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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : C08L 23/04	A1	(11) International Publication Number: WO 93/00400 (43) International Publication Date: 7 January 1993 (07.01.93)

(21) International Application Number: PCT/US92/05214

(22) International Filing Date: 19 June 1992 (19.06.92)

(30) Priority data:
719,228 21 June 1991 (21.06.91) US

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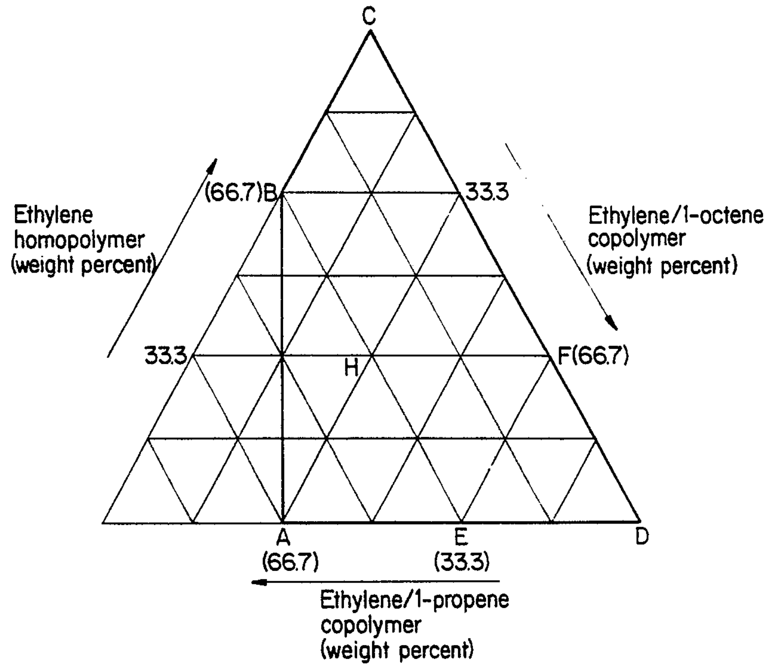
(81) Designated States: CA, FI, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LU, MC, NL, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: POLYETHYLENE BLENDS FOR MOLDING

(57) Abstract



Multicomponent polyethylene resin compositions which are processable using conventional molding techniques (e.g., rotational molding, injection molding and blow molding) have been discovered which offer improved IZOD impact strength of the molded part. Multicomponent polyethylene compositions comprising a uniform composition falling within the area of a polygon ABCD bounded by points A(66.7, 33.3, 0), B(33.3, 0, 66.7), C(0, 0, 100), D(0, 100, 0) and excluding the composition defined by line AB have improved room temperature notched IZOD impact strength over that calculated for the components using an additive rule. For three component polyethylene compositions, a first component (a) comprising a polyethylene resin having a density of about 0.92 g/cc and a melt index of about 1 g/10 minutes, a second component (b) comprising a polyethylene resin having a density of about 0.96 g/cc, and a melt index of about 1g/10 minutes, and a third component (c) comprising a polyethylene resin having a density of about 0.95 g/cc and a melt index of about 17 g/10 minutes are preferred. One of the components can also be replaced by a post consumer recycled plastic.

POLYETHYLENE BLENDS FOR MOLDING

This invention relates to multicomponent polyethylene blend compositions for use in molding processes (e.g., rotational, injection or blow molding). The multicomponent blend can incorporate a post consumer recycled plastic as one of the components.

Plastics, especially polyethylene, have been utilized in molding processes due to their thermoplastic nature. There are several important parameters for molding polyethylene, including polymer flow characteristics and end product strength properties (e.g., impact strength). Impact strength of articles molded from plastics is an especially important property when the article is subject to rough handling and repeated impact. Impact strength helps to prevent the article from prematurely rupturing.

The processing parameters of the molding process also create unique demands on the plastic. For example, plastics used in a rotational molding process need to be screened to a particular particle size for optimum flow and melting. For polyethylene, the typical particle size for use in rotational molding is approximately 35 mesh.

The density and the molecular weight of the plastic are also important in a molding process, allowing the molded article to be homogeneous and uniform throughout, as well as supplying strength and modulus or stiffness. The many types of molding processes require different types of plastics. Density, and molecular weight of the plastic will vary depending upon the molding process and the desired end product properties.

The dominant molding processes are rotational molding, injection molding and blow molding. The largest volume consumer of these, the rotational molding process, forms hollow parts from plastic powders. Polyethylene is most often used in a rotational molding process, due to its low melting point and relatively high fabrication strength. Impact strength of the fabricated/rotomolded part continues to be a commercial need for success in areas in which rotomolding can be used.

Plastics, and particularly polyethylene, also have the advantage of being recyclable. Even though plastics account for only 7 weight percent of solid waste, they are viewed negatively by the public. This negative view and increasing landfill costs have led industry to investigate disposal alternatives. Some alternatives include degradation, chemical conversion, incineration, and recycling. Post-consumer materials, defined as those products generated by a business or consumer that have served their intended end uses, and that have been separated or diverted from solid waste for the purpose of collection, recycling, and disposition, represent a viable source of raw material for new product manufacture, if they can be processed appropriately.

