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(54) Title: HIGH TEMPERATURE SLIP AGENT FOR POLYOLEFIN FILM			
(57) Abstract			
A high temperature slip agent for polyolefin films comprising a polyamide. The polyamide is blended with the polyolefin film so that the polyamide constitutes approximately 1 to about 4 percent of the blend.			

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HIGH TEMPERATURE SLIP AGENT FOR POLYOLEFIN FILM

The present invention relates to an improved slip agent for polyolefin films. Specifically, the present invention relates to a polyolefin film that exhibits good slip properties at elevated temperatures without clarity change.

Flexible polyolefin films are used to create a variety of bags and containers. Typically, polyolefin films are created into bags or containers in processing machines. An example of such a processing machine is a form, fill and seal packaging machine. The form, fill and seal packaging machine is utilized to create, from a web of film, a flexible plastic container that houses a product.

Because the film must travel through a processing machine it is important that the film exhibits a sufficiently low coefficient of friction to minimize drag and film marking. It is also important that the coefficient of friction is sufficiently low to ease the filling of the flexible containers with solids in, for example, a form, fill and seal packaging machine.

The coefficient of friction may be especially important at elevated temperatures. The coefficient of friction of most materials increases as the temperature of the material is elevated and the material begins to soften. In such industries as the medical and food industry the products and flexible containers typically must be sterilized. During the

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sterilization process the web of film often approaches its softening point. This can be an especially critical problem when one container is contained within another container, i.e., "overpouched." For example, in the medical industry parenteral products are overpouched within a second container. If the primary container has a softening point which is lower than the overpouch, during the sterilization process the primary container will grab the film of the overpouch. This will cause wrinkling in the containers. Moreover, unless the coefficient of friction is sufficiently low it will be difficult to overpouch the primary package and/or remove the primary package from the overpouch.

Heretofore, typically the slip additives for polyolefin films were amides of fatty acids. Examples of such amides of fatty acids are erucamide and ethylene bis-steramide. These slip additives have generally been effective at room temperatures. However, when the polyolefin within which these additives are contained are heated to typical sterilization temperatures of approximately 120° C their slip properties are not adequate. Even in those films in which the slip properties are generally effective, there is a problem with the clarity of the film because of the slip additives. In the medical industry, for example, clarity is an essential characteristic.

Accordingly, there is a need for an improved polyolefin film with good slip characteristics at high temperatures.

SUMMARY OF THE INVENTION

The present invention provides a high temperature slip agent for polyolefin films comprising a polyamide. The polyamide is blended with the polyolefin film so that the
5 polyamide constitutes approximately 1 to about 4 percent by weight of the blend. The polyamide is chosen from the group consisting of nylon 6, nylon 6,6, nylon 11, and nylon 12. The polyolefin is chosen from the group consisting of polyethylene and polypropylene.

10 Preferably, the polyamide and polyolefin are chosen so that the refractive index of the polyamide and polyolefin do not differ by more than approximately 0.07. Preferably, the polyamide and polyolefin are chosen so that the melt flow index of the polyamide does not differ by more than approximately 50%
15 with respect to the polyolefin.

Accordingly, it is an advantage of the present invention to provide a high temperature efficient slip agent for a polyolefin film.

It is a further advantage of the present invention to
20 provide a slip agent that does not change the clarity of the film.

A further advantage of the present invention is to provide a slip agent with low slip properties at elevated temperatures.

Moreover, an advantage of the present invention is to
25 provide a slip agent with a sufficiently low cost.

Another advantage of the present invention is to provide a slip agent with low stain-out.

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A still further object of the present invention is to provide a slip agent that will allow polyolefin film to be processed on form, fill and seal equipment.

5 Moreover, an advantage of the present invention is to provide a slip agent that minimizes the drag on the film and film marking when the film is processed on a form, fill and seal packaging machine.

10 A still further advantage of the present invention is to provide a slip agent for the overpouch that minimizes wrinkles when a primary package is packaged in the overpouch and the combined unit is sterilized.

A further advantage of the present invention is to provide a slip agent that maintains a low coefficient of friction at temperatures of approximately 120° C.

15 Additionally, an advantage of the present invention is to provide a slip agent that is sufficiently compatible with the base polyolefin so that the resultant film does not have poor optics, maldispersion, gels, or fish-eyes.

