EXHIBIT F



IW 1548480

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United States Patent and Trademark Office

December 18, 2006

THIS IS TO CERTIFY THAT ANNEXED IS A TRUE COPY FROM THE RECORDS OF THIS OFFICE OF THE FILE WRAPPER AND CONTENTS OF:

APPLICATION NUMBER: *08/927,393*
FILING DATE: *August 27, 1997*
PATENT NUMBER: *6,111,023*
ISSUE DATE: *August 29, 2000*

By Authority of the
Under Secretary of Commerce for Intellectual Property
and Director of the United States Patent and Trademark Office

L. Edelen

L. EDELEN
Certifying Officer

08/27/97

Class	Subclass
525	240

ISSUE CLASSIFICATION SC 00 ENS

[redacted]

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UTILITY SERIAL NUMBER	PATENT DATE	PATENT NUMBER
	AUG 29 2000	HARLAN

SERIAL NUMBER	FILING DATE	CLASS	SUBCLASS	GROUP ART UNIT	EXAMINER
08/927393	08/27/97	525	240	1713	Robago Wilson

APPLICANTS

[illegible] WINE STEVE CHUM LAKE JACKSON, TX; GEORGE W. KNIGHT, LAKE JACKSON, TX; RONALD P. MARKOVICH, FRIENDSWOOD, TX; SHIH-YAW LAI, SUGAR LAND, TX.

CONTINUING DATA******** CON

VERIFIED

THIS APPLN IS A ~~DIV~~ CON OF 08/544,497 10/18/95 PAT 5,677,383

DRW RH

WHICH IS A CON OF 08/378,998 1/27/95 ABN

WHICH IS A CON OF 08/054,379 4/28/93 ABN

int. - WHICH IS A CIP OF 07/776,130 10/15/91 PAT 5,272,236

int. - AND A CIP OF 07/939,281 9/2/92 PAT. 5,278,272.

[illegible] APPLICATION******** VERIFIED

DRW NONE

Certificate
AUG 29 2006
of Correction

NOTE-DISCLAIMER
The term of this patent shall not extend beyond the expiration date of Pat. No. 5677383.

[illegible] CLENSE GRANTED 01/23/98

Foreign priority claimed 35 USC 119 conditions met	☐ yes ☑ no ☐ yes ☑ no	AS FILED	STATE OR COUNTRY	SHEETS DRWGS.	TOTAL CLAIMS	INDEP. CLAIMS	FILING FEE RECEIVED	ATTORNEY'S DOCKET NO.
Verified and Acknowledged	Examiner's initials RH	→	TX	2	23	6	$1,336.00	40121PU

ADDRESS

THE DOW CHEMICAL COMPANY
[illegible] PATENT DEPT
[illegible], TX 77541

← Osborne K. McKinney

#9

TITLE

[illegible] ARTICLES MADE FROM ETHYLENE POLYMER BLENDS

U.S. DEPT. OF COMM./PAT. & TM—PTO-436L (Rev. 12-94)

PARTS OF APPLICATION FILED SEPARATELY

Applications Examiner

NOTICE OF ALLOWANCE MAILED

4-13-00

R. Harlan
Assistant Examiner

CLAIMS ALLOWED

Total Claims	Print Claim
16	1

ISSUE FEE

Amount Due	Date Paid
1210.00	07-18-00

DAVID W. WU
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700
Primary Examiner

DRAWING

Sheets Drwg.	Figs. Drwg.	Print Fig.
2	2	—

ISSUE BATCH NUMBER 615

PREPARED FOR ISSUE

FORM PTC-1267 (REV. 10-94) U.S. DEPARTMENT OF COMMERCE PATENT & TRADEMARK OFFICE

DISCLAIMER LABEL

SERIAL NO.	FILING DATA
08/927393	8-27-97

A terminal disclaimer has been entered and recorded under 35 U.S.C. 253 in this file by Patent Issue Division.

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Form PTO-436A (Rev. 8/92)

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ISSUE FEE IN FILE

(FACE)

68698 U.S. PTO
08/927393
08/27/97

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

11/07/1997 KDUNCAN 00000034 DA#:041512 08927393
01 FC:101 770.00 CH
02 FC:103 66.00 CH
03 FC:102 240.00 CH
04FC:104 260.00 CH

PTO-1556
(5/87)

JC462 U.S. PTO 08/27/97

A/S

THE UNITED STATES PATENT AND TRADEMARK OF

Docket No. 40121BU
Anticipated Classification of this Application:
Class 525 Subclass 240.000
Prior Application:
Examiner D. Wu
Art Unit 1505

EXPRESS MAIL MAILING LABEL NO.
EM 400556222 US
DATE OF DEPOSIT: August 27,1997

Assistant Commissioner for Patents
Washington D.C. 20231

Sir:

This is a request for filing a ☐ continuation)
☒ divisional)
application under 37 CFR 1.60 and claiming benefit under 35 USC 120
of pending prior application Serial No. 08/544,497
filed on October 18, 1995 of Pak-Wing S. Chum; Ronald P. Markovich; George W. Knight; Shih-Yaw Lai.
for FABRICATED ARTICLES MADE FROM ETHYLENE POLYMER BLENDS.

1. ☒ Enclosed is a copy of the prior application, including the oath or declaration and drawings (if any) as originally filed.
2. ☒ Cancel in this application original claims _____ of the prior application before calculating the filing fee.
3. ☒ The filing fee is calculated below.

For	Number Filed		Number Extra		Rate		Basic Fee
							$770.00
Total Claims	23	- 20 =	3	x	$ 22.00	=	$66.00
Independent Claims	10	- 3 =	7	x	80.00	=	$616.00
Multiple Dependent Claims Presented			4		260.00	=	$1040.00
Total Filing Fee						=	$2492.00

4. ☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment, to Account No. 04-1512. This sheet is enclosed in triplicate.
5. ☐ Amend the specification by inserting after Title of the Invention -- Cross-Reference to Related Application.
This is a --☐ continuation ☐ divisional of application Serial No. _____ filed _____--.
6. ☐ Transfer the drawings from the prior application to this application and abandon said prior application as of the filing date accorded this application. A duplicate copy of this sheet is enclosed for filing in the prior application file. (May only be used if signed by person authorized in Rule 138 and before payment of base issue fee.)
7. ☒ New drawings are enclosed.
8. ☒ The prior application is assigned to The Dow Chemical Company by virtue of an unrecorded assignment.
☐ The prior application is assigned of record to _____ and is recorded at Reel No. _____ Frame No. _____.
9. ☒ The inventorship of this application is the same as that of the prior copending U.S. application.
☐ Fewer inventors are to be named in this application than in the prior copending U.S. application. Delete _____ as inventor(s) in this application.
10. ☒ The Power of Attorney in the prior application is to Stephen P. Krupp, Reg. No. 34,366, L. Wayne White, Reg. No. 25,415, Glenn H. Korfhage, Reg. No. 27,204, Richard G. Waterman, Reg. No. 20,128; and Stephen S. Grace, Registration No. 24,834
Please address all communications to Osborne K. McKinney, 2301 Brazosport Blvd. B-1211, Freeport, Texas 77541.
a. ☒ The power appears in the original papers in the prior application.
b. ☒ The power does not appear in the original papers. A copy of the power in the prior application is enclosed.
c. ☐ Recognize as Associate Attorney _____ whose Registration No. is _____ and whose phone number is._____.
11. ☒ A Preliminary Amendment is enclosed. (Claims added by this amendment have been properly numbered consecutively beginning with the number next following the highest numbered original claim in the prior application.)
12. ☐ A new Disclosure Statement is enclosed.
☒ Applicant(s)' Disclosure Statement is as filed with the parent application (copy attached w/o references).
13. ☒ I hereby verify that the attached papers are a true copy of prior application Serial No. 08/544,497 as originally filed on October 18, 1995, with the exception that the attorney's docket number in the lower left-hand corner of each paper has been adjusted to reflect the instant application.

The undersigned declares further that all statements made herein of his/her own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements may jeopardize the validity of the application or any patent issuing thereon.

August 27, 1997
(Date)

Osborne K. McKinney
Registration No. 40,084
Phone: -(409) 238-7889

40121BU

Docket No. C-40,121-AU
Anticipated Classification of this Application:
Class 526 Subclass
Prior Application:
Examiner David Wu
Art Unit 1505

"Express Mail" mailing number TB192922488US
Date of Deposit October 18, 1995
I hereby certify that this paper or fee is being deposited with the United States Postal Service, with sufficient postage "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231
Stephen P. Krupp
(Typed or printed name of person mailing paper or fee)
(Signature of person mailing paper or fee)

08/927393 08/27/97 68698 U.S. PTO

The Commissioner of Patents and Trademarks
Washington D.C. 20231

Sir:

This is a request for filing a ☒ continuation) divisional)
application under 37 CFR 1.60 and claiming benefit under 35 USC 120
of pending prior application Serial No. 08378,998
filed on January 27, 1995 of Pak-Wing Steve Chum; Ronald P. Markovich; George W. Knight; Shih-Yaw Lai
for FABRICATED ARTICLES MADE FROM ETHYLENE POLYMER BLENDS.

1. ☒ Enclosed is a copy of the prior application, including the oath or declaration as originally filed.
2. ☐ Cancel in this application original claims _____ of the prior application before calculating the filing fee.
3. ☒ The filing fee is calculated below.

