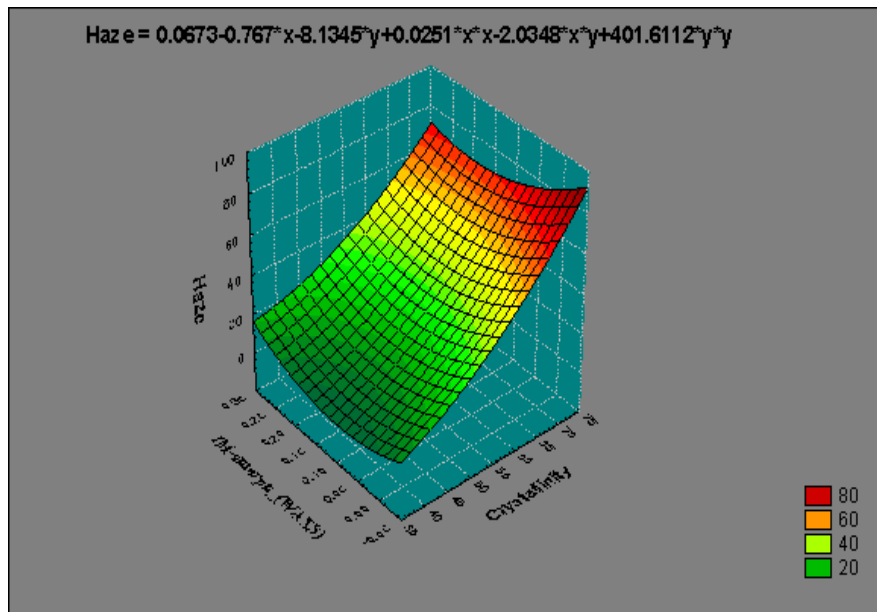
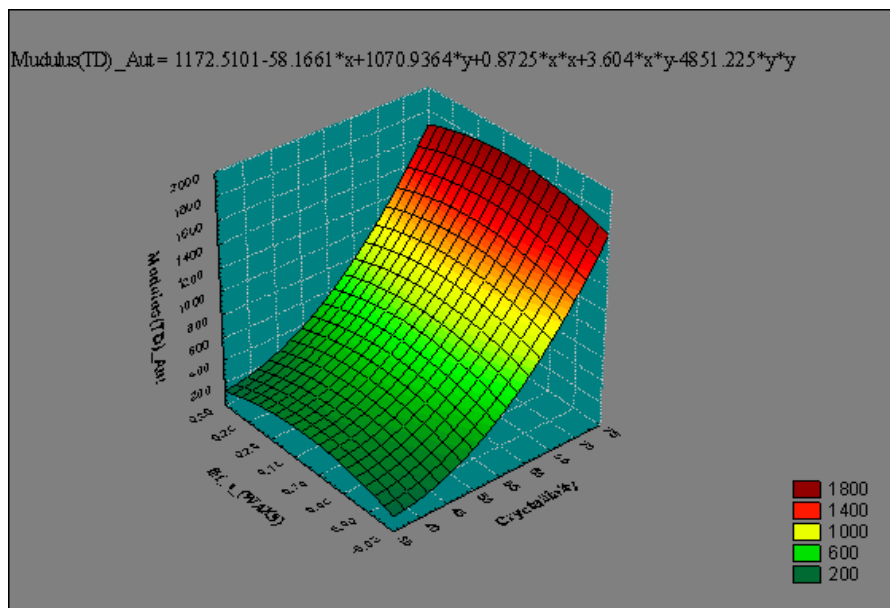


Design of experiment: Study of the major effects

The relationships between the microstructure parameters
and the properties using surface plots



Response surface for Haze; f_{M_amorph} (WAXS) and Crystallinity as independent variables



Response surface for Modulus (TD); f_{M_a} (WAXS) and Crystallinity, as independent variables

N=22	Regression Summary for Dependent Variable: Modulus(MD)_Aut (p R= .99716770 R ² = .99434343 Adjusted R ² = .99086246 F(8,13)=285.65 p<.00000 Std.Error of estimate: 42.177					
	Beta	Std.Err. of Beta	B	Std.Err. of B	t(13)	p-level
Intercept			-508.881	234.0995	-2.17378	0.048788
Crystallinity	0.402556	0.207954	11.531	5.9566	1.93579	0.074944
fT-amorph_(WAXS)	0.085083	0.028753	324.594	109.6916	2.95915	0.011075
lamellar Thickness *	0.216010	0.098730	5.455	2.4931	2.18787	0.047544
Roughness	-0.034301	0.028042	-0.800	0.6540	-1.22320	0.242965
Crystall Length(SAXS)	0.398390	0.161965	55.129	22.4127	2.45973	0.028684
fM_a_(WAXS)	0.045654	0.024214	277.132	146.9844	1.88545	0.081914
Crystal size(110)	-0.124945	0.060181	-10.373	4.9964	-2.07615	0.058278
Crystal size(200)	0.080536	0.057213	11.116	7.8970	1.40765	0.182696

$$\text{Modulus(MD)}_{\text{Aut}} = -508.9 + 324.6 * fT_{\text{amorph}} + 5.5 * \text{Lamellar thickness} + 55.1 * \text{Crystal length}$$

