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Appendices

Appendix A

Instruments

A1. Sample Preparation

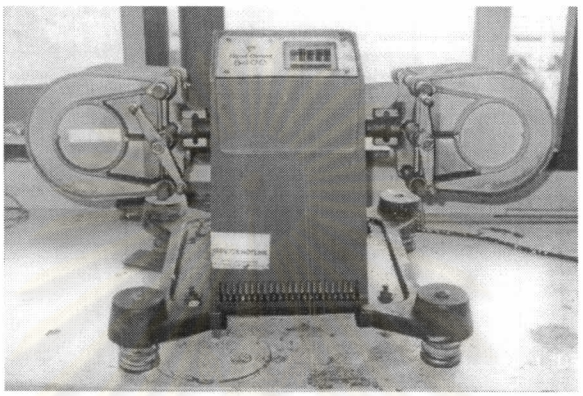


Figure A1.1 Dry blender : Red Devil 5400/5410 Paint Mixer

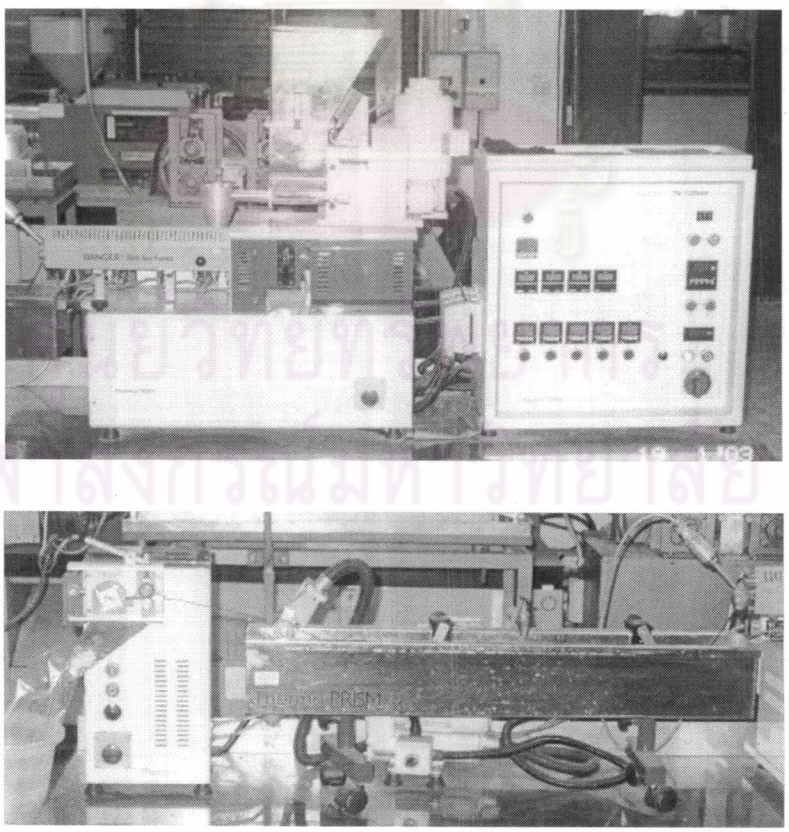


Figure A1.2 Twin screw extruder : TSE systems, Thermo Prism

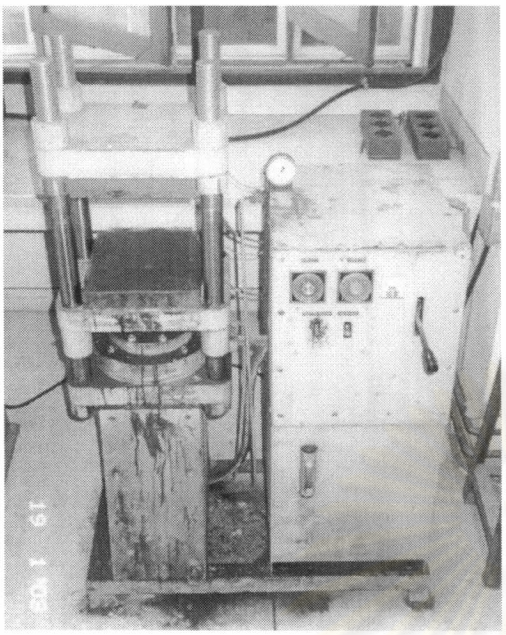


Figure A1.3

Compression molding machine

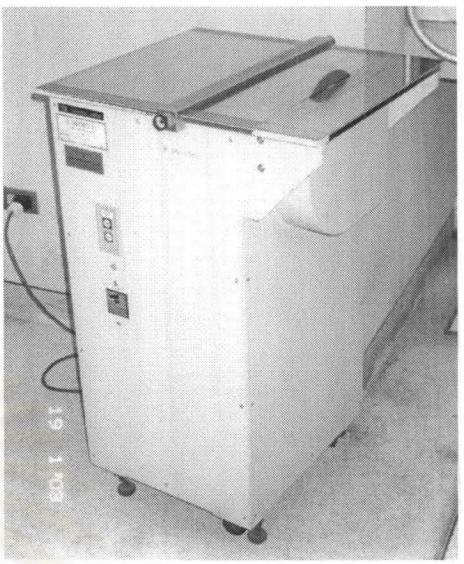


Figure A1.4

Cutter : Yasuda Seiki Seisakusho Ltd.

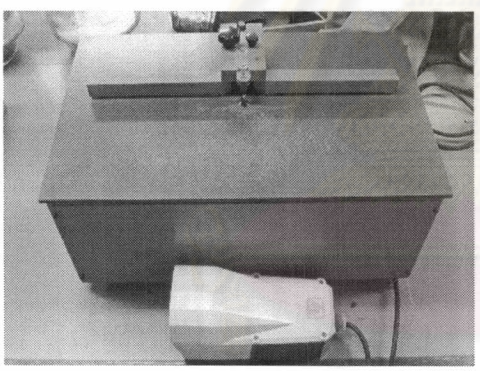


Figure A1.5 Lathe : ATS FAAR SPA MILANO / ITALIA

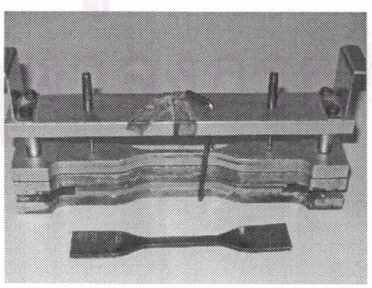


Figure A1.6 Contour holder

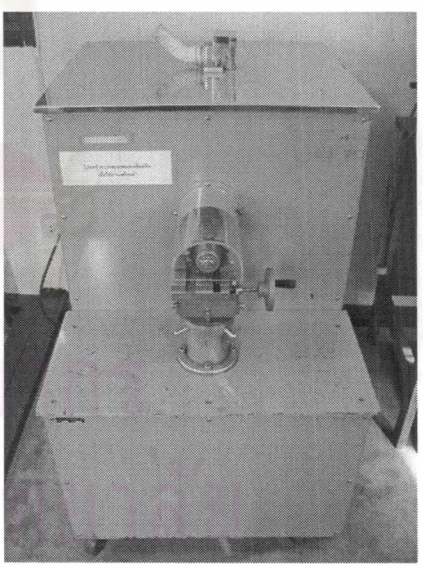


Figure A1.7

Plastic sample cutting machine

: Izod Impact Notcher

of Yasuda Seiki No.189-PFN

A2. Mechanical Property

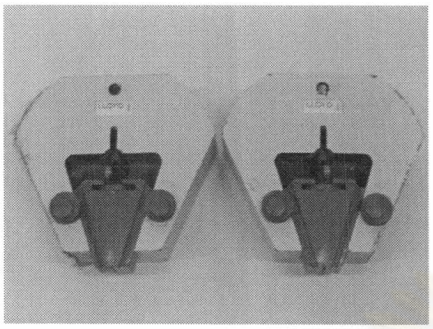


Figure A2.1
Grips of tensile testing for plastic sheet

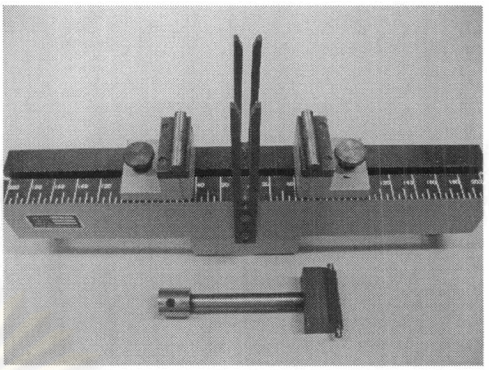


Figure A2.2
Flexural testing accessory for support the specimen

Figure A2.3
Tensile and flexural testing machine
: Universal Testing Machine
LLOYD LR 100K, LLOYD Instruments

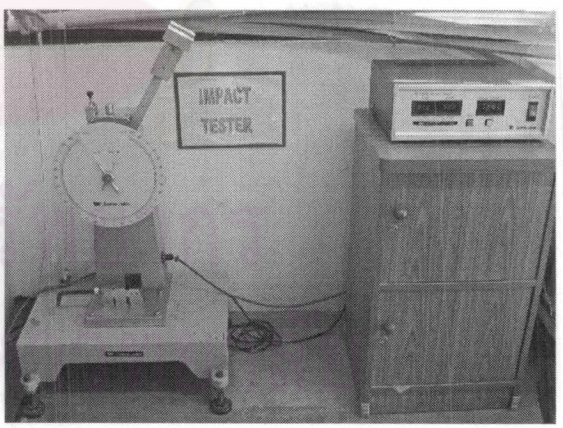


Figure A2.4
Impact testing machine
: Izod Impact Tester, Yasuda Seiki No.258-D

A3. Physical Property

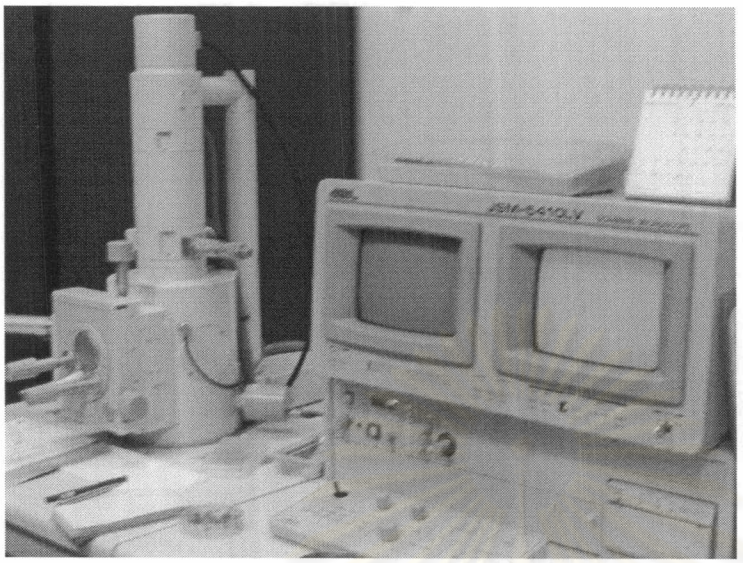


Figure A3.1 Scanning electron microscope machine
: JSM – 5410 LV Scanning Microscope of JEOL

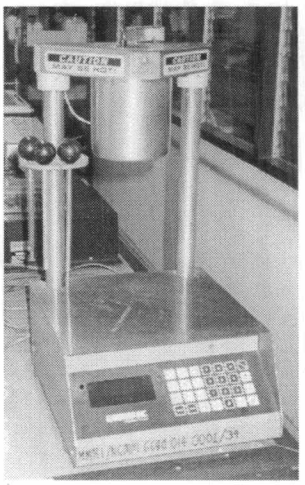


Figure A3.2
Melt index tester
model 7053 of Kayeness Inc.