For	Number Filed			Number Extra		Rate	Basic Fee $750.00
Total Claims	30	- 20	=	10	x	$ 22.00 =	220
Independent Claims	4	- 3	=	1	x	$ 78.00 =	78
Multiple Dependent Claims Presented						$250.00 =	
Total Filing Fee						=	$ 1,048

4. ☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment, to Account No. 04-1512 This sheet is enclosed in triplicate.
5. ☒ Amend the specification by inserting after Title of the Invention: -- Cross-Reference to Related Application. This is a ☒ continuation divisional of application Serial No., 08378,998 filed January 27, 1995 .--
6. ☐ Transfer the drawings from the prior application to this application and abandon said prior application as of the filing date accorded this application. A duplicate copy of this sheet is enclosed for filing in the prior application file. (May only be used if signed by person authorized in Rule 138 and before payment of base issue fee.)
7. ☒ New drawings are enclosed.
8. ☒ The prior application is assigned to The Dow Chemical Company by virtue of an unrecorded assignment.
   ☐ The prior application is assigned of record to _____ and is recorded at Reel No. _____ Frame No. _____.
9. ☒ The inventorship of this application is the same as that of the prior copending U.S. application. Fewer inventors are to be named in this application than in the prior copending U.S. application. Delete _____ as inventor(s) in this application.
10. ☒ The Power of Attorney in the prior application is to STEPHEN P. KRUPP, Reg. No. 34,366; L. Wayne White, Reg. No. 25,415; Glenn H. Korfhage, Reg. No. 27,204; Richard G. Waterman, Reg. No. 20,128.
    Please address all communications to Osborne K. McKinney, 2301 Brazosport Blvd., B-1211; Freeport, Texas 77541.
    a. ☒ The power appears in the original papers in the prior application.
    b. ☐ The power does not appear in the original papers. A copy of the power in the prior application is enclosed.
    c. ☒ Recognize as Associate Attorney Osborne K. McKinney whose Registration No. is P-40,084 and whose phone number is (409) 238-7889.
11. ☐ A Preliminary Amendment is enclosed. (Claims added by this amendment have been properly numbered consecutively beginning with the number next following the highest numbered original claim in the prior application.)
12. ☐ A new Disclosure Statement is enclosed.
    ☐ Applicant(s)' Disclosure Statement is as filed with the parent application (copy attached).
13. ☒ I hereby verify that the attached papers are a true copy of prior application Serial No. 08/378,998 as originally filed on January 27, 1995, with the exception that the attorney's docket number in the lower left-hand corner of each paper has been adjusted to reflect the instant application.

The undersigned declares further that all statements made herein of his/her own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements may jeopardize the validity of the application or any patent issuing thereon.

10-18-95
(Date)

Stephen P. Krupp
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Phone: 409-238-2889

C-40,121-AU

"Express Mail" mailing number TB303883096
Date of Deposit April 29, 1993
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231
Margaret Greene
(Typed or printed name of person mailing paper or fee)
Margaret Greene
(Signature of person mailing paper or fee)

APPLICATION FOR LETTERS PATENT

Applicant(s): Pak-Wing Steve Chum, Ronald P. Markovich, George W. Knight, and Shih-Yaw Lai

Title: FABRICATED ARTICLES MADE FROM ETHYLENE POLYMER BLENDS

Attorney's Docket No.: C-40,121-G ~~PA~~ BU

EXPRESS MAIL MAILING LABEL NO. **EM 400556222 US**
DATE OF DEPOSIT: **August 27, 1997**

APPLICATION FOR LETTERS PATENT

Applicant(s): Pak-Wing S. Chum, Ronald P. Markovich, George W. Knight, and Shih-Yaw Lai

Title: FABRICATED ARTICLES MADE FROM ETHYLENE POLYMER BLENDS

Attorney's
Docket No.: 40121BU

08/927,393

Abstract of the Disclosure

Fabricated articles made from formulated ethylene polymer compositions are disclosed. Films made from such formulated compositions have surprisingly good impact and tensile properties, and an especially good combination of modulus and toughness. The ethylene polymer compositions have at least one homogeneously branched substantially linear ethylene/α-olefin interpolymer and at least one heterogeneously branched ethylene polymer. The homogeneously branched substantially linear ethylene/α-olefin interpolymer has a density from about 0.89 to about 0.92 g/cm^3 and a slope of strain hardening coefficient greater than or equal to about 1.3.

SUBSTITUTE SHEET (RULE 26)

FABRICATED ARTICLES MADE FROM ETHYLENE POLYMER BLENDS

Cross-Reference to Related Applications

~~This application is a continuation-in-part of pending~~ application serial number 07/776,130, filed October ~~15,~~ 1991 and is related to pending application serial number 07/939,281 entitled "Elastic Substantially Linear ~~Olefin~~ Polymers" filed September 2, 1992 in the names ~~of~~ Shih-Yaw Lai, George W. Knight, John R. Wilson ~~and James C. Stevens, the disclosures of each of which is incorporated herein in their entirety by reference.~~ This application is also related to pending application serial number 08/010,958, filed January 29, 1993 in the names of Brian W. S. Kolthammer and Robert S. Cardwell and entitled Ethylene Interpolymerizations, the disclosure of which is incorporated herein by reference.

Field of the Invention

This invention relates to compositions comprising specific ethylene/α-olefin polymer blends.

The polymer blends preferably comprise:

(A) at least one homogeneously branched substantially linear ethylene/α-olefin interpolymer having specific processing characteristics, blended together with

(B) a heterogeneously branched ethylene polymer.

Such compositions are particularly useful in film applications (e.g., high strength thin gauge packaging film or heat sealable packaging film).

Background of the Invention

Thin film products fabricated from linear low density polyethylene (LLDPE) and/or high density polyethylene (HDPE) are widely used for packaging applications such as merchandise bags, grocery sacks, and industrial liners. For these applications, films with high tensile strength, as well as high impact strength, are desired

because film producers can down gauge their film products and still retain packaging performance.

Previous attempts were made to optimize film tensile strength and yield strength by blending various heterogeneous polymers together on theoretical basis. While such blends exhibited a synergistic response to increase the film yield strength, the film impact strength followed the rule of mixing, often resulting in a "destructive synergism" (i.e., the film impact strength was actually lower than film made from one of the two components used to make the blend).

For example, it is known that while improved modulus linear polyethylene resin can be produced by blending high density polyethylene with a very low density polyethylene (VLDPE), the impact strength of the resin blend follows the rule of mixing.

There is a continuing need to develop polymers which can be formed into fabricated articles (e.g., film) having these combinations of properties (e.g., improved modulus, yield strength, impact strength and tear strength). The need is especially great for polymers which can be made into film which can also be down gauged without loss of strength properties, resulting in savings for film manufacturers and consumers, as well as protecting the environment by source reduction.

Surprisingly, we have now discovered that film can have synergistically enhanced physical properties, when the film is made from a blend of at least one homogeneously branched ethylene/α-olefin interpolymer and a heterogeneously branched ethylene/α-olefin interpolymer.

Brief Description of the Drawings

Figure 1 shows the relationship between the density and the slope of strain hardening coefficient for homogeneously branched substantially linear ethylene/α-olefin interpolymers used in the compositions disclosed herein, in comparison with a heterogeneously branched ethylene/α-olefin copolymer.

Figure 2 shows the short chain branching distribution (as measured by analytical ~~temperture~~ temperature rising elution fractionation (ATREF)) for a homogeneously branched substantially linear ethylene/1-octene copolymer used in the invention, in comparison with Dowlex™ 2045 (a heterogeneously branched ethylene/1-octene copolymer made by The Dow Chemical Company).

Summary of the Invention

Formulated ethylene/α-olefin compositions have now been discovered to have improved physical and mechanical strength and are useful in making fabricated articles. Films made from these novel compositions exhibit surprisingly good impact and tensile properties, and an especially good combination of modulus , yield, ultimate tensile, and toughness (~~e.g.~~ e.g., Dart impact).

The compositions comprise (A) from about 10 percent (by weight of the total composition) to about 95 percent (by weight of the total composition) of

~~(A)~~ at least one homogeneously branched substantially linear ethylene/α-olefin interpolymer having:

(i) a density from about 0.89 grams/cubic centimeter (g/cm^3) to about 0.92 g/cm^3,

(ii) a molecular weight distribution (M_w/M_n) from about 1.8 to about 2.8,

(iii) a melt index (I_2) from about 0.001 grams/10 minutes (g/10 min) to about 10 g/10 min,

(iv) no linear polymer fraction, and

(v) a single melting peak as measured using differential scanning calorimetry; and

(B) at least one heterogeneously branched ethylene polymer having a density from about 0.93 g/cm^3 to about 0.965 g/cm^3.

In another aspect, the compositions comprise from about 10 percent (by weight of the total composition) to about 95 percent (by weight of the total composition) of :

(A) at least one homogeneously branched linear ethylene/α-olefin interpolymer having:

(i) a density from about 0.89 grams/cubic centimeter (g/cm^3) to about 0.92 g/cm^3,

(ii) a molecular weight distribution (M_w/M_n) from about 1.8 to about 2.8,

(iii) a melt index (I_2) from about 0.001 grams/10 minutes (g/10 min) to about 10 g/10 min,

(iv) no linear polymer fraction, and

(v) a single melting peak as measured using differential scanning calorimetry; and

(B) at least one heterogeneously branched ethylene polymer having a density from about 0.93 g/cm^3 to about 0.965 g/cm^3.

Preferably, both the homogeneously branched substantially linear ethylene/α-olefin interpolymer and the homogeneously branched linear ethylene/α-olefin interpolymer each have a slope of strain hardening coefficient greater than or equal to about 1.3.

Detailed Description of the Invention

The homogeneously branched ethylene/α-olefin interpolymer is preferably a homogeneously branched substantially linear ethylene/α-olefin interpolymer as described in pending USSN 07/776,130. The homogeneously branched ethylene/α-olefin interpolymer can also be a linear ethylene/α-olefin interpolymer as described in USP 3,645,992 (Elston), the disclosure of which is incorporated herein by reference.