Household plastic waste, collected either at curbside by a refuse collection organization or at voluntary drop-off centers, is recognized as a primary source of post-consumer material to be used in the manufacture of recycle plastic-content products. However, post consumer recycled plastic has limited utility, due to the complex nature of the recycled plastic mix. The recycled plastic seldom resembles the original virgin plastic. The recycled plastic can contain different plastics, making fabrication into a useful article extremely complex. While collection of recycled plastic is a universal problem for the public, the useful disposition of these recycled plastics is becoming an increasingly serious problem.

Certain multicomponent polyethylene compositions have now been discovered to have an improvement in room temperature notched IZOD impact strength when formed into molded articles. The measured IZOD impact strength of the molded article is greater than the calculated IZOD impact strength of a molded article made from the multicomponent composition using an additive rule. The multicomponent polyethylene compositions contain two or more linear polyethylene components. Multicomponent polyethylene compositions comprising a uniform composition falling within the area of a polygon ABCD bounded by points A(66.7, 33.3, 0), B(33.3, 0, 66.7), C(0, 0, 100), D(0, 100, 0) and excluding the composition defined by line AB in FIGURE 1 have improved room temperature notched IZOD impact strength over that calculated for the components using an additive rule. For three component polyethylene compositions, a first component (a) comprising a polyethylene resin having a density of about 0.92 g/cc and a melt index of about 1 g/10 minutes, a second component (b) comprising a polyethylene resin having a density of about 0.96 g/cc, and a melt index of about 1 g/10 minutes, and a third component (c) comprising a polyethylene resin having a density of about 0.95 g/cc and a melt index of about 17 g/10 minutes are preferred. Linear ethylene/1-octene copolymers as component (a), linear ethylene homopolymers as component (b), and linear ethylene/1-propene copolymers as component (c) are especially preferred.

In another aspect, the invention is a method of improving the room temperature notched IZOD impact strength, measured in accordance with ASTM D-256, of a molded article made from a multicomponent polyethylene composition comprising at least two polyethylene polymers, wherein said IZOD impact strength is higher than that calculated by the additive rule. The method comprises:

(a) blending at least two linear polyethylenes in amounts sufficient to form a uniform composition falling within the area of a polygon ABCD bounded by points A(66.7, 33.3, 0), B(33.3, 0, 66.7), C(0, 0, 100), D(0, 100, 0) and excluding the composition defined by line AB in FIGURE 1, and

(b) molding said uniform composition to form a molded article having enhanced room temperature notched IZOD impact strength. The method of improving the IZOD impact strength is especially effective when the composition falls w thin the area of a polygon EHCD defined by points E(33.3, 66.7, 0), H(33.3, 33.3, 33.3), C(0, 0, 100), D(0, 100, 0) in FIGURE 2, and most particularly effective when the composition falls within the area of a triangle EFD defined by points E(33.3, 66.7, 0), F(0, 66.7, 33.3). D(0, 100, 0) in FIGURE 3.

The molded article can be made in a molding process selected from the group consisting of: rotational molding, injection molding and blow molding. The improvement in room temperature notched IZOD impact strength is especially effective in a rotational molding process.

Post consumer recycled plastic, usually comprising at least about 90 weight percent polyethylene (such as recycled blow molded bottles and/or recycled molded rigid bottles) can also be incorporated into the three component composition as component (b).

Figure 1 is a compositional ternary diagram of three polyethylene polymers and shows operative weight percentages resulting in increased IZOD impact strength of a molded article over that obtained using an additive rule.

Figure 2 is a ternary diagram based on weight percentage of three polyethylene polymers and shows a preferred embodiment of this invention.

Figure 3 is a ternary diagram based on weight percentage of three polyethylene polymers and shows an especially effective embodiment of this invention.

Linear polyethylene is the preferred type of polyethylene useful in practicing the present invention. Manufacture of linear polyethylene is disclosed, e.g., in U.S. Patent 4,076,698, incorporated herein by reference, and involves coordination catalysts of the "Ziegler" type or "Phillips" type and includes variations of the Ziegler type, such as the Natta type. These catalysts may be used at very high pressures, but may also (and generally are) used at very low or intermediate pressures. The products made by these coordination catalysts are generally known as "linear" polymers because of the substantial absence of branched chains of polymerized monomer units pendant from the main polymer "backbone." Two types of linear polyethylene are suitable for use in the present invention: linear high density polyethylene (HDPE) and linear low density polyethylene (LLDPE).

Linear high density polyethylene has a density from 0.941 to 0.965 g/cc while linear low density polyethylene typically has a density from 0.88 g/cc to 0.94 g/cc. The density of the linear polyethylene is lowered by polymerizing ethylene along with minor amounts of alpha, beta-ethylenically unsaturated alkenes having from 3 to 20 carbons per alkene molecule (e.g., 1-propene, 1-dodecene), preferably 4 to 8 (e.g., 1-butene, 4-methyl 1-pentene, 1-hexene) and most preferably 8 carbons per alkene molecule (i.e., 1-octene). The amount of the alkene comonomer is generally sufficient to cause the density of the linear low density polymer to be substantially in the same density range as LDPE, due to the alkyl side chains on the polymer molecule, yet the polymer remains in the "linear" classification. These polymers retain much of the strength, crystallinity, and toughness normally found in HDPE homopolymers of ethylene, but the higher alkene comonomers impart high "cling" and "block" characteristics to extrusion or cast films and the high "slip" characteristic inherently found in HDPE is diminished.