20 Furthermore, an advantage of the present invention is to provide a slip agent that provides for the easy removal of the primary container from the overpouch.

Another advantage of the present invention is to provide an improved film for creating an overpouch.

25 Additional features and advantages are described in, and will be apparent from, the detailed description of the presently preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a graph of the melt flow index of a representative polyolefin and some polyamides versus temperature.

Fig. 2 illustrates a cross-sectional view of the web of film of the present invention.

Fig. 3 illustrates an overpouch created by a web of film of the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

The present invention discloses a high temperature efficient slip agent for polyolefin films. An especially important advantage of the resultant film is its use as an overpouch for flexible containers. However, it is possible to utilize the present invention to create flexible containers for housing products.

The present invention provides a high temperature efficient slip agent for polyolefin films. Moreover, the present invention provides a polyolefin film with good slip characteristics even at elevated temperatures. It has been found that by blending a polyamide with a polyolefin a flexible film can be created that has a low coefficient of friction.

The polyolefin and polyamide must be chosen so that the polyolefin and polyamide are not miscible. Accordingly, a two phase system is created after the polyamide and polyolefin are blended causing the polyamide to migrate to the outer surface of the resultant film.

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However, the polyolefin and polyamide must have a sufficient degree of compatibility in order to ensure that the film created has sufficient clarity. If the polyamide and polyolefin are not sufficiently compatible, the resultant film could have poor clarity, haze, maldispersion, gels, or fish-eyes.

Preferably, the polyolefin and polyamide should have a similar melt viscosity through the extrusion temperature range, i.e., from the hopper zone to the nozzle. Figure 1 illustrates a graph of the melt flow index (MFI) of a representative polyolefin and two polyamides versus temperature. The polyolefin is a polypropylene. The polyamides are nylon 11 and nylon 6. As illustrated, the most acceptable MFI/temperature curves are located between curves A and B. The temperatures graphed are the typical temperatures one finds over the extrusion process utilizing a polyolefin. The polyamides with a MFI/temperature curve close to the polyolefin to be used, are preferred. Conversely, polyamides with a MFI differing by more than approximately 50% with respect to the polyolefin to be used are generally too incompatible.

Moreover, preferably the difference in the refractive index of the chosen polyamide and polyolefin is low and should not exceed approximately 0.07. If the difference in refractive index is increased it will impact on the clarity of the film created.

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TABLE I

REFRACTIVE INDEX AND PROCESSING TEMPERATURES FOR
REPRESENTATIVE POLYAMIDES AND POLYOLEFINS

	MATERIALS	REFRACTIVE INDEX ²⁰	MELTING RANGE (°C)	USUAL PROCESSING TEMPERATURE (°C)
.5	-----			
	Low Density Poly- ethylene	1.51	105 - 125	190 - 250
	High Density Poly- ethylene	1.54	125 - 135	200 - 280
10	Polypropylene	1.49	165 - 170	200 - 280
	Nylon 6	1.54	218 - 221	225 - 280
	Nylon 6,6	1.53	255 - 265	260 - 290
	Nylon 11	1.54	184 - 189	190 - 250
	Nylon 12	1.55	175 - 178	190 - 250

15 Table I, above, indicates the refractive index of some
representative polyamides and representative polyolefins. As
indicated, the difference in the refractive index of the
polyamides listed: nylon 6, nylon 6,6, nylon 11, and nylon 12
versus the polyolefins listed: low density polyethylene; high
20 density polyethylene; and polypropylene are all within the
acceptable range, i.e., 0.07. The refractive index of polyamide
and polyolefin is determined by ASTM Test No. D-542.

 Preferably, the polyamide slip agent is nylon 6, nylon
25 nylon 6,6, nylon 11, or nylon 12. It has been found that nylon 6 and
nylon 6,6 function satisfactorily and are preferred for cost
reasons. If water absorption is a key factor however, nylon 11

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and nylon 12 are preferable. Because nylon 6,6 has a higher melting point than the other polyamides, and accordingly requires higher processing temperatures, nylon 6,6 is not recommended when the base polyolefin is susceptible to thermal degradation.

The base polyolefin for the film is preferably chosen from the group comprising, polyethylene or polypropylene. The polyethylene may be high density, medium density, or low density polyethylene. The polypropylene may be cast or oriented, as well as exhibiting low or medium crystallinity. Polypropylene has been found to function satisfactorily as the base film if the resultant film is to be used to create an overpouch.