The substantially linear ethylene/α-olefin interpolymers are not "linear" polymers in the traditional sense of the term, as used to describe linear low density polyethylene (e.g., Ziegler polymerized linear low density polyethylene (LLDPE)), nor are they highly branched polymers, as used to describe low density polyethylene (LDPE).

The substantially linear ethylene/α-olefin interpolymers of the present invention are herein defined as in copending application serial number 07/776,130 and in copending application entitled "Elastic

Substantially Linear Olefin Polymers" filed September 2, 1992 in the names of Shih-Yaw Lai, George W. Knight, John R. Wilson and James C. Stevens.

The homogeneously branched ethylene/α-olefin interpolymers useful for forming the compositions described herein are those in which the comonomer is randomly distributed within a given interpolymer molecule and wherein substantially all of the interpolymer molecules have the same ethylene/comonomer ratio within that interpolymer. The ~~homogeniety~~ homogeneity of the interpolymers is typically described by the SCBDI (Short Chain Branch Distribution Index) or CDBI (Composition Distribution Branch Index) and is defined as the weight percent of the polymer molecules having a comonomer content within 50 percent of the median total molar comonomer content. The CDBI of a polymer is readily calculated from data obtained from techniques known in the art, such as, for example, temperature rising elution fractionation (abbreviated herein as "TREF") as described, for example, in Wild et al, Journal of Polymer Science, Poly. Phys. Ed., Vol. 20, p. 441 (1982), in U.S. Patent 4,798,081 (Hazlitt et al.), or in U.S. Patent 5,089,321 (Chum et al.) the disclosures of all of which are incorporated herein by reference. The SCBDI or CDBI for the linear and for the substantially linear olefin polymers of the present invention is preferably greater than about 30 percent, especially greater than about 50 percent. The homogeneous ethylene/α-olefin polymers used in this invention essentially lack a measurable "high density" fraction as measured by the TREF technique (i.e., the homogeneously branched ethylene/α-olefin polymers do not contain a polymer fraction with a degree of branching less than or equal to 2 methyls/1000 carbons). The ~~homogeneousli~~ homogeneously branched ethylene/α-olefin polymers also do not contain any highly short chain branched fraction (i.e., the homogeneously branched ethylene/α-olefin polymers do not contain a polymer fraction with a degree of branching equal to or more than about 30 methyls/1000 carbons).

The substantially linear ethylene/α-olefin interpolymers for use in the present invention typically are interpolymers of ethylene

with at least one C_3-C_{20} α-olefin and/or C_4-C_{18} diolefins. Copolymers of ethylene and 1-octene are especially preferred. The term "interpolymer" is used herein to indicate a copolymer, or a terpolymer, or the like. That is, at least one other comonomer is polymerized with ethylene to make the interpolymer. Ethylene copolymerized with two or more comonomers can also be used to make the homogeneously branched substantially linear interpolymers useful in this invention. Preferred comonomers include the C_3-C_{20} α-olefins, especially propene, isobutylene, 1-butene, 1-hexene, 4-methyl-1-pentene, 1-heptene, 1-octene, 1-nonene, and 1-decene, more preferably 1-butene, 1-hexene, 4-methyl-1-pentene and 1-octene.

The term "linear ethylene/α-olefin interpolymer" means that the interpolymer does not have long chain branching. That is, the linear ethylene/α-olefin interpolymer has an absence of long chain branching, as for example the linear low density polyethylene polymers or linear high density polyethylene polymers made using uniform (i.e., homogeneous) branching distribution polymerization processes (e.g., as described in USP 3,645,992 (Elston)) and are those in which the comonomer is randomly distributed within a given interpolymer molecule and wherein substantially all of the interpolymer molecules have the same ethylene/comonomer ratio within that interpolymer. The term "linear ethylene/α-olefin interpolymer" does not refer to high pressure branched (free-radical polymerized) polyethylene which is known to those skilled in the art to have numerous long chain branches. The branching distribution of the homogeneously branched linear ethylene/α-olefin interpolymers is the same or substantially the same as that described for the homogeneously branched substantially linear ethylene/α-olefin interpolymers, with the exception that the linear ethylene/α-olefin interpolymers do not have any long chain branching. The homogeneously branched linear ethylene/α-olefin interpolymers comprise ethylene with at least one C_3-C_{20} α-olefin and/or C_4-C_{18} diolefin. Copolymers of ethylene and 1-octene are especially preferred. Preferred comonomers include the C_3-C_{20} α-olefins, especially propene, isobutylene, 1-butene, 1-hexene, 4-methyl-1-

pentene, 1-heptene, 1-octene, 1-nonene, and 1-decene, more preferably 1-butene, 1-hexene, 4-methyl-1-pentene and 1-octene.

Both the homogeneously branched substantially linear and linear ethylene/α-olefin interpolymers have a single melting point, as opposed to traditional heterogeneously branched Ziegler polymerized ethylene/α-olefin copolymers having two or more melting points, as determined using differential scanning calorimetry (DSC).

The density of the homogeneously branched linear or substantially linear ethylene/α-olefin interpolymers (as measured in accordance with ASTM D-792) for use in the present invention is generally from about 0.89 g/cm^3 to about 0.935 g/cm^3, preferably from about 0.905 g/cm^3 to about 0.925 g/cm^3, and especially from about 0.905 g/cm^3 to less than about 0.92 g/cm^3.

The amount of the homogeneously branched linear or substantially linear ethylene/α-olefin polymer incorporated into the composition varies depending upon the heterogeneously branched ethylene polymer to which it is combined. However, about 50 percent (by weight of the total composition) of the homogeneous linear or substantially linear ethylene/α-olefin polymer is especially preferred in the novel compositions disclosed herein.

The molecular weight of the homogeneously branched linear or substantially linear ethylene/α-olefin interpolymers for use in the present invention is conveniently indicated using a melt index measurement according to ASTM D-1238, Condition 190°C/2.16 kg (formerly known as "Condition (E)" and also known as I_2). Melt index is inversely proportional to the molecular weight of the polymer. Thus, the higher the molecular weight, the lower the melt index, although the relationship is not linear. The lower melt index limit for the homogeneously branched linear or substantially linear ethylene/α-olefin interpolymers useful herein is generally about 0.001 grams/10 minutes (g/10 min). The upper melt index limit for the homogeneously branched linear or substantially linear ethylene/α-olefin interpolymers

is about 10 g/10 min, preferably less than about 1 g/10 min, and especially less than about 0.5 g/10 min.

Another measurement useful in characterizing the molecular weight of the homogeneously branched linear or substantially ~~substantialy~~ linear ethylene/α-olefin interpolymers is conveniently indicated using a melt index measurement according to ASTM D-1238, Condition 190°C/10 kg (formerly known as "Condition (N)" and also known as I_{10}). The ratio of the I_{10} and I_2 melt index terms is the melt flow ratio and is designated as I_{10}/I_2. Generally, the I_{10}/I_2 ratio for the homogeneously branched linear ethylene/α-olefin interpolymers is about 5.6. For the homogeneously branched substantially linear ethylene/α-olefin interpolymers used in the compositions of the invention, the I_{10}/I_2 ratio indicates the degree of long chain branching, i.e., the higher the I_{10}/I_2 ratio, the more long chain branching in the interpolymer. Generally, the I_{10}/I_2 ratio of the homogeneously branched substantially linear ethylene/α-olefin interpolymers is at least about 6, preferably at least about 7, especially at least about 8 or above. For the homogeneously branched substantially linear ethylene/α-olefin interpolymers, the higher the I_{10}/I_2 ratio, the better the processability.

Other additives such as antioxidants (e.g., hindered phenolics (e.g., Irganox® 1010 made by Ciba Geigy Corp.), phosphites (e.g., Irgafos® 168 also made by Ciba Geigy Corp.)), cling additives (e.g., PIB), antiblock additives, pigments, fillers, and the like can also be included in the formulations, to the extent that they do not interfere with the enhanced formulation properties discovered by Applicants.

Molecular Weight Distribution Determination

The molecular weight distribution of the linear or substantially linear olefin interpolymer product samples is analyzed by gel permeation chromatography (GPC) on a Waters 150C high temperature chromatographic unit equipped with three mixed porosity columns (Polymer Laboratories 10^3, 10^4, 10^5, and 10^6), operating at a system temperature of 140°C. The solvent is 1,2,4-trichlorobenzene, from which 0.3 percent by weight solutions of the samples are prepared

for injection. The flow rate is 1.0 milliliter/minute and the injection size is 200 microliters. A differential refractometer is being used as the detector.

The molecular weight determination is deduced by using narrow molecular weight distribution polystyrene standards (from Polymer Laboratories) in conjunction with their elution volumes. The equivalent polyethylene molecular weights are determined by using appropriate Mark-Houwink coefficients for polyethylene and polystyrene (as described by Williams and Word in Journal of Polymer Science, Polymer Letters, Vol. 6, (621) 1968, incorporated herein by reference) to derive the following equation:

$$M_{polyethylene} = a * (M_{polystyrene})^{b}.$$

In this equation, a = 0.4316 and b = 1.0. Weight average molecular weight, M_w, is calculated in the usual manner according to the following formula: $M_w = R\, w_i * M_i$, where w_i and M_i are the weight fraction and molecular weight, respectively, of the ith fraction eluting from the GPC column.

For both the homogeneously branched linear and substantially linear ethylene/α-olefin polymers, the molecular weight distribution (M_w/M_n) is preferably from about 1.8 to about 2.8, more preferably from about 1.89 to about 2.2 and especially about 2.