Figure A3.3 Laser particle size analyzer : Mastersizer S long bed
Ver. 2.11 Serial Number : 32734 – 89

A4. Thermal Property

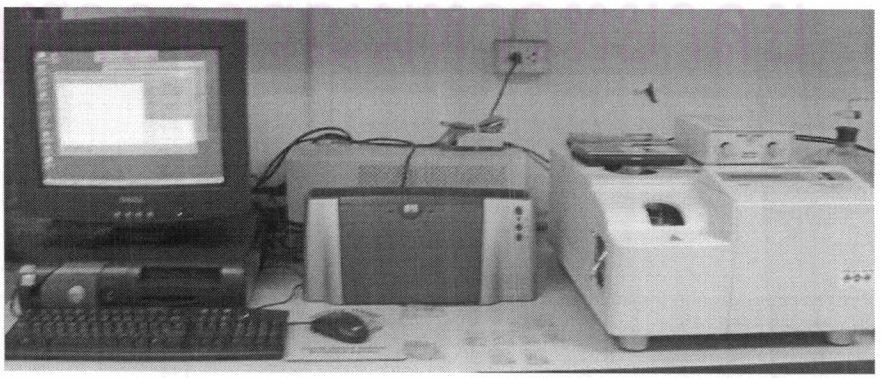


Figure A4 Differential scanning calorimetry (DSC) : DSC 822^e of Mettler Toledo Ltd.

Appendix B

Specimen Dimensions for Mechanical Properties Testing

Table B1 The specimen dimension of the tensile testing

Positions (See drawings)	Specimen Dimension mm (in.)
T - Thickness	4 (0.16) or under
W - Width of narrow section	6 (0.25)
L - Length of narrow section	33 (1.30)
WO – Width overall, min[a]	19 (0.75)
LO - Length overall, min[b]	115 (4.5)
G - Gauge length	25 (1.00)
D - Distance between grips	65 (2.5)
R - Radius of fillet	14 (0.56)
RO – Outer radius	25 (1.00)

[a] Overall widths greater than the minimum indicated may be desirable for some materials in order to avoid breaking in the grips.

[b] Overall lengths greater than the minimum indicated may be desirable either to avoid breaking in the grips or to satisfy special test requirements.

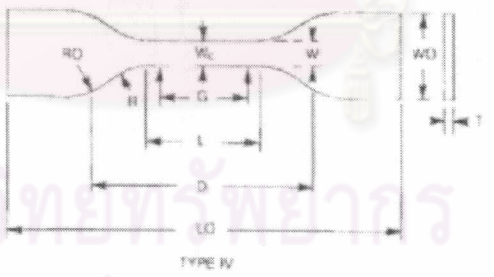


Figure B1 The specimen of the tensile testing

Table B2 The specimen dimension of the flexural testing

Positions (See drawings)	Specimen Dimension (mm)
D - Depth	3.2 or less
W - Width	12.7
S - Support span	At least 80%

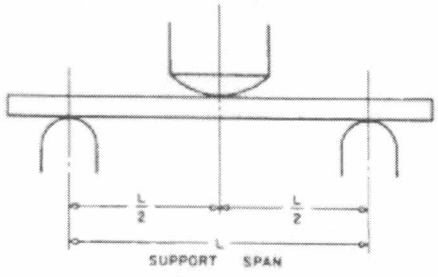


Figure B2 The specimen of the flexural testing

Table B3 The specimen dimension of the izod-type impact testing

Positions (See a drawing in Figure B3)	Specimen Dimension
A	10.16 ± 0.05 mm
	0.400 ± 0.002 in.
B	3.0 – 12.7 mm
	0.118 – 0.500 in.
C	64 ± 2 mm
	2.50 ± 0.08 in.
D	2.54 ± 0.2 mm
	0.1 in.
E	12.7 ± 0.2 mm
	0.500 ± 0.008 in.
θ	45 °

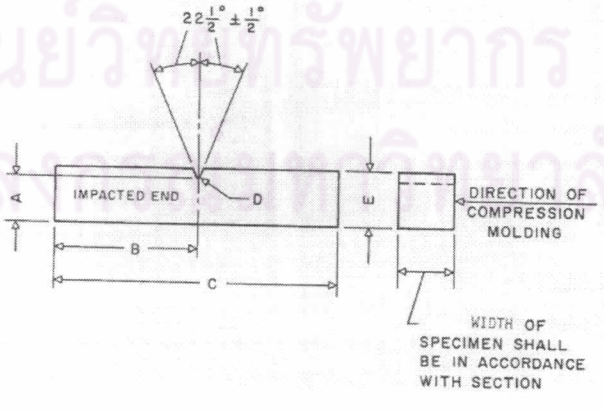
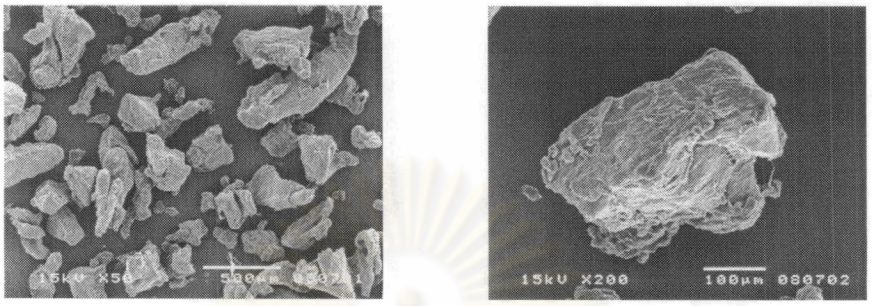


Figure B3 The specimen of the izod-type impact testing

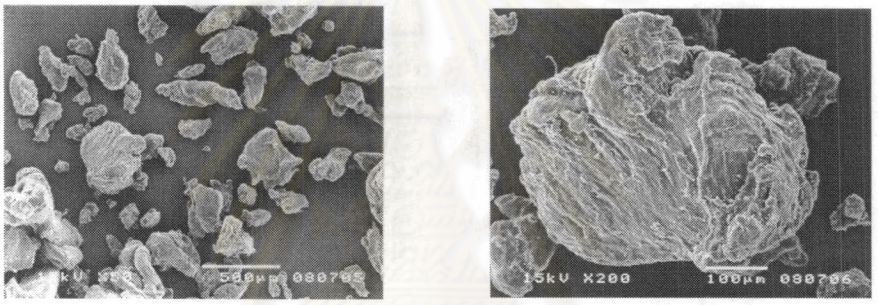
Appendix C

Physical Appearance Characterization



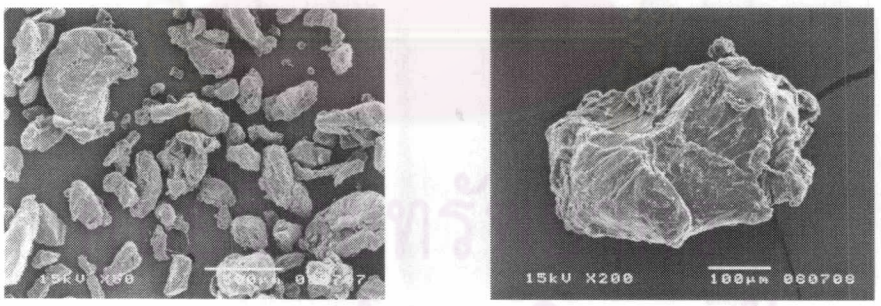
(a) 50 X (b) 200 X

Figure C1 SEM micrographs of MDPE powder



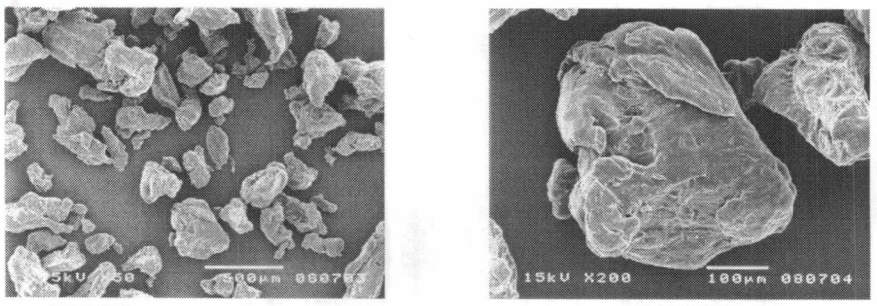
(a) 50 X (b) 200 X

Figure C2 SEM micrographs of the dry mixture of MDPE powder and diarylide pigment



(a) 50 X (b) 200 X

Figure C3 SEM micrographs of the dry mixture of MDPE powder and phthalocyanine pigment



(a) 50 X (b) 200 X

Figure C4 SEM micrographs of the dry mixture of MDPE powder and quinacridone pigment

Appendix D

Effect of Blending Condition

Table D1 Tensile modulus (MPa) of colored MDPE containing PR122 (0.4 phr) in different extrusion conditions

No. of Sample Condition*	Trial No.					Mean	SD
	1	2	3	4	5		
1	355.1	406.8	414.4	346.6	399.0	384.4	27.9
2	393.7	235.1	208.1	190.2	351.6	275.8	81.5
3	375.8	289.2	332.4	182.5	190.6	274.1	76.6
4	189.3	209.9	237.3	182.2	232.7	210.3	22.2
5	296.1	287.4	273.8	239.1	206.4	260.5	33.3
6	214.0	207.8	316.6	255.3	323.7	263.5	49.1
7	227.5	257.5	204.5	240.4	208.4	227.6	19.8
8	228.0	350.4	197.0	302.0	286.2	272.7	54.4
9	279.9	277.5	209.0	258.6	198.3	244.6	34.5

Table D2 Tensile stress at maximum (MPa) of colored MDPE containing PR122 (0.4 phr) in different extrusion conditions

No. of Sample Condition*	Trial No.					Mean	SD
	1	2	3	4	5		
1	27.8	28.0	27.6	27.8	28.0	27.8	0.1
2	27.3	27.9	27.1	27.5	28.5	27.7	0.5
3	26.5	27.3	27.1	27.2	27.3	27.1	0.3
4	27.1	28.3	28.0	27.3	27.4	27.6	0.5
5	27.3	28.0	27.3	27.5	27.5	27.5	0.3
6	28.1	27.3	28.4	27.7	28.1	27.9	0.4
7	28.3	28.0	28.2	27.9	27.9	28.0	0.2
8	27.7	28.0	28.2	27.7	28.2	27.9	0.2
9	27.8	27.8	27.7	27.9	27.6	27.7	0.1

Table D3 Tensile stress at break (MPa) of colored MDPE containing PR122 (0.4 phr) in different extrusion conditions

No. of Sample Condition*	Trial No.					Mean	SD
	1	2	3	4	5		
1	7.9	13.5	12.2	8.2	9.6	10.3	2.2
2	8.8	11.3	10.2	9.2	10.3	9.9	0.9
3	10.9	8.8	9.3	8.2	9.8	9.4	0.9
4	7.9	9.7	8.5	9.5	8.7	8.9	0.7
5	8.4	9.1	10.9	9.6	11.9	10.0	1.3
6	6.9	6.5	7.4	8.9	8.2	7.6	0.9
7	9.5	8.7	10.2	9.7	9.1	9.4	0.5
8	11.5	10.0	10.5	12.6	12.1	11.3	1.1
9	9.4	10.0	8.9	10.4	8.3	9.4	0.8

Table D4 Percentage strain at break (%) of colored MDPE containing PR122 (0.4 phr) in different extrusion conditions