The use of coordination-type catalysts for polymerizing ethylene into homopolymers or copolymerizing ethylene with higher alkenes to make copolymers having densities above about 0.94 g/cc as defined in ASTM D-1248 (i.e., HDPE polymers) and/or for copolymerizing ethylene with higher alkenes to make copolymers having densities in the range of LDPE and medium density polyethylene (i.e., LLDPE copolymers) is disclosed variously in, e.g., U.S. 2,699,457; U.S. 2,862,917; U.S. 2,905,645; U.S. 2,846,425; U.S. 3,058,963 and U.S. 4,076,698, all of which are expressly incorporated herein by reference. The density of the linear polyethylene useful as component (a), (b) and/or (c) in the present invention is from 0.88 g/cc to 0.965 g/cc.

The molecular weight of the linear polyethylene is indicated and measured by melt index according to ASTM D-1238, Condition (E) (i.e., 190°C/2.16 kilograms). The melt index of the linear polyethylene useful as component (a), (b) and/or (c) in the present invention is from 0.05 grams/10 minutes (g/10 min) to 200 g/10 min and preferably from 0.5 g/10 min to 25 g/10 min.

The post consumer recycled plastic which can replace one of the components (usually component (b)) can comprise various thermoplastic polymers conventionally used in molding processes. Preferably, the post consumer recycle plastic comprises at least about 90 weight percent polyethylene, more preferably at least about 95 weight percent polyethylene, based on the total recycle plastic weight. Other thermoplastic polymers in the post consumer recycle plastic component include, e.g., polypropylene, polyester and polystyrene. A paper presented by M.L. Wu at The Society of Plastics Engineering VII International Conference on February 27. 1991 entitled "Plastic Recycling: Walnut Creek City Curbside Collection Pilot Study" describes typical mixed. or co-mingled, disposable recyclable plastics which were collected from households and characterized according to type as described in Table 1:

Table 1

Category	Plastic Description	Plastic Type*	Weight Percent
1	Unpigmented polyethylene bottles. Typically milk and water containers.	HDPE	21
2	Low specific gravity (<1 g/cc) rigid parts. Typically pigmented bottles for laundry, cleaning, and personal care product containers, lids, other household containers.	HDPE, LLDPE, PP (minor)	26
3	Film structures. Typically grocery sacks, soft good overwraps, and various bags.	HDPE, LLDPE, PP (minor)	23
4	Polyester beverage bottles. Typically soft drink containers.	PET	13
5	High specific gravity (>1 g/cc) rigid parts. Typically food trays and containers.	PS, PET, PVC	15
6	Foam structures. Typically insulated food and beverage containers. Packing material.	PS	2

* HDPE = High Density Polyethylene, LLDPE = Linear Low Density Polyethylene, PP = polypropylene, PET = polyethylene terephthalate, PS = polystyrene and PVC = polyvinyl chloride.

Municipal curbside plastic pick-up programs currently collect predominately co-mingled or segregated rigid plastics described above as categories 1, 2, and 4. Hand sortation is used in start-up programs to deliver separated plastics for recycle. However, for commercial operations, mechanized technology has been developed to clean and separate co-mingled rigid plastics according to specific gravity. Resultant cleaned, separated, ground rigid polyethylene "flake", is then extruded (compounded), devolatilized, screened, and pelletized to form a homogenized recycle pellet to be used in formulation with compositions of the present invention to manufacture new molded products.

Recycled polyethylene from combined categories 1 and 2 also known as "mixed lights" (natural and pigmented blow molded, injection molded, and thermoformed HDPE and LLDPE rigids) will generally have the properties described in Table 2:

Table 2

Melt index (g/10 minutes)	0.2 - 1.5
Density (g/cc)	0.950 - 0.970
Volatiles (weight percent)	≦0.5
Heavies (e.g., metal, PVC, PET, dirt, etc.) (weight percent)	≦0.5
Paper or fiber (weight percent)	≦0.5
Polypropylene (weight percent)	≦10

Recycled polyethylene from a more segregated combination of categories 1 and 2 (natural and pigmented blow molded HDPE bottles) will generally have the

Table 3

Melt index (g/10 minutes)	0.25 - 1.1
Density (g/cc)	0.950 - 0.970
Volatiles (weight percent)	≦0.5
Heavies (weight percent)	≦0.5
Paper or fiber (weight percent)	≦0.5
Polypropylene (weight percent)	≦5

Recycled polyethylene from category 1 (natural HDPE bottles) will generally have the properties described in Table 4:

Table 4

Melt index (g/10 minutes)	0.25 - 0.90
Density (g/cc)	0.950 - 0.970
Volatiles (weight percent)	≦ 0.5
Heavies (weight percent)	≦ 0.5
Paper or fiber (weight percent)	≦ 0.5
Polypropylene (weight percent)	≦ 5

Household film waste, described as category 3, is generally not collected in curbside pick-up programs, but rather specific film products are collected in voluntary collection programs. Grocery sacks (mixture of LLDPE and HDPE films) are currently being collected at grocery stores via voluntary consumer drop-off programs. Collected grocery sacks are then shredded, cleaned, and separated (from paper contamination) via mechanized systems similar to those used for rigids. Resultant film "flake" is then generally extruded to be formulated with virgin resin to manufacture new products. Recycled polyethylene from grocery sack will generally have the properties described in Table 5:

Table 5

Melt Index (g/10 minutes)	0.05 - 1.0
Density (g/cc)	0.930 - 0.960
Volatiles (weight percent)	≦0.5
Heavies (weight percent)	≦0.1
Paper or fiber (weight percent)	≦0.1

The multicomponent polyethylene compositions of the present invention can also contain minor amounts of additives (e.g., antioxidants, pigments) which do not interfere with the molding of the polymer blend. Phosphites and phenolics (e.g., IRGAFOS™ 168 and IRGANOX™ 1010, respectively, both sold by Ciba-Geigy Corporation) are particularly effective antioxidants for use in the polyethylene compositions of the present invention. Other antioxidants commonly used in the polymer industry can be incorporated into the three component polyethylene compositions of the present invention.

