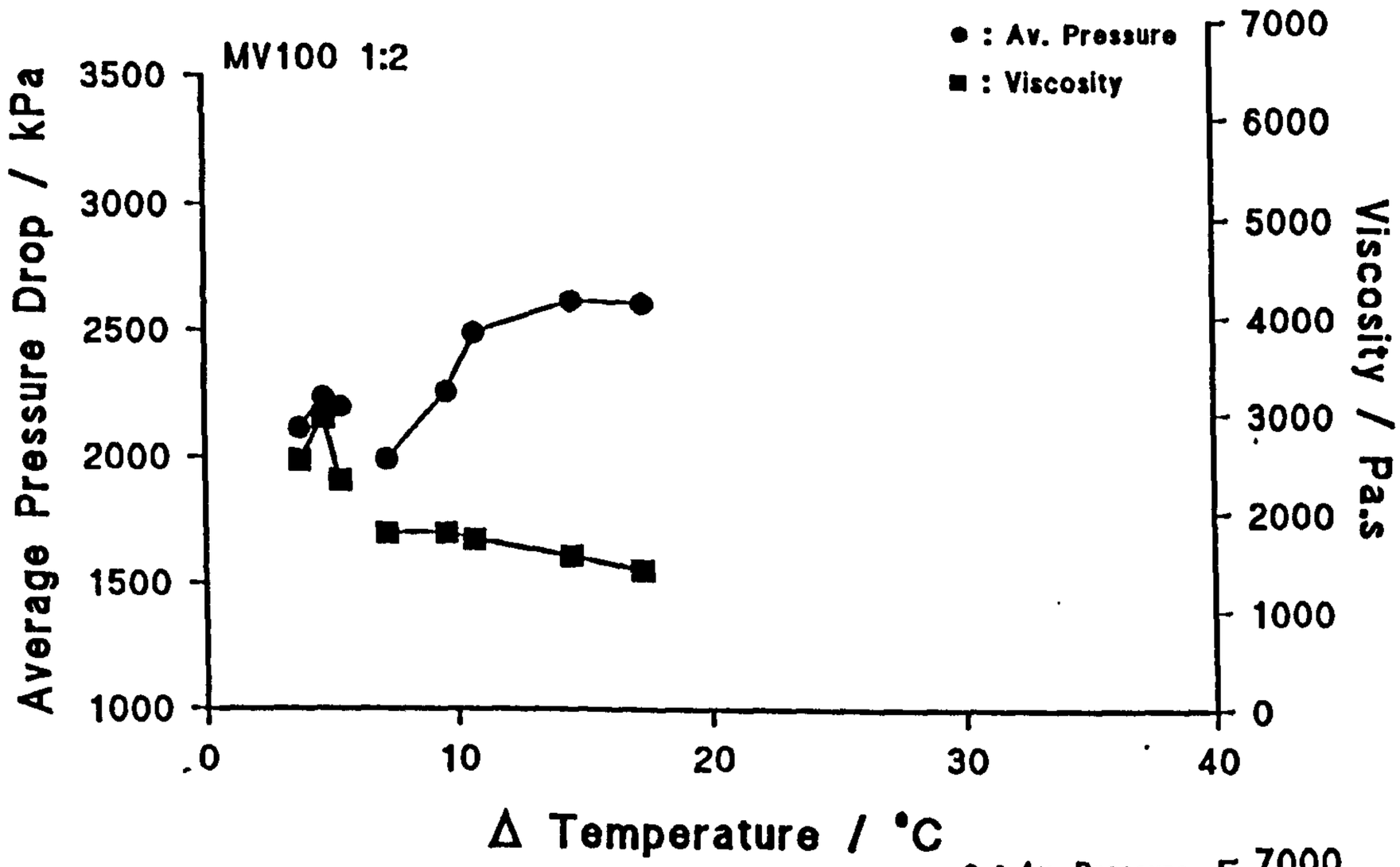
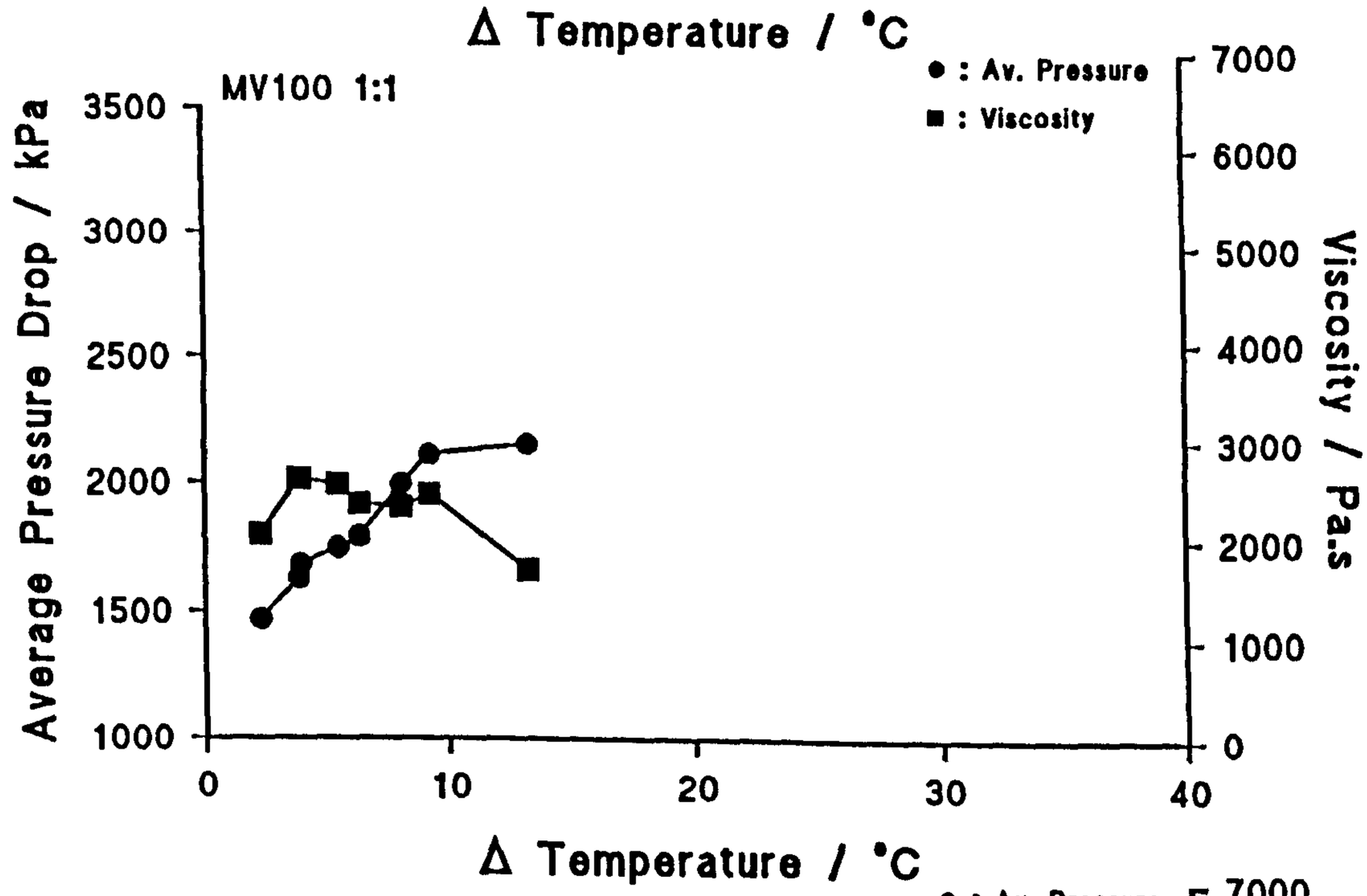

MV60 2:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
Δ Temperature / °C

Figure 119(a) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 119(b) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 119(c) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the MV medium and 100 Mesh grit with a grit to polymer ratio of 2.


MV100 1:2
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
Δ Temperature / °C


MV100 1:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
Δ Temperature / °C

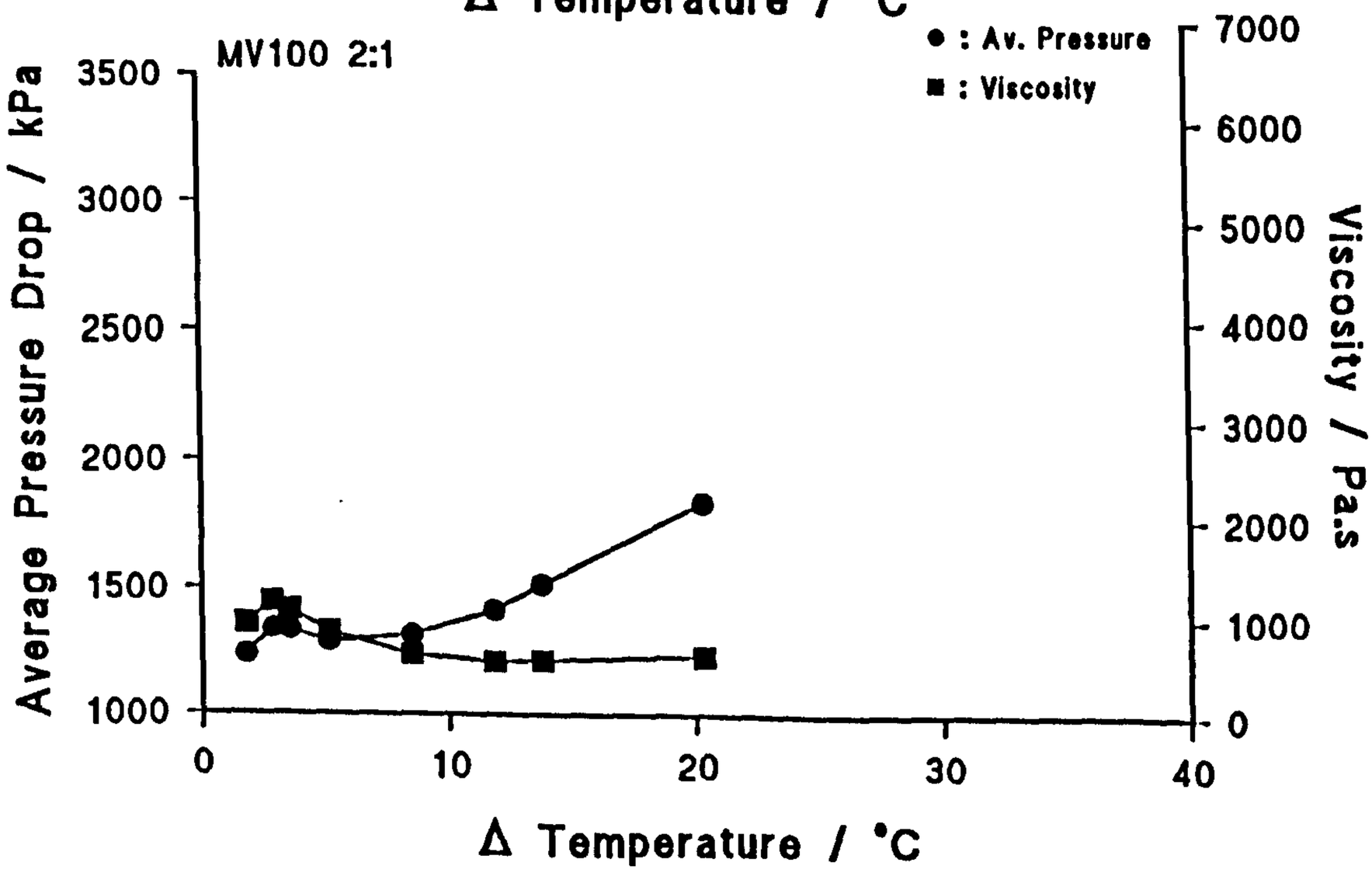
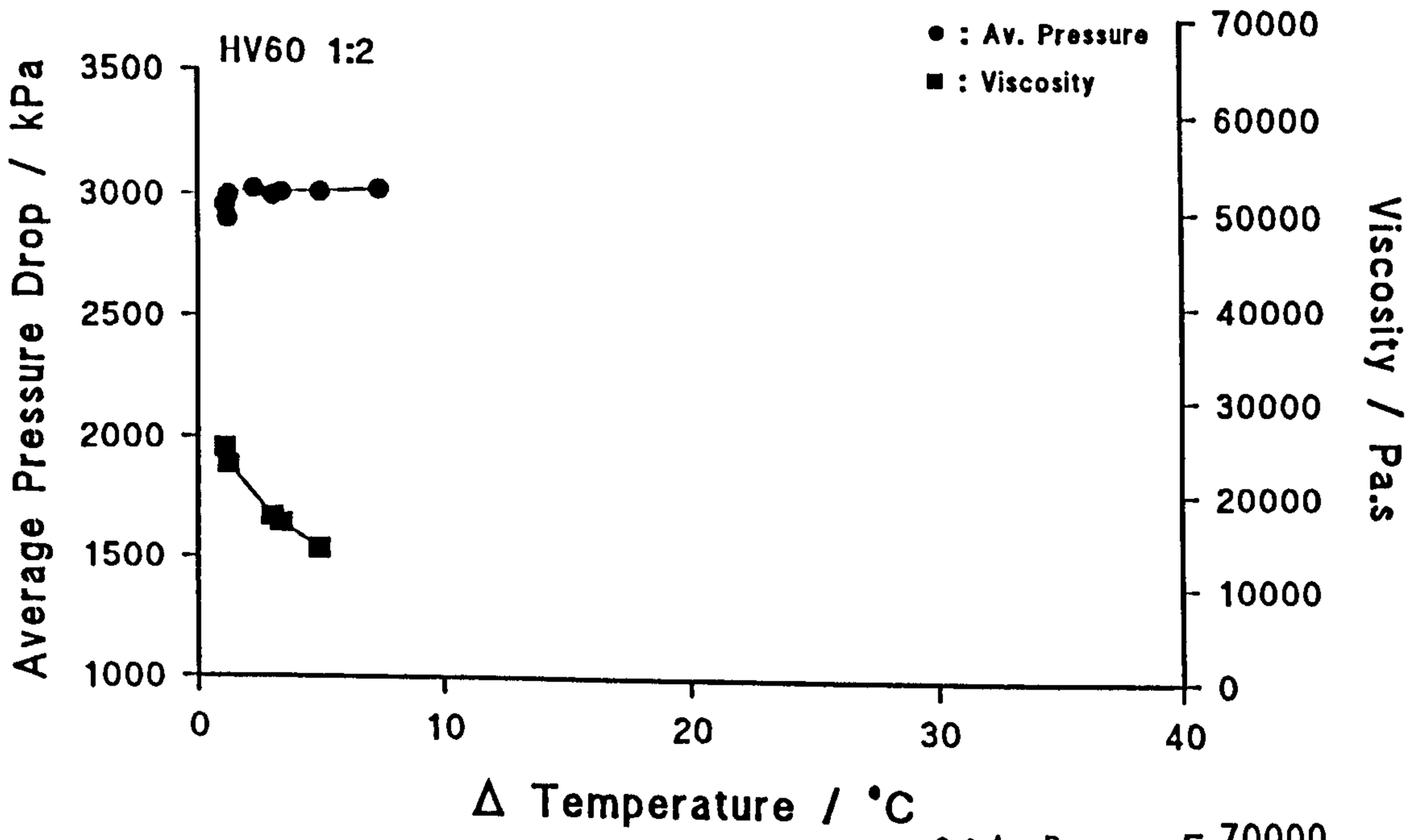
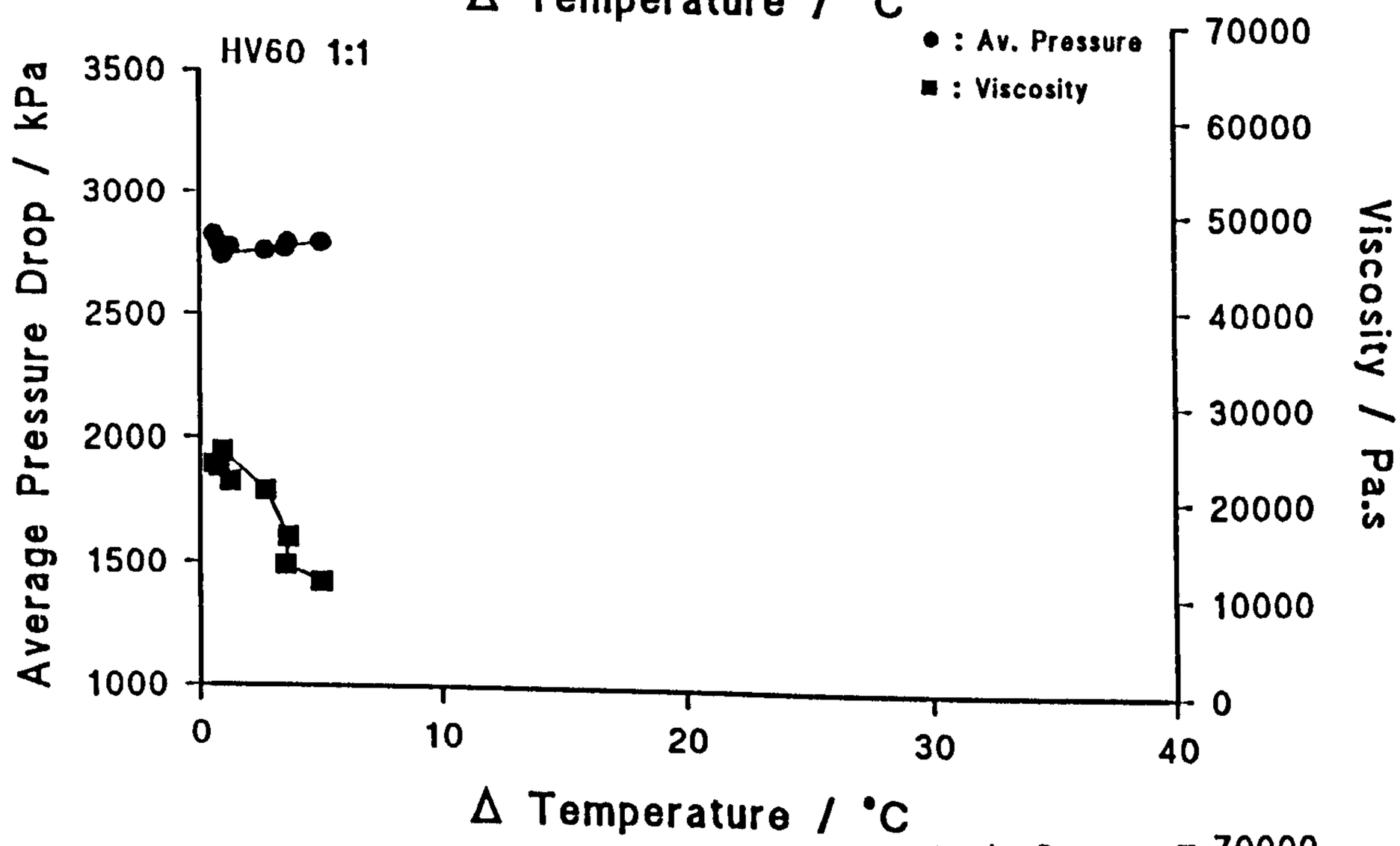

MV100 2:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
Δ Temperature / °C

Figure 120(a) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the HV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 120(b) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 120(c) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the HV medium and 60 Mesh grit with a grit to polymer ratio of 2.