No. of Sample Condition*	Trial No.					Mean	SD
	1	2	3	4	5		
1	248.9	190.8	277.1	255.0	230.6	240.5	29.0
2	211.5	279.0	268.0	297.9	247.9	260.9	29.5
3	306.2	239.1	354.3	250.1	272.0	284.3	41.8
4	263.3	368.3	263.8	332.5	268.9	299.4	43.2
5	260.4	355.1	297.8	383.9	319.5	323.3	43.1
6	350.7	247.7	379.8	229.3	432.4	328.0	77.8
7	453.5	282.9	399.1	494.6	583.3	442.7	100.0
8	552.0	292.5	376.5	389.2	483.4	418.7	90.0
9	422.7	268.1	447.1	320.4	493.1	390.3	83.3

* 1 = Screw Speed 10 rpm, Temperature 160 °C; 2 = Screw Speed 10 rpm, Temperature 180 °C;
3 = Screw Speed 10 rpm, Temperature 200 °C; 4 = Screw Speed 20 rpm, Temperature 160 °C;
5 = Screw Speed 20 rpm, Temperature 180 °C; 6 = Screw Speed 20 rpm, Temperature 200 °C;
7 = Screw Speed 30 rpm, Temperature 160 °C; 8 = Screw Speed 30 rpm, Temperature 180 °C;
9 = Screw Speed 30 rpm, Temperature 200 °C

Appendix E

Mechanical Properties Characterization

E1. Tensile Properties

Table E1.1 Tensile modulus (MPa) of colored MDPEs

Sample*	Trial No.					Mean	SD
	1	2	3	4	5		
- (MDPE)/0.0/d	183.2	196.3	245.5	226.2	233.2	216.9	23.4
PY/0.1/d	236.9	233.5	226.7	224.9	221.0	228.6	5.8
PY/0.2/d	201.8	210.4	196.7	233.9	187.5	206.1	15.8
PY/0.3/d	270.1	209.1	204.0	231.3	280.1	238.9	31.1
PY/0.4/d	210.0	274.4	259.8	222.2	248.1	242.9	23.7
PY/0.1/m	235.4	197.7	193.9	225.3	257.2	221.9	23.7
PY/0.2/m	239.2	262.1	211.0	227.7	231.3	234.3	16.7
PY/0.3/m	227.9	195.4	216.1	237.6	208.4	217.1	14.7
PY/0.4/m	230.1	207.8	232.7	239.3	211.9	224.4	12.3
PB/0.1/d	190.0	179.1	172.6	205.3	218.7	193.2	16.9
PB/0.2/d	221.6	204.7	174.5	190.9	227.3	203.8	19.5
PB/0.3/d	194.0	194.7	246.0	191.2	242.3	213.6	25.0
PB/0.4/d	147.0	168.7	179.9	178.4	197.8	174.4	16.6
PB/0.1/m	275.4	215.7	224.1	216.4	213.9	229.1	23.4
PB/0.2/m	196.6	248.2	252.1	174.2	234.8	221.2	30.6
PB/0.3/m	212.1	208.0	202.6	236.6	309.0	233.6	39.4
PB/0.4/m	241.7	204.2	214.8	223.8	215.9	220.1	12.5
PR/0.1/d	183.2	220.0	207.0	189.8	205.0	201.0	13.1
PR/0.2/d	197.9	184.9	208.5	196.9	216.1	200.9	10.7
PR/0.3/d	180.1	182.3	202.1	198.8	201.9	193.1	9.8
PR/0.4/d	323.0	332.4	240.6	212.4	200.1	261.7	55.6
PR/0.1/m	214.2	210.1	205.3	286.8	221.3	227.6	30.1
PR/0.2/m	283.9	184.7	227.8	173.7	280.8	230.2	46.3
PR/0.3/m	202.5	207.2	208.0	190.6	236.1	208.9	15.0
PR/0.4/m	203.6	254.1	340.0	261.9	188.1	249.5	53.4
- (MDPE)/0.0/r	161.3	159.7	159.1	158.6	162.9	160.3	1.6
PY/0.4/r	162.0	171.6	163.9	212.0	147.7	171.5	21.7
PB/0.4/r	176.4	155.9	148.6	150.9	168.7	160.1	10.7
PR/0.4/r	175.9	169.6	163.8	178.8	157.9	169.2	7.7

Table E1.2 Tensile stress at maximum load (MPa) of colored MDPEs

Sample*	Trial No.					Mean	SD
	1	2	3	4	5		
- (MDPE)/0.0/d	27.8	28.1	27.1	27.4	27.7	27.6	0.3
PY/0.1/d	27.5	27.2	26.9	27.1	27.4	27.2	0.2
PY/0.2/d	26.6	26.9	26.9	27.3	26.4	26.8	0.3
PY/0.3/d	27.2	26.9	27.0	26.8	26.8	26.9	0.2
PY/0.4/d	26.9	27.7	26.4	26.8	26.9	27.0	0.4
PY/0.1/m	26.9	27.0	27.2	27.0	27.3	27.1	0.1
PY/0.2/m	27.7	27.6	27.4	27.6	27.4	27.5	0.1
PY/0.3/m	27.3	27.3	26.9	27.3	27.1	27.2	0.2
PY/0.4/m	28.2	27.6	28.1	27.7	28.3	28.0	0.3
PB/0.1/d	26.8	26.2	26.1	26.4	26.3	26.4	0.3
PB/0.2/d	26.4	26.4	25.9	26.7	25.8	26.3	0.3
PB/0.3/d	25.9	26.1	25.7	26.1	26.1	26.0	0.1
PB/0.4/d	26.8	26.8	26.8	26.7	26.6	26.7	0.1
PB/0.1/m	26.9	27.0	27.2	27.3	26.3	27.0	0.3
PB/0.2/m	26.9	26.9	26.0	26.4	26.5	26.5	0.4
PB/0.3/m	26.5	26.4	26.2	27.0	26.7	26.6	0.3
PB/0.4/m	27.3	27.5	27.2	27.2	27.1	27.3	0.1
PR/0.1/d	26.1	26.5	26.5	26.3	26.8	26.4	0.3
PR/0.2/d	26.6	26.7	26.4	26.7	25.8	26.5	0.3
PR/0.3/d	26.5	26.0	25.9	26.5	25.9	26.2	0.3
PR/0.4/d	26.0	26.2	26.2	26.3	26.3	26.2	0.1
PR/0.1/m	27.7	27.5	27.1	27.7	27.3	27.4	0.3
PR/0.2/m	27.8	27.6	27.6	27.3	27.5	27.6	0.2
PR/0.3/m	27.3	27.3	27.0	26.6	27.0	27.0	0.3
PR/0.4/m	27.3	27.2	27.2	27.2	27.2	27.2	0.1
- (MDPE)/0.0/r	27.3	27.1	27.4	27.4	26.9	27.2	0.2
PY/0.4/r	27.2	27.1	27.3	27.1	27.1	27.2	0.1
PB/0.4/r	28.1	27.8	26.2	27.6	26.8	27.3	0.7
PR/0.4/r	26.1	25.1	24.8	25.5	25.0	25.3	0.5

Table E1.3 Tensile stress at break (MPa) of colored MDPEs

Sample*	Trial No.					Mean	SD
	1	2	3	4	5		
- (MDPE)/0.0/d	5.6	5.6	5.4	5.5	5.5	5.5	0.1
PY/0.1/d	5.5	5.4	5.4	5.4	5.5	5.4	0.0
PY/0.2/d	5.3	5.4	5.4	5.5	5.3	5.4	0.1
PY/0.3/d	5.4	5.4	5.4	5.4	5.4	5.4	0.0
PY/0.4/d	5.4	5.5	5.3	5.4	5.4	5.4	0.1
PY/0.1/m	5.4	5.4	5.4	5.4	5.5	5.4	0.0
PY/0.2/m	5.5	5.5	5.5	5.5	5.5	5.5	0.0
PY/0.3/m	5.5	5.5	5.4	5.5	5.4	5.4	0.0
PY/0.4/m	5.6	5.5	5.6	5.5	5.7	5.6	0.1
PB/0.1/d	5.4	5.2	5.2	5.3	5.3	5.3	0.1
PB/0.2/d	5.3	5.3	5.2	5.3	5.2	5.2	0.1
PB/0.3/d	5.2	5.2	5.1	5.2	5.2	5.2	0.0
PB/0.4/d	5.4	5.4	5.4	5.3	5.3	5.3	0.0
PB/0.1/m	5.4	5.4	5.4	5.5	5.3	5.4	0.1
PB/0.2/m	5.4	5.4	5.2	5.3	5.3	5.3	0.1
PB/0.3/m	5.3	5.3	5.2	5.4	5.3	5.3	0.1
PB/0.4/m	5.5	5.5	5.4	5.4	5.4	5.5	0.0
PR/0.1/d	5.2	5.3	5.3	5.3	5.4	5.3	0.1
PR/0.2/d	5.1	5.1	5.2	8.0	5.2	5.7	1.1
PR/0.3/d	5.3	5.2	5.2	5.3	5.2	5.2	0.1
PR/0.4/d	5.2	5.2	5.2	5.3	5.3	5.2	0.0
PR/0.1/m	5.4	5.6	5.8	5.4	5.4	5.5	0.2
PR/0.2/m	5.6	5.5	5.5	5.5	5.5	5.5	0.0
PR/0.3/m	5.5	5.5	5.4	5.3	5.4	5.4	0.1
PR/0.4/m	5.5	5.4	5.4	5.4	5.4	5.4	0.0
- (MDPE)/0.0/r	5.4	5.4	5.5	5.5	5.4	5.4	0.0
PY/0.4/r	5.4	5.4	5.5	5.4	5.4	5.4	0.0
PB/0.4/r	5.6	5.6	5.2	5.5	5.4	5.5	0.1
PR/0.4/r	5.2	5.0	5.0	5.1	5.0	5.1	0.1

Table E1.4 Percentage strain at break (%) of colored MDPEs

Sample*	Trial No.					Mean	SD
	1	2	3	4	5		
- (MDPE)/0.0/d	1228.2	1131.8	1207.4	1214.2	1286.4	1213.6	49.5
PY/0.1/d	1204.1	647.4	1021.4	594.2	680.0	829.4	240.0
PY/0.2/d	349.0	396.2	597.6	545.3	483.6	474.3	91.8
PY/0.3/d	365.2	466.2	401.5	401.5	362.5	399.4	37.4
PY/0.4/d	240.0	207.2	276.3	345.9	338.6	281.6	54.2
PY/0.1/m	1302.7	1180.6	1241.3	1332.1	631.9	1137.7	258.2
PY/0.2/m	1270.2	735.0	722.2	732.9	1266.5	945.4	263.8
PY/0.3/m	1325.6	1265.4	1076.5	1249.0	970.2	1177.3	132.6
PY/0.4/m	1036.4	1302.4	1244.4	1114.5	1255.3	1190.6	99.1
PB/0.1/d	622.7	578.3	654.3	432.9	513.1	560.3	79.4
PB/0.2/d	727.0	728.8	522.5	682.0	554.3	642.9	87.6
PB/0.3/d	303.2	401.4	245.0	379.8	219.7	309.8	71.6
PB/0.4/d	266.7	239.7	179.9	253.4	223.5	232.6	30.0
PB/0.1/m	549.5	307.2	429.4	499.5	522.2	461.6	86.8
PB/0.2/m	352.2	293.4	420.6	308.9	336.2	342.2	44.2
PB/0.3/m	242.8	358.8	338.8	353.6	246.2	308.0	52.3
PB/0.4/m	412.9	433.0	493.0	490.9	489.2	463.8	34.0
PR/0.1/d	153.5	124.3	104.0	187.1	128.5	139.5	28.5
PR/0.2/d	51.3	48.4	61.3	62.5	84.9	61.7	12.8
PR/0.3/d	81.2	93.7	65.3	67.5	58.1	73.2	12.7
PR/0.4/d	55.2	43.2	39.5	45.2	46.5	45.9	5.2
PR/0.1/m	586.6	730.9	411.0	572.3	467.9	553.7	110.1
PR/0.2/m	345.7	378.1	334.0	413.7	424.4	379.2	35.8
PR/0.3/m	352.7	392.7	337.0	360.0	395.2	367.5	22.8
PR/0.4/m	626.2	450.2	692.3	609.5	391.5	553.9	113.6
- (MDPE)/0.0/r	263.6	251.8	274.5	244.7	274.7	261.8	12.0
PY/0.4/r	76.2	59.6	65.1	62.7	75.4	67.8	6.8
PB/0.4/r	56.7	57.8	64.9	61.4	62.6	60.7	3.0
PR/0.4/r	33.9	33.1	34.7	32.3	33.0	33.4	0.8