The multicomponent polyethylene compositions can be made by dry blending, melt blending discrete polymers, or by in-situ reactor polymerization. Dry blending pellets can be accomplished by any convenient means, e.g., tumble blending weighed portions of pellets in fiber packs. Since pellet stratification can occur in dry blends while in transit, melt blending is preferred, especially to ensure uniformity of the composition. Melt blending can be accomplished by feeding a dry blend (made as described above) into an extruder/compounder line equipped with a pelletization system (e.g., an underwater pelletizer, or a water trough through which the reextruded strands are cooled and later chopped into pellets). A double pass through the extruder system is preferred to ensure compositional uniformity.

Blends formed by in-situ reactor polymerization can be made by side-arm extrusion of one or more of the polyethylene polymers into another of the polyethylene polymer stream just prior to pelletization, or the blends can be made by operating multiple reactors such that the polymers are each made and blended immediately after polymerization, before or after removal from the reactor(s), but prior to pelletization in a single continuous system. Such multiple reactor operation is disclosed, for example, in U.S. Patent 3,914,342 (incorporated herein by reference). There are several ways known to skilled artisans for making in-situ polymerized reactor blends, and the invention is not limited to any one of the methods.

Example 1

A three component polyethylene blend was prepared according to the percentages described in Table 6. Table 6 also lists the properties of each of the 3 components, for later calculational use:

Table 6

Polymer Type	Weight percent	Melt index (g/10 minutes)	Density (g/cc)	IZOD Impact Strength (foot-pounds/inch)
ethylene/1-propene copolymer	16.7	17.1	0.9520	0.50
ethylene/1-octene copolymer	66.6	1	0.9206	9.97
ethylene homopolymer	16.7	1	0.9620	5.31

The blend was prepared by dry blending the components, and then double pass compounding at 220°C in a one inch diameter single screw extruder using an 80 mesh screen and having feed, transition and metering sections in the screw. The screw was run between 80 revolutions per minute (rpm) and 100 rpm. The extrudate was pelletized through a single strand die, a cooling trough and a strand cutter. The resultant pellets were dry blended and reextruded as before, thus completing the double pass.

The pelletized blend was molded into a plaque according to ASTM D-1928 and the room temperature notched IZOD impact strength was measured using the technique described in ASTM D-256. At least 10 specimens were broken and averaged for each reported value.

The predicted IZOD impact strength of the blend using the additive rule was calculated as follows: ((Percentage of component 1 × IZOD impact strength of component 1) + (Percentage of component 2 × IZOD impact strength of component 2) + (Percentage of component 3 × IZOD impact strength of component 3)) ÷ 100 = IZOD impact strength of the blend.

For the three component blend of Example 1, the calculation is:
((16.7 × 0.50 ft-lbs/in) + (66.6 × 9.97 ft-lbs/in) + (16.7 × 5.31 ft-lbs/in)) ÷ 100 = 7.69 ft-lbs/in.

Tensile yield and tensile break elongation were determined according to ASTM D-638. At least 6 specimens were tested and averaged for each reported value. Two separate blending trials of the same formulation, made into molded plaques, had the properties described in Table 7:

Table 7

Blend melt index (g/10 minutes)	Blend density (g/cc)	Tensile yield (psi)	Tensile break elongation (percent)	IZOD impact strength (foot-pounds/inch)
1.5	0.9322	2349	810	13.23
1.4	0.9318	2415	799	11.61

Thus, the three component blend had an average impact strength (12.42 foot-pounds/inch) which was greater than that obtained by calculating the IZOD impact strength using the additive rule (i.e., 7.69 foot-pounds/inch) and greater than that of any of the individual components.

Examples 2-6

The polyethylene polymers described in Example 1 were blended in varying percentages as in Example 1 and made into molded plaques for physical property tests. Table 8 lists the composition percentages as well as the resultant room temperature notched IZOD impact strength of the molded plaques.

Table 8

Ex.	Weight percent ethylene/ 1-propene copolymer	Weight percent ethylene/ 1-octene copolymer	Weight percent ethylene homo-polymer	Calculated IZOD Impact Strength (foot-pounds/inch)	Measured IZOD Impact Strength (foot-pounds/inch)
2	33.3	33.3	33.3	5.25	6.75*
3	33.3	66.7	0	6.82	11.21***
4	16.7	16.7	66.6	5.29	5.95**
5	0	66.7	33.3	8.42	12.47***
6	0	33.3	66.7	6.86	10.75***

*Average of 4 trials (total of at least 40 specimens)
**Average of 2 trials (total of at least 20 specimens)
***1 trial (total of at least 10 specimens)

The area of a polygon bounded by points A(66.7, 33.3, 0), B(33.3, 0, 66.7), C(0, 0, 100), D(0, 100, 0) in FIGURE 1 (excluding the composition defined by line AB and excluding the corner points, where the composition was essentially a single component), graphically shows both two component and three component compositions for these three specific polymers which had IZOD impact strengths higher than that obtained by using the additive rule.