Design of experiment: Empirical modeling



Parameters

- Crystallinity
- Crystal Length(Lc)
- Lamellar Thickness
- Crystal Size(110)
- Crystal Size(200)
- Roughness
- Orientation factors:
 - fM_a
 - fT_a
 - fM_b
 - fT_b
 - fM_amourph
 - fT_amourph

The total of 22 test run include
4 LLDPE, 8 LDPE, 10 HDPE films

	Crystallinity	Crystal length (Lc)	lamellar Thickness	Crystal size(110)	Crystal size(200)	fM_a	fT_a	fM_b	fT_b	fM-amorph	fT-amorph	Roughness
LLDPE9	37.75	3.77	14.22	36.59	30.59	0.141	-0.048	-0.200	0.037	0.021	0.025	21.4
LLDPE1	41.43	4.16	14.55	36.17	30.37	0.155	-0.051	-0.206	0.025	0.034	0.039	11.7
LLDPE5	38.31	3.98	12.76	36.83	31.05	0.132	-0.036	-0.162	-0.025	0.022	0.013	31.5
LLDPE10	40.70	3.63	14.03	39.77	32.66	0.247	-0.111	-0.123	0.081	0.050	0.011	15.9
LDPE13	39.91	3.55	9.73	40.16	31.66	0.204	-0.073	-0.216	0.128	0.032	0.032	22.1
LDPE12	39.92	3.60	9.55	34.28	30.38	0.136	-0.020	-0.227	0.143	0.019	0.049	10.9
LDPE11	39.13	3.48	9.61	37.43	32.79	0.124	-0.045	-0.241	0.091	0.051	0.060	49.5
LDPE10	42.20	4.24	8.90	36.48	32.78	0.120	-0.018	-0.237	0.118	0.013	0.048	28.2
LDPE7	41.23	4.14	9.61	40.71	33.69	0.126	-0.064	-0.243	0.069	0.036	0.037	8.4
LDPE5	41.23	4.14	9.61	39.63	31.50	0.133	-0.060	-0.232	0.094	0.030	0.046	13.5
LDPE3	42.09	3.76	9.61	35.96	32.88	0.116	-0.038	-0.187	0.045	0.017	0.026	19.2
LDPE0	37.73	4.18	9.38	36.11	32.03	0.097	-0.028	-0.255	0.086	0.023	0.049	14.4
HDPE10n	72.59	12.25	37.01	49.68	37.85	0.049	-0.100	-0.318	0.252	0.080	0.292	33.6
HDPE9n	68.58	9.59	45.69	46.78	36.36	0.040	-0.089	-0.353	0.308	0.279	0.235	28.0
HDPE8	70.21	9.84	48.54	47.19	38.03	-0.024	-0.112	-0.317	0.303	0.094	-0.048	67.2
HDPE7n	68.73	9.61	38.85	46.48	35.85	0.066	-0.097	-0.357	0.309	0.167	0.407	46.8
HDPE6n	71.28	10.01	51.76	51.00	41.05	0.113	-0.116	-0.361	0.277	0.248	0.327	69.4
HDPE5	69.27	9.69	42.00	46.99	38.19	0.148	-0.199	-0.334	0.315	0.047	0.141	23.6
HDPE4n	71.77	10.08	51.76	40.73	36.88	0.198	-0.150	-0.338	0.258	0.041	0.141	24.6
HDPE2n	70.65	9.91	47.07	48.68	39.56	0.243	-0.154	-0.326	0.227	-0.032	0.058	54.5
HDPE2	69.49	9.73	43.16	46.73	35.30	0.232	-0.145	-0.334	0.246	-0.003	0.109	21.3
HDPE1n	69.69	9.76	37.91	43.90	33.50	0.274	-0.160	-0.326	0.228	-0.007	0.057	62.1

Independent variables

Design of experiment: Empirical modeling



Responses

- MD/TD Tensile strength @ Yield , MD/TD Tensile strength @Break
- MD/TD strain @ Yield, MD/TD strain @ Break, MD/TD Modulus