Determination of the Slope of Strain Hardening Coefficient

The slope of strain hardening is measured by compression molding a plaque from the polymer to be tested. Typically, the plaque is molded at about 177°C for 4 minutes under almost no pressure and then pressed for 3 minutes under a pressure of about 200 psi. The plaque is then allowed to cool at about 8°C/minute while still under 200 psi pressure. The molded plaque has a thickness of about 0.005 inches. The plaque is then cut into a dogbone shaped test piece using a steel rule die. The test piece is 0.315 inches wide and 1.063 inches long. The start of the curved portion of the dogbone shape begins at 0.315 inches from each

end of the sample and gently curves (i.e., tapers) to a width of 0.09 inches. The curve ends at a point 0.118 inches from the start of the curve such that the interior portion of the dogbone test piece has a width of 0.09 inches and a length of 0.197 inches.

The tensile properties of the test sample is tested on an Instron Tensile Tester at a crosshead speed of 1 inch/minute. The slope of strain hardening is calculated from the resulting tensile curve by drawing a line parallel to the strain hardening region of the resulting stress/strain curve. The strain hardening region occurs after the sample has pulled its initial load ((i.e., stress) usually with little or no elongation during the ~~intial~~ initial load) and after the sample has gone through a slight drawing stage (usually with little or no increase in load, but with increasing elongation (i.e., strain)). In the strain hardening region, the load and the elongation of the sample both continue to increase. The load increases in the strain hardening region at a much lower rate than during the ~~intial~~ initial load region and the elongation also increase, again at a rate lower than that experienced in the drawing region. Figure 1 shows the various stages of the stress/strain curve used to calculate the slope of strain hardening. The slope of the parallel line in the strain hardening region is then determined.

The slope of strain hardening coefficient (SHC) is calculated according to the following equation:

$$SHC = (\text{slope of strain hardening}) * (I_2)^{0.25}$$

where I_2 = melt index in grams/10 minutes.

For both the homogeneously branched linear and substantially linear ethylene/α-olefin interpolymers used in the invention, the SHC is greater than about 1.3, preferably greater than about 1.5.

Surprisingly, the slope of strain hardening coefficient reaches a maximum for the linear or the substantially linear ethylene/α-olefin polymers at a density from about 0.89 g/cm^3 to about 0.935 g/cm^3. Heterogeneous ethylene/α-olefin polymers, in contrast, do not behave in the same manner. Figure 1 graphically depicts the relationship between the density of the homogeneously branched substantially linear

ethylene polymers and ethylene/α-olefin polymers as a function of their slope of strain hardening coefficient, and includes a ~~heterogenously~~ heterogeneously branched ethylene/1-octene copolymer (polymer W** in Table 1) for comparison purposes. Table 1 displays the data of Figure 1 in tabular form:

Table 1

Polymer	Melt Index (I_2) (g/10 min)	Density (g/cm^3)	I_{10}/I_2	SHC*
A	1	0.8564	7.36	0.004
B	1.03	0.8698	7.46	0.45
C	0.57	0.873	7.22	0.54
D	1.01	0.8817	7.36	0.89
E	1.06	0.9018	7.61	1.84
F	2.01	0.9041	8.07	2.03
G	0.77	0.9047	9.01	1.57
H	9.82	0.9048	7.03	1.67
I	4.78	0.9077	7.18	2.08
J	3.13	0.9113	7.67	2.04
K	2.86	0.9139	7.87	2.27
L	1.08	0.9197	8.07	2.24
M	0.96	0.9198	9.61	1.93
N	0.99	0.9203	9.09	2.23
O	1.11	0.9204	10.15	1.59
P	1.06	0.9205	9.08	2.25
Q	1.12	0.9216	8.94	2.3
R	30.74	0.9217	6.27	2
S	31.58	0.94	6.02	0.24
T	0.97	0.9512	12.11	0
U	0.97	0.9533	10.5	0
V	0.92	0.954	7.39	0
W**	0.8	0.905	8.7	1.02

*SHC = Slope of Strain Hardening Coefficient

**A comparative heterogeneously branched ethylene/1-octene copolymer

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The Heterogeneously Branched Ethylene Polymer

The ethylene polymer to be combined with the homogeneous ethylene/α-olefin interpolymer is a heterogeneously branched (e.g., Ziegler polymerized) interpolymer of ethylene with at least one C_3-C_{20} α-olefin (e.g., linear low density polyethylene (LLDPE)).

Heterogeneously branched ethylene/α-olefin interpolymers differ from the homogeneously branched ethylene/α-olefin interpolymers primarily in their branching distribution. For example, heterogeneously branched LLDPE polymers have a distribution of branching, including a highly branched portion (similar to a very low density polyethylene), a medium branched portion (similar to a medium branched polyethylene) and an essentially linear portion (similar to linear homopolymer polyethylene). The amount of each of these fractions varies depending upon the whole polymer properties desired. For example, linear homopolymer polyethylene has neither branched nor highly branched fractions, but is linear. A very low density heterogeneous polyethylene having a density from about 0.9 g/cm^3 to about 0.915 g/cm^3 (such as Attane® copolymers, sold by The Dow Chemical Company and Flexomer® sold by Union Carbide Corporation) has a higher percentage of the highly short chain branched fraction, thus lowering the density of the whole polymer.

Heterogeneously branched LLDPE (such as Dowlex® sold by The Dow Chemical Company) has a lower amount of the highly branched fraction, but has a greater amount of the medium branched fraction. Figure 2 graphically depicts the relative amounts of these various fractions (as measured using temperature rising elution fractionation) for Dowlex® 2045 (a heterogeneously branched ethylene/1-octene copolymer having a melt index (I_2) of about 1 g/10 min, a density of about 0.92 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 7.93 and a molecular weight distribution (M_W/M_n) of about 3.34), as compared with a homogeneously branched substantially linear ethylene/1-octene copolymer having a melt index (I_2) of about 1 g/10 min, a density of about 0.92 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 10.5

and a molecular weight distribution (M_W/M_n) of about 2.18. Note that the homogeneously branched polymer has a single relatively narrow peak at an elution temperature of about 85°C, while the Dowlex® 2045 polymer has a broad branching distribution, as represented by the breadth of elution ~~tempertaures~~ temperatures over which the polymer fractions elute. Dowlex® 2045 also has a distinct peak at an elution temperature of about 98°C, indicating the "linear" fraction of the whole polymer. Increasing the fraction of the polymer which has the beneficial properties, without ~~concommitantly~~ concomitantly increasing other fractions has not been demonstrated here-to-fore.

Preferably, however, the heterogeneously branched ethylene polymer is a heterogeneously branched Ziegler polymerized ethylene/α-olefin interpolymer having no more than about 10 percent (by weight of the polymer) of a polymer fraction having a SHC ≥ 1.3.

More preferably, the heterogeneously branched ethylene polymer is a copolymer of ethylene with a C_3-C_{20} α-olefin, wherein the copolymer has:

(i) a density from about 0.93 g/cm^3 to about 0.965 g/cm^3,

(ii) a melt index (I_2) from about 0.1 g/10 min to about 500 g/10 min, and

(iii) no more than about 10 percent (by weight of the polymer) of a polymer fraction having a SHC ≥ 1.3.

The heterogeneously branched ethylene/α-olefin interpolymers and/or copolymers also have at least two melting peaks as determined using Differential Scanning Calorimetry (DSC).

The Formulated Compositions

The compositions disclosed herein can be formed by any convenient method, including dry blending the individual components and subsequently melt mixing or by pre-melt mixing in a separate extruder (e.g., a Banbury mixer, a Haake mixer, a Brabender internal mixer, or a twin screw extruder).

Another technique for making the compositions in-situ is disclosed in pending USSN 08/010,958, entitled Ethylene Interpolymerizations, which was filed January 29, 1993 in the names of Brian W.S. Kolthammer and Robert S. Cardwell, the disclosure of which is incorporated herein in its entirety by reference. USSN 08/010,958 describes, inter alia, interpolymerizations of ethylene and C_3-C_{20} alpha-olefins using a homogeneous catalyst in at least one reactor and a heterogeneous catalyst in at least one other reactor. The reactors can be operated sequentially or in parallel.

The compositions can also be made by fractionating a heterogeneous ethylene/α-olefin polymer into specific polymer fractions with each fraction having a narrow composition (i.e., branching) distribution, selecting the fraction having the specified properties (e.g., SHC ≥ 1.3), and blending the selected fraction in the appropriate amounts with another ethylene polymer. This method is obviously not as economical as the in-situ interpolymerizations of USSN 08/010,958, but can be used to obtain the compositions of the invention.

Fabricated Articles Made from the Novel Compositions

Many useful fabricated articles benefit from the novel compositions disclosed herein. For example, molding operations can be used to form useful fabricated articles or parts from the compositions disclosed herein, including various injection molding processes (e.g., that described in Modern Plastics Encyclopedia/89, Mid October 1988 Issue, Volume 65, Number 11, pp. 264-268, "Introduction to Injection Molding" by H. Randall Parker and on pp. 270-271, "Injection Molding Thermoplastics" by Michael W. Green, the disclosures of which are incorporated herein by reference) and blow molding processes (e.g., that described in Modern Plastics Encyclopedia/89, Mid October 1988 Issue, Volume 65, Number 11, pp. 217-218, "Extrusion-Blow Molding" by Christopher Irwin, the disclosure of which is incorporated herein by reference), profile extrusion, calandering, pultrusion (e.g., pipes) and the like. Rotomolded articles can also benefit from the novel compositions

described herein. Rotomolding techniques are well known to those skilled in the art and include, for example, those described in Modern Plastics Encyclopedia/89, Mid October 1988 Issue, Volume 65, Number 11, pp. 296-301, "Rotational Molding" by R.L. Fair, the disclosure of which is incorporated herein by reference).