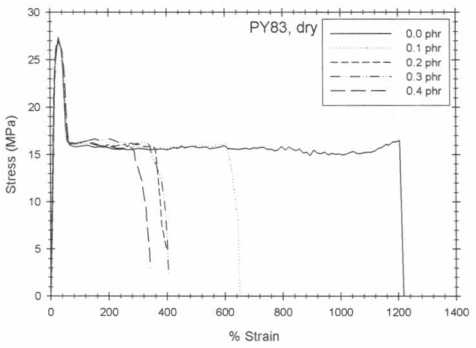
* Type / Content / Technique

Type of pigment (PY = PY83, PB = PB15, and PR = PR122),

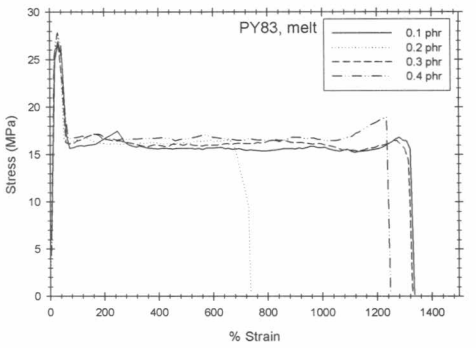
Content of pigment (0.1, 0.2, 0.3, and 0.4 phr), and

Blending Technique or Manufacturing Process

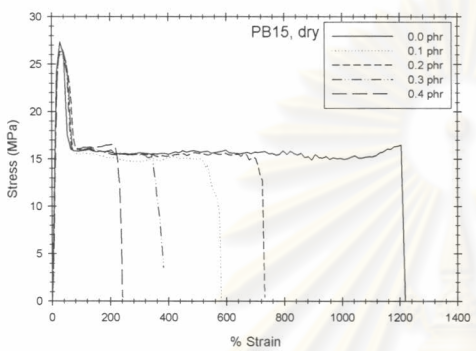
(d = dry blending technique, m = melt blending technique, and r = Rotational Molding)



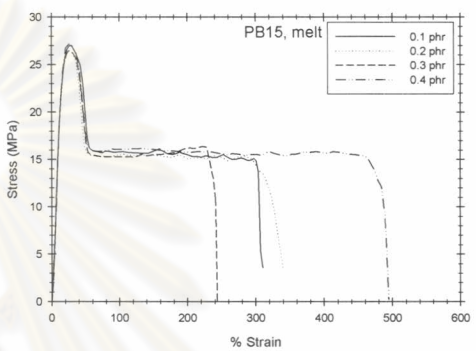
(a) PY 83, dry blending



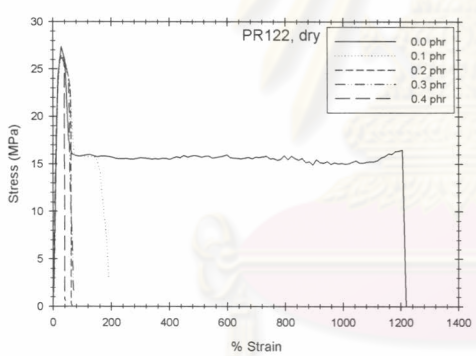
(b) PY 83, melt blending



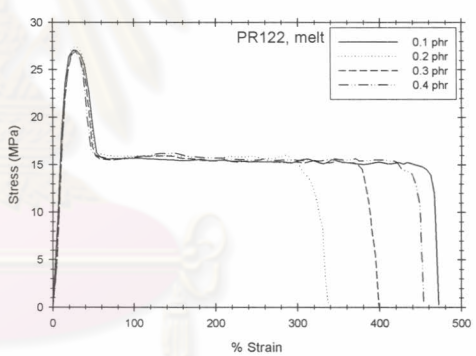
(c) PB 15, dry blending



(d) PB 15, melt blending

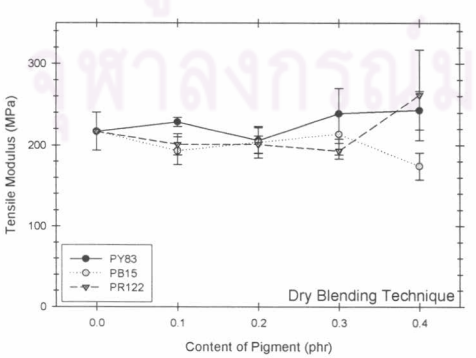


(e) PR 122, dry blending

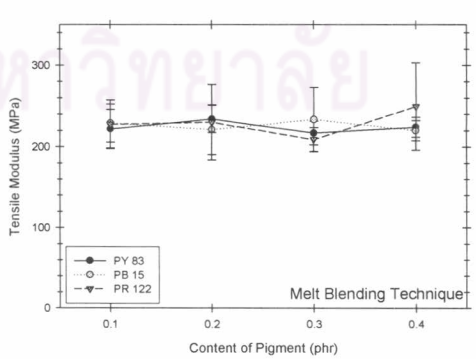


(f) PR 122, melt blending

Figure E1.1 Effect of pigment contents on the tensile properties of colored MDPEs

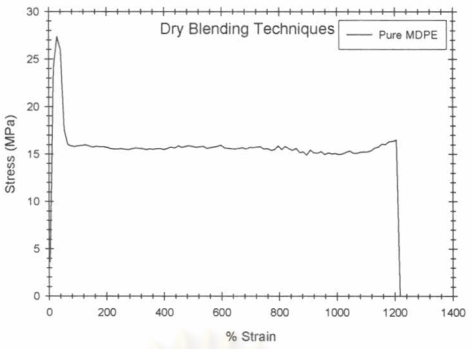


(a) Dry blending technique

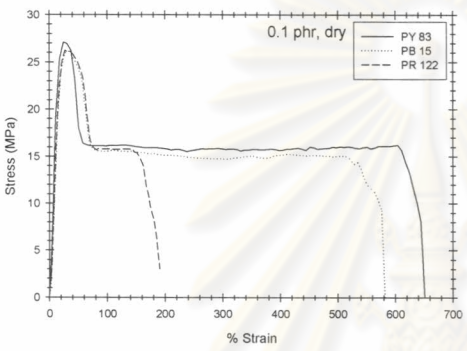


(b) Melt blending technique

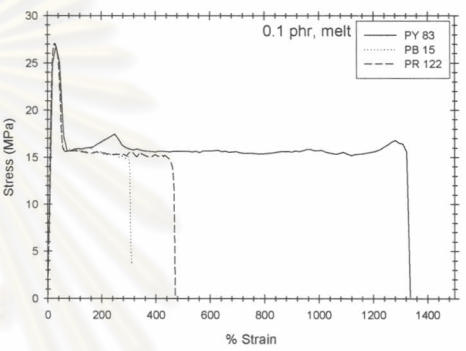
Figure E1.2 Effect of pigment contents and pigment types on the tensile modulus of colored MDPEs



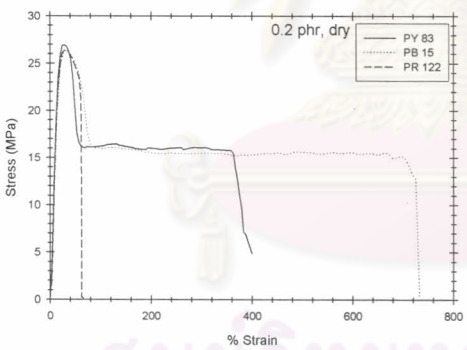
(a) Pure MDPE



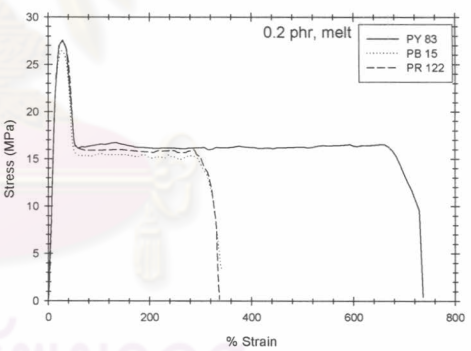
(b) 0.1 phr, dry blending



(c) 0.1 phr, melt blending

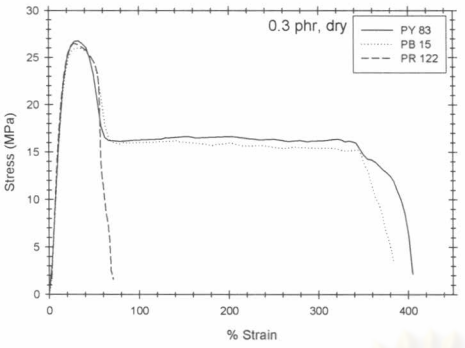


(d) 0.2 phr, dry blending

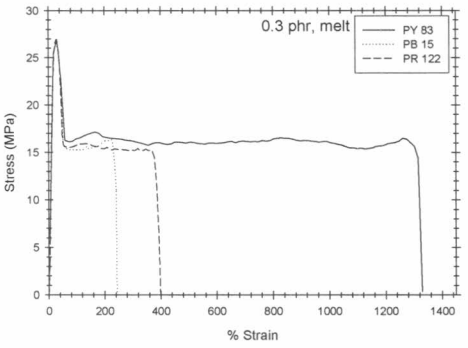


(e) 0.2 phr, melt blending

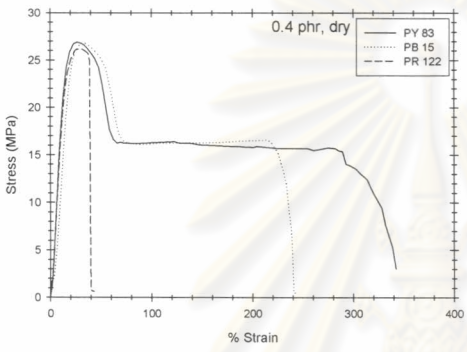
Figure E1.3 Effect of pigment types on the tensile properties of colored MDPEs