	Tensile strength	% strain	Tensile strength	% strain	Modulus		Tensile strength	% strain	Tensile strength	% strain	Modulus		DART impact	Tear strength		Haze	Clarity
	Yield(MD)	@Yield	Break(MD)	Break	Man	AUT	Yield(TD)	@Yield	Break(TD)	@Break	Man	AUT	g(École)	MD gr/µm	TD gr/µm	%	%
LLDPE9	10.50	13.97	31.93	659.64	235.7	232.1	10.95	13.74	29.37	746.87	261.2	255.9	296.0	16.10	28.19	9.7	98.8
LLDPE1	10.09	13.43	30.04	601.23	223.2	217.9	10.14	12.64	18.25	596.93	245.7	246.9	336.0	14.81	27.23	6.4	97.9
LLDPE5	10.46	13.27	23.40	621.73	233.7	234.2	10.48	14.12	17.86	593.14	264.3	258.6	480.0	17.32	24.22	8.2	99.0
LLDPE10	10.55	12.05	38.47	575.97	241.4	227.2	10.31	10.70	20.81	687.37	277.4	278.5	174.0	8.91	29.60	5.2	99.0
LDPE13	11.90	12.05	14.54	164.84	286.7	221.5	9.10	4.63	4.90	60.84	329.2	326.9	15.8	7.34	8.17	6.3	91.2
LDPE12	11.04	11.89	16.26	166.28	259.7	201.0	9.19	6.37	5.36	176.52	312.9	312.0	4.0	9.43	7.43	6.0	92.0
LDPE11	10.73	12.44	14.23	196.63	256.0	194.2	9.84	6.78	5.00	131.97	324.1	326.4	6.8	7.22	8.86	6.5	90.3
LDPE10	12.08	11.91	10.12	283.35	298.1	251.5	10.84	8.09	7.59	265.56	349.1	346.7	11.8	9.65	12.11	6.4	91.9
LDPE7	11.69	12.63	12.83	210.09	290.3	224.1	10.63	7.94	5.16	176.07	361.9	362.2	13.9	12.34	9.48	7.0	91.0
LDPE5	11.20	13.24	16.37	441.66	274.4	222.4	11.25	9.32	11.07	551.93	347.7	346.5	22.3	28.26	21.64	6.4	93.7
LDPE3	11.60	14.60	10.32	431.57	289.0	283.5	11.91	11.81	14.60	737.73	333.3	326.1	49.5	4.91	8.12	9.4	92.4
LDPE0	10.86	14.12	12.27	353.56	280.2	217.1	11.30	9.30	8.75	361.41	354.4	354.5	38.5	8.75	10.80	9.6	86.4
HDPE10n	31.10	4.77	58.26	293.31	1303.7	1185.6	20.42	2.24	14.88	70.59	1444.7	1519.6	0.0	0.55	7.91	54.5	34.9
HDPE9n	37.53	6.00	71.39	318.34	1222.2	1113.0	26.41	3.16	17.09	64.80	1553.6	1371.5	0.0	0.24	12.15	51.3	34.7
HDPE8	30.89	6.00	44.16	243.73	1094.9	933.2	18.59	2.26	12.16	36.82	1275.5	1279.2	0.0	0.33	9.26	58.1	33.0
HDPE7n	30.17	5.33	46.75	273.24	1098.6	1047.9	18.30	1.99	8.83	41.53	1481.4	1537.2	0.0	0.29	16.14	58.4	32.5
HDPE6n	27.82	4.73	38.53	324.82	1085.7	1112.7	22.98	1.61	16.35	13.47	1782.7	1799.5	0.0	0.44	16.00	63.3	26.0
HDPE5	27.37	5.05	35.08	327.03	1109.2	1096.3	18.61	2.74	12.20	15.93	1074.6	1090.2	0.0	0.16	13.07	71.3	19.5
HDPE4n	28.48	4.49	46.83	382.70	1226.1	1229.6	22.03	2.36	12.04	48.23	1489.2	1498.8	0.0	0.26	29.60	65.2	24.9
HDPE2n	30.20	6.55	44.19	621.60	1112.9	1107.9	24.43	2.40	16.82	54.23	1441.1	1461.4	1.3	0.45	38.25	74.4	16.0
HDPE2	29.11	6.65	47.54	582.83	987.7	1009.3	27.51	2.60	21.44	6.68	1453.0	1468.2	3.8	0.23	24.33	70.6	17.8
HDPE1n	24.57	6.52	31.29	645.17	953.5	1015.3	25.68	2.81	16.40	67.67	1356.2	1363.4	3.7	0.43	17.82	72.9	15.6

Dependent variables

Experimental:

Structural parameters and the Study of the major effects of process conditions by design of experiment:



• Dependent Parameters

- Crystallinity
- Crystal Length(Lc)
- Lamellar Thickness
- Crystal Size(110) → BUR
- Crystal Size(200) → BUR
- Roughness
- Orientation factors:
 - fM_a → TUR
 - fT_a → BUR
 - fM_b
 - fT_b → TUR, BUR
 - fM_amorph → TUR
 - fT_amorph → TUR

The total of 22 test run include
4 LLDPE, 8 LDPE, 10 HDPE films

Independent variables: TUR, BUR, FLH

$$fT_b = 0.756 - 0.5993 \cdot x - 0.0025 \cdot y + 0.1076 \cdot x \cdot x + 0.002 \cdot x \cdot y + 5.4406 \cdot 10^{-6} \cdot y \cdot y$$