HV60 1:2
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
Δ Temperature / °C


HV60 1:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
Δ Temperature / °C

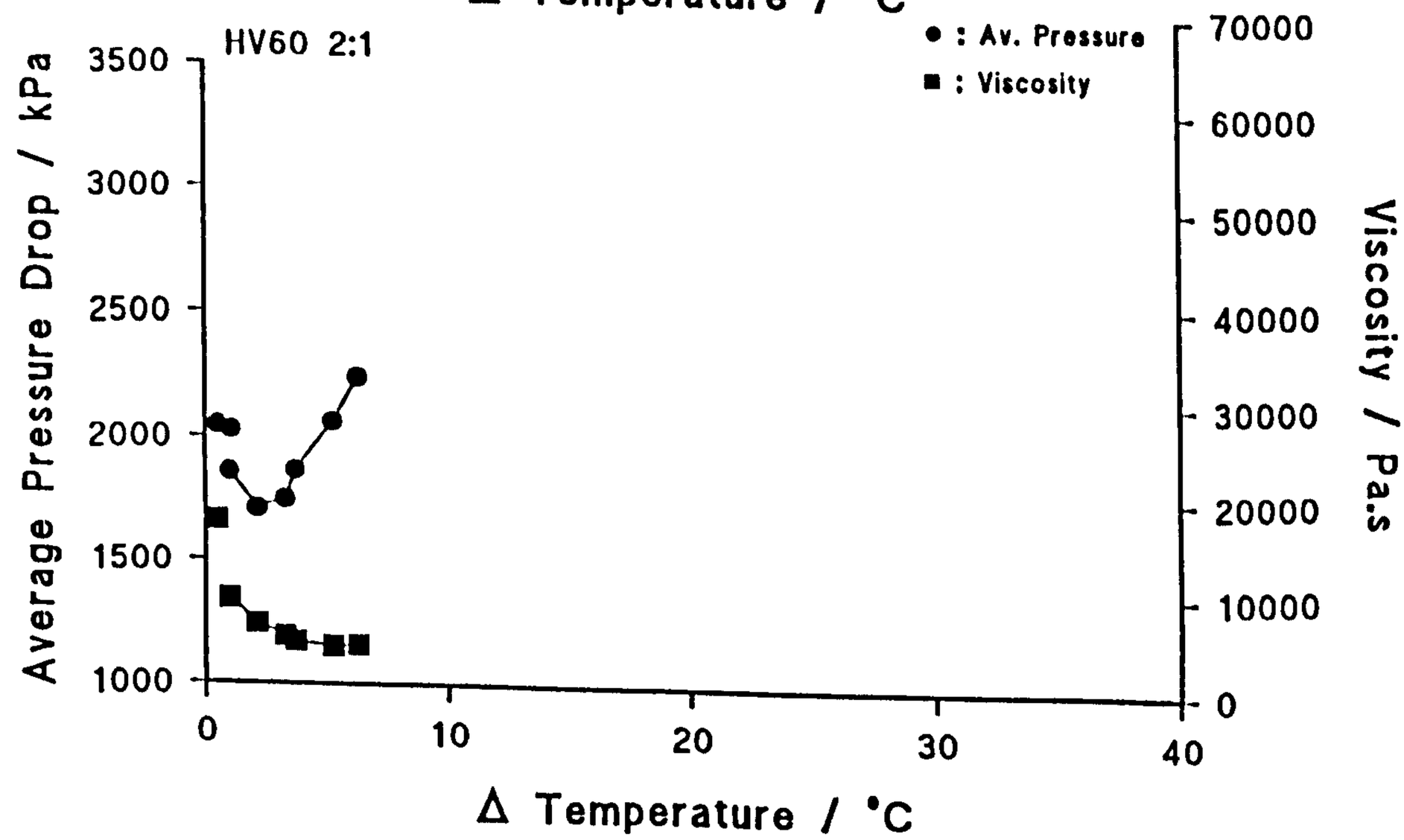
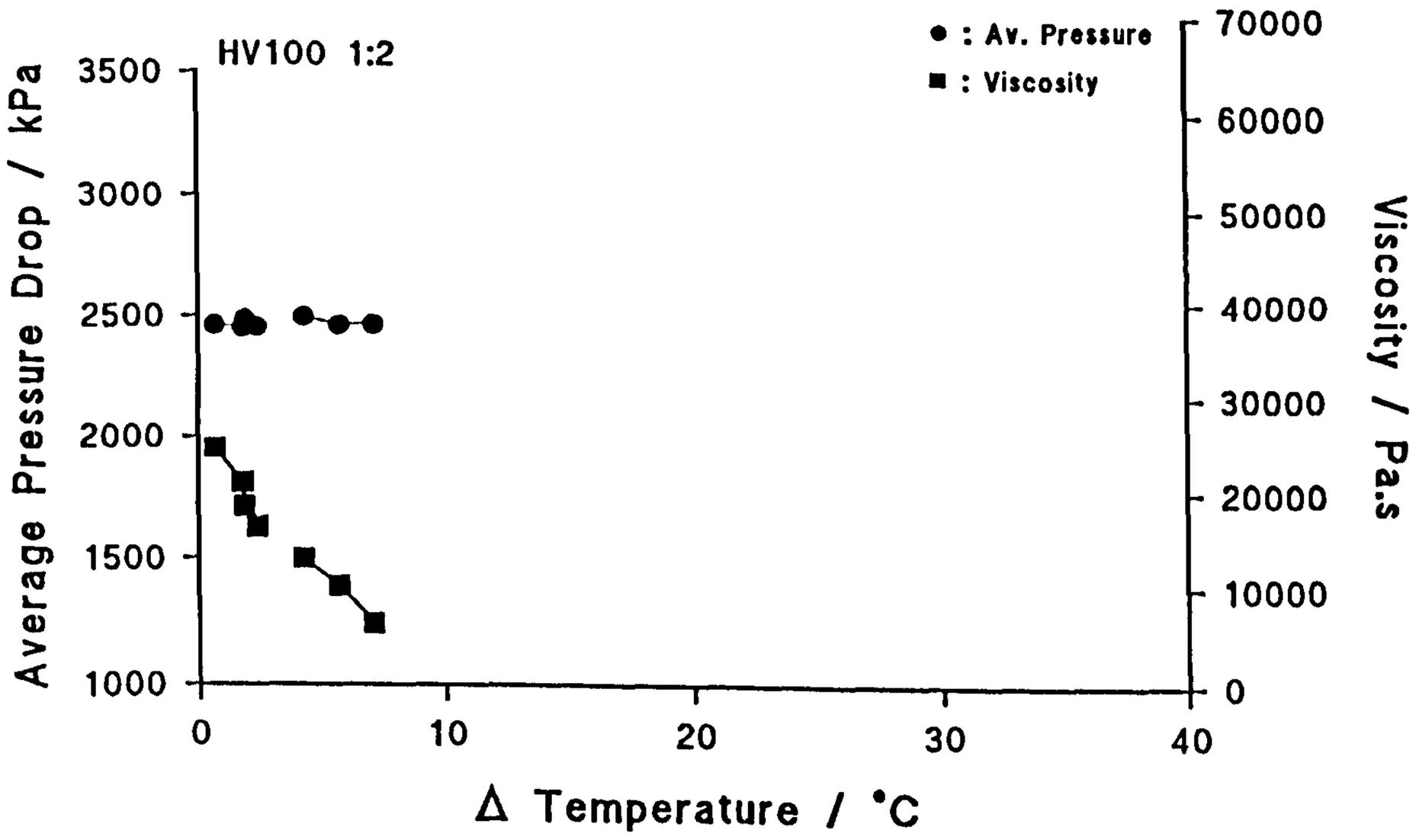

HV60 2:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
Viscosity / Pa.s
3500
3000
2500
2000
1500
1000
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
Δ Temperature / °C

Figure 121(a) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the HV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 121(b) : The relationship between the change in temperature and (i) the average pressure drop, and (ii) the viscosity for the HV medium and 100 Mesh grit with a grit to polymer ratio of 2.


HV100 1:2
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
Viscosity / Pa.s
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
Δ Temperature / °C

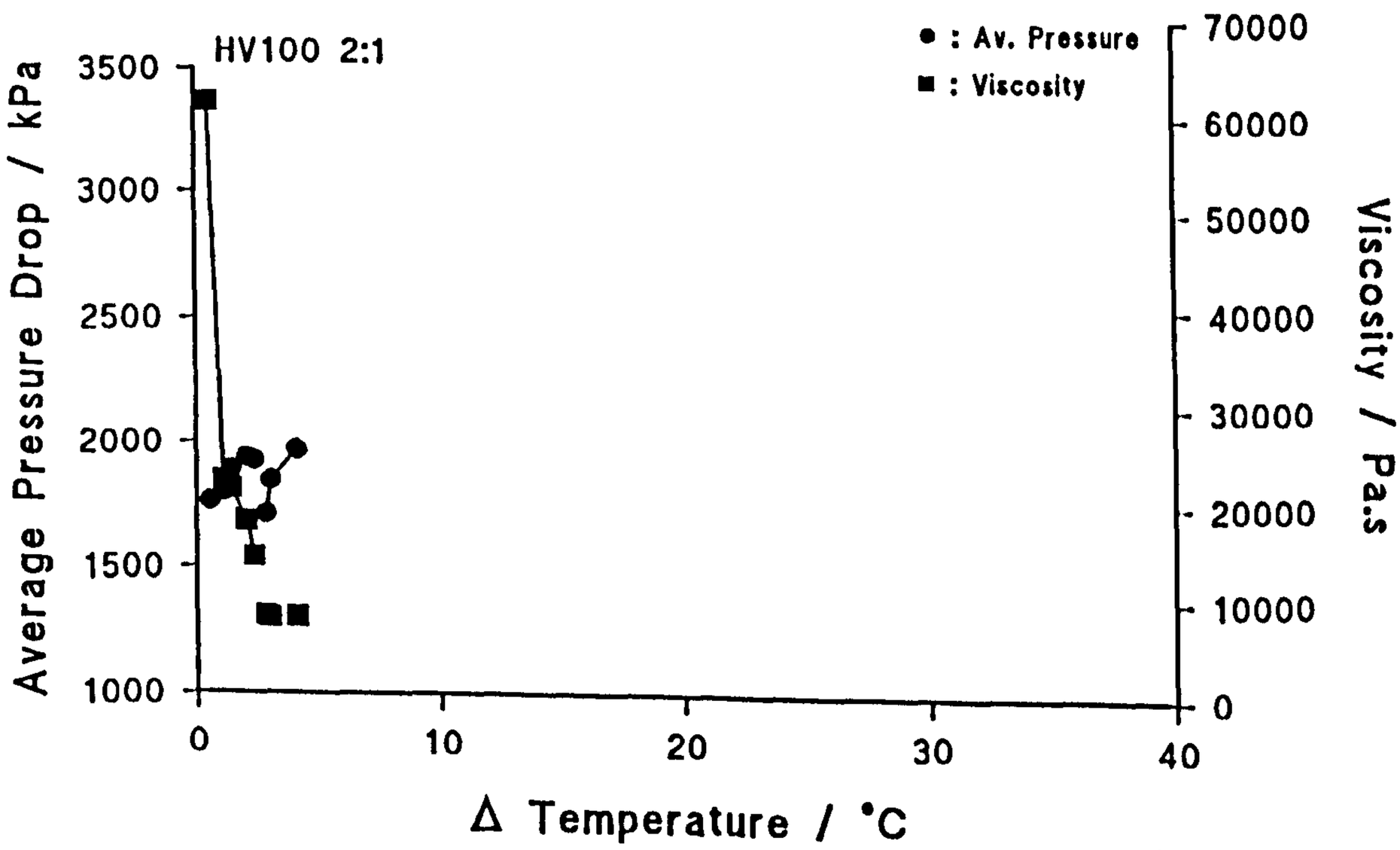
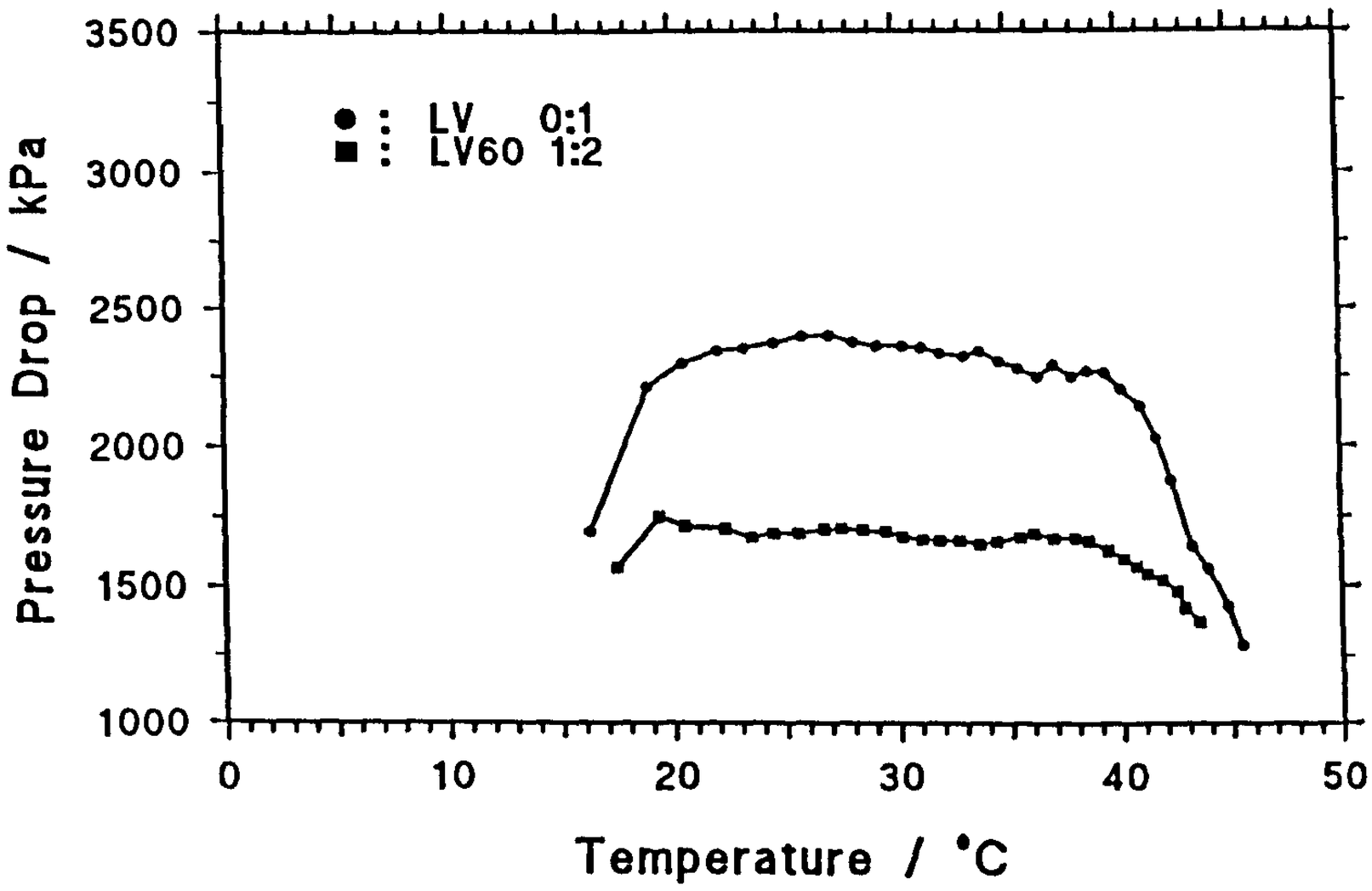
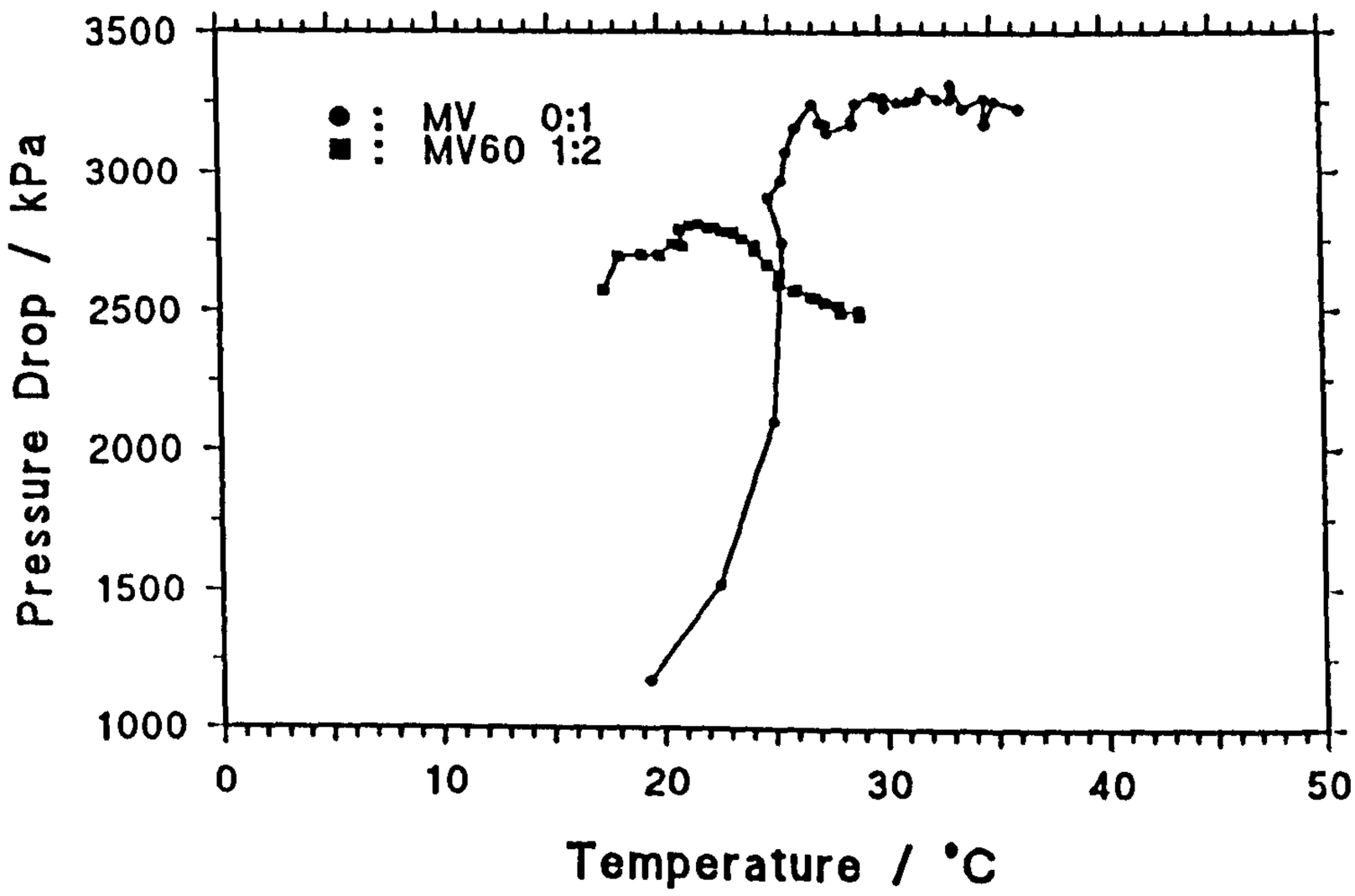

HV100 2:1
● : Av. Pressure
■ : Viscosity
Average Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
Viscosity / Pa.s
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
Δ Temperature / °C

Figure 122(a) : The relationship between the temperature and pressure drop across the die for (i) the LV medium and 60 Mesh grit mixture with a grit to polymer ratio of 0.5, and (ii) the pure LV medium.