Fibers (e.g., staple fibers, melt blown fibers or spunbonded fibers (using, e.g., systems as disclosed in USP 4,340,563, USP 4,663,220, USP 4,668,566, or USP 4,322,027, all of which are incorporated herein by reference), and gel spun fibers (e.g., the system disclosed in USP 4,413,110, incorporated herein by reference)), both woven and nonwoven fabrics (e.g., spunlaced fabrics disclosed in USP 3,485,706, incorporated herein by reference) or structures made from such fibers (including, e.g., blends of these fibers with other fibers, e.g., PET or cotton)) can also be made from the novel compositions disclosed herein.

Film and film structures particularly benefit from the novel compositions described herein and can be made using conventional hot blown film fabrication techniques or other biaxial orientation processes such as tenter frames or double bubble processes. Conventional hot blown film processes are described, for example, in The Encyclopedia of Chemical Technology, Kirk-Othmer, Third Edition, John Wiley & Sons, New York, 1981, Vol. 16, pp. 416-417 and Vol. 18, pp. 191-192, the disclosures of which are incorporated herein by reference. Biaxial orientation film manufacturing process such as described in a "double bubble"process as in U.S. Patent 3,456,044 (Pahlke), and the processes described in U.S. Patent 4,352,849 (Mueller), U.S. Patent 4,597,920 (Golike), U.S. Patent 4,820,557 (Warren), U.S. Patent 4,837,084 (Warren), U.S. Patent 4,865,902 (Golike et al.), U.S. Patent 4,927,708 (Herran et al.), U.S. Patent 4,952,451 (Mueller), U.S. Patent 4,963,419 (Lustig et al.), and U.S. Patent 5,059,481 (Lustig et al.), the disclosures of each of which are incorporated herein by reference, can also be used to make film structures from the novel compositions described herein. The film structures can also be made as described in a tenter-frame technique, such as that used for oriented polypropylene.

Other multi-layer film manufacturing techniques for food packaging applications are described in Packaging Foods With Plastics, by Wilmer A. Jenkins and James P. Harrington (1991), pp. 19-27, and in "Coextrusion Basics" by Thomas I. Butler, Film Extrusion Manual: Process, Materials, Properties pp. 31-80 (published by TAPPI Press (1992)) the disclosures of which are incorporated herein by reference.

The films may be monolayer or multilayer films. The film made from the novel compositions can also be coextruded with the other layer(s) or the film can be laminated onto another layer(s) in a secondary operation, such as that described in Packaging Foods With Plastics, by Wilmer A. Jenkins and James P. Harrington (1991) or that described in "Coextrusion For Barrier Packaging" by W.J. Schrenk and C.R. Finch, Society of Plastics Engineers RETEC Proceedings, June 15-17 (1981), pp. 211-229, the disclosure of which is incorporated herein by reference. If a monolayer film is produced via tubular film (i.e., blown film techniques) or flat die (i.e., cast film) as described by K.R. Osborn and W.A. Jenkins in "Plastic Films, Technology and Packaging Applications" (Technomic Publishing Co., Inc. (1992)), the disclosure of which is incorporated herein by reference, then the film must go through an additional post-extrusion step of adhesive or extrusion lamination to other packaging material layers to form a multilayer structure. If the film is a coextrusion of two or more layers (also ~~decribed~~ described by Osborn and Jenkins), the film may still be laminated to additional layers of packaging materials, depending on the other physical requirements of the final film. "Laminations Vs. Coextrusion" by D. Dumbleton (Converting Magazine (September 1992), the disclosure of which is incorporated herein by reference, also ~~dicusses~~ discusses lamination versus coextrusion. Monolayer and coextruded films can also go through other post extrusion techniques, such as a biaxial orientation process.

Extrusion coating is yet another technique for producing multilayer film structures using the novel compositions described herein. The novel compositions comprise at least one layer of the film structure. Similar to cast film, extrusion coating is a flat die technique.

A sealant can be extrusion coated onto a substrate either in the form of a monolayer or a coextruded extrudate.

Generally for a multilayer film structure, the novel compositions described herein comprise at least one layer of the total multilayer film structure. Other layers of the multilayer structure include but are not limited to barrier layers, and/or tie layers, and/or structural layers. Various materials can be used for these layers, with some of them being used as more than one layer in the same film structure. Some of these materials include: foil, nylon, ethylene/vinyl alcohol (EVOH) copolymers, polyvinylidene chloride (PVDC), polyethylene ~~terepthalate~~ terephthalate (PET), oriented polypropylene (OPP), ethylene/vinyl acetate (EVA) copolymers, ethylene/acrylic acid (EAA) copolymers, ethylene/methacrylic acid (EMAA) copolymers, LLDPE, HDPE, LDPE, nylon, graft adhesive polymers (e.g., maleic anhydride grafted polyethylene), and paper. Generally, the multilayer film structures comprise from 2 to about 7 layers.

Example 1

Seventy five percent (by weight of the total composition) of a homogeneously branched substantially linear ethylene/1-octene copolymer having I_2 of about 1 g/10 min, density of about 0.91 g/cm^3, I_{10}/I_2 of about 10, M_w/M_n of about 2, and SHC of about 1.81 is dry blended and then melt blended with 25 percent (by weight of the total composition) of a heterogeneously branched ethylene/1-octene copolymer having I_2 of about 1 g/10 min, density of about 0.935 g/cm^3, I_{10}/I_2 of about 7.8, and M_w/M_n of about 3.4. The heterogeneously branched ethylene/1-octene copolymer has a fraction of about 5 percent (by weight of the heterogeneously branched copolymer) having a SHC ≥ 1.3. The dry blend is tumble blended in a 50 gallon drum for about 1 hour.

The melt blend is produced in a ZSK 30 twin screw extruder (30 mm screw diameter) and is then fabricated into film. The final blended composition has a density of about 0.919 g/cm^3.

The blended composition is then fabricated into blown film having a thickness of about 1 mil on an Egan Blown Film Line having a 2 inch diameter screw, a 3 inch die and at a 2.5 inch blow up ratio (BUR), as described in Table 2. For all film samples in Examples 1, 2, 4, and 6 and for comparative examples 3, 5, and 7, the targeted gauge is about 1 mil, using a blow-up ratio (BUR) of 2.5:1, a LLDPE screw design is used, a die gap of 70 mils is used, and a lay flat of about 11.875 inches is used.

Film properties are measured and reported in Table 3 with other examples of the invention and with comparative examples. Dart impact (type A) of the films is measured in accordance with ASTM D-1709-85; tensile strength, yield, toughness, and 2% secant modulus of the films is measured in accordance with ASTM D-882; Elmendorf tear (type B) is measured in accordance with ASTM D-1922; PPT tear is measured in accordance with ASTM D-2582; Block is measured in accordance with ASTM D-3354.

Puncture is measured by using an Instron tensiometer Tensile Tester with an integrator, a specimen holder that holds the film sample taut across a circular opening, and a rod-like puncturing device with a rounded tip (ball) which is attached to the cross-head of the Instron and impinges perpendicularly onto the film sample. The Instron is set to obtain a crosshead speed of 10 inches/minute and a chart speed (if used) of 10 inches/minute. Load range of 50% of the load cell capacity (100 lb. load for these tests) should be used. The puncturing device is installed to the Instron such that the clamping unit is attached to the lower mount and the ball is attached to the upper mount on the crosshead. Six film specimens are used (each 6 inches square). The specimen is clamped in the film holder and the film holder is secured to the mounting bracket. The crosshead travel is set and continues until the specimen breaks. Puncture resistance is defined as the energy to puncture divided by the volume of the film under test. Puncture resistance (PR) is calculated as follows:

$$PR = E/((12)(T)(A))$$

where PR = puncture resistance ($ft\text{-}lbs/in^3$)

E = energy (inch-lbs) = area under the load displacement curve

12 = inches/foot

T = film thickness (inches), and

A = area of the film sample in the clamp = 12.56 in^2.

Example 2

Seventy five percent (by weight of the total composition) of a homogeneously branched substantially linear ethylene/1-octene copolymer having I_2 of about 0.5 g/10 min, density of about 0.915 g/cm^3, I_{10}/I_2 of about 11, M_w/M_n of about 2.4, and SHC of about 2.265 is dry blended and then melt blended (as described in Example 1) with 25 percent (by weight of the total composition) of a heterogeneously branched ethylene/1-octene copolymer having I_2 of about 1 g/10 min, density of about 0.935 g/cm^3, I_{10}/I_2 of about 7.8, and M_w/M_n of about 3.4. The heterogeneously branched ethylene/1-octene copolymer has a fraction of about 5 percent (by weight of the heterogeneously branched copolymer) having a SHC ≥ 1.3. The final blended composition has a density of about 0.92 g/cm^3.

Blown film is made as described in Table 2 and film properties are measured and reported in Table 3 with other examples of the invention and with comparative examples.

Comparative Example 3

A heterogeneously branched ethylene/1-octene copolymer having I_2 of about 1 g/10 min, density of about 0.92 g/cm^3, I_{10}/I_2 of about 7.93, and M_w/M_n of about 3.34 is made into film as described in Example 1. The heterogeneously branched ethylene/1-octene copolymer has a fraction of about 36 percent (by weight of the heterogeneous copolymer) having a SHC ≥ 1.3. The entire heterogeneous ethylene/1-octene copolymer has a SHC of about 1.5.