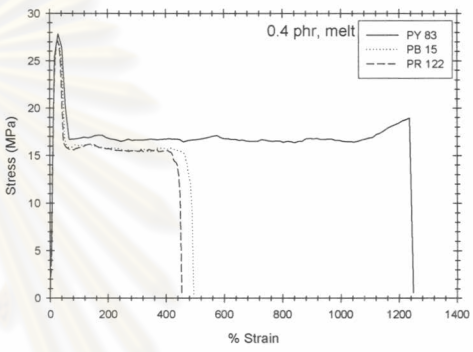
(f) 0.3 phr, dry blending



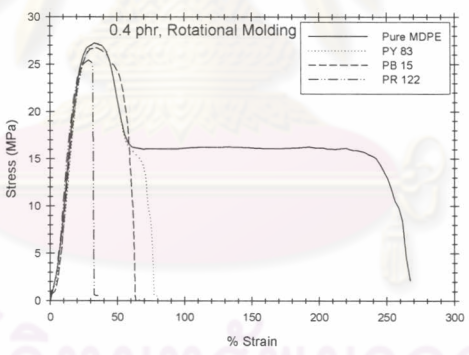
(g) 0.3 phr, melt blending



(h) 0.4 phr, dry blending

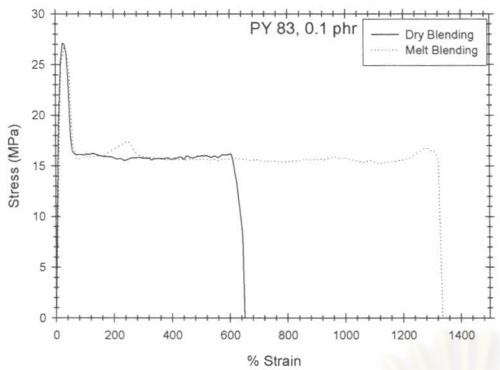


(i) 0.4 phr, melt blending

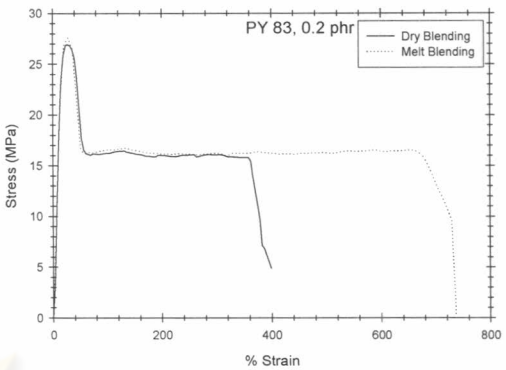


(j) 0.4 phr, rotational molding

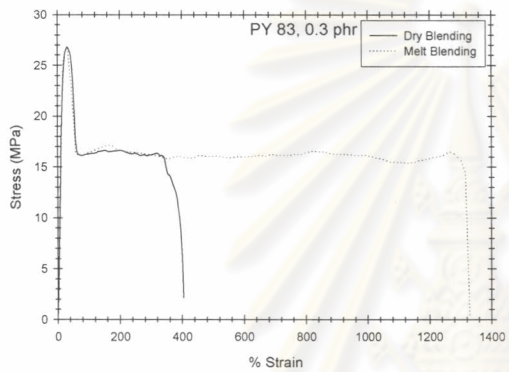
Figure E1.3 Effect of pigment types on the tensile properties of colored MDPEs (continued)



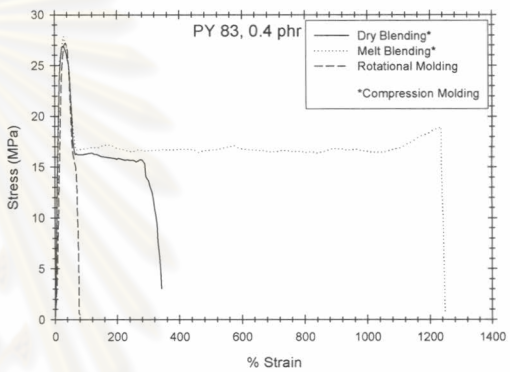
(a) PY 83, 0.1 phr



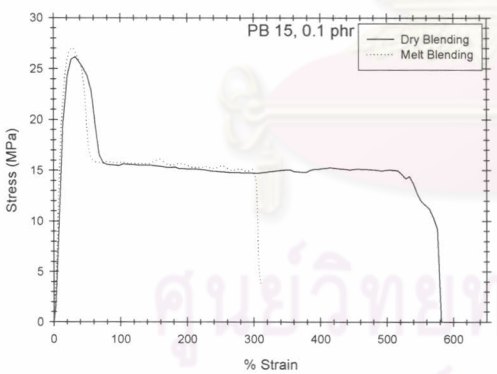
(b) PY 83, 0.2 phr



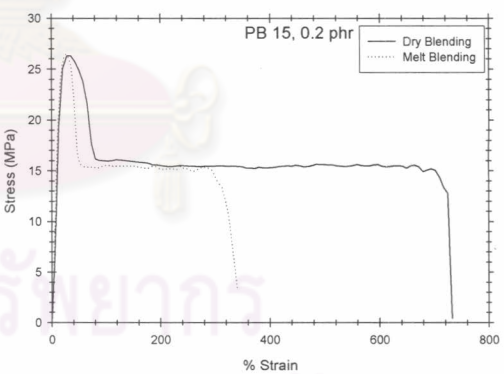
(c) PY 83, 0.3 phr



(d) PY 83, 0.4 phr

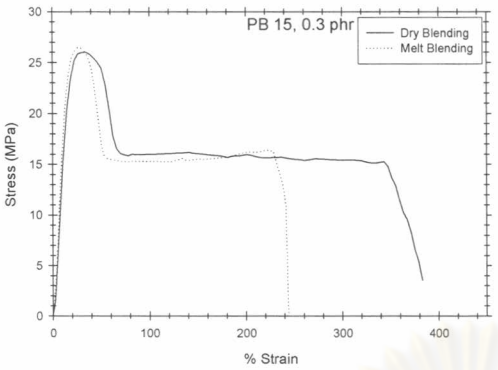


(e) PB 15, 0.1 phr

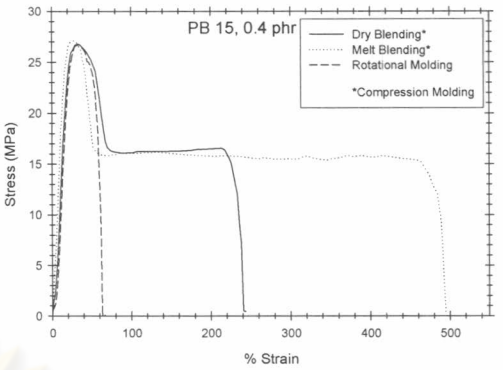


(f) PB 15, 0.2 phr

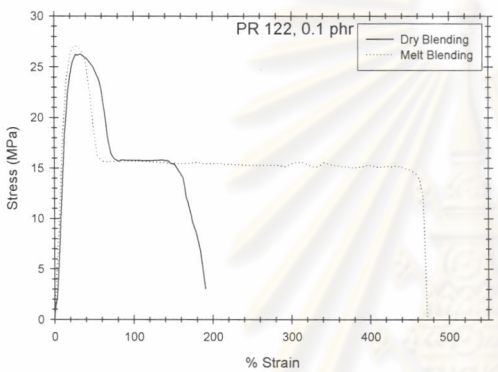
Figure E1.4 Effect of blending techniques and manufacturing processes on the tensile properties of colored MDPEs



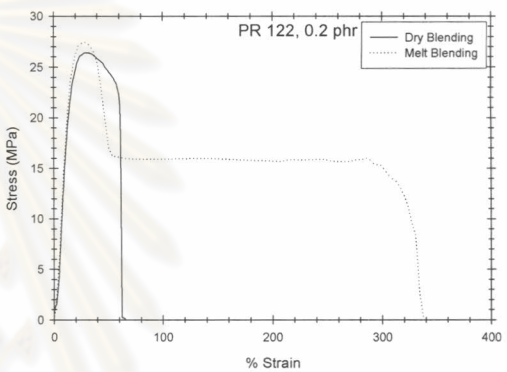
(g) PB 15, 0.3 phr



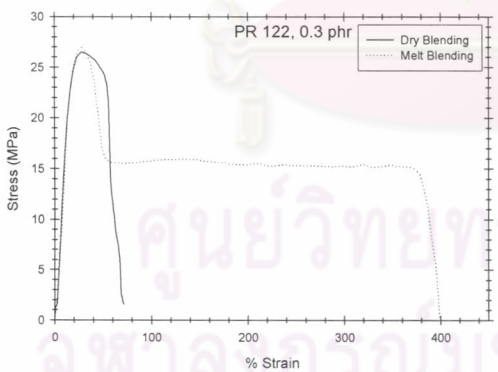
(h) PB 15, 0.4 phr



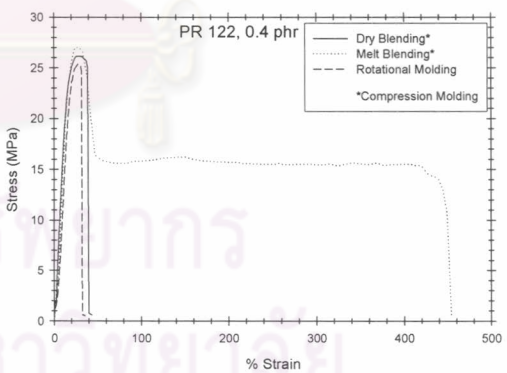
(i) PR 122, 0.1 phr



(j) PR 122, 0.2 phr



(k) PR 122, 0.3 phr



(l) PR 122, 0.4 phr

Figure E1.4 Effect of blending techniques and manufacturing processes on tensile properties of colored MDPEs (continued)

E2. Flexural Properties

Table E2.1 Flexural modulus (MPa) of colored MDPEs

Sample*	Trial No.					Mean	SD
	1	2	3	4	5		
- (MDPE)/0.0/d	910.7	827.8	786.8	922.0	805.0	850.4	55.5
PY/0.1/d	816.7	815.1	743.5	761.8	836.3	794.7	35.6
PY/0.2/d	793.8	853.1	803.2	767.8	772.7	798.1	30.5
PY/0.3/d	796.5	848.8	1037.2	970.0	1051.3	940.8	101.6
PY/0.4/d	810.9	814.1	827.7	800.0	805.8	811.7	9.3
PY/0.1/m	835.4	849.8	888.5	848.2	857.5	855.9	17.8
PY/0.2/m	878.2	871.3	892.4	916.3	912.7	894.2	18.0
PY/0.3/m	890.6	866.9	885.1	881.6	891.4	883.1	8.9
PY/0.4/m	903.2	865.1	845.8	827.4	893.2	866.9	28.3
PB/0.1/d	815.4	816.4	766.6	845.4	997.4	848.2	78.7
PB/0.2/d	765.7	739.6	833.0	753.3	774.7	773.3	32.1
PB/0.3/d	897.0	1295.0	1291.5	883.9	776.5	1028.8	220.0
PB/0.4/d	803.3	779.5	874.8	779.2	969.3	841.2	73.0
PB/0.1/m	911.5	903.0	938.9	898.0	999.5	930.2	37.4
PB/0.2/m	1067.7	884.2	965.1	847.7	1002.8	953.5	79.5
PB/0.3/m	886.2	875.0	996.3	914.5	926.8	919.8	42.6
PB/0.4/m	954.2	917.7	929.3	844.5	884.6	906.0	38.1
PR/0.1/d	774.0	817.8	764.9	828.2	827.2	802.4	27.3
PR/0.2/d	784.3	826.1	830.5	805.4	798.8	809.0	17.2
PR/0.3/d	787.2	846.4	905.5	814.8	858.2	842.4	40.1
PR/0.4/d	857.4	796.4	885.7	898.9	839.5	855.6	36.2
PR/0.1/m	878.9	853.8	865.9	930.3	905.7	886.9	27.7
PR/0.2/m	961.5	959.6	932.2	933.0	897.3	936.7	23.4
PR/0.3/m	873.6	929.6	1017.1	908.2	863.5	918.4	54.7
PR/0.4/m	893.9	882.1	916.6	1187.4	912.3	958.5	115.1
PY/0.4/r/o	661.3	735.0	662.6	653.4	738.3	690.1	38.1
PY/0.4/r/i	653.3	668.6	733.9	730.5	709.0	699.1	32.6
PB/0.4/r/o	714.5	696.6	675.5	688.5	720.0	699.0	16.4
PB/0.4/r/i	658.2	687.7	612.0	594.2	593.0	629.0	37.7
PR/0.4/r/o	582.5	587.5	648.4	620.7	594.2	606.7	24.7
PR/0.4/r/i	572.1	545.8	573.4	544.6	559.8	559.2	12.3