Figure 122(b) : The relationship between the temperature and pressure drop across the die for (i) the MV medium and 60 Mesh grit mixture with a grit to polymer ratio of 0.5, and (ii) the pure MV medium.

Figure 122(c) : The relationship between the temperature and pressure drop across the die for (i) the HV medium and 60 Mesh grit mixture with a grit to polymer ratio of 0.5, and (ii) the pure HV medium.


LV 0:1
LV60 1:2
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
40
50
Temperature / °C


MV 0:1
MV60 1:2
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
40
50
Temperature / °C

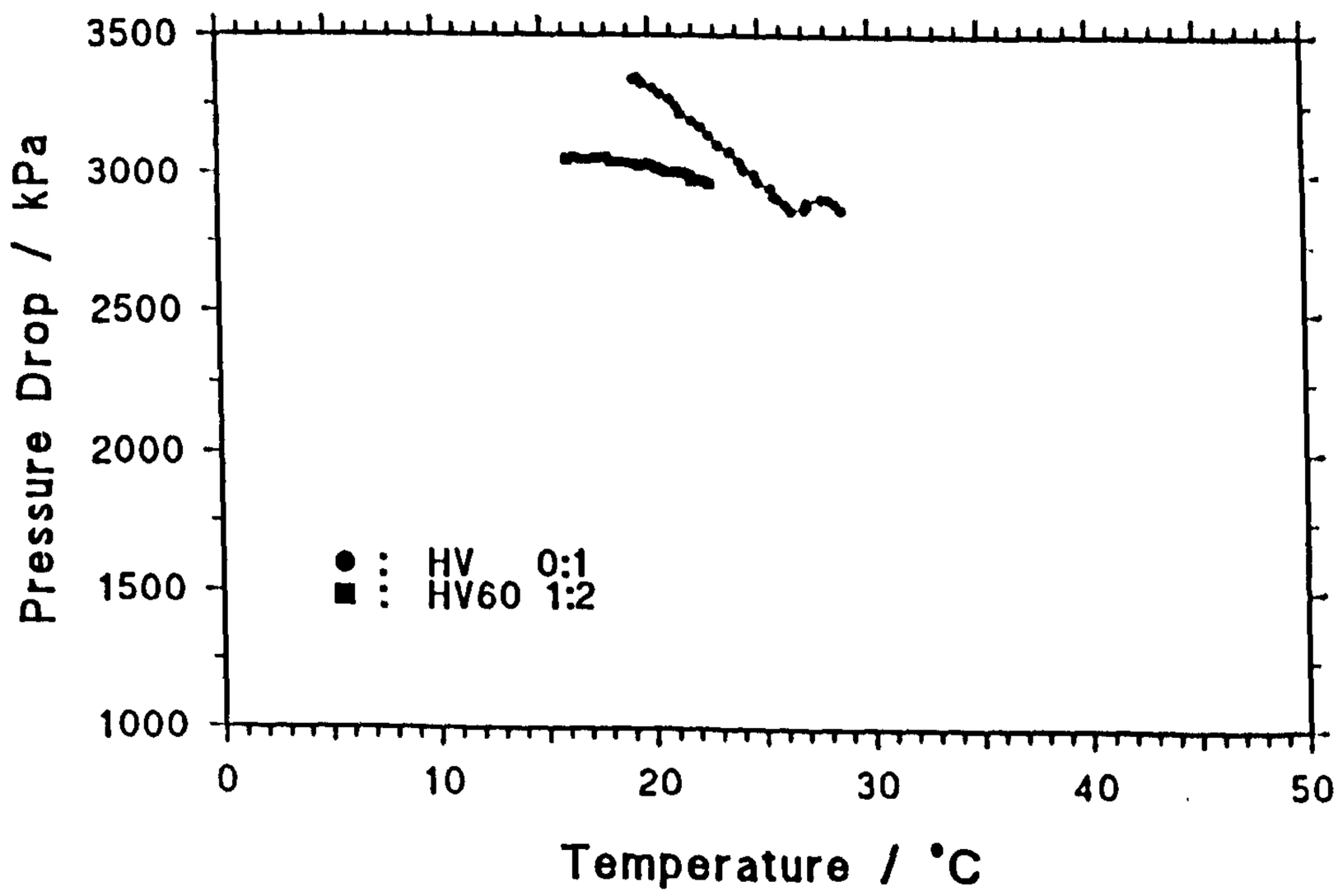
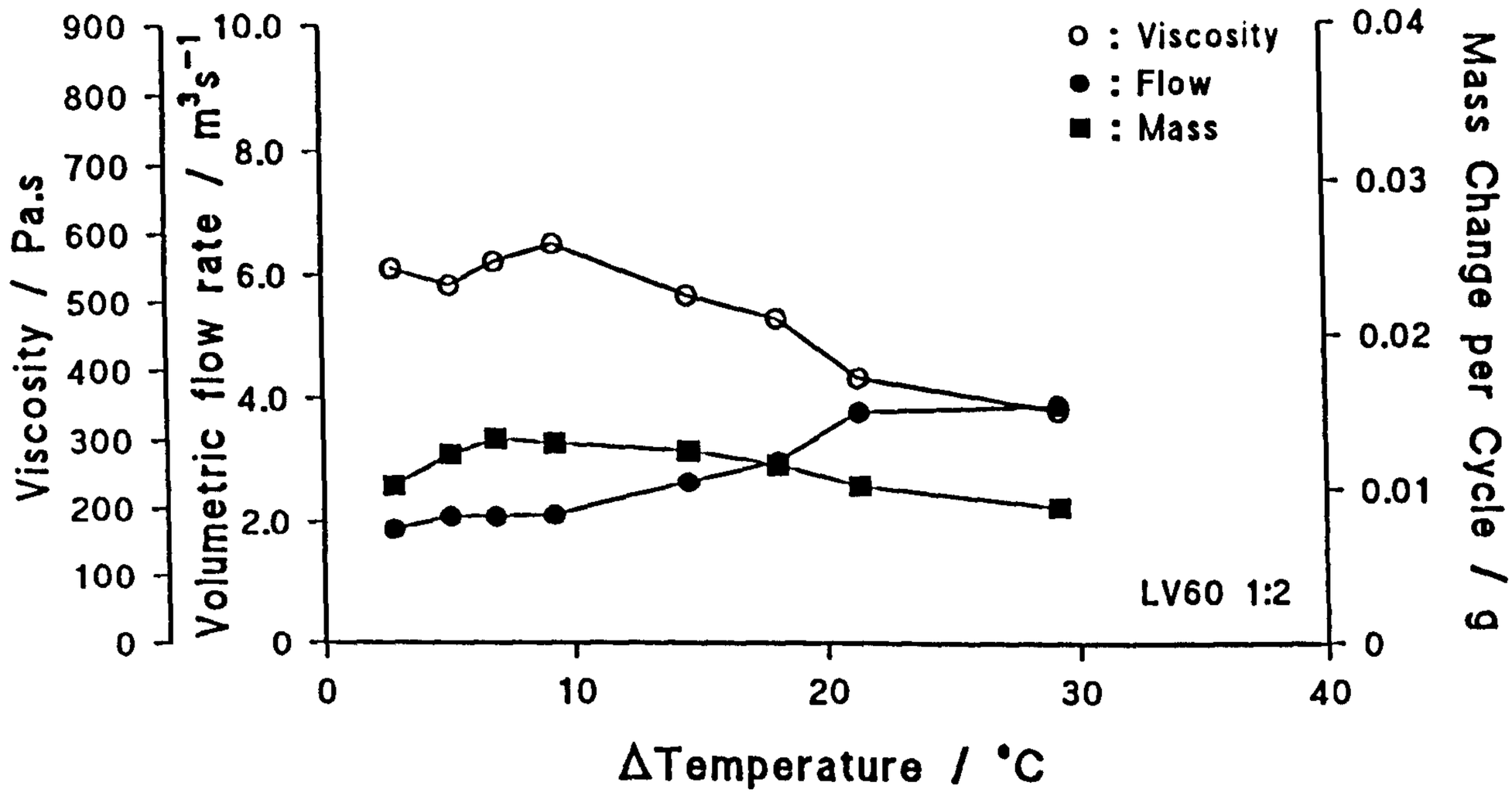
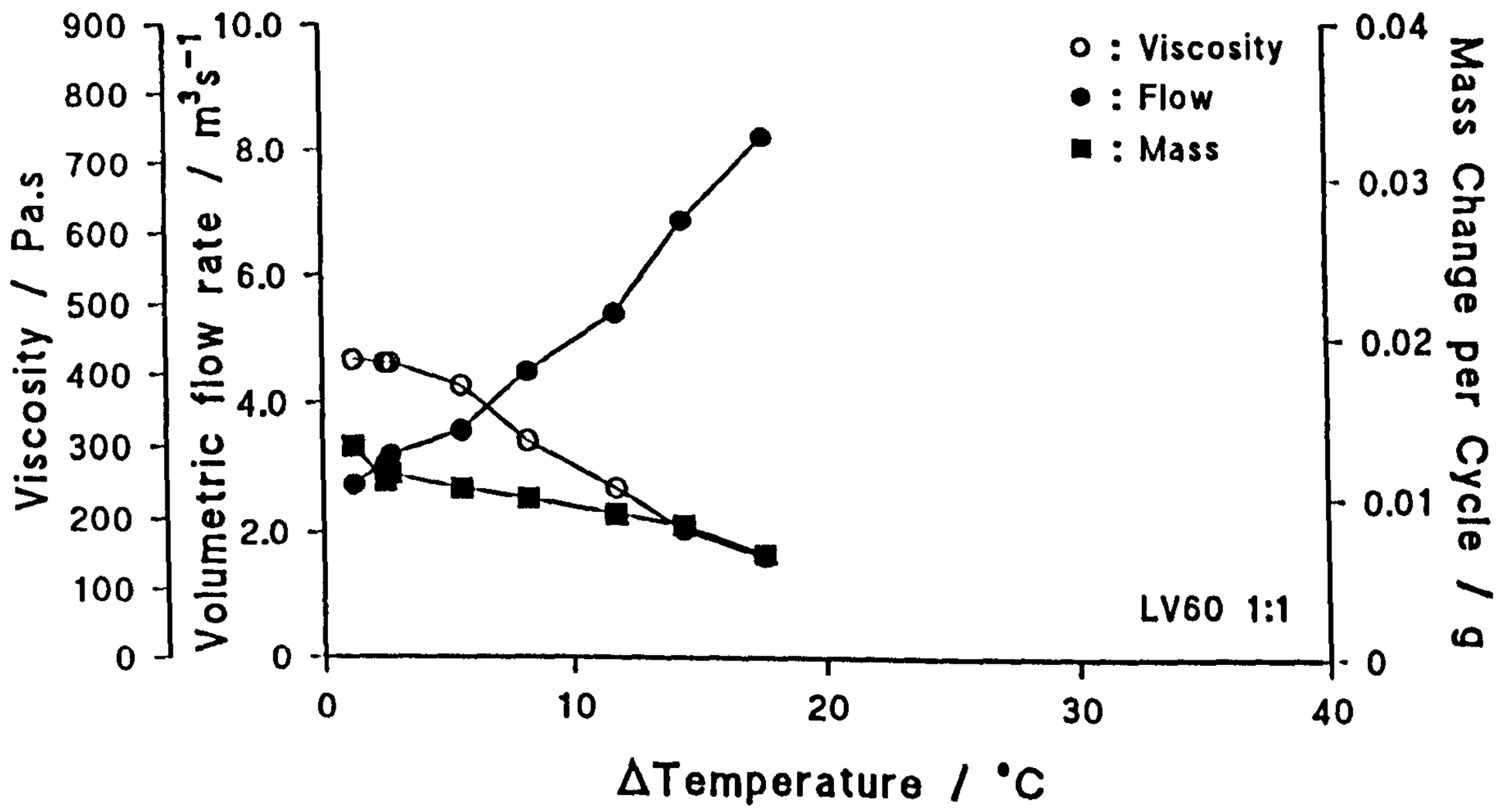

HV 0:1
HV60 1:2
Pressure Drop / kPa
3500
3000
2500
2000
1500
1000
0
10
20
30
40
50
Temperature / °C

Figure 123(a) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 123(b) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 123(c) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for LV medium and 60 Mesh grit with a grit to polymer ratio of 2.


Viscosity / Pa.s
Volumetric flow rate / m^3s^{-1}
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
LV60 1:2
ΔTemperature / °C


Viscosity / Pa.s
Volumetric flow rate / m^3s^{-1}
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
LV60 1:1
ΔTemperature / °C

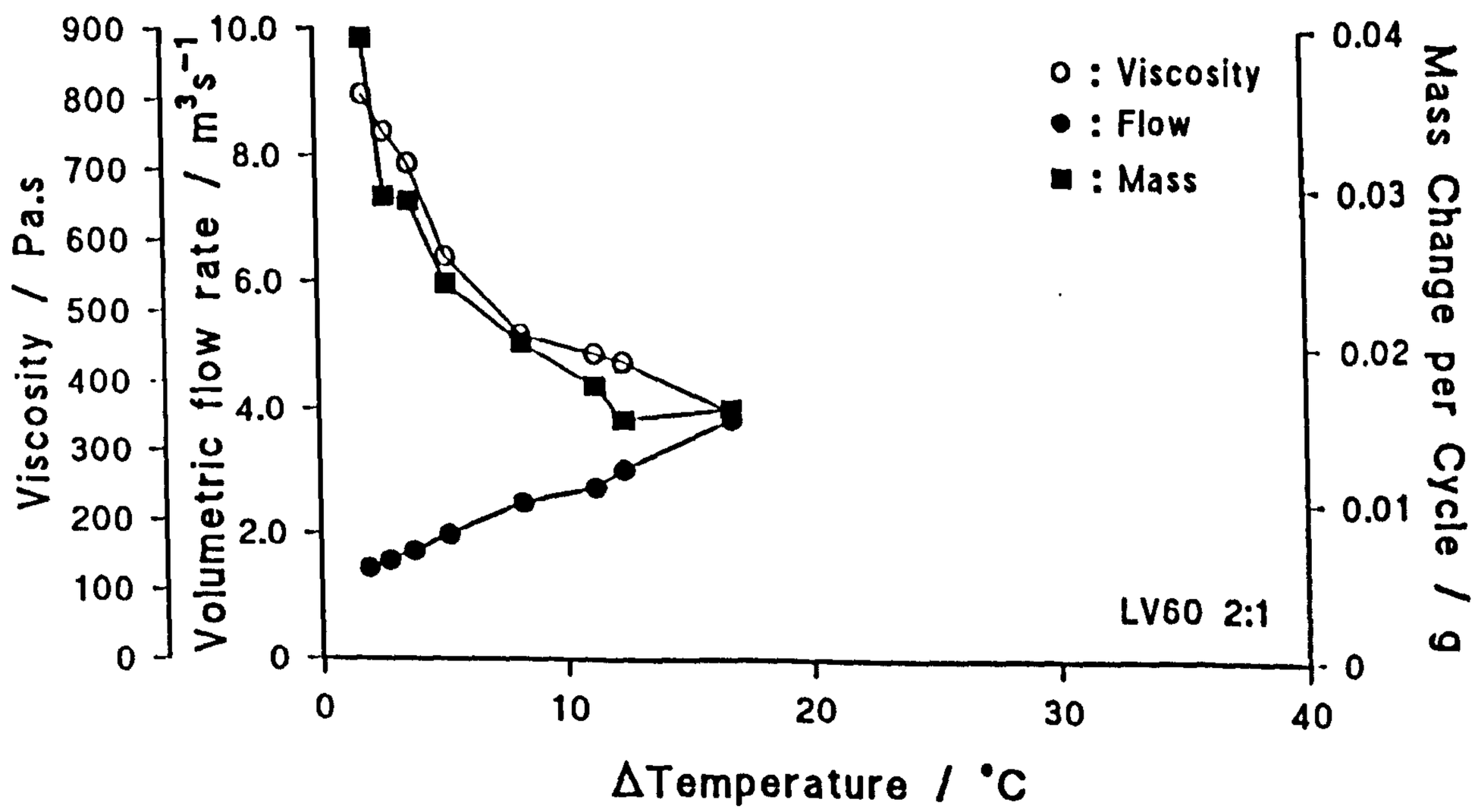

Viscosity / Pa.s
Volumetric flow rate / m^3s^{-1}
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
LV60 2:1
ΔTemperature / °C

Figure 124(a) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for LV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 124(b) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 124(c) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for LV medium and 100 Mesh grit with a grit to polymer ratio of 2.