Blown film is made as described in Table 2 and film properties are measured and reported in Table 3 with other examples of the invention and with comparative examples.

Example 4

Example 4 is an *in-situ* blend made according to USSN 08/010,958, wherein the homogeneously branched substantially linear polymer is made in a first reactor and is an ethylene/1-octene copolymer having a melt index (I_2) of about 0.5 g/10 min., and a density of about 0.9054 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 8.27 and a molecular weight distribution (M_W/M_n) of about 1.979 and comprises about 50% (by weight of the total composition). A heterogeneously branched ethylene/1-octene copolymer is made in a second reactor operated sequentially with the first reactor and has a melt index (I_2) of about 1.5 g/10 min., and a density of about 0.944 g/cm^3 and comprises the remaining 50% (by weight of the total composition). The total composition has a melt index (I_2) of about 1 g/10 min., a density of about 0.9248 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 7.22 and a molecular weight distribution (M_W/M_n) of about 2.641. This composition is made into blown film as described in Table 2 and the resultant film properties are reported in Table 3.

Comparative Example 5

Comparative Example 5 is an ethylene/1-octene copolymer made according to USSN 07/773,375, filed October 7, 1991, the disclosure of which is incorporated herein by reference. About 15% (by weight of the total composition) is made in a first reactor, with the remaining portion of the composition polymerized in a second sequentially operated reactor. Both reactors utilize Ziegler type catalysts and make heterogeneously branched polymers. The total composition has a melt index (I_2) of about 0.56 g/10 min., a density of about 0.9256 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 9.5 and a molecular weight distribution (M_W/M_n) of about 4.35. This composition is also made into blown film as described in Table 2 and the resultant film properties are reported in Table 3.

Example 6

Example 6 is an *in-situ* blend made according to USSN 08/010,958, wherein the homogeneously branched substantially linear polymer is made in a first reactor and is an ethylene/1-octene copolymer having a fractional melt index (I_2) , a density of about 0.906 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 8-10 and a molecular weight distribution (M_W/M_n) of about 2.2 and comprises about 43% (by weight of the total composition). A second heterogeneously branched ethylene/1-octene copolymer is made in a second reactor operated sequentially with the first reactor and has a melt index (I_2) of about 0.85 g/10 minutes, a density of about 0.938 g/cm^3 and comprises the remaining 57% (by weight of the total composition). The total composition has a melt index (I_2) of about 0.53 g/10 minutes, a density of about 0.9246 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 7.83, and a molecular weight distribution (M_W/M_n) of about 2.8. This composition is made into blown film as described in Table 2 and the film properties are reported in Table 3.

Comparative Example 7

Comparative Example 7 is an ethylene/1-octene copolymer made according to USSN 07/773,375, filed October 7, 1991, the disclosure of which is incorporated herein by reference. About 25% (by weight of the total composition) is made in a first reactor, with the remaining portion of the composition polymerized in a second sequentially operated reactor. Both reactors utilize Ziegler type catalysts and make heterogeneously branched polymers. The total composition has a melt index (I_2) of about 0.49 g/10 min., a density of about 0.9244 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 10 and a molecular weight distribution (M_W/M_n) of about 4.78. This composition is also made into blown film as described in Table 2 and the resultant film properties are reported in Table 3.

Comparative Example 8

Comparative example 8 is a heterogeneously branched ethylene/1-octene copolymer having a melt index (I_2) of about 1 g/10 minutes, a density of ~~baout~~ about 0.9249 g/cm^3, a melt flow ratio (I_{10}/I_2) of about 8 and a molecular weight ~~distrubution~~ distribution (M_w/M_n) of about 3.5.

Blown film is made as described in Table 2 and film properties are measured and reported in Table 3 with other examples of the invention and comparative examples.

Table 2

	Ex. 1	Ex. 2	Comp. Ex. 3	Ex. 4	Comp. Ex. 5	Ex. 6	Comp. Ex. 7	Comp. Ex. 8
Zone 1A (°F)	300	300	300	300	300	300	300	300
Zone 1B (°F)	450	451	475	474	475	475	475	474
Zone 1C (°F)	450	450	475	475	475	475	475	475
Zone 2A (°F)	450	450	475	474	475	475	475	475
Zone 2B (°F)	450	450	455	475	475	475	475	475
Zone 2C (°F)	450	450	475	475	475	475	475	475
Zone 3 (°F)	451	452	474	477	477	476	476	474
Zone 4 (°F)	450	450	473	475	475	475	475	475
Zone 5 (°F)	450	450	475	475	475	475	475	475
Melt temp. (°F)	475	477	515	501	502	499	499	497
Blower Air temp. (°F)	47.3	45.7	57	44.4	86.5	47.6	NA	47.3
Chill Water temp. (°F)	39	37.6	51.1	38.3	86.8	40	38.7	40.5
Extruder Die press. (psi)	2843	3427	1321	1874	1763	2883	2525	1952
Nozzle press. (in.)	3.2	4.5	4.38	4.4	4.9	4.6	4.6	4.3
Amps	27.3	33.1	37.7	39.9	40.2	50.1	42.6	38.6
Extruder speed (rpm)	27.6	28.8	21.5	23.1	21.1	21.5	22.1	21.7
Nip Roll speed (rpm)	33.1	36.9	39	39.8	36.2	37	36	37.8
Output (lbs/hr)	31	NR*	38.3	39	NR*	36	36	36
Frost line height (in.)	12.5	9	13	12	12	10.5	11	10.5

*NR = Not recorded

Table 3

	Ex. 1	Ex. 2	Comp. Ex. 3	Ex. 4	Comp. Ex. 5	Ex. 6	Comp. Ex. 7	Comp. Ex. 8
Yield (MD*) (psi)	1605	1595	1643	2040	2243	1973	1810	1782
Tensile (MD*) (psi)	8522	9525	7444	7794	7931	9325	8455	4928
Toughness (MD*) ($ft\text{-}lbs/in^3$)	1689	1773	1439	1671	1519	NR	NR	~~549~~ NR
Yield (CD**) (psi)	1530	1489	1706	2267	2407	1997	1809	1832
Tensile (CD**) (psi)	6252	7603	5807	7079	7458	7153	6326	4598
Toughness (CD**) ($ft\text{-}lbs/in^3$)	1282	1599	1358	1656	1495	NR	NR	~~507~~ NR
Elmendorf B (MD*) (grams)	288	216	334	317	194	320	398	~~438~~ 297
Elmendorf B (CD**) (grams)	621	566	413	630	664	640	621	~~550~~ 527
PPT Tear (MD*) (lbs.)	6.79	6.18	5.99	6.2	6.5	6.2	6.2	~~5.3~~ 5.8
PPT Tear (CD**) (lbs.)	7.44	7.42	6.46	6.8	8.1	7.0	7.5	~~6.1~~ 6.3
Dart Impact A (grams)	708	610	354	410	186	412	186	164
Puncture ($ft\text{-}lbs/in^3$)	316	349	251	231	256	250	227	237
Film Block g.	75	33	87	32	17	11.8	17	22
Film Gradient Density (g/cm^3)	0.9145	0.9153	0.9155	0.9205	0.9218	0.9198	0.9201	0.9206
Film Gauge (low) (mils)	0.9	0.9	0.9	0.85	0.8	0.98	0.95	1.05
Film Gauge (high) (mils)	1.2	1.05	1.1	0.95	1	1.08	1.05	1.15

*MD = Machine direction

**CD = Cross direction

NR = Not Recorded

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In general, films made from the novel formulated ethylene/α-olefin compositions exhibit good impact and tensile properties, and an especially good combination of tensile, yield and toughness (e.g., toughness and dart impact). Further, films from the example resins exhibited significant improvements over films made from the comparative resins in a number of key properties.

For example, comparing examples 1 and 2 with comparative example 3, the data show films produced from the melt blends (examples 1 and 2) exhibited significantly higher values for the following film properties: dart ~~ipact~~ impact, MD tensile, CD tensile, MD toughness, CD toughness MD ppt tear, ~~DC ppt tear,~~ CD ppt tear CD Elmendorf tear B, puncture and significantly lower block.

Comparing example 4 to comparative example 5, the data show films produced from the *in-situ* blend (made according to USSN 08/010,958) exhibited significantly higher values for the following film properties: dart impact, MD toughness and CD toughness.

Comparing example 6 to comparative examples 7 (an ethylene/1-octene copolymer made according to USSN 07/773,375) and 8 (an heterogeneously branched ethylene/1-octene copolymer), the data show films produced from the *in-situ* blend (made according to USSN 08/010,958) exhibited significantly higher values for the following film properties: dart impact, MD yield, CD yield, MD tensile, CD tensile, CD Elmendorf tear B and puncture and significantly lower block.

We Claim:

1. A film made from an ethylene polymer composition, wherein the composition comprises from about 10 percent (by weight of the total composition) to about 95 percent (by weight of the total composition) of :

(A) at least one homogeneously branched substantially linear ethylene/α-olefin interpolymer having:

(i) a density from about 0.89 grams/cubic centimeter (g/cm^3) to about 0.92 g/cm^3,

(ii) a molecular weight distribution (M_W/M_n) from about 1.8 to about 2.8,

(iii) a melt index (I_2) from about 0.001 grams/10 minutes (g/10 min) to about 10 g/10 min,

(iv) no linear polymer fraction, and

(v) a single melting peak as measured using differential scanning calorimetry; and

(B) from about 5 percent (by weight of the total composition) to about 90 percent (by weight of the total composition) of at least one heterogeneously branched ethylene polymer having a density from about 0.93 g/cm^3 to about 0.965 g/cm^3.