Preferably, 96 to 99 weight percent of the base polyolefin is blended with 1 to 4 weight percent of polyamide to create the resultant film. The polyolefin and polyamide resins can be blended by dry tumbling. Through dry tumbling, polyolefin pellets and polyamide pellets are mixed in a tumbler or blender. This will mix the polyolefin and polyamide on a macroscopic level. The blend can then be extruded and accordingly mixed on a microscopic level by the extrusion process.

The polyolefin and polyamide can also be mixed by the use of a predispersed master batch. The master batch can comprise, for example, 50% polyamide and 50% polyolefin. It should be noted that the master batch can comprise the base polyolefin or any other polyolefin provided the compatibility requirements are met.

T A B L E II

FRICTION PROPERTIES OF OVERPOUCH VERSUS
HIGH DENSITY POLYETHYLENE CONTAINERS

OVERPOUCH DESCRIP.	FRICTION COEFFICIENTS			
	25 $\pm$ 1°C		100 $\pm$ 1°C	
	DYNAMIC	STATIC	DYNAMIC	STATIC
Polypropylene film with no polyamide	0.25 $\pm$ 0.03	0.35 $\pm$ 0.03	0.72 $\pm$ 0.24	1.7 $\pm$ 0.2
98% Polypropylene 2% Nylon 6	0.23 $\pm$ 0.02	0.30 $\pm$ 0.03	0.21 $\pm$ 0.04	0.26 $\pm$ 0.03
98% Polypropylene 2% Nylon 11	0.20 $\pm$ 0.02	0.27 $\pm$ 0.03	0.21 $\pm$ 0.02	0.27 $\pm$ 0.03
96% Polypropylene 4% Nylon 11	0.18 $\pm$ 0.02	0.25 $\pm$ 0.02	0.21 $\pm$ 0.02	0.25 $\pm$ 0.03
96% Polypropylene 4% Nylon 11	0.18 $\pm$ 0.02	0.28 $\pm$ 0.02	0.21 $\pm$ 0.02	0.25 $\pm$ 0.03

Table II, above, demonstrates the efficiency of resultant polyamide/polyolefin films at elevated temperatures. The coefficient of friction of the resultant films were measured versus a high density polyethylene film. The high density polyethylene film container functioned to represent a container the resultant film overpouched. The coefficient of friction was measured by ASTM Test No. D-1894. As can be seen, at temperatures of 100° C the polypropylene film without a polyamide slip agent has a much higher coefficient of friction than the polypropylene/polyamide films.

If the web of film is to be utilized to create an overpouch for a flexible container that must be terminally sterilized, for example as in the medical industry, the overpouch and flexible container will be heated to a temperature of approximately 120° C. At this temperature the polyolefins that comprise the films of the overpouch

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and flexible container will begin to soften and accordingly, as illustrated in Table II, the coefficient of friction will be increased. However, due to the polyamide, the coefficient of friction of the film will remain low. Accordingly, the polyamide provides a high temperature efficient slip additive.

TABLE III

SLIP PROPERTIES OF POLYOLEFIN/POLYAMIDE OVERPOUCH
FOR FLEXIBLE POLYOLEFIN CONTAINERS

	MATERIAL	TEMPERATURE					WRINKLES
		25°C	60°C	75°C	90°C	100°C	ON CONTAINER RATING*
10	Rubber Modified High Density Polyethylene	81	49	53	61	66	1
15	Polypropylene 85 um	51	100	82	N/A	N/A	8
	Polypropylene 50 um	63	120	N/A	N/A	N/A	10
	40 um Polypropylene and 0.5% Erucamide	59	50	55	60	N/A	3
20	50 um Polypropylene and 0.5% Erucamide	70	62	56	70	N/A	3
	96% Polypropylene and 4% Nylon 11	38	56	52	45	42	1
	96% Polypropylene and 4% Nylon 11	40	58	54	45	43	1

25

RATING: 0 = PERFECT 10 = BAD

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Table III, above, further illustrates the slip properties of the polyolefin films blended with polyamides at various temperatures. As one can see, the films with the polyamide additive maintain a low coefficient of friction, at the various temperatures, while the films without the polyamide slip agent do not. Moreover, the film with the polyamides that create the overpouches, produce packages that have an overall lower wrinkle on container rating.