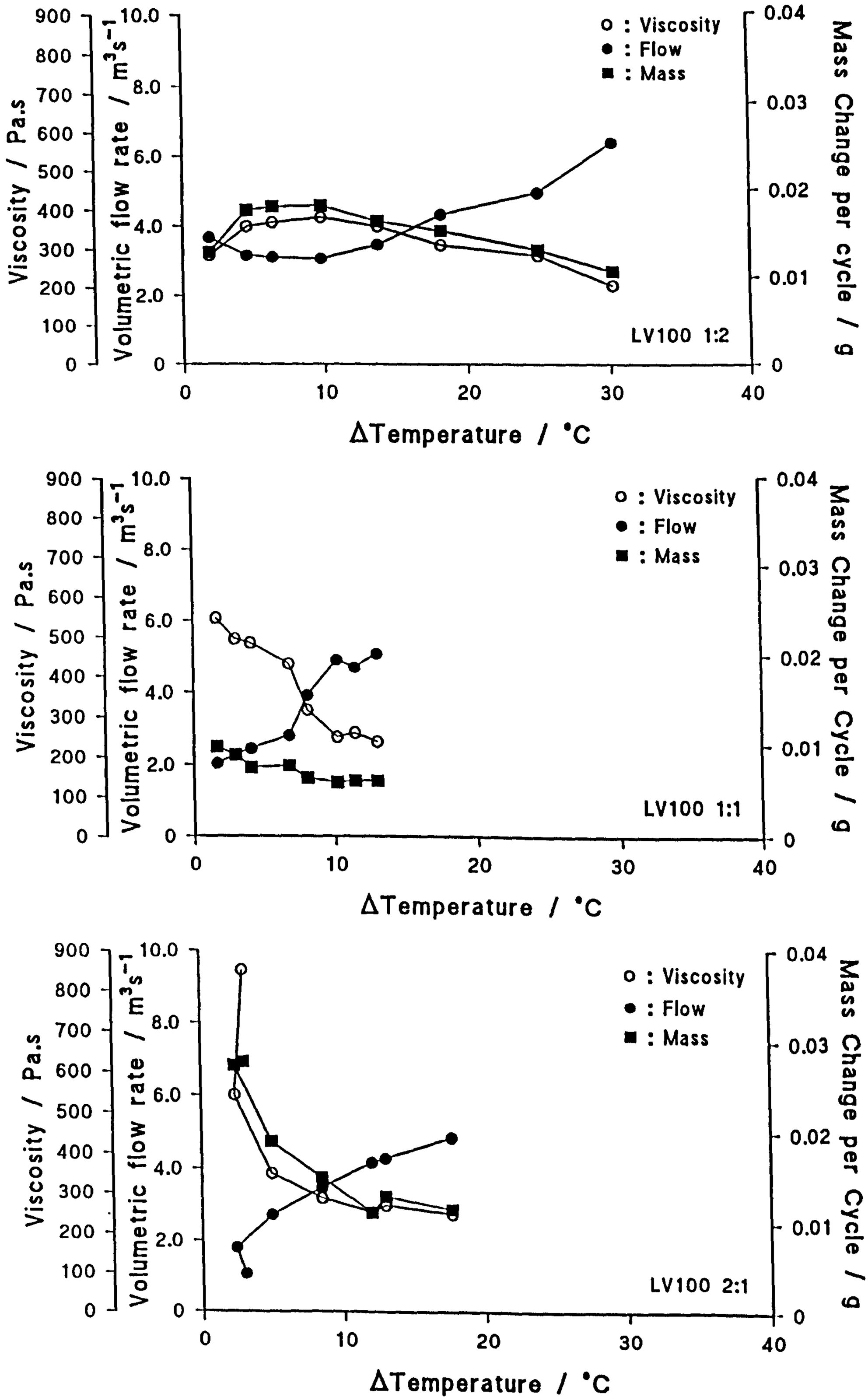
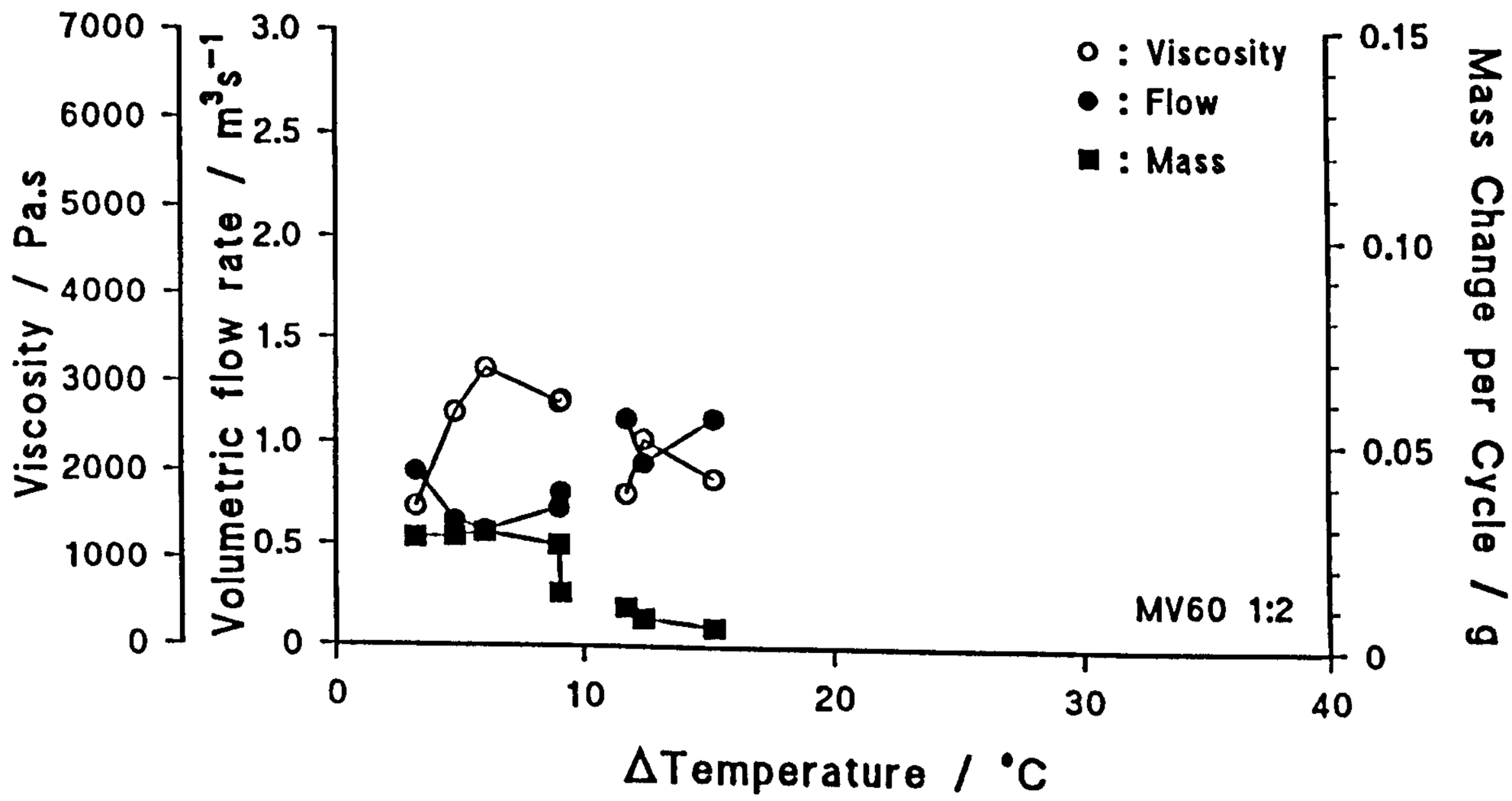
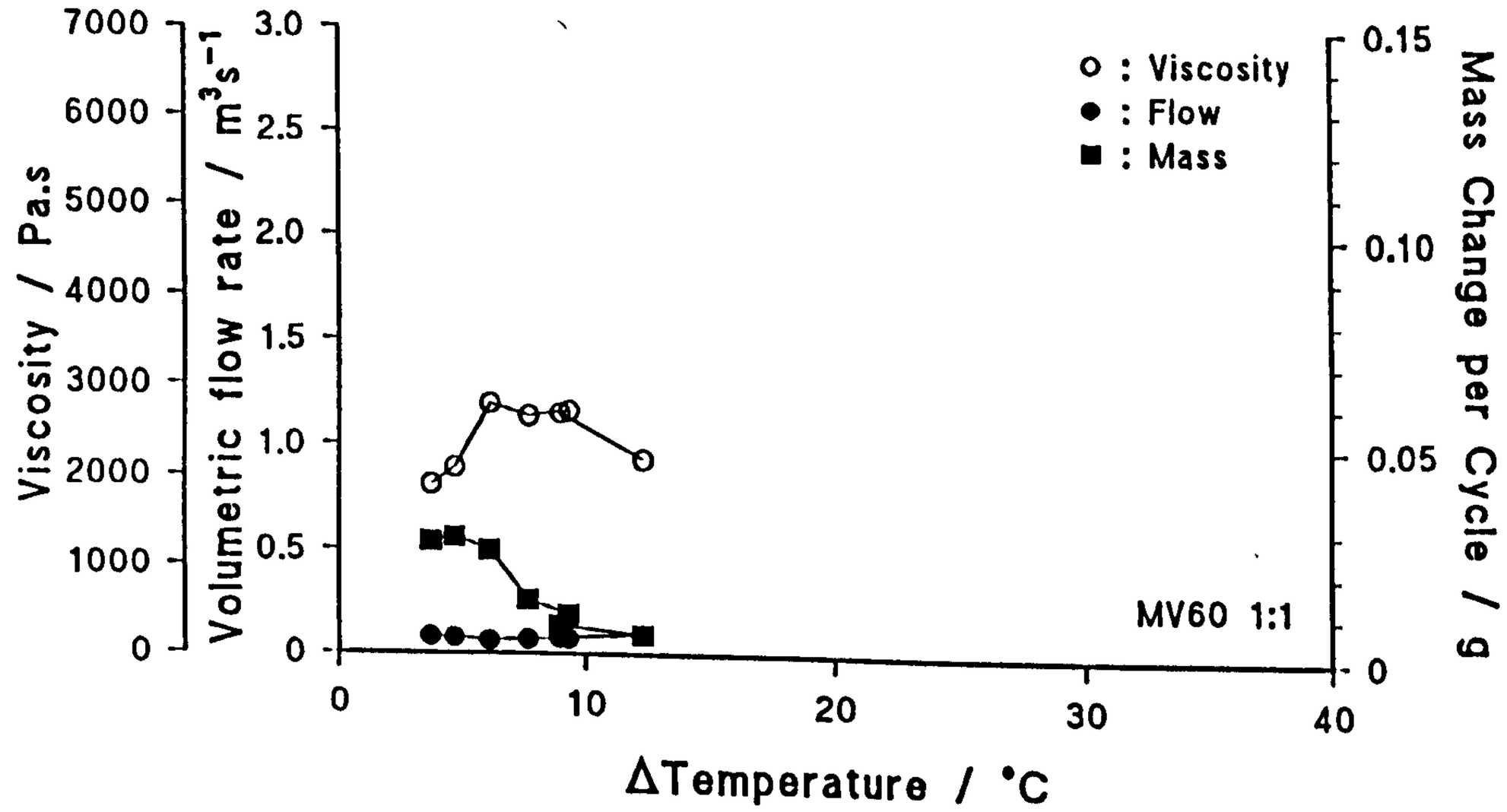

Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per cycle / g
ΔTemperature / °C
o : Viscosity
● : Flow
■ : Mass
LV100 1:2
LV100 1:1
LV100 2:1

Figure 125(a) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 125(b) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 125(c) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for MV medium and 60 Mesh grit with a grit to polymer ratio of 2.


Viscosity / Pa.s
Volumetric flow rate / m^3s^{-1}
Mass Change per Cycle / g
○ : Viscosity
● : Flow
■ : Mass
MV60 1:2
ΔTemperature / °C


Viscosity / Pa.s
Volumetric flow rate / m^3s^{-1}
Mass Change per Cycle / g
○ : Viscosity
● : Flow
■ : Mass
MV60 1:1
ΔTemperature / °C