The area within the polygon defined by the points E(33.3, 66.7, 0), H(33.3, 33.3, 33.3), C(0, 0, 100), D(0, 100, 0) in Figure 2 graphically shows preferred ranges of compositions for these three specific polymers which, when blended and made into a molded article, had room temperature notched IZOD impact strengths greater than that calculated using the additive rule.

The area within the triangle defined by points E(33.3, 66.7, 0), F(0, 66.7, 33.3), D(0, 100, 0) in FIGURE 3 graphically shows both two component and three component compositions for these three specific polymers which are most preferred for molding into articles. These compositions had room temperature notched IZOD impact strengths higher than that obtained by any one of the components.

Comparative Examples 7-10
(Not examples of the invention)

Multicomponent polyethylene blends were prepared as described in Example 1 and made into molded plaques for physical property tests. The blend compositions and the resultant room temperature IZOD impact strength of the molded plaque is listed in Table 9:

Table 9

Comp. Ex.	Weight percent ethylene/ 1-propene copolymer	Weight percent ethylene/ 1-octene copolymer	Weight percent ethylene homo-polymer	Calculated IZOD Impact Strength (foot-pounds/inch)	Measured IZOD Impact Strength (foot-pounds/inch)
7	66.7	0	33.3	2.1	0.75**
8	66.7	16.7	16.7	3.22	1.28*
9	66.7	33.3	0	3.65	2.48**
10	33.3	0	66.7	3.71	1.79**

*Average of 2 trials
**1 trial (total of at least 10 specimens)

Thus, when the polyethylene polymers were blended in proportions which lie outside the area of Figure 1 defined by a polygon which is formed by points A(66.7, 33.3, 0), B(33.3, 0, 66.7), C(0, 0, 100), D(0, 100, 0) in FIGURE 1, or when the compositions were blended in proportions as defined by line AB in Figure 1, the multicomponent polyethylene compositions had room temperature IZOD impact strengths less than that obtained by the additive rule. Thus, these multicomponent polyethylene compositions are not examples of the invention.

Example 11

A three component blend comprising two virgin polyethylene polymers and a post consumer recycled plastic was prepared according to the percentages and properties described in Table 10:

Table 10

Polymer Type	Weight percent	Melt index (g/10 minutes)	Density (g/cc)	IZOD Impact Strength (foot-pounds/inch)
ethylene/1-propene copolymer	16.7	16.2	0.9516	0.5
ethylene/1-octene copolymer	66.7	1	0.9209	10.95
post consumer recycled plastic*	16.7	1.15	0.9618	0.49

*Comprising plastics described by categories 1 and 2 (Table 3 herein)

The blend was prepared by dry blending in 2500 gram batches and then compounded on a 1 inch diameter Killion single screw 30:1 L/D extruder, as described in Example 1. The blend was passed through the extruder system twice for better mixing.

This blend was roto-molded into a rectangular box having a wall thickness of about 0.125 inches, thus demonstrating that blends of the present invention can also incorporate post consumer recycled plastic and maintain utility. A molded plaque made from the blend according to ASTM D-1928, when tested in accordance with ASTM D-256, had the properties described in Table 11:

Table 11

Blend melt index (g/10 minutes)	Blend density (g/cc)	Tensile yield stress (psi)	Tensile break elongation (percent)	IZOD impact strength (foot-pounds/inch)
1.45*	0.9319*	2296*	810*	12.35*

*Average of 2 trials

The three component blend had an average room temperature notched IZOD impact strength of 12.35 foot-pounds/inch which was greater than that obtained by calculating the IZOD impact strength using the additive rule (i.e., 7.46 foot-pounds/incn).

The multicomponent blends disclosed herein, whether made from virgin polymers or incorporating recycled plastic, are useful for manufacturing many molded articles, including refuse containers, roll-out refuse carts, trash bins and toys.

CLAIMS

1. An improved molded article made from a multicomponent polyethylene composition characterized by the molded article having a room temperature notched IZOD impact strength measured in accordance with ASTM D-256 greater than a calculated room temperature notched IZOD impact strength of an article made from the multicomponent composition using an additive rule.

2. The molded article of Claim 1, wherein the molded article is made by rotational molding, injection molding or blow molding.

3. The molded article of Claim 2 made by a rotational molding process.

4. The multicomponent polyethylene composition used in Claim 1 comprising a uniform composition of a three component linear polyethylene falling within the area of a polygon ABCD bounded by points A(66.7, 33.3, 0), B(33.3, 0, 66.7), C(0, 0, 100). D(0, 100, 0) and excluding the composition defined by line AB in FIGURE 1.

5. The multicomponent polyethylene composition used in Claim 1 comprising a uniform composition of a three component linear polyethylene composition falling within the area of a polygon EHCD defined by points E(33.3, 66.7, 0), H(33.3, 33.3, 33.3), C(0, 0, 100), D(0, 100, 0) in FIGURE 2.

6. The three component linear polyethylene composition of Claim 4 wherein a first component (a) is a linear low density polyethylene, a second component (b) is a linear ethylene homopolymer and a third component (c) is a linear polyethylene.