2. The film of claim 1 wherein the homogeneously branched substantially linear ethylene/α-olefin interpolymer has a slope of strain hardening coefficient greater than or equal to about 1.3.

3. The film of claim 1 wherein the heterogeneously branched ethylene polymer is an interpolymer of ethylene with at least one C_3-C_{20} α-olefin.

4. The film of claim 1 wherein the homogeneously branched substantially linear ethylene/α-olefin interpolymer is an interpolymer of ethylene with at least one C_3-C_{20} α-olefin.

5. The film of claim 1 wherein the homogeneously branched substantially linear ethylene/α-olefin interpolymer is a copolymer of ethylene and a C_3-C_{20} α-olefin.

6. The film of claim 5 wherein the homogeneously branched substantially linear ethylene/α-olefin copolymer is a copolymer of ethylene and 1-octene.

7. The film of claim 3 wherein the heterogeneously branched ethylene polymer is a copolymer of ethylene and a C_3-C_{20} α-olefin.

8. The film of claim 7 wherein the heterogeneously branched ethylene polymer is a copolymer of ethylene and 1-octene.

9. A film made from an ethylene polymer composition, wherein the composition comprises from about 10 percent (by weight of the total composition) to about 95 percent (by weight of the total composition) of :

(A) at least one homogeneously branched linear ethylene/α-olefin interpolymer having:

(i) a density from about 0.89 grams/cubic centimeter (g/cm^3) to about 0.92 g/cm^3,

(ii) a molecular weight distribution (M_W/M_n) from about 1.8 to about 2.8,

(iii) a melt index (I_2) from about 0.001 grams/10 minutes (g/10 min) to about 10 g/10 min,

(iv) no linear polymer fraction, and

(v) a single melting peak as measured using differential scanning calorimetry; and

(B) from about 5 percent (by weight of the total composition) to about 90 percent (by weight of the total composition) of at least one heterogeneously branched ethylene polymer having a density from about 0.93 g/cm^3 to about 0.965 g/cm^3.

10. The film of claim 9 wherein the homogeneously branched linear ethylene polymer has a slope of strain hardening coefficient greater than or equal to about 1.3.

11. The film of claim 9 wherein the heterogeneously branched ethylene polymer is an interpolymer of ethylene with at least one C_3-C_{20} α-olefin.

12. The film of claim 9 wherein the homogeneously branched linear ethylene/α-olefin interpolymer is an interpolymer of ethylene with at least one C_3-C_{20} α-olefin.

13. The film of claim 9 wherein the homogeneously branched linear ethylene/α-olefin interpolymer is a copolymer of ethylene and a C_3-C_{20} α-olefin.

14. The film of claim 13 wherein the homogeneously branched linear ethylene/α-olefin copolymer is a copolymer of ethylene and 1-octene.

15. The film of claim 11 wherein the heterogeneously branched ethylene polymer is a copolymer of ethylene and a C_3-C_{20} α-olefin.

16. The film of claim 15 wherein the heterogeneously branched ethylene polymer is a copolymer of ethylene and 1-octene.

Sub 14

17. In a composition comprising at least one homogeneously branched ethylene/α-olefin interpolymer and at least one heterogeneously branched ethylene/α-olefin interpolymer, the improvement comprising incorporating into the composition from about 10 percent (by weight of the total composition) to about 95 percent

(by weight of the total composition) of at least one homogeneously branched substantially linear ethylene/α-olefin interpolymer having:

(i) a density from about 0.89 grams/cubic centimeter (g/cm^3) to about 0.92 g/cm^3,

(ii) a molecular weight distribution (M_w/M_n) from about 1.8 to about 2.8,

(iii) a melt index (I_2) from about 0.001 grams/10 minutes (g/10 min) to about 10 g/10 min,

(iv) no linear polymer fraction, and

(v) a single melting peak as measured using differential scanning calorimetry.

18. The improvement of claim 17 wherein the homogeneously branched substantially linear ethylene/α-olefin interpolymer has a slope of strain hardening coefficient greater than or equal to about 1.3.

19. The improvement of claim 17 wherein the homogeneously branched substantially linear ethylene/α-olefin interpolymer is an interpolymer of ethylene with at least one C_3-C_{20} α-olefin.

20. The improvement of claim 17 wherein the homogeneously branched substantially linear ethylene/α-olefin interpolymer is a copolymer of ethylene and a C_3-C_{20} α-olefin.

21. The improvement of claim 20 wherein the homogeneously branched substantially linear ethylene/α-olefin interpolymer is a copolymer of ethylene and 1-octene.

22. The improvement of claim 17 wherein the heterogeneously branched ethylene polymer is a copolymer of ethylene and a C_3-C_{20} α-olefin.

23. The improvement of claim 22 wherein the heterogeneously branched ethylene polymer is a copolymer of ethylene and 1-octene.

24. In a composition comprising at least one homogeneously branched ethylene/α-olefin interpolymer and at least one heterogeneously branched ethylene/α-olefin interpolymer, the improvement comprising incorporating into the composition from about 10 percent (by weight of the total composition) to about 95 percent (by weight of the total composition) of at least one homogeneously branched linear ethylene/α-olefin interpolymer having:

(i) a density from about 0.89 grams/cubic centimeter (g/cm^3) to about 0.92 g/cm^3,

(ii) a molecular weight distribution (M_w/M_n) from about 1.8 to about 2.8,

(iii) a melt index (I_2) from about 0.001 grams/10 minutes (g/10 min) to about 10 g/10 min,

(iv) no linear polymer fraction, and

(v) a single melting peak as measured using differential scanning calorimetry.

25. The improvement of claim 24 wherein the homogeneously branched linear ethylene/α-olefin interpolymer has a slope of strain hardening coefficient greater than or equal to about 1.3.

26. The improvement of claim 24 wherein the homogeneously branched linear ethylene/α-olefin interpolymer is an interpolymer of ethylene with at least one C_3-C_{20} α-olefin.

27. The improvement of claim 24 wherein the homogeneously branched linear ethylene/α-olefin interpolymer is a copolymer of ethylene and a C_3-C_{20} α-olefin.

28. The improvement of claim 27 wherein the homogeneously branched linear ethylene/α-olefin interpolymer is a copolymer of ethylene and 1-octene.

29. The improvement of claim 24 wherein the heterogeneously branched ethylene polymer is a copolymer of ethylene and a C_3-C_{20} α-olefin.

30. The improvement of claim 29 wherein the heterogeneously branched ethylene polymer is a copolymer of ethylene and 1-octene.

Add A5

Add B2

...ration and Power of Attorney 1000 is in the ENGLISH ... nd has the same meaning in other languages with the same ...

DECLARATION AND POWER OF ATTORNEY

USA/PCT

...ow named inventor, I hereby declare that:

(a) My residence and Citizenship are as stated below my name. My P.O. (mailing) address is the same as my residence unless otherwise stated.

(b) I verily believe I am/we are the original, first and sole/joint inventor(s) of the subject matter which is embraced by and for which a patent is sought on the invention entitled: FABRICATED ARTICLES MADE FROM ETHYLENE POLYMER BLENDS

and the specification of which: (check one)
- X is attached hereto (C-40,121-G).
- ___ was filed on ___ as (C-). Application No. ___ and was amended on ___

(c) I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

(d) I acknowledge my duty under 37 CFR 1.56 to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR 1.56(b). I acknowledge the same duty of disclosure with respect to information which is first published or which arises after the filing date of any prior application claimed under paragraph (f) to the extent that the subject matter of any claim of this application is not disclosed in the prior United States application.

(e) I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)			PRIORITY CLAIMED
Number	Country	Day/Month/Year Filed	YES NO

(f) I hereby Claim the benefit under Title 35, United States Code § 120 of any United States applications(s) listed below:

07/776,130	October 15, 1991	Pending
Application Serial No.	Filing Date	Status (Patented, Pending, Abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith. Address all correspondence to: **THE DOW CHEMICAL COMPANY, Patent Dept., B-1211, Freeport, TX 77541** and telephonic communications to the following:

(1)	Stephen P. Krupp	(TEL. (409)238-2889	Reg. No. 34,366
(2)	L. Wayne White		Reg. No. 25,415
(3)	Glenn H. Korfhage		Reg. No. 27,204
(4)	Richard G. Waterman		Reg. No. 20,128

This appointment, including the right to delegate this appointment, shall also apply to the same extent to any proceedings established by the Patent Cooperation Treaty.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Title 18, United States Code § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor(s):

At Freeport, Texas 77541, U.S.A
this ___ day of ___ 19___

Signature ___
Full Name: Pak-Wing Steve Chum
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Country: United States of America
Citizenship: United States of America
P.O. Address: Same as Residence

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this ___ day of ___ 19___

Signature ___
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Country: United States of America
Citizenship: United States of America
P.O. Address: Same as Residence

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this ___ day of ___ 19___

Signature ___
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Residence: 1618 North Road
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Country: United States of America
Citizenship: United States of America
P.O. Address: Same as Residence

At Freeport, Texas 77541, U.S.A.
this ___ day of ___ 19___

Signature ___
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City, State, Zip: Sugar Land, Texas 77479
Country: United States of America
Citizenship: United States of America
P.O. Address: Same as Residence

( ) Additional names and signatures are attached.

R-10 88

DECLARATION AND POWER OF ATTORNEY

USA/PCT

As a named inventor, I hereby declare that:

(a) My residence and Citizenship are as stated below my name. My P.O. (mailing) address is the same as my residence unless otherwise stated.