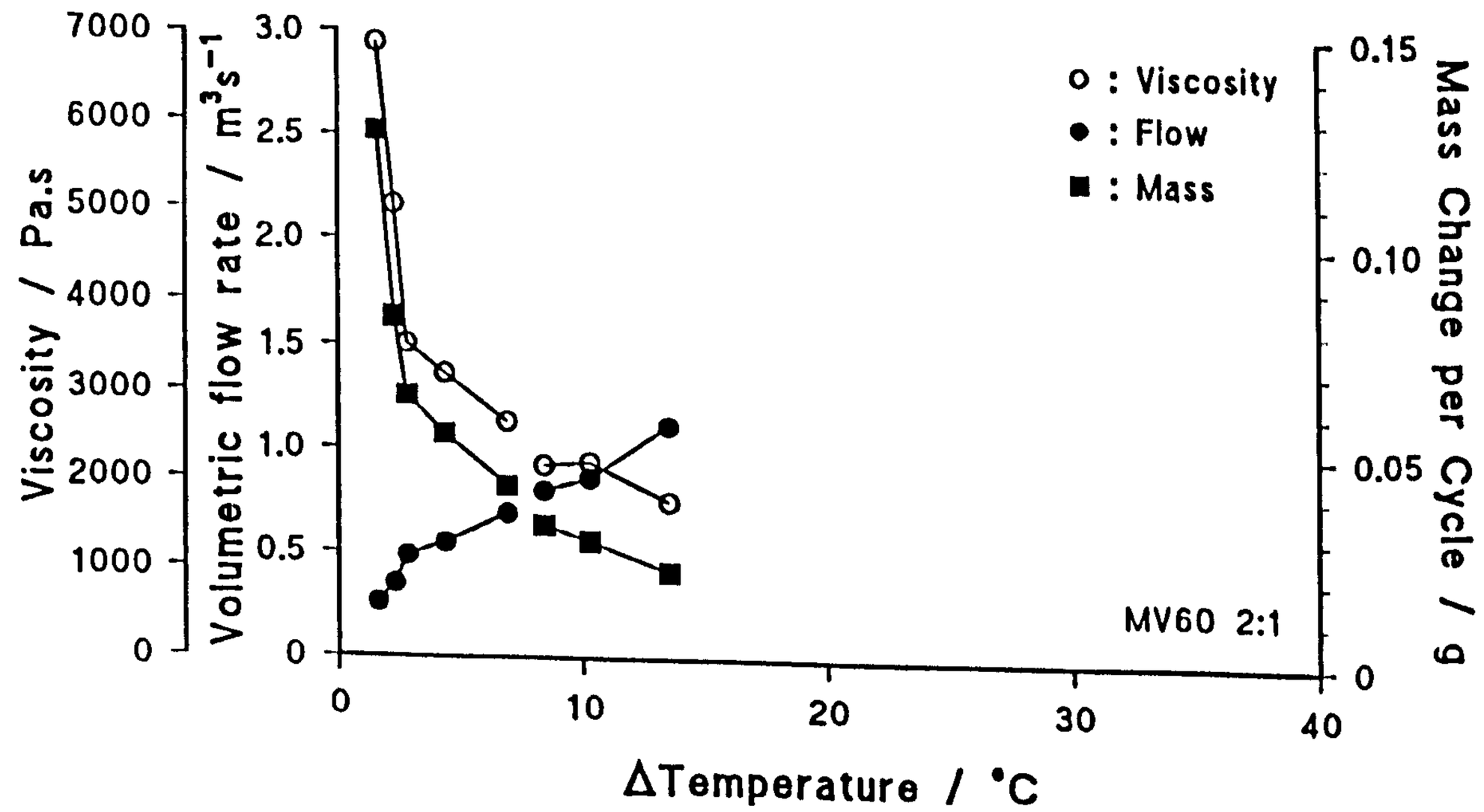
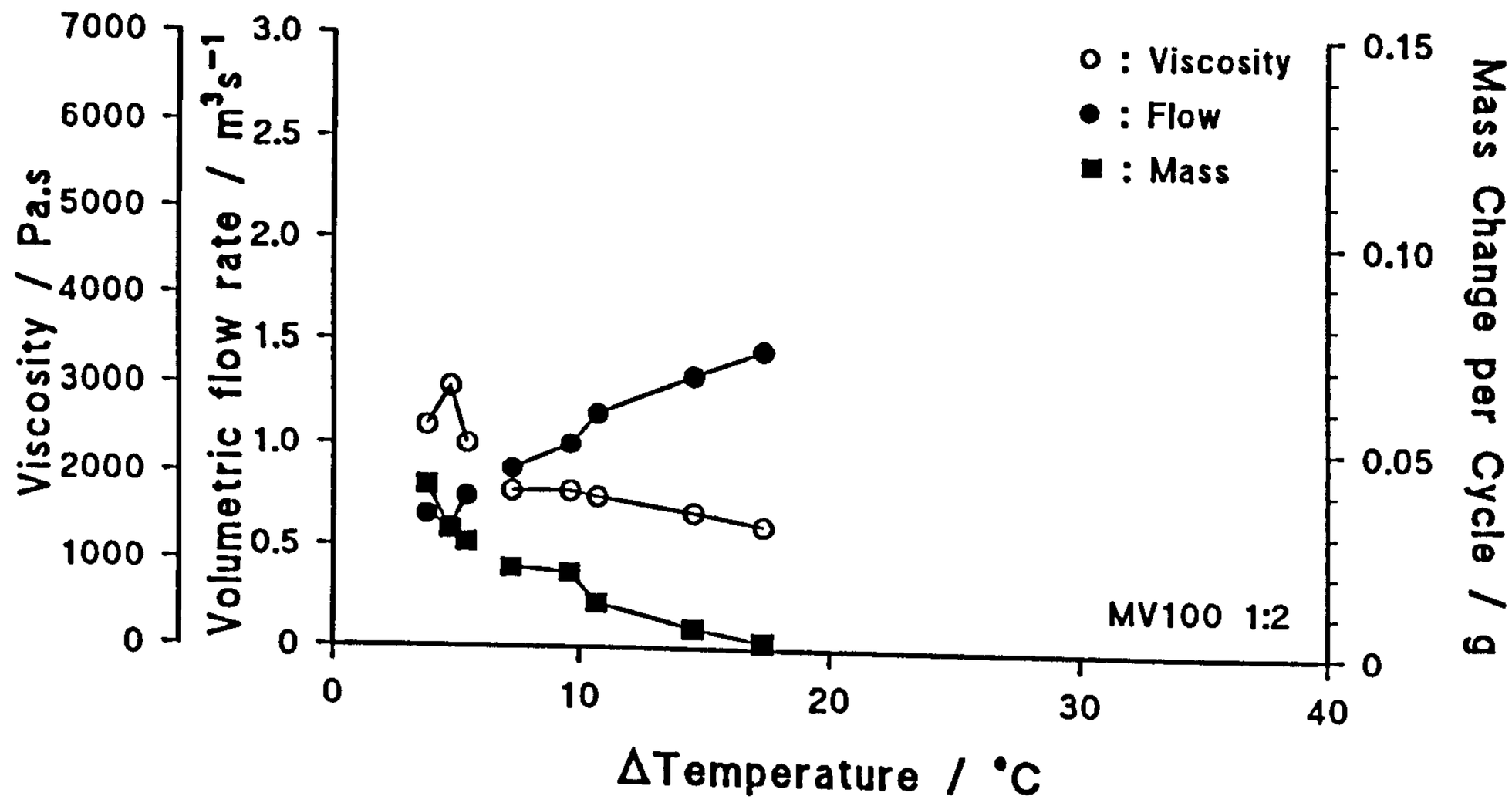
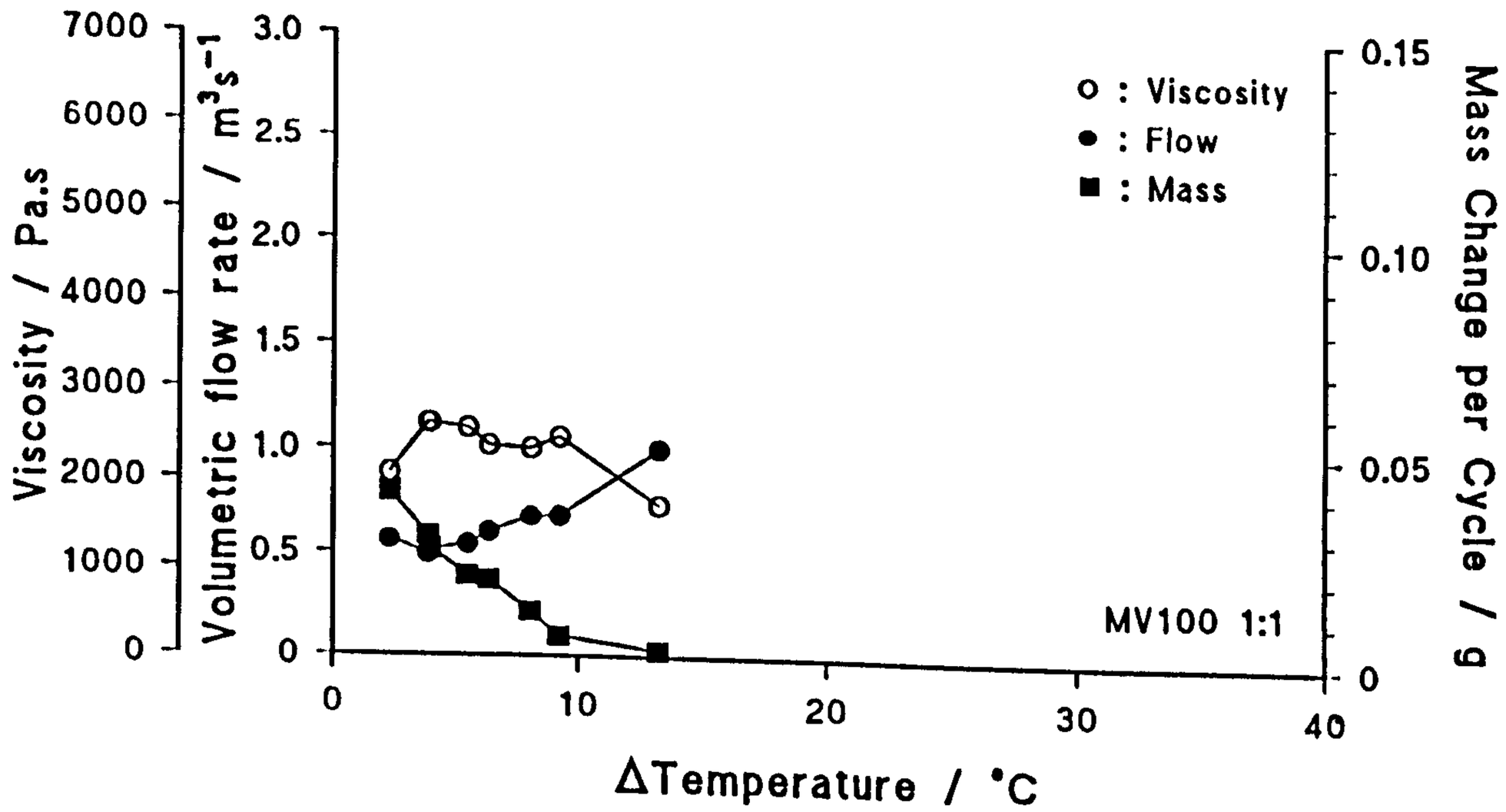

Viscosity / Pa.s
Volumetric flow rate / m^3s^{-1}
Mass Change per Cycle / g
○ : Viscosity
● : Flow
■ : Mass
MV60 2:1
ΔTemperature / °C

Figure 126(a) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 126(b) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 126(c) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for MV medium and 100 Mesh grit with a grit to polymer ratio of 2.


Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
MV100 1:2
ΔTemperature / °C


Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
MV100 1:1
ΔTemperature / °C

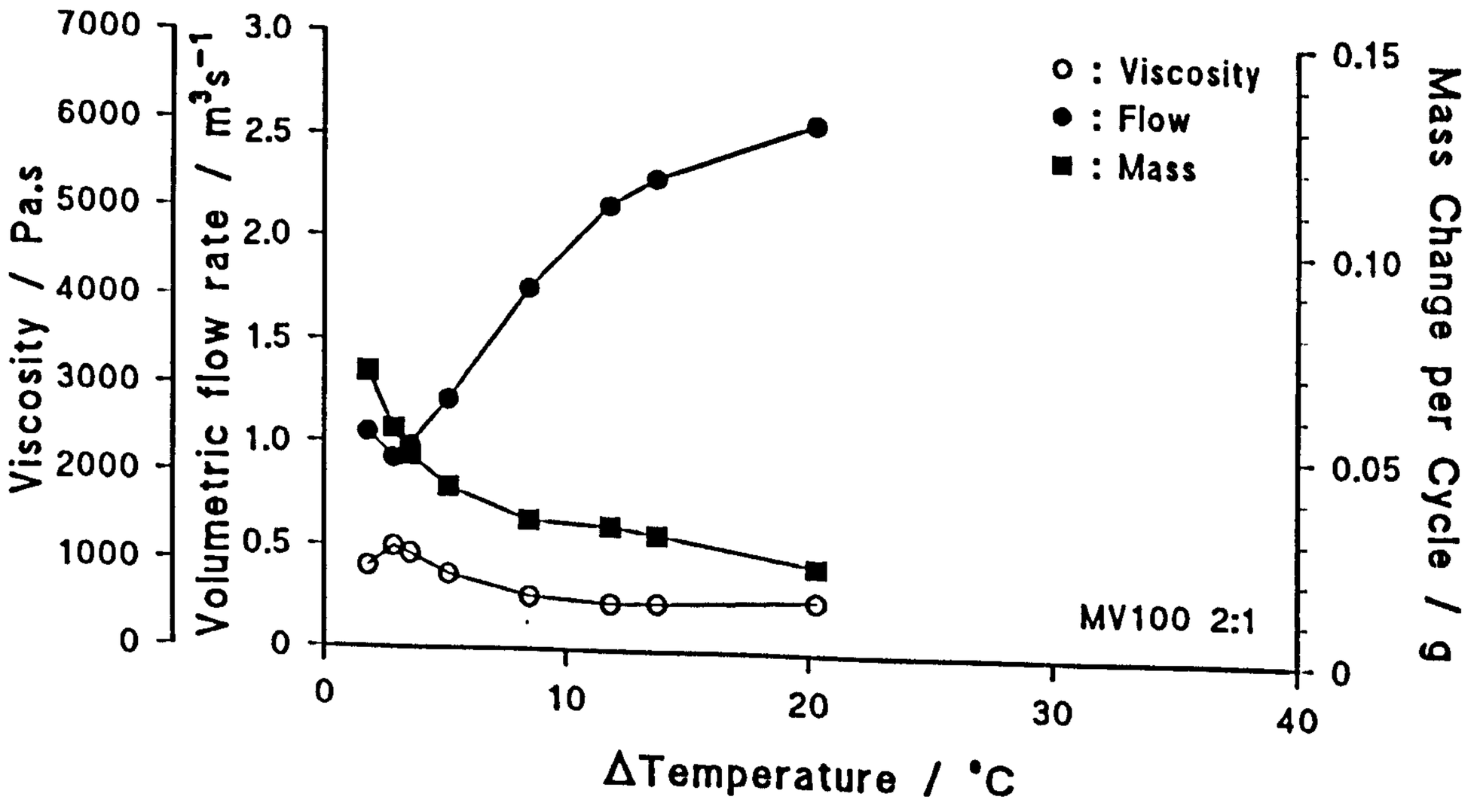
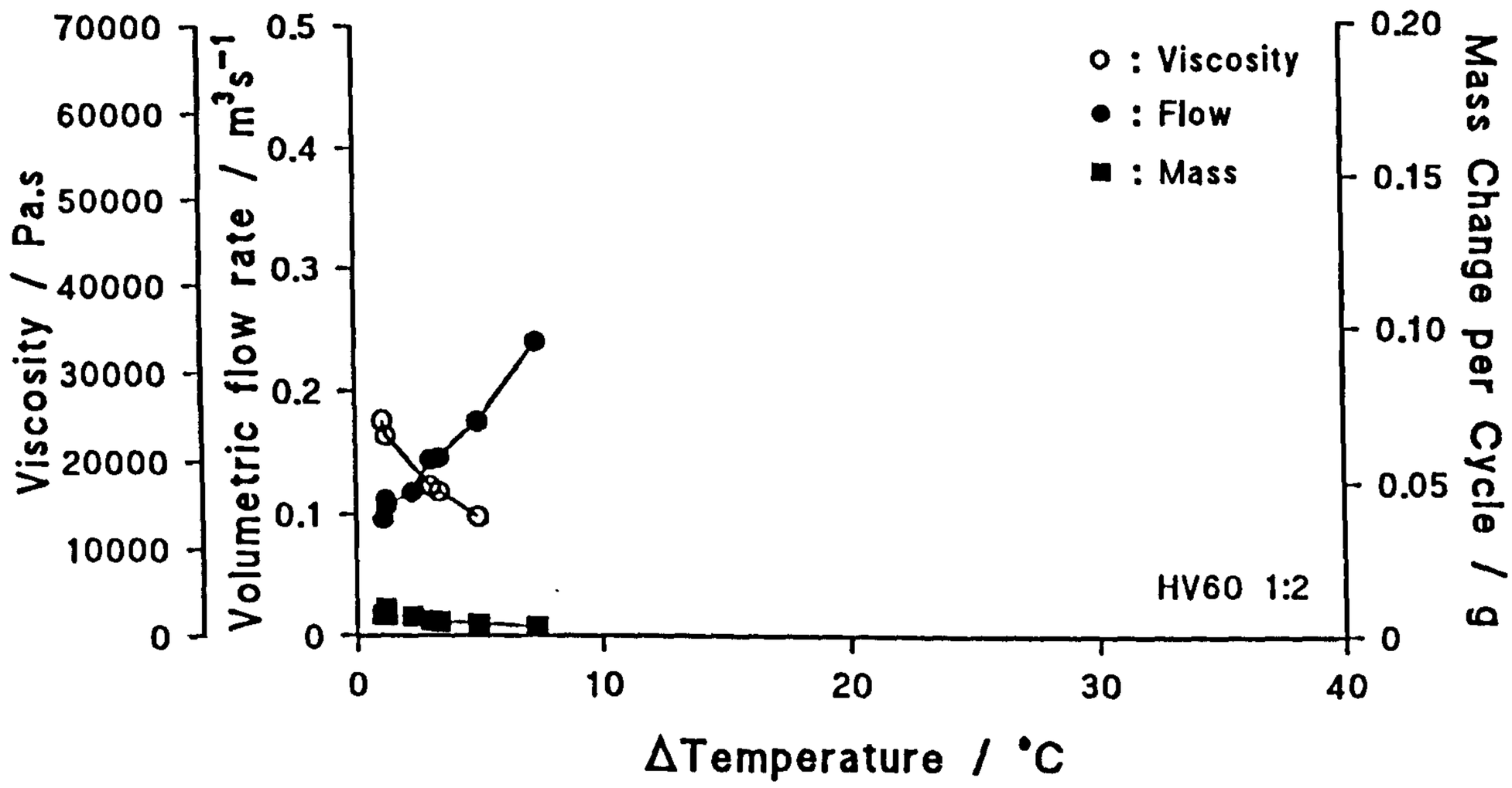
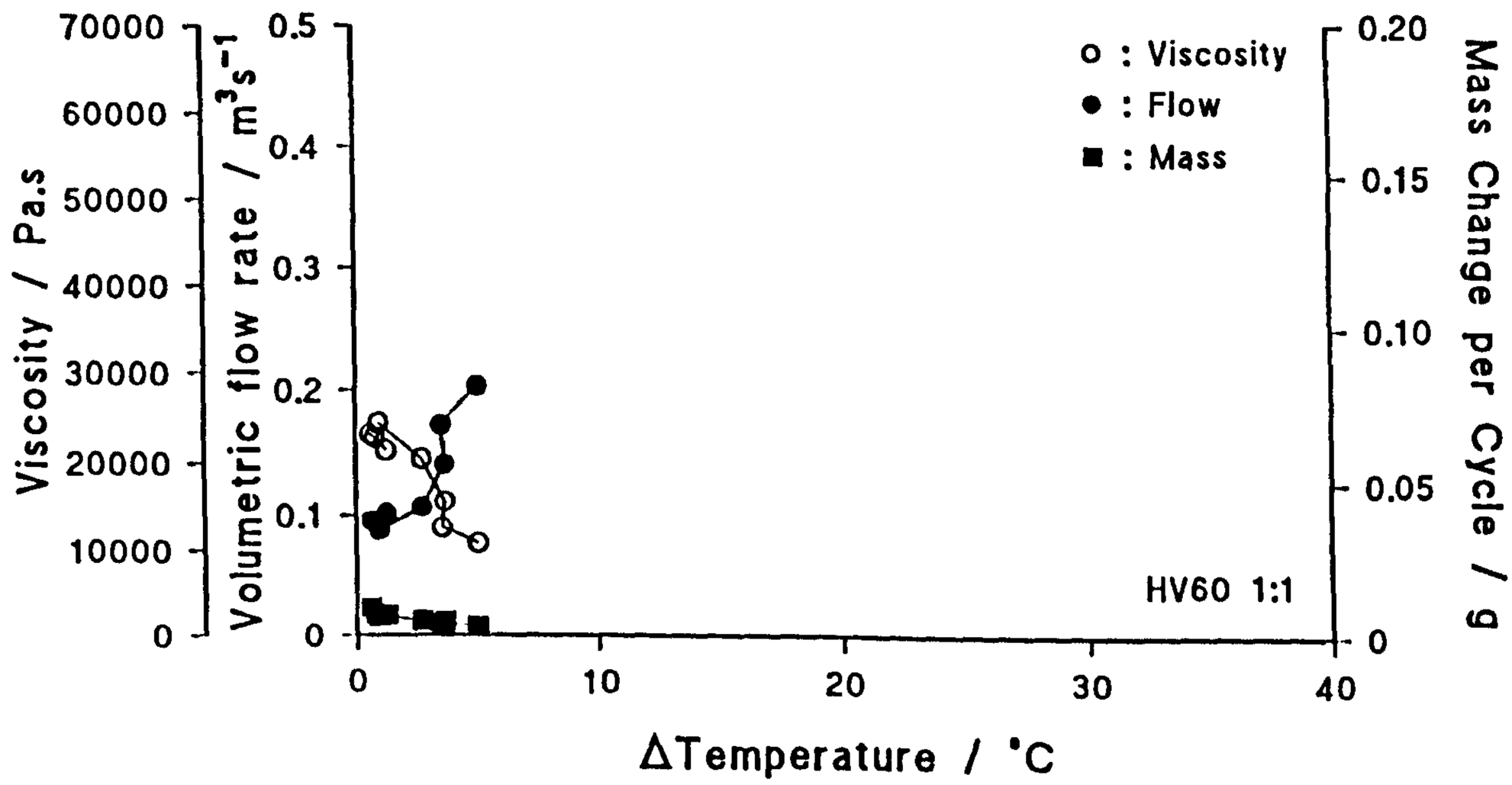

Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
MV100 2:1
ΔTemperature / °C

Figure 127(a) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for HV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 127(b) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 127(c) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for HV medium and 60 Mesh grit with a grit to polymer ratio of 2.


Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
HV60 1:2
ΔTemperature / °C


Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
HV60 1:1
ΔTemperature / °C

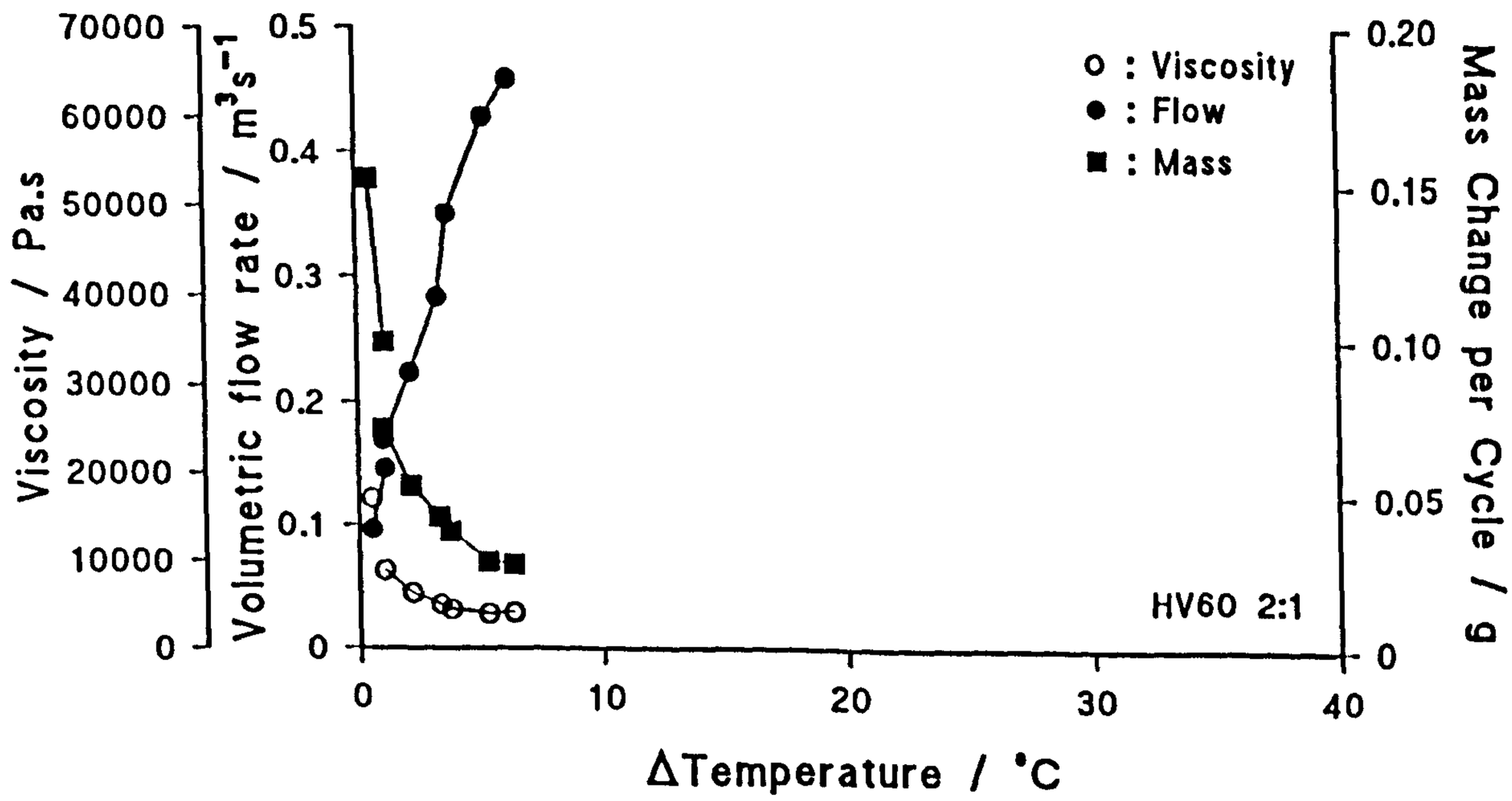
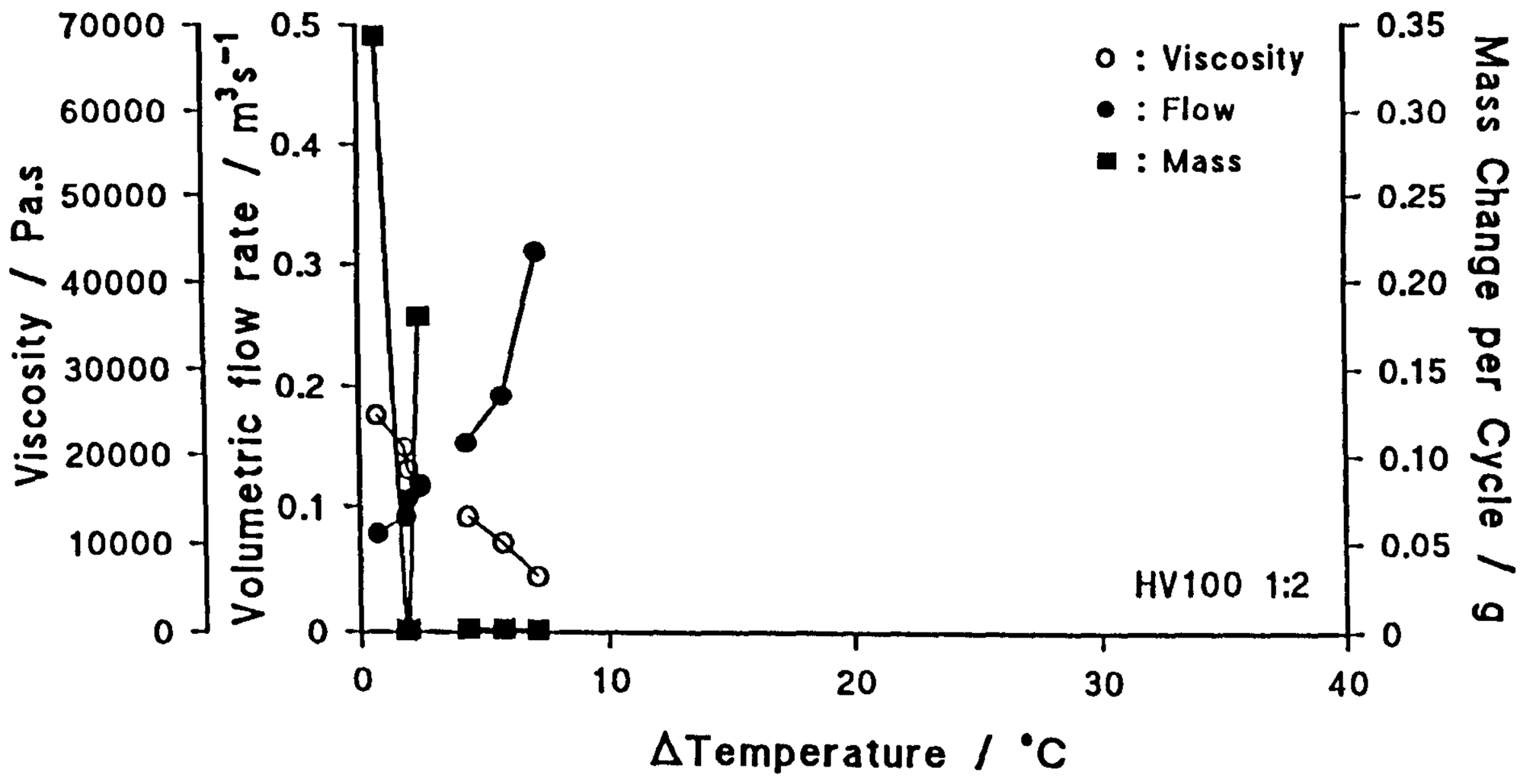

Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
HV60 2:1
ΔTemperature / °C

Figure 128(a) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for HV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 128(b) : The relationship between the temperature and (i) the viscosity, (ii) the volumetric flow rate, and (iii) the mass change per cycle for HV medium and 100 Mesh grit with a grit to polymer ratio of 2.


Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
HV100 1:2
ΔTemperature / °C
70000
60000
50000
40000
30000
20000
10000
0
0.5
0.4
0.3
0.2
0.1
0
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
0
10
20
30
40

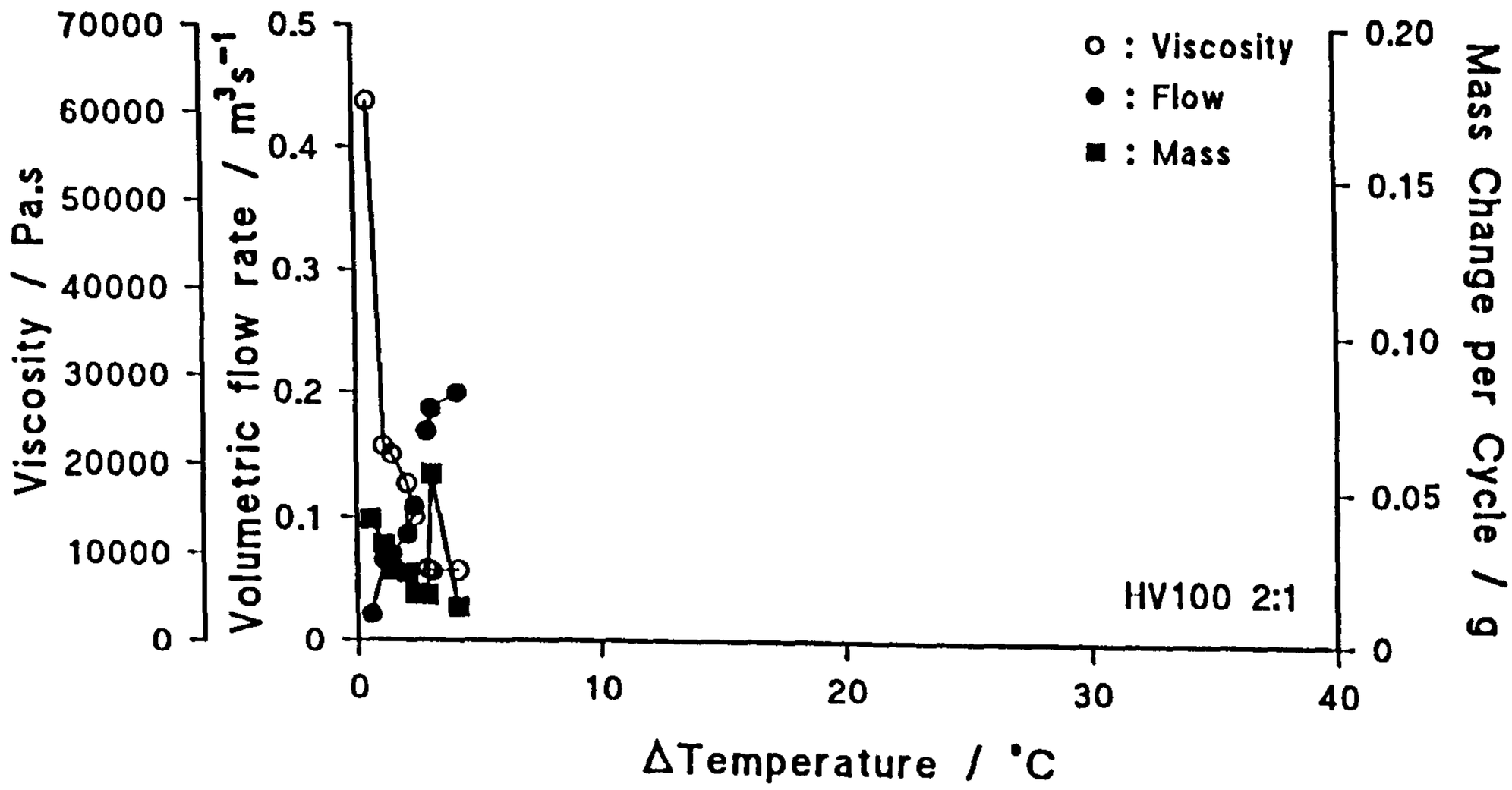

Viscosity / Pa.s
Volumetric flow rate / m³s⁻¹
Mass Change per Cycle / g
o : Viscosity
● : Flow
■ : Mass
HV100 2:1
ΔTemperature / °C
70000
60000
50000
40000
30000
20000
10000
0
0.5
0.4
0.3
0.2
0.1
0
0.20
0.15
0.10
0.05
0
0
10
20
30
40

Figure 129(a) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for LV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 129(b) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for LV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 129(c) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for LV medium and 60 Mesh grit with a grit to polymer ratio of 2.

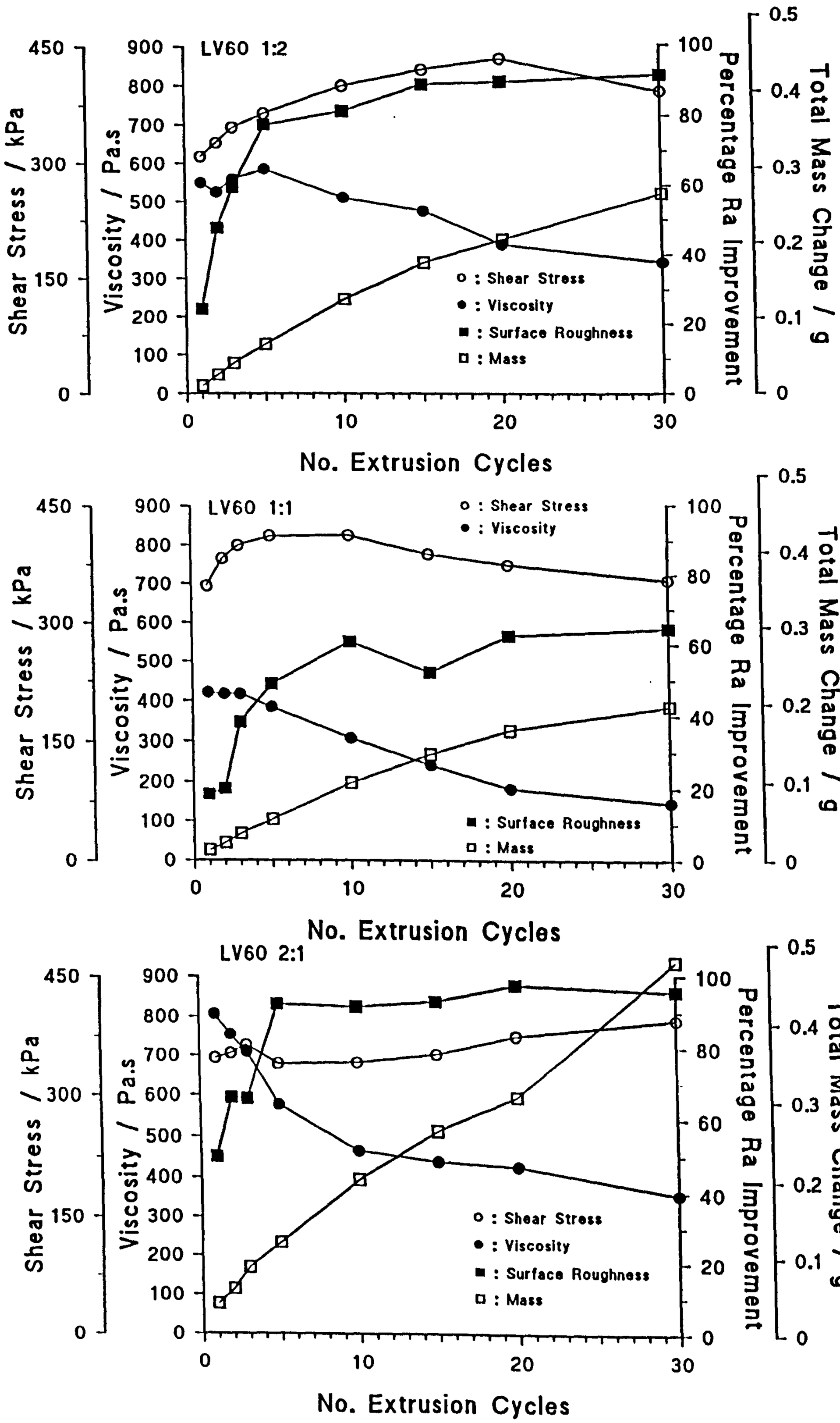

LV60 1:2
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
No. Extrusion Cycles
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass
LV60 1:1
LV60 2:1

Figure 130(a) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for LV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 130(b) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for LV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 130(c) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for LV medium and 100 Mesh grit with a grit to polymer ratio of 2.