Table E 2.2 Flexural strength at maximum (MPa) of colored MDPEs

Sample*	Trial No.					Mean	SD
	1	2	3	4	5		
- (MDPE)/0.0/d	18.6	18.7	18.5	18.8	18.8	18.7	0.1
PY/0.1/d	18.3	18.4	18.3	18.4	18.3	18.3	0.1
PY/0.2/d	18.9	18.8	18.4	18.4	18.8	18.7	0.2
PY/0.3/d	18.3	18.5	18.6	17.9	18.1	18.3	0.2
PY/0.4/d	18.6	18.3	18.1	18.0	18.3	18.2	0.2
PY/0.1/m	19.0	19.6	19.7	19.2	18.7	19.2	0.4
PY/0.2/m	19.6	19.6	19.3	19.5	19.2	19.4	0.2
PY/0.3/m	19.8	19.4	19.5	19.3	19.1	19.4	0.2
PY/0.4/m	19.2	19.0	19.1	19.4	19.4	19.2	0.2
PB/0.1/d	17.4	17.7	17.5	18.0	17.5	17.6	0.2
PB/0.2/d	16.9	17.2	17.1	16.9	17.2	17.0	0.1
PB/0.3/d	17.6	17.6	17.2	17.6	17.6	17.5	0.2
PB/0.4/d	17.2	17.0	17.0	17.1	16.8	17.0	0.1
PB/0.1/m	19.2	18.7	18.4	18.6	18.6	18.7	0.3
PB/0.2/m	18.9	18.8	18.9	19.1	18.9	18.9	0.7
PB/0.3/m	18.9	18.7	18.9	18.6	18.7	18.8	0.1
PB/0.4/m	18.5	18.4	18.0	18.2	18.6	18.4	0.2
PR/0.1/d	17.5	17.5	17.5	17.4	17.3	17.4	0.1
PR/0.2/d	16.9	17.1	17.0	17.0	17.2	17.1	0.1
PR/0.3/d	16.9	16.8	17.2	16.9	17.2	17.0	0.2
PR/0.4/d	18.0	18.1	17.6	17.7	17.8	17.8	0.2
PR/0.1/m	18.8	18.6	18.8	18.7	18.7	18.7	0.1
PR/0.2/m	19.2	18.9	19.2	18.7	17.9	18.8	0.5
PR/0.3/m	18.4	18.4	18.5	18.6	18.6	18.5	0.1
PR/0.4/m	19.2	19.2	19.4	19.2	19.0	19.2	0.1
PY/0.4/r/o	17.0	17.1	17.3	17.5	17.4	17.2	0.2
PY/0.4/r/i	16.5	17.2	16.7	17.2	16.8	16.9	0.3
PB/0.4/r/o	19.5	19.1	19.3	19.2	19.6	19.3	0.2
PB/0.4/r/i	18.0	18.0	15.6	15.4	15.6	16.5	1.2
PR/0.4/r/o	15.8	15.1	15.3	15.5	15.3	15.4	0.2
PR/0.4/r/i	14.4	15.0	15.0	14.5	14.7	14.7	0.2

* Type / Content / Technique

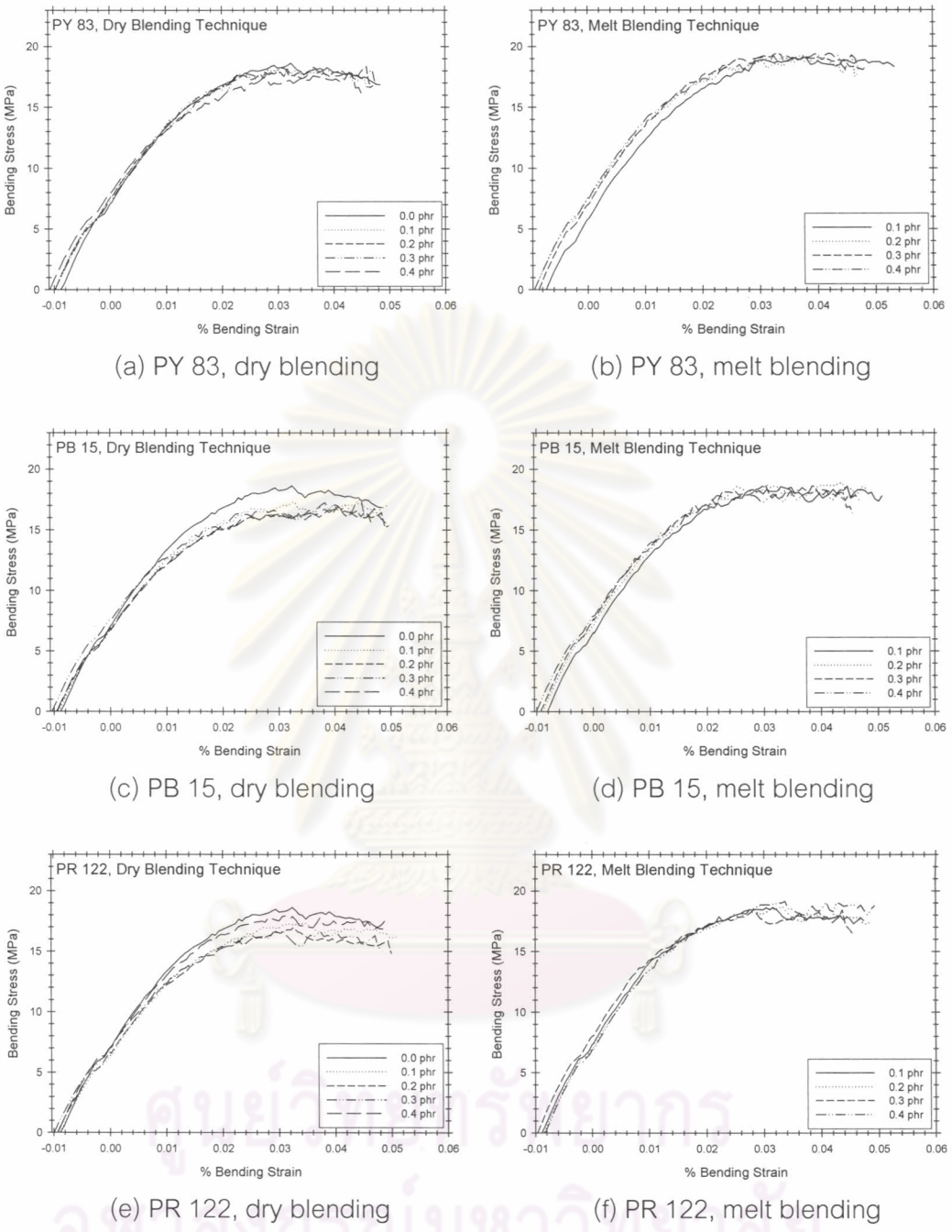
Type of pigment (PY = PY83, PB = PB15, and PR = PR122),

Content of pigment (0.1, 0.2, 0.3, and 0.4 phr), and

Blending Technique or Manufacturing Process

(d = Dry blending technique, m = Melt blending technique,

r/O = Rotational Molding / Outside Surface, and r/i = Rotational Molding / Inside Surface)

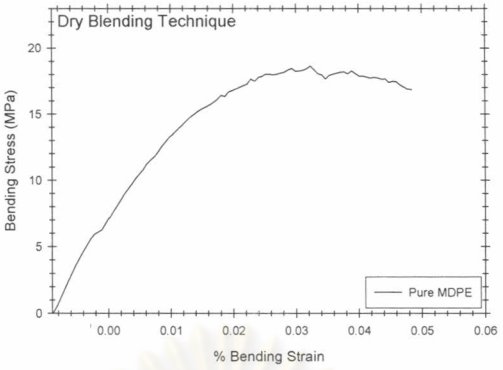


(a) PY 83, dry blending (b) PY 83, melt blending

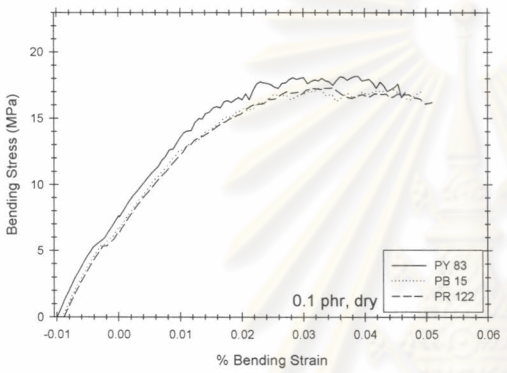
(c) PB 15, dry blending (d) PB 15, melt blending

(e) PR 122, dry blending (f) PR 122, melt blending

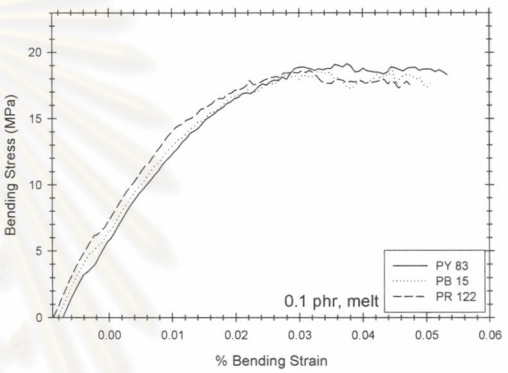
Figure E2.1 Effect of pigment contents on the flexural properties of colored MDPEs



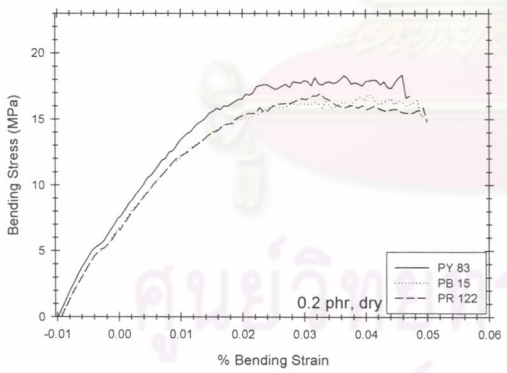
(a) Pure MDPE



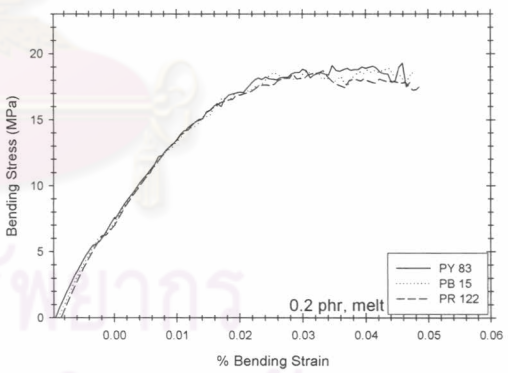
(b) 0.1 phr, dry blending



(c) 0.1 phr, melt blending

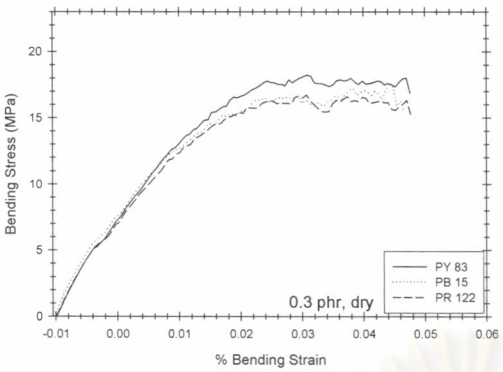


(d) 0.2 phr, dry blending

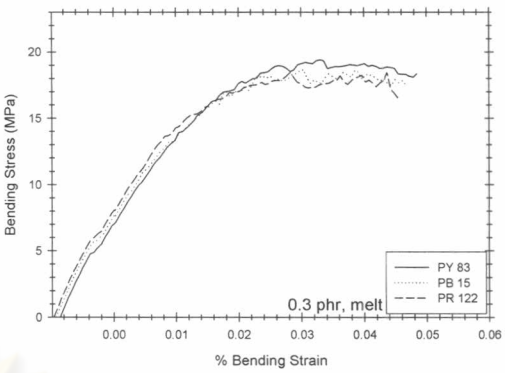


(e) 0.2 phr, melt blending

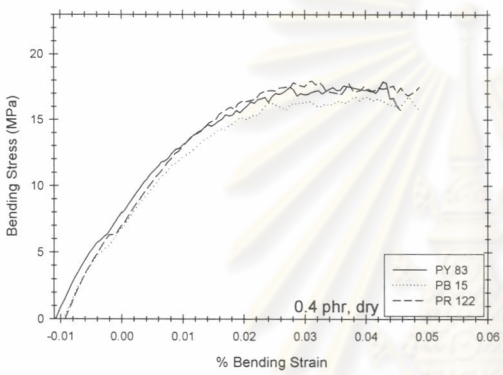
Figure E2.2 Effect of pigment types on the flexural properties of colored MDPEs