(b) I verily believe I am/we are the original, first and sole/joint inventor(s) of the subject matter which is embraced by and for which a patent is sought on the invention entitled: FABRICATED ARTICLES MADE FROM ETHYLENE POLYMER BLENDS

and the specification of which:

(check one) X was filed on April 28, 1993 as (C- 40,121-G).
Application No. 08/054379
and was amended on

(c) I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

(d) I acknowledge my duty under 37 CFR 1.56 to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 CFR 1.56(b). I acknowledge the same duty of disclosure with respect to information which is first published or which arises after the filing date of any prior application claimed under paragraph (f) to the extent that the subject matter of any claim of this application is not disclosed in the prior United States application.

(e) I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)			PRIORITY CLAIMED
Number	Country	Day/Month/Year Filed	YES NO

(f) I hereby Claim the benefit under Title 35, United States Code § 120 of any United States applications(s) listed below:

07/776,130	October 15, 1991	Pending
Application Serial No.	Filing Date	Status (Patented, Pending, Abandoned)

(g) I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith. Address all correspondence to: THE DOW CHEMICAL COMPANY, Patent Dept., B-1211, Freeport, TX 77541 and telephonic communications to the following:

(1)	Stephen P. Krupp	(TEL (409)238-2889	Reg. No 34,366
(2)	~~L. Wayne White~~		~~Reg. No 25,415~~
(3)	Glenn H. Korfhage		Reg. No 27,204
(4)	Richard G. Waterman		Reg. No. 20,128

This appointment, including the right to delegate this appointment, shall also apply to the same extent to any proceedings established by the Patent Cooperation Treaty.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Title 18, United States Code § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor(s):

At Freeport, Texas 77541, U.S.A
this 7th day of June 19 93
Signature Pak-Wing Steve Chum
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this 8th day of June 19 93
Signature Ronald P. Markovich
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Country: United States of America
Citizenship: United States of America
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At Freeport, Texas 77541, U.S.A.
this 7 day of June 19 93
Signature George W. Knight
Full Name: George W. Knight
Residence: 1618 North Road
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Country: United States of America
Citizenship: United States of America
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At Freeport, Texas 77541, U.S.A.
this 8th day of June 19 93
Signature Shih-Yaw Lai
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City, State, Zip: Sugar Land, Texas 77479
Country: United States of America
Citizenship: United States of America
P.O. Address: Same as Residence

( ) Additional names and signatures are attached.

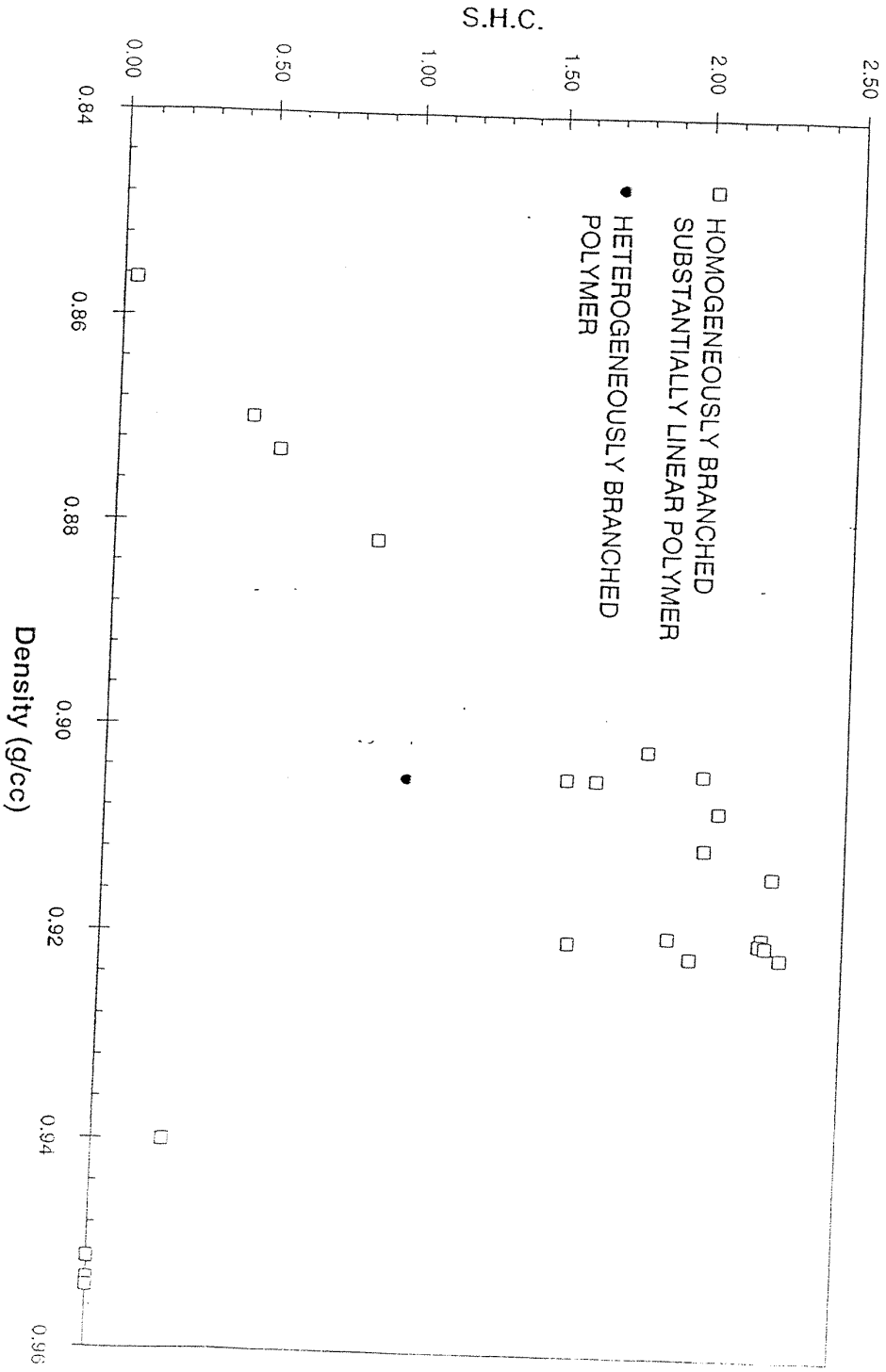

FIGURE 1

SLOPE OF STRAIN-HARDENING COEFFICIENT (S.H.C.) VS. DENSITY

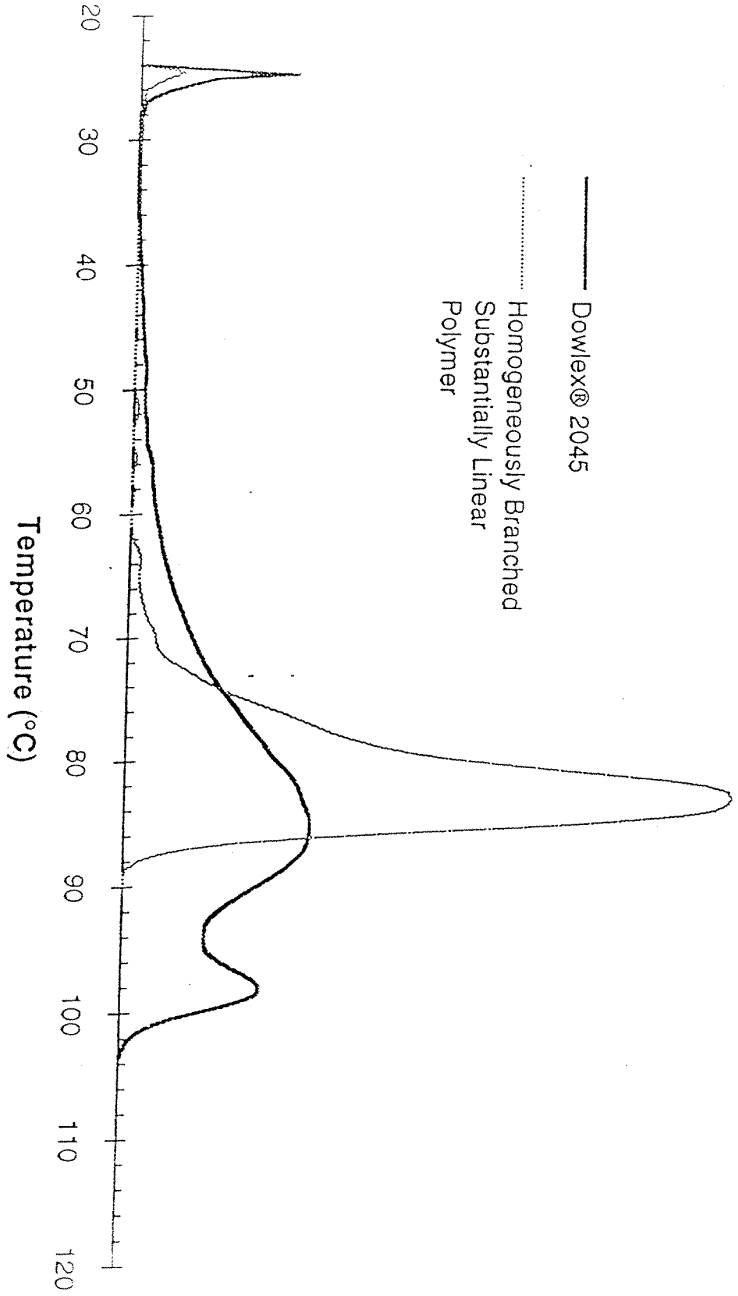
Analytical Temperature Rising Elution Fractionation (ATREF)
Comparison of SCBD
Dowlex® 2045
Homogeneously Branched
Substantially Linear
Polymer
Temperature (°C)
20
30
40
50
60
70
80
90
100
110
120

Figure 2