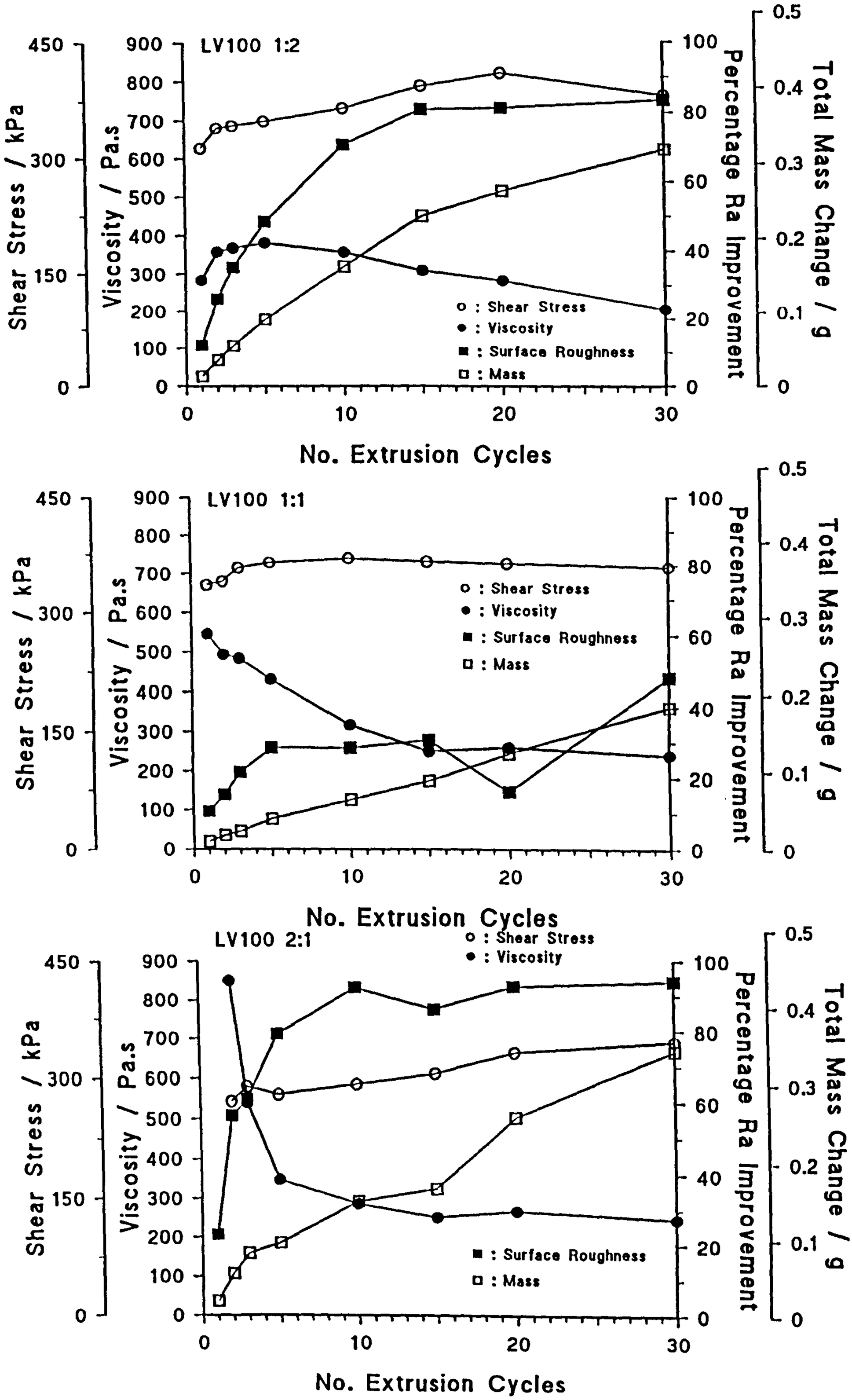

LV100 1:2
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass
No. Extrusion Cycles
LV100 1:1
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass
No. Extrusion Cycles
LV100 2:1
o : Shear Stress
● : Viscosity
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
■ : Surface Roughness
□ : Mass
No. Extrusion Cycles

Figure 131(a) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for MV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 131(b) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for MV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 131(c) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for MV medium and 60 Mesh grit with a grit to polymer ratio of 2.

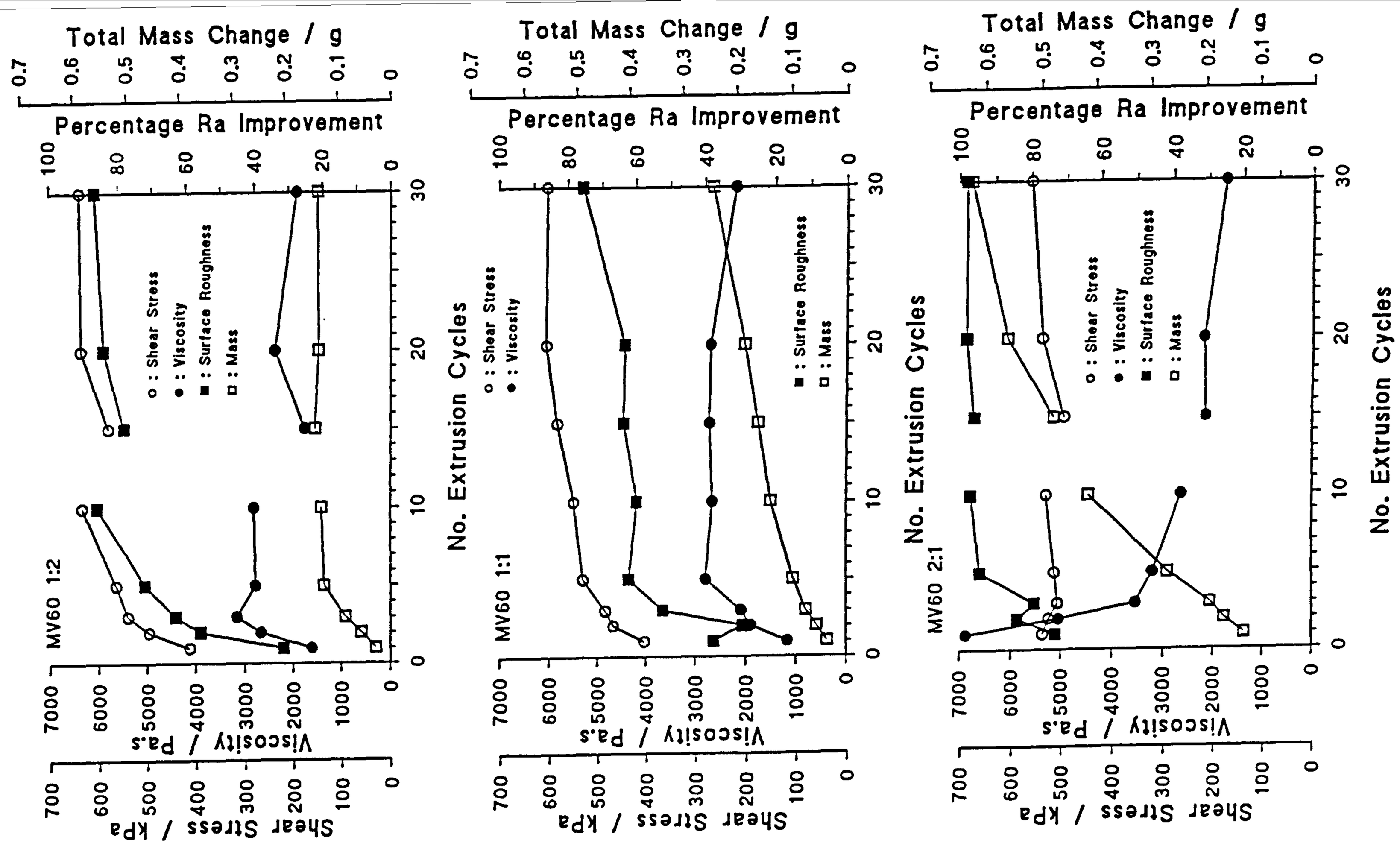

MV60 1:2
MV60 1:1
MV60 2:1
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
No. Extrusion Cycles
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass

Figure 132(a) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for MV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 132(b) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for MV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 132(c) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for MV medium and 100 Mesh grit with a grit to polymer ratio of 2.

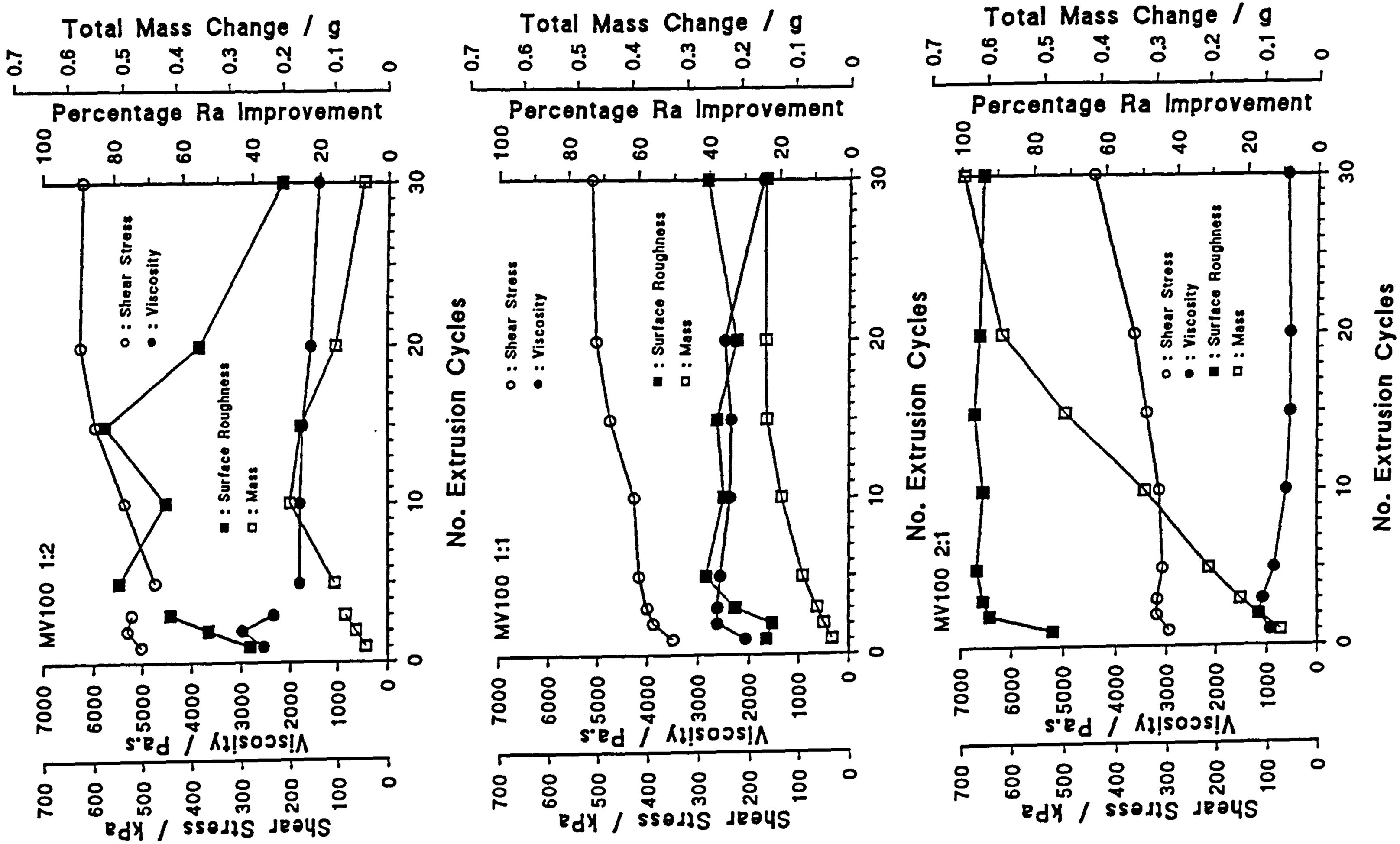

MV100 1:2
MV100 1:1
MV100 2:1
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
No. Extrusion Cycles
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass

Figure 133(a) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for HV medium and 60 Mesh grit with a grit to polymer ratio of 0.5.

Figure 133(b) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for HV medium and 60 Mesh grit with a grit to polymer ratio of 1.

Figure 133(c) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for HV medium and 60 Mesh grit with a grit to polymer ratio of 2.

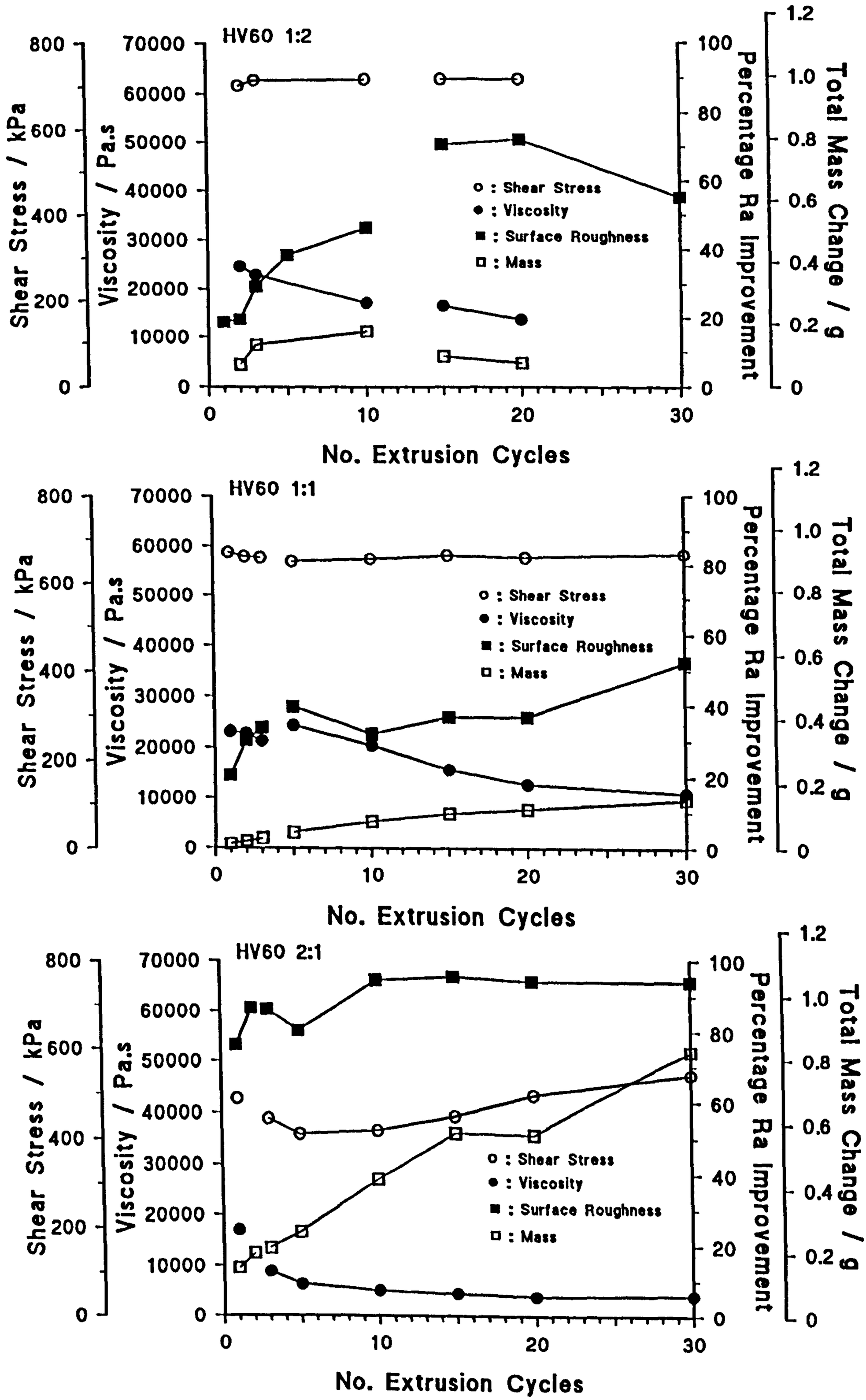
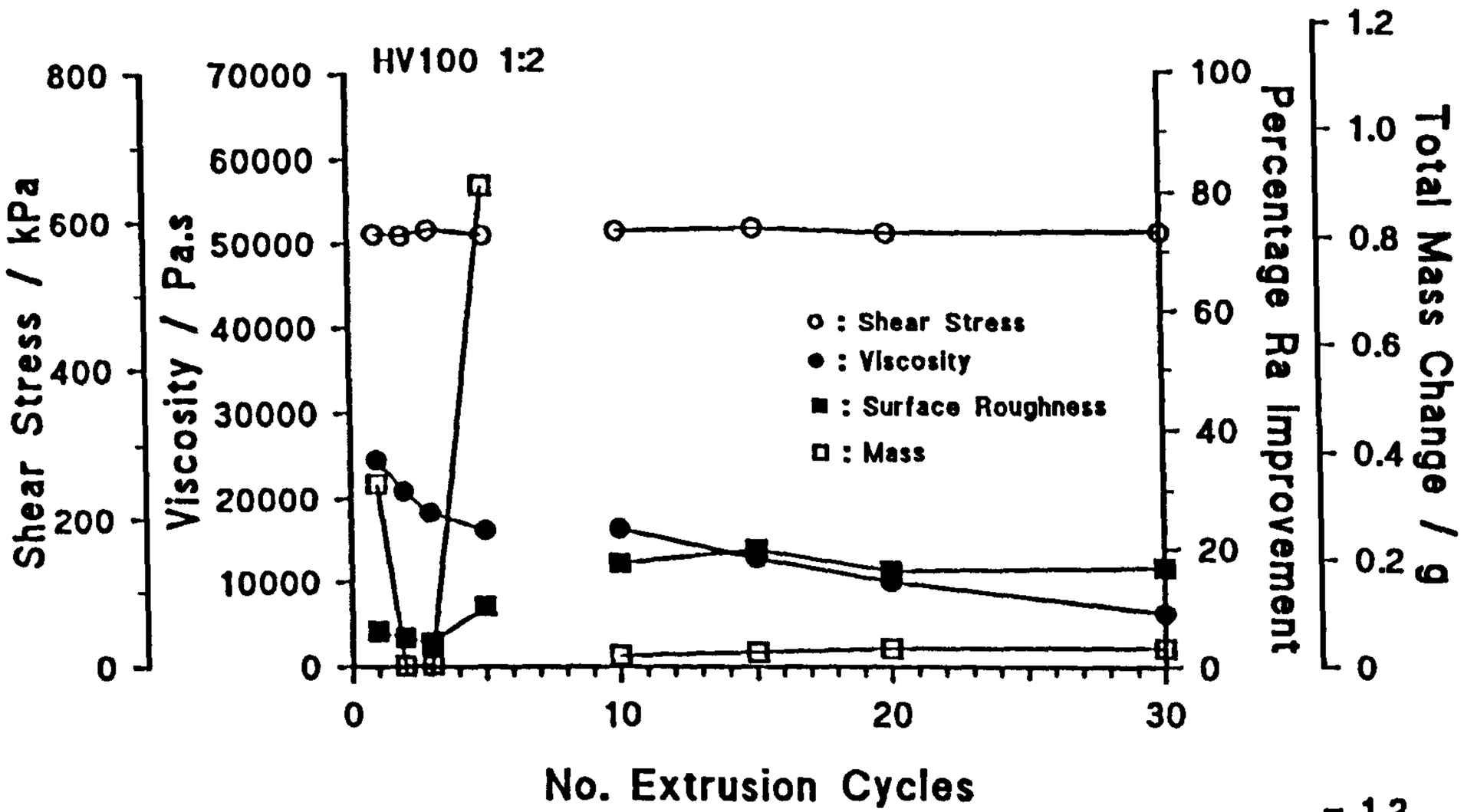
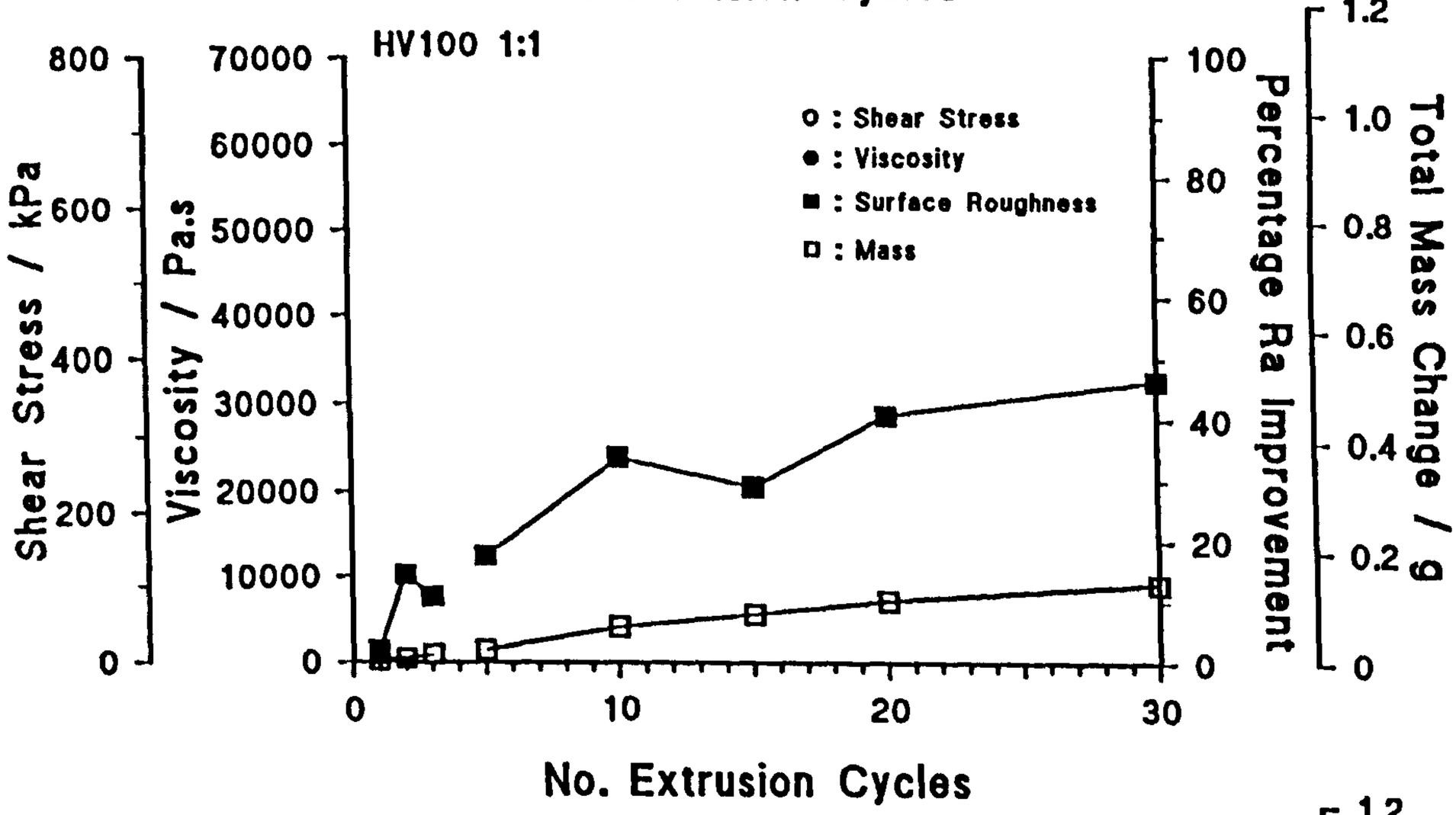