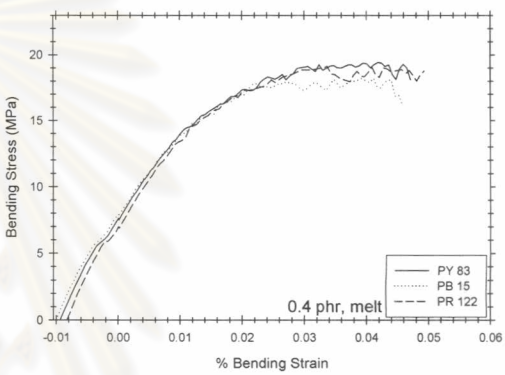
(f) 0.3 phr, dry blending



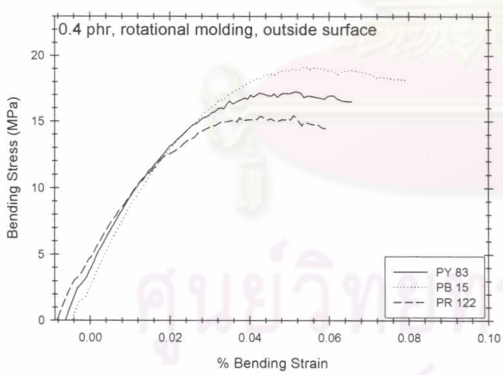
(g) 0.3 phr, melt blending



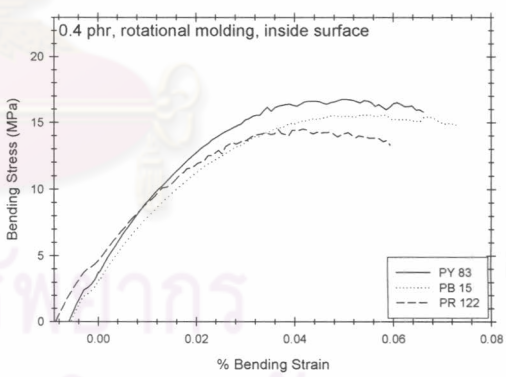
(h) 0.4 phr, dry blending



(i) 0.4 phr, melt blending

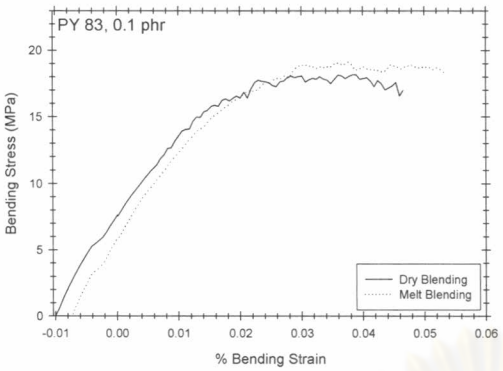


(j) 0.4 phr, rotational molding outside surface

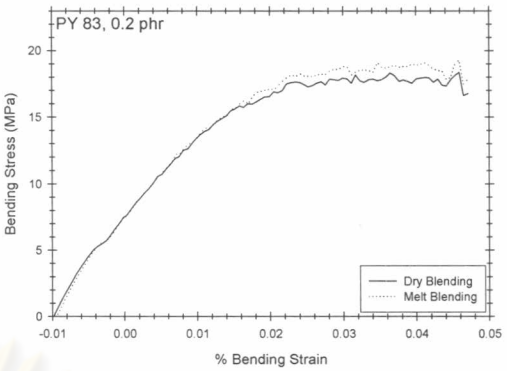


(k) 0.4 phr, rotational molding, inside surface

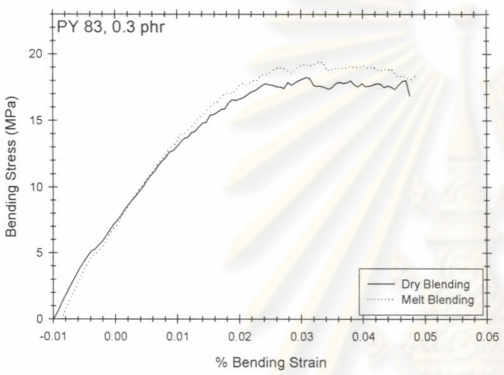
Figure E2.2 Effect of pigment types on the flexural properties of colored MDPEs (continued)



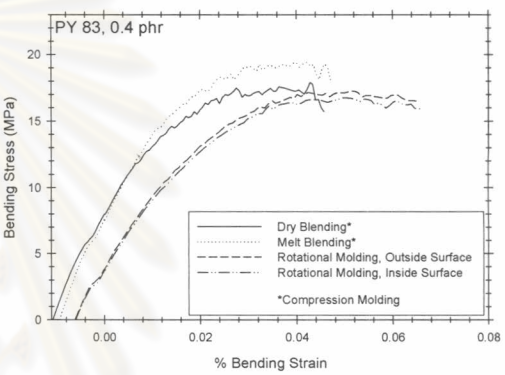
(a) PY 83, 0.1 phr



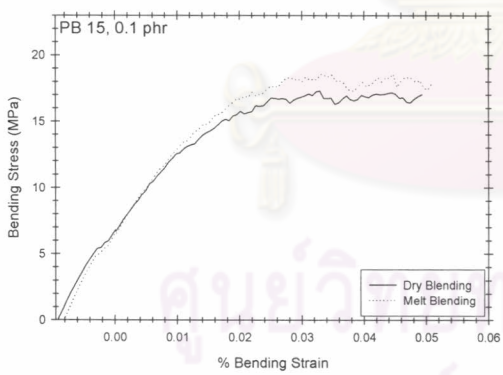
(b) PY 83, 0.2 phr



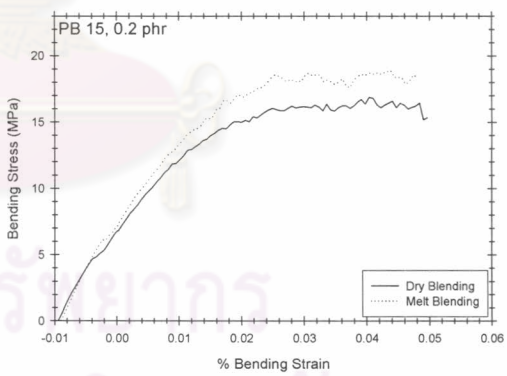
(c) PY 83, 0.3 phr



(d) PY 83, 0.4 phr

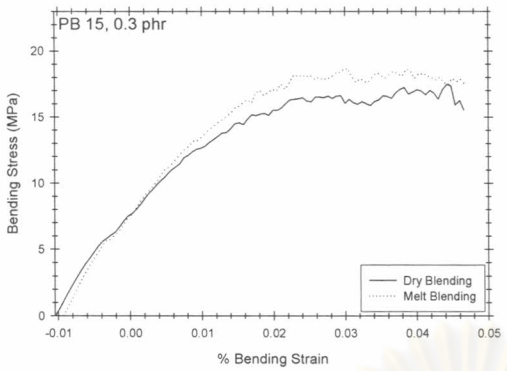


(e) PB 15, 0.1 phr

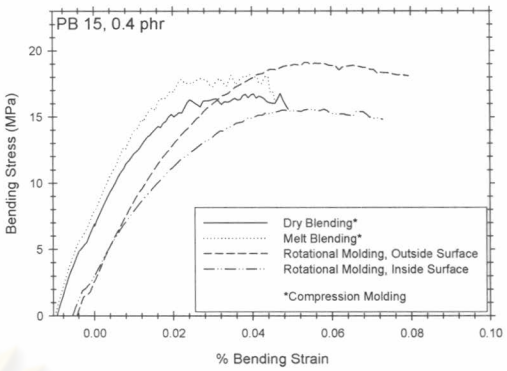


(f) PB 15, 0.2 phr

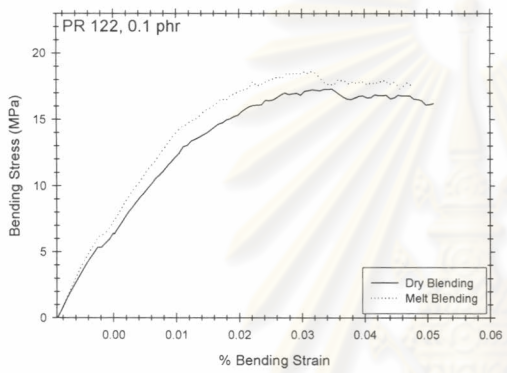
Figure E2.3 Effect of blending techniques and manufacturing processes on the flexural properties of colored MDPEs



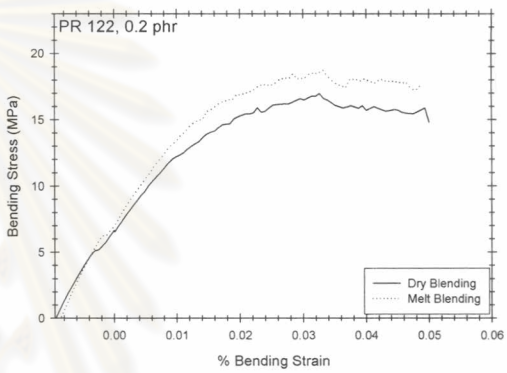
(g) PB 15, 0.3 phr



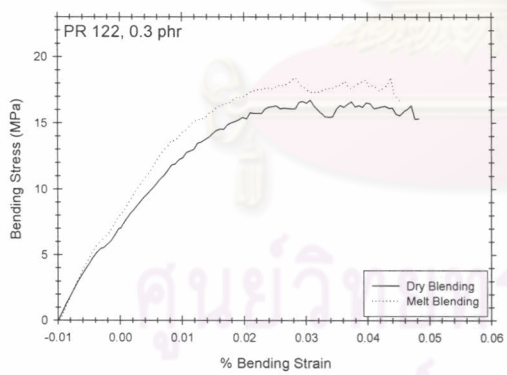
(h) PB 15, 0.4 phr



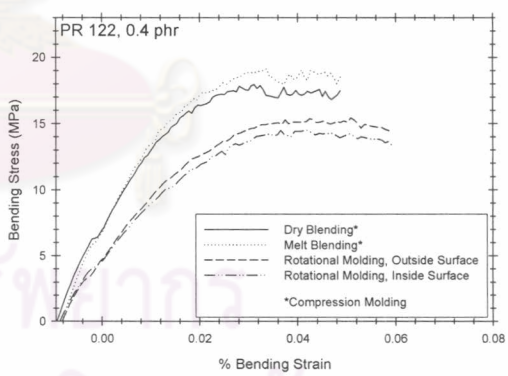
(i) PR 122, 0.1 phr



(j) PR 122, 0.2 phr



(k) PR 122, 0.3 phr



(l) PR 122, 0.4 phr

Figure E2.3 Effect of blending techniques and manufacturing processes on the flexural properties of colored MDPEs (continued)