By way of example, and not limitation, an example of a film is as follows:

As illustrated in Figure 2, the film 10 is a coextrusion including two outer layers 13 and 15, and a core layer 17. The core layer 17 is constructed from a medium crystallinity polypropylene. The outer layers 13 and 15 comprise 2 to 4% by weight nylon 11 blended with 98 to 96% by weight medium crystallinity polypropylene.

In the example given, the film 10 is to be utilized to create an overpouch. Preferably, the outer layers 13 and 15 each have a thickness of approximately 15 microns and the core layer 17 preferably has a thickness of approximately 60 microns. Figure 3 illustrates an overpouch 20 created from the film of the present invention.

The medium crystallinity polypropylene can be either a single polypropylene grade with medium crystallinity or a blend of high and low crystallinity polypropylenes. Using a medium crystallinity polypropylene results in a film with a good balance of mechanical properties, optics, and sealability. The film structure is symmetrical and therefore can be sealed on both outer layers 3 and 5. Accordingly both a "fin seal" (inside surface to inside surface) and a "lap seal" (inside surface to outside surface) can be achieved.

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It should be understood that various changes and modifications to the preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without diminishing its attendant advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

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CLAIMS

1. A high temperature slip agent for polyolefin films comprising a polyamide.
2. The slip agent of Claim 1 wherein the polyamide is blended with the polyolefin film so that the polyamide constitutes approximately 1 to about 4 percent by weight of the blend.
3. The slip agent of Claim 1 wherein the polyamide is chosen from the group consisting of nylon 6, nylon 6,6, nylon 11, and nylon 12.
4. The slip agent of Claim 1 wherein the polyolefin is chosen from the group consisting of high density polyethylene, medium density polyethylene, low density polyethylene, and polypropylene.
5. The slip agent of Claim 1 wherein:
the polyolefin is polypropylene; and
Approximately 1 to about 4 weight percent of polyamide is blended with the polypropylene.
6. The slip agent of Claim 5 wherein the polyamide comprises approximately 2 to about 4 weight percent of the blend.

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7. The slip agent of Claim 1 wherein the polyamide has a refractive index within approximately 0.07 of the refractive index of the polyolefin.

8. The slip agent of Claim 1 wherein the polyamide has a melt flow index that is not more than approximately 50% different than the melt flow index of the polyolefin.

9. A film with improved high temperature slip properties comprising:
approximately 96 to about 99 weight percent
polyolefin; and
approximately 1 to about 4 weight percent polyamide.

10. The film of Claim 9 wherein the polyamide is chosen from the group consisting of nylon 6, nylon 6,6, nylon 11, and nylon 12.

11. The film of Claim 9 wherein the polyolefin is chosen from the group consisting of polyethylene or polypropylene.

12. The film of Claim 9 wherein:
the polyolefin comprises approximately 96 to about 98 weight percent of the film; and
the polyamide comprises approximately 2 to about 4 weight percent of the film.

13. The film of Claim 12 wherein:
the polyamide is nylon 11; and
the polyolefin is polypropylene.

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14. The film of Claim 9 wherein the melt flow index of the polyolefin and polyamide does not differ by more than approximately 50%.

5 15. The film of Claim 9 wherein the refractive index of the polyamide and polyolefin does not differ by more than approximately 0.07.

16. An overpouch created from a polyolefin film comprising:
10 at least one outer layer including a polyamide slip agent.

17. The overpouch of Claim 16 wherein the film includes two outer layers and a core layer.

18. The overpouch of Claim 17 wherein:
the core layer is constructed from a polyolefin; and
15 the outer layers are constructed from approximately 96 to about 99% by weight of polyolefin and from approximately 2 to about 4% by weight polyamide.

19. The film for the overpouch of Claim 18 wherein;
the polyolefin is chosen from the group consisting of
20 polyethylene and polypropylene; and
the polyamide is chosen from the group consisting of nylon 6, nylon 6,6, nylon 11, and nylon 12.

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20. The film of Claim 19 wherein the refractive index of the polyolefin and polyamide chosen do not differ by more than approximately 0.07.

05 21. The film of Claim 19 wherein the melt flow index of the polyolefin and polyamide chosen do not differ by more than approximately 50%.

AMENDED CLAIMS

[received by the International Bureau on 23 December 1986 (23.12.86)
original claims 1-13 replaced by amended claims 1-13; other claims unchanged