HV60 1:2
HV60 1:1
HV60 2:1
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
No. Extrusion Cycles
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass

Figure 134(a) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for HV medium and 100 Mesh grit with a grit to polymer ratio of 0.5.

Figure 134(b) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for HV medium and 100 Mesh grit with a grit to polymer ratio of 1.

Figure 134(c) : The relationship between the number of extrusion cycles and (i) the shear stress, (ii) the viscosity, (iii) the percentage surface roughness improvement, and (iv) the total mass change for HV medium and 100 Mesh grit with a grit to polymer ratio of 2.


HV100 1:2
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass
No. Extrusion Cycles


HV100 1:1
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass
No. Extrusion Cycles

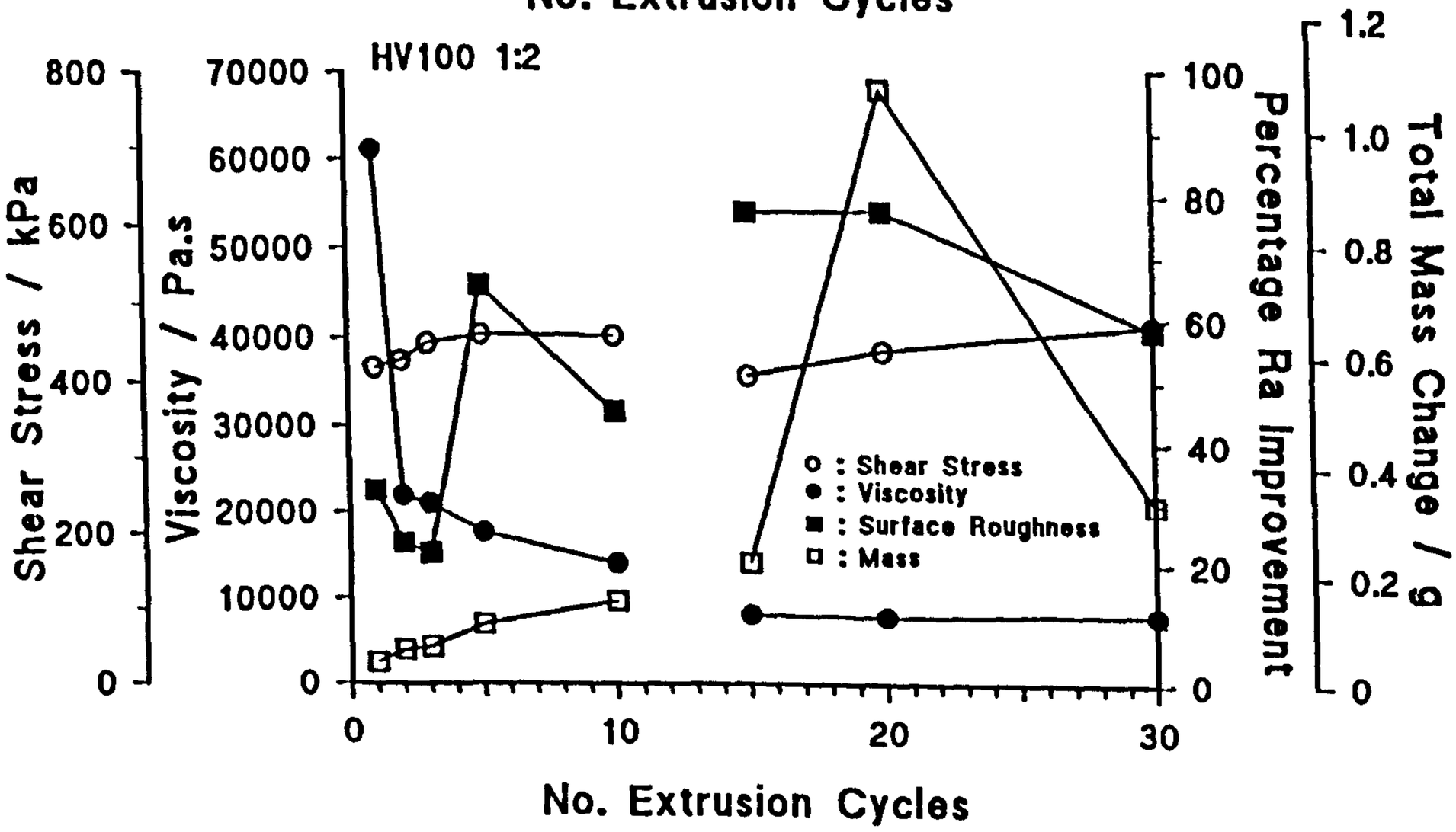
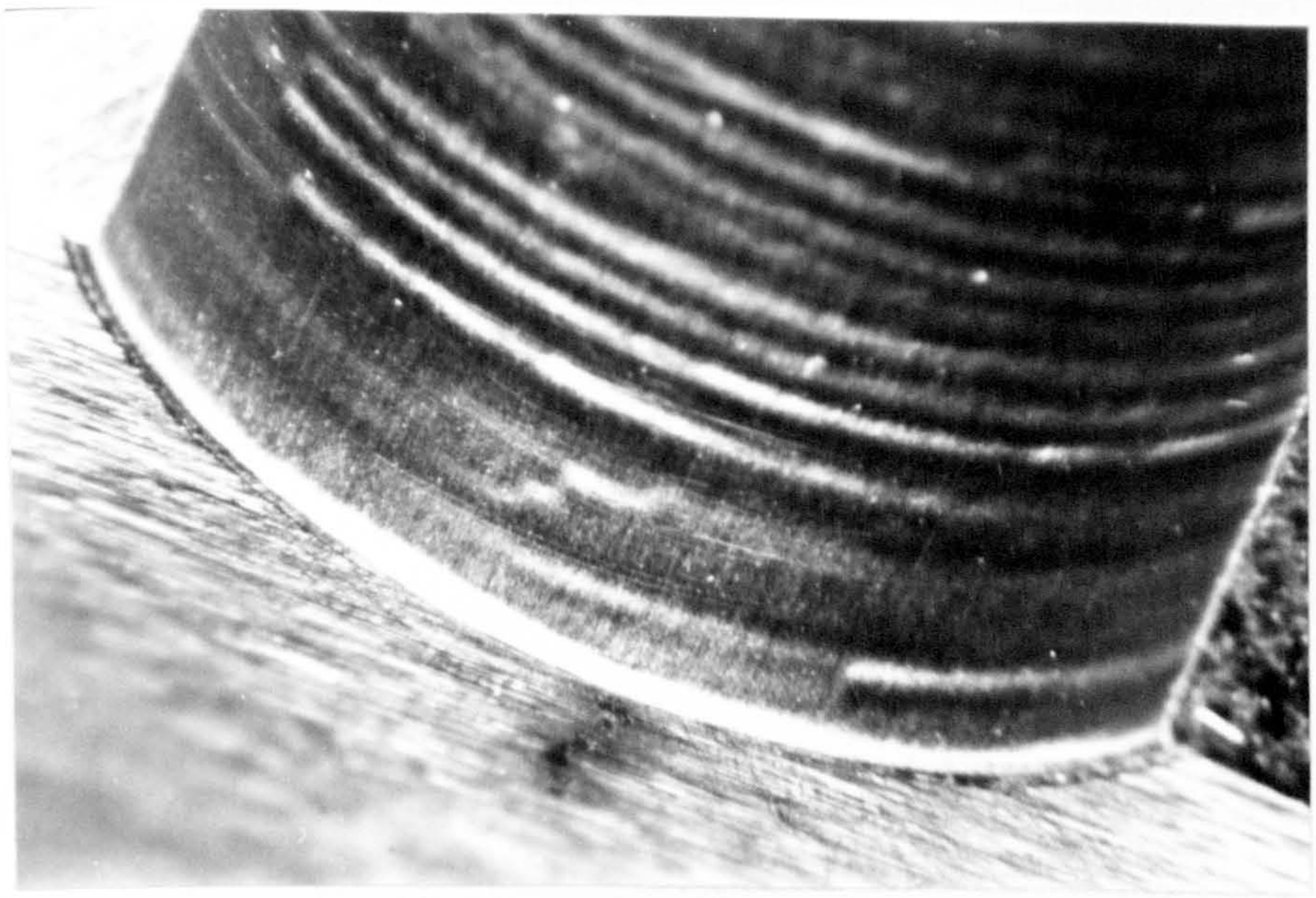
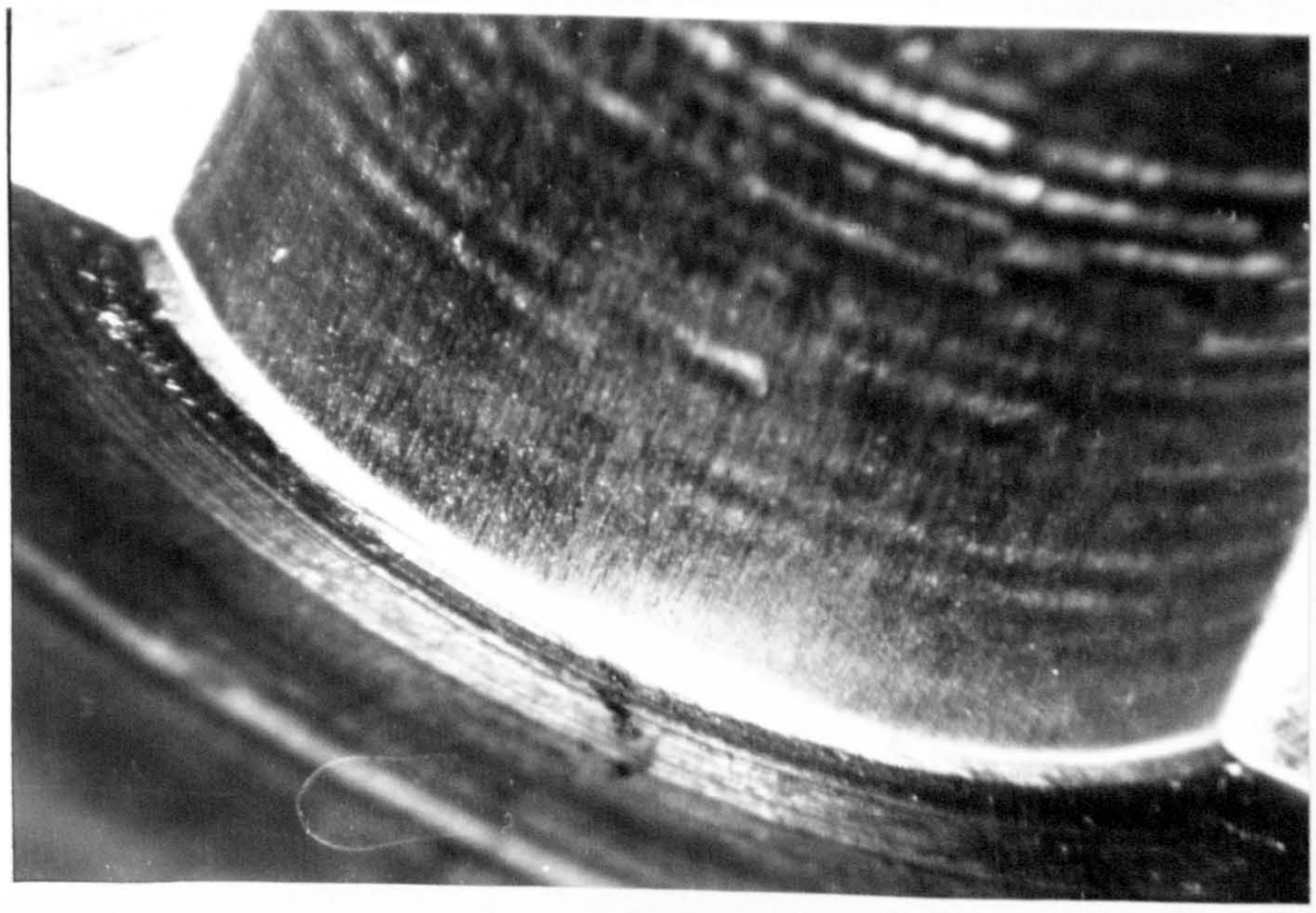

HV100 1:2
Shear Stress / kPa
Viscosity / Pa.s
Percentage Ra Improvement
Total Mass Change / g
o : Shear Stress
● : Viscosity
■ : Surface Roughness
□ : Mass
No. Extrusion Cycles

Figure 135(a) : The illustration of the surface edge condition of the die after 30 extrusion cycles using LV medium with 100 Mesh grit and a grit to polymer ratio of 1.

Figure 135(b) : The illustration of the surface edge condition of the die after 30 extrusion cycles using MV medium with 100 Mesh grit and a grit to polymer ratio of 1.

Figure 135(c) : The illustration of the surface edge condition of the die after 30 extrusion cycles using HV medium with 100 Mesh grit and a grit to polymer ratio of 1.





APPENDIX 1

A1.0 Viscosity Calculation of the LV Medium with 60 Mesh Grit and a Grit to Polymer Ratio of 0.5

A1.1 Data recorded in relation to the 30 extrusion cycle run:

Processing time:	t	= 383.4s
Average presure drop:	P	= 1636.03kPa
Die diameter:	D	= 0.0150992m
Die length:	L	= 0.0158m
Volume of medium available:	V	= $4.462 \times 10^{-3} m^3$

A1.2 Calculation of the extruded volume from the dimensions of the medium chambers when the extremities of their forward strokes are reached:

Diameter of both medium chambers:	d	= 0.1524m
Lower medium chamber length:	L_L	= 0.038m
Upper medium chamber length:	L_U	= 0.072m

Volume of medium retained within the lower chamber:

$$V_L = \pi (d^2/4) L_L$$

$$= 0.693 \times 10^{-3} m^3$$

Volume of medium retained within the lower chamber:

$$V_U = \pi (d^2/4) L_U$$

$$= 1.313 \times 10^{-3} m^3$$

Volume of medium extruded on the first half cycle:

$$V_1 = V - V_L$$
$$= 3.769 \times 10^{-3} m^3$$

Volume of medium extruded on the second half cycle and subsequent half cycles:

$$V_2 = V_1 - V_U$$
$$= 2.456 \times 10^{-3} m^3$$

Total volume extruded during 30 extrusion cycles:

$$V_E = (V_1 + V_2) + (V_2 \times 58)$$
$$= 148.614 \times 10^{-3} m^3$$

A1.3 Data calculated from the recorded data:

Flow rate: $Q = V_E / t$

$= 0.00038762 m^3 s^{-1}$

Die radius: $r = D / 2$

$= 0.0075496 m$

A1.4 Rheological measurements:

Shear stress: $\tau = (P\ r) / (2\ L)$

$= 390866.205 Pa$

Shear rate: $\dot{\gamma} = (4\ Q) / (\pi\ r^3)$

$= 1146.492 s^{-1}$

Viscosity: $\eta = \tau / \dot{\gamma}$

$= 340.924 Pa.s$