E3. Impact Properties

Table E3 Impact strength (kJ m^{-2}) of colored MDPEs

Sample*	Trial No.					Mean	SD
	1	2	3	4	5		
- (MDPE)/0.0/d	5.1	5.0	5.0	5.2	5.0	5.1	0.1
PY/0.1/d	6.0	6.1	6.0	6.3	5.9	6.1	0.1
PY/0.2/d	4.9	5.2	6.2	5.9	5.0	5.4	0.5
PY/0.3/d	6.1	6.0	6.1	5.9	6.2	6.1	0.1
PY/0.4/d	6.0	5.2	6.1	5.1	5.5	5.6	0.4
PY/0.1/m	6.5	6.6	6.4	6.3	6.6	6.5	0.1
PY/0.2/m	6.4	6.2	6.5	6.5	6.1	6.3	0.2
PY/0.3/m	5.8	5.7	5.9	5.9	5.9	5.8	0.1
PY/0.4/m	5.5	5.6	5.7	5.7	5.7	5.6	0.1
PB/0.1/d	7.4	6.5	6.7	7.3	6.4	6.9	0.4
PB/0.2/d	6.1	6.1	6.0	6.1	6.0	6.0	0.0
PB/0.3/d	6.2	6.2	5.6	5.3	6.3	5.9	0.4
PB/0.4/d	5.9	6.0	6.0	6.1	5.6	5.9	0.2
PB/0.1/m	7.6	7.5	7.4	7.3	7.3	7.4	0.1
PB/0.2/m	7.5	7.6	7.3	7.3	7.4	7.4	0.1
PB/0.3/m	7.2	7.3	6.9	7.2	7.1	7.1	0.1
PB/0.4/m	6.4	6.6	6.5	6.4	6.5	6.5	0.1
PR/0.1/d	6.6	6.0	6.7	5.6	6.3	6.2	0.4
PR/0.2/d	6.4	5.3	5.7	4.9	6.4	5.8	0.6
PR/0.3/d	6.0	5.9	5.7	5.9	5.8	5.9	0.1
PR/0.4/d	5.8	5.8	5.1	5.2	6.0	5.6	0.4
PR/0.1/m	7.9	7.7	7.8	8.1	7.7	7.8	0.2
PR/0.2/m	7.3	7.0	7.2	7.0	7.1	7.1	0.1
PR/0.3/m	6.6	6.6	6.8	6.8	6.6	6.7	0.1
PR/0.4/m	6.2	6.2	6.3	6.3	6.3	6.3	0.1
- (MDPE)/0.0/r	4.0	3.9	3.9	3.8	3.9	3.9	0.1
PY/0.4/r	3.8	3.5	3.6	3.6	3.6	3.6	0.1
PB/0.4/r	3.8	3.8	4.2	3.8	3.8	3.9	0.2
PR/0.4/r	4.0	4.1	3.8	4.1	4.0	4.0	0.1

* Type / Content / Technique

Type of pigment (PY = PY83, PB = PB15, and PR = PR122),

Content of pigment (0.1, 0.2, 0.3, and 0.4 phr), and

Blending Technique or Manufacturing Process

(d = dry blending technique, m = melt blending technique, and r = Rotational Molding)

Appendix F

Physical Properties Characterization

F. Melt Flow Index (MFI)

Table F Melt flow index (g / 10 minutes) of colored MDPEs

Sample*	Trial No.					Mean	SD
	1	2	3	4	5		
- (MDPE)/0.0/d	4.30	4.29	4.25	4.23	4.24	4.26	0.03
PY/0.1/d	4.21	4.24	4.25	4.22	4.24	4.23	0.02
PY/0.2/d	4.27	4.29	4.25	4.24	4.26	4.26	0.02
PY/0.3/d	4.28	4.29	4.28	4.31	4.30	4.29	0.01
PY/0.4/d	4.31	4.33	4.32	4.31	4.33	4.32	0.01
PY/0.1/m	4.28	4.33	4.31	4.30	4.29	4.30	0.02
PY/0.2/m	4.32	4.30	4.28	4.31	4.29	4.30	0.01
PY/0.3/m	4.30	4.27	4.29	4.30	4.28	4.29	0.01
PY/0.4/m	4.28	4.26	4.29	4.28	4.30	4.28	0.01
PB/0.1/d	4.32	4.32	4.29	4.30	4.29	4.30	0.02
PB/0.2/d	4.29	4.29	4.33	4.35	4.32	4.32	0.03
PB/0.3/d	4.35	4.33	4.34	4.35	4.38	4.35	0.02
PB/0.4/d	4.37	4.36	4.38	4.38	4.35	4.37	0.01
PB/0.1/m	4.32	4.35	4.35	4.37	4.32	4.34	0.02
PB/0.2/m	4.33	4.37	4.37	4.39	4.38	4.37	0.02
PB/0.3/m	4.29	4.31	4.36	4.36	4.31	4.33	0.03
PB/0.4/m	4.33	4.33	4.30	4.28	4.31	4.31	0.02
PR/0.1/d	4.35	4.35	4.36	4.34	4.36	4.35	0.01
PR/0.2/d	4.29	4.30	4.29	4.27	4.24	4.28	0.02
PR/0.3/d	4.25	4.24	4.25	4.22	4.20	4.23	0.02
PR/0.4/d	4.21	4.11	4.13	4.16	4.20	4.16	0.04
PR/0.1/m	4.32	4.33	4.32	4.33	4.33	4.33	0.01
PR/0.2/m	4.31	4.31	4.33	4.28	4.30	4.31	0.02
PR/0.3/m	4.28	4.30	4.28	4.31	4.29	4.29	0.01
PR/0.4/m	4.28	4.29	4.29	4.29	4.23	4.28	0.02

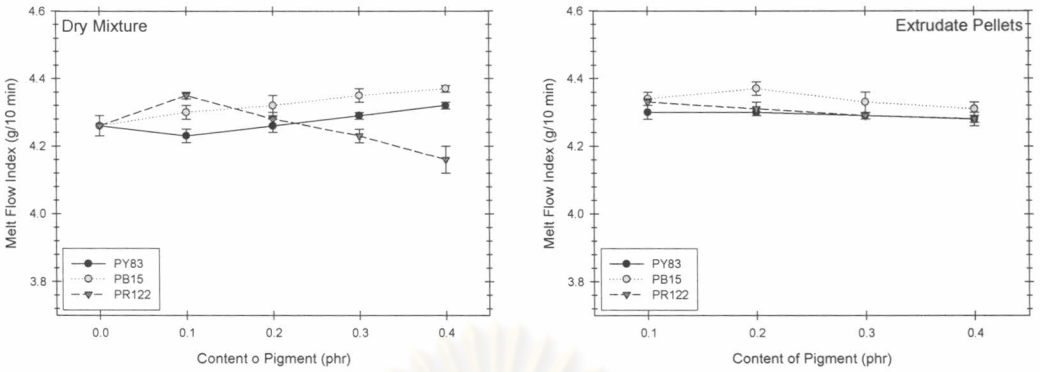
* Type / Content / Technique

Type of pigment (PY = PY83, PB = PB15, and PR = PR122),

Content of pigment (0.1, 0.2, 0.3, and 0.4 phr), and

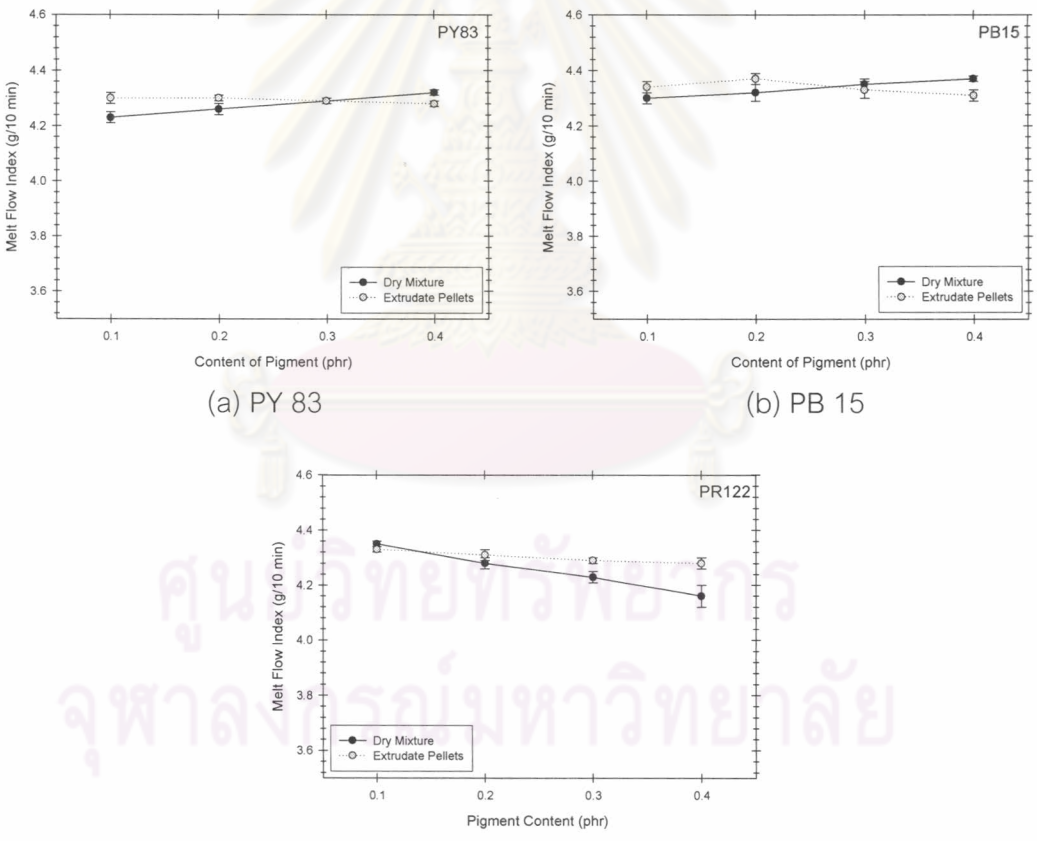
Blending Technique or Manufacturing Process

(d = dry blending technique, m = melt blending technique)



(a) Dry mixture of colored MDPEs (b) Pelletized extrudate of colored MDPEs

Figure F1 Melt flow index of colored MDPEs



(a) PY 83 (b) PB 15

(c) PR 122

Figure F2 Melt flow index of colored MDPEs in different forms

Biography

Miss Ratchanu Buhngachat was born in Nakhorn Sri Thammarat, Thailand, on 12th July, 1978. She received the Bachelor of Science degree majoring in Polymer Science from the Polymer Science Programme in Faculty of Science, Prince of Songkhla University in March 2001. Afterwards, she persuaded her post graduate degree at the Department of Materials Science, Faculty of Science, Chulalongkorn University in 2001. She completed the programme and obtained her Master degree in Applied Polymer Science and Textile Technology in October 2003.