7. The multicomponent composition of Claim 6 wherein (a) is an ethylene/1-octene copolymer and (c) is an ethylene/1-propene copolymer.

8. The composition of Claim 4 wherein one of the components is a post consumer recycled plastic.

9. A method of improving the room temperature notched IZOD impact strength, measured in accordance with ASTM D-256, of a molded article made from a multicomponent polyethylene composition comprising at least two polyethylene polymers, wherein said IZOD impact strength is higher than that calculated by the additive rule, said method comprising the steps of:

(a) blending at least two linear polyethylenes in amounts sufficient to form a uniform composition falling within the area of a polygon ABCD bounded by points A(66.7, 33.3, 0), B(33.3, 0, 66.7), C(0, 0, 100), D(0, 100, 0) and excluding the composition defined by line AB in FIGURE 1, and

(b) molding said uniform composition in a molding process to form a molded article having enhanced room temperature notched IZOD impact strength.

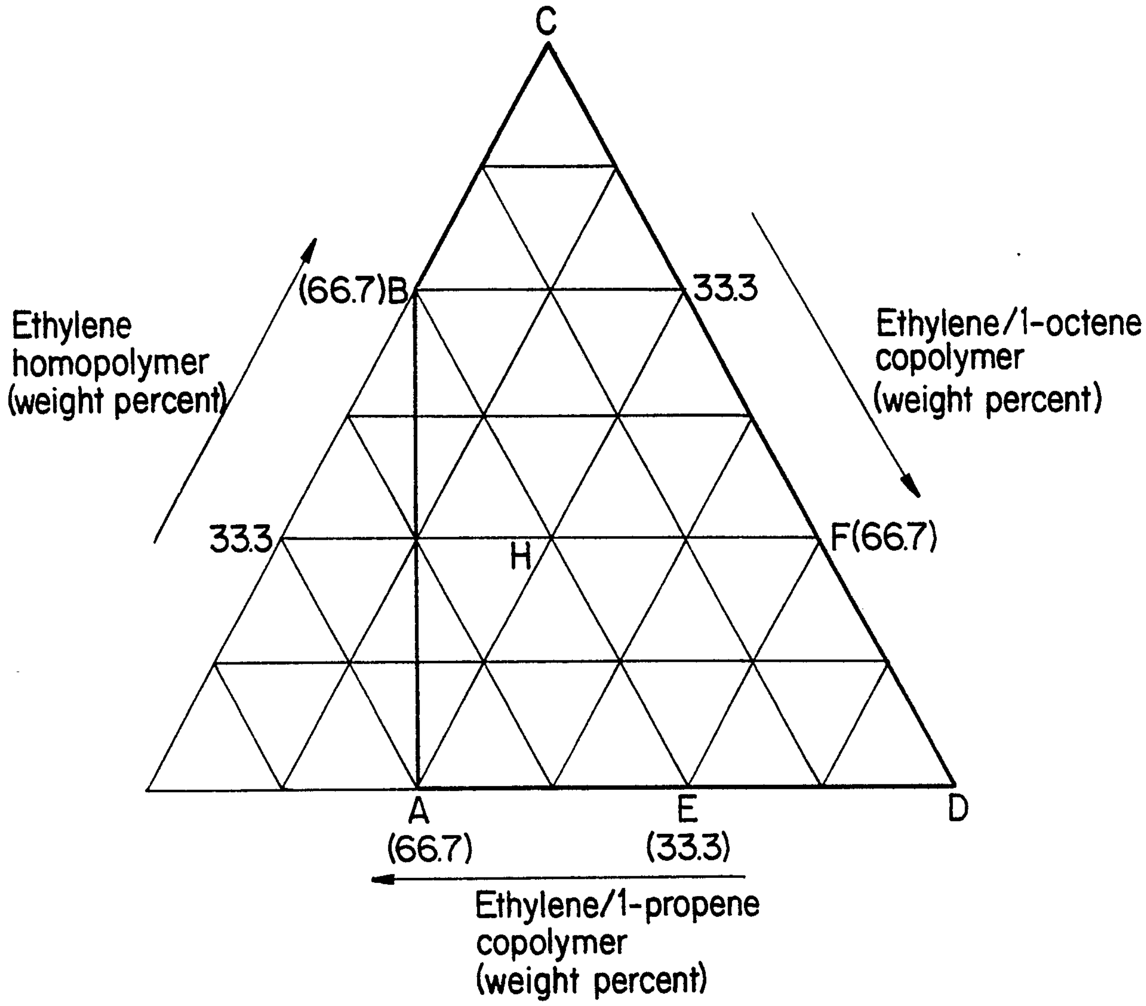
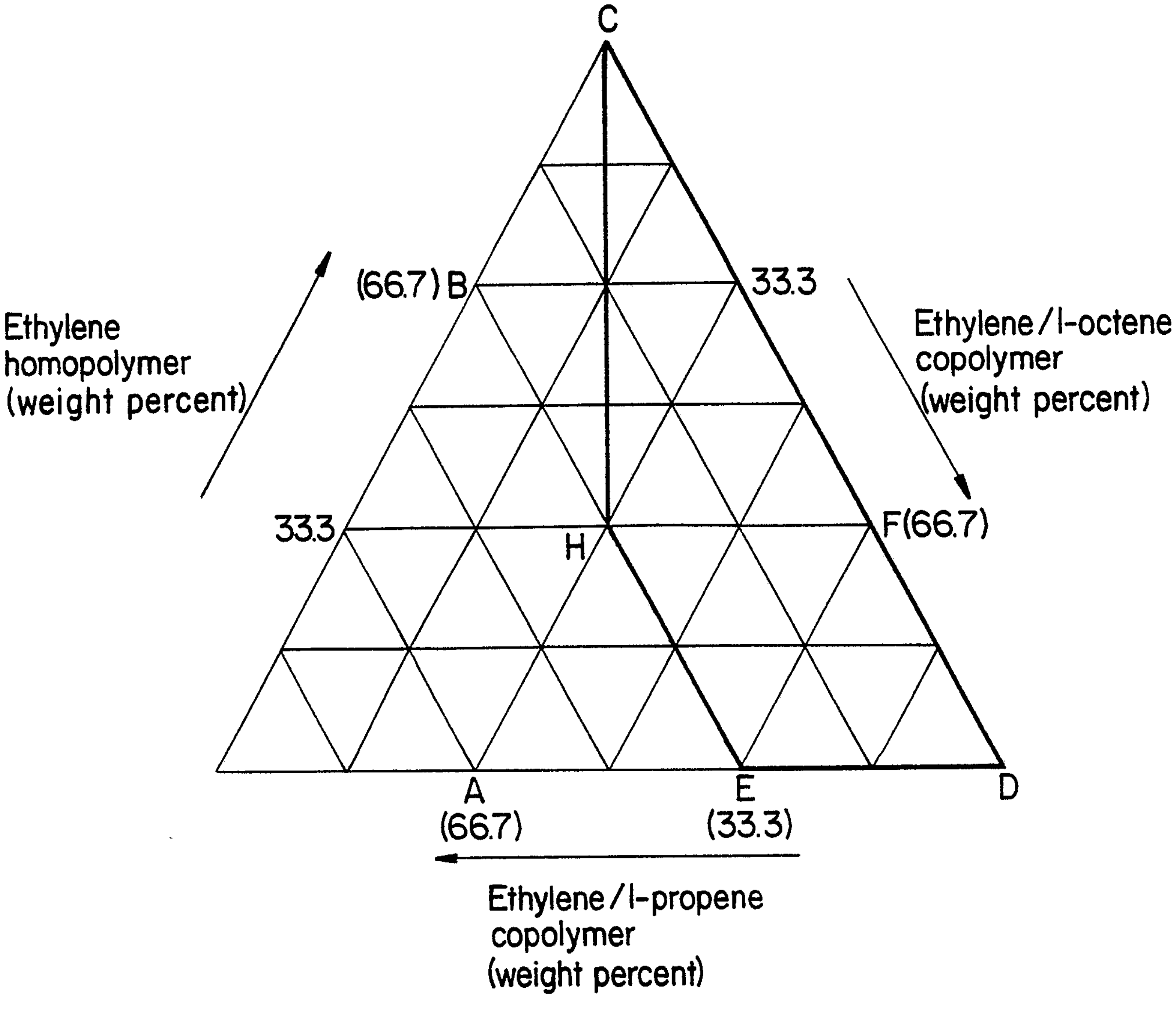

C
(66.7)B
33.3
Ethylene
homopolymer
(weight percent)
Ethylene/1-octene
copolymer
(weight percent)
33.3
H
F(66.7)
A
(66.7)
E
(33.3)
D
Ethylene/1-propene
copolymer
(weight percent)

FIG. 1



C
(66.7) B
33.3
Ethylene
homopolymer
(weight percent)
Ethylene/l-octene
copolymer
(weight percent)
33.3
F(66.7)
H
A
(66.7)
E
(33.3)
D
Ethylene/l-propene
copolymer
(weight percent)

FIG. 2

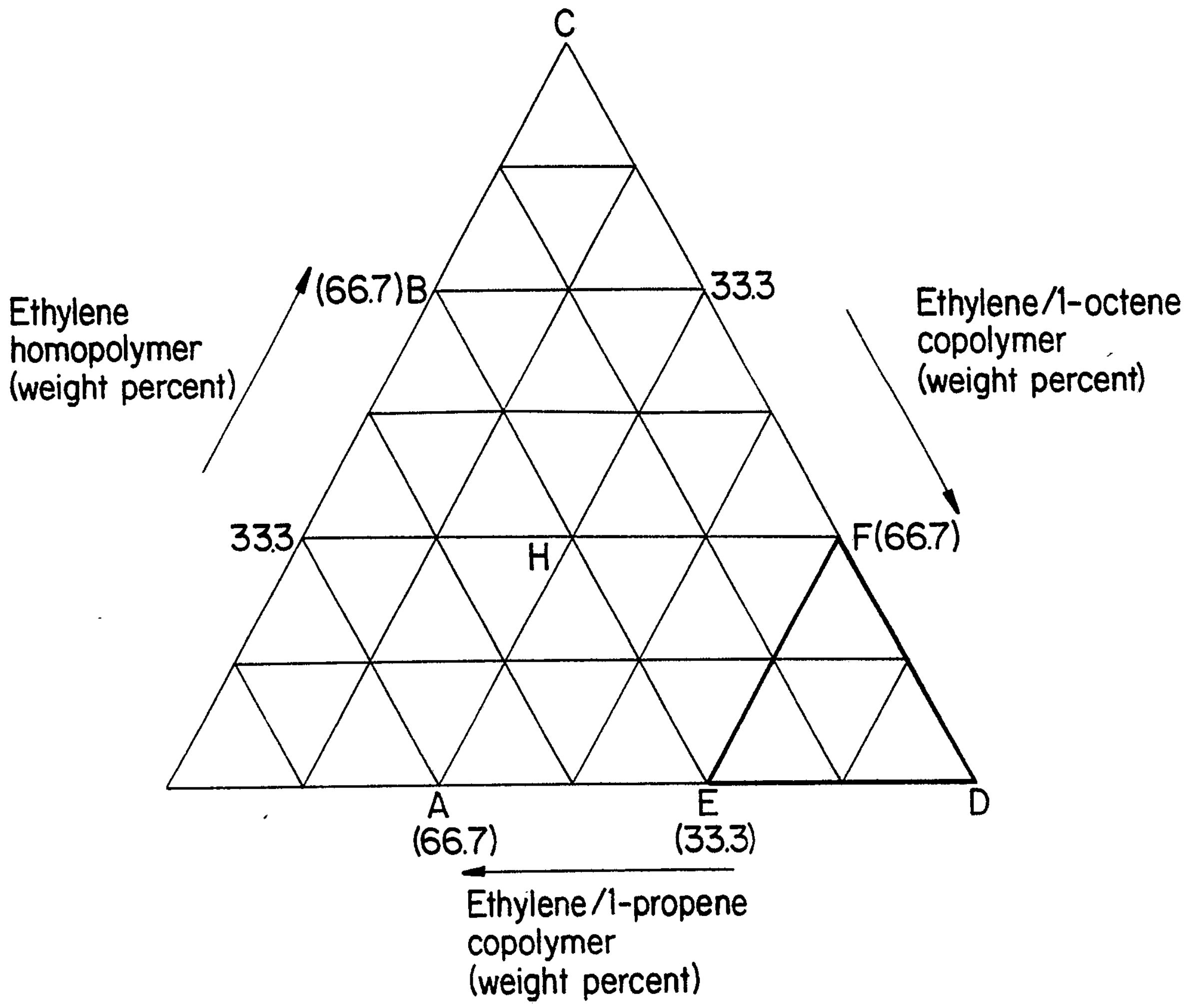

C
(66.7)B
33.3
Ethylene
homopolymer
(weight percent)
Ethylene/1-octene
copolymer
(weight percent)
33.3
H
F(66.7)
A
(66.7)
E
(33.3)
D
Ethylene/1-propene
copolymer
(weight percent)

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 92/05214

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 C08L23/04

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	C08L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
P,X	US,A,5 082 902 (J. GUREVITCH ET AL) 21 January 1992 see column 2, line 51 - column 3, line 63 ---	1-7,9
P,X	US,A,5 030 662 (A. K. BANARJIE) 9 July 1991 Abstract see column 1, line 58 - column 2, line 4 ---	8
P,X	WO,A,9 119 763 (EXXON CHEMICAL PATENTS) 26 December 1991 see page 2, line 17 - page 4, line 17 ---	1-9

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° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

1

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
22 OCTOBER 1992	29. 10. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	R.GOOVAERTS

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	DATABASE WPIL Section Ch, Week 8451, Derwent Publications Ltd., London, GB; Class A17, AN 84-314827 & JP,A,59 196 346 (ASAHI CHEMICAL) 7 November 1984 see abstract	1-7,9
X	US,A,4 525 322 (M. A. PAGE ET AL) 25 June 1985 see column 3, line 18 - line 52	1,2,4-7, 9
X	US,A,3 914 342 (J. H. MITCHELL) 21 October 1975 see column 1, line 67 - column 2, line 65	1,2,5,9
X	EP,A,0 100 689 (SOCIETE CHIMIQUE DES CHARBONNAGES) 15 February 1984 see page 1, line 23 - page 3, line 30	1,2,5,9
A	EP,A,0 209 294 (DU PONT CANADA) 21 January 1987 Abstract see page 7, line 17 - line 21	1-3
X	GB,A,2 218 997 (TENO) 29 November 1989 see page 3, line 10 - page 4, line 24	8
A	DE,A,2 229 169 (DUNLOP) 10 January 1974 see claim 1	8

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9205214 SA 61714

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 22/10/92
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-5082902	21-01-92	None		
US-A-5030662	09-07-91	None		
WO-A-9119763	26-12-91	None		
US-A-4525322	25-06-85	US-A-	4617352	14-10-86
US-A-3914342	21-10-75	BE-A-	786053	10-01-73
		CA-A-	977094	28-10-75
		DE-A-	2233983	25-01-73
		FR-A,B	2145650	23-02-73
		GB-A-	1391804	23-04-75
		NL-A-	7209676	16-01-73
EP-A-0100689	15-02-84	FR-A-	2526803	18-11-83
		JP-B-	3073582	22-11-91
		JP-A-	58210948	08-12-83
EP-A-0209294	21-01-87	JP-A-	62079244	11-04-87
GB-A-2218997	29-11-89	SE-B-	461221	22-01-90
		SE-A-	8801981	28-11-89
DE-A-2229169	10-01-74	GB-A-	1382749	05-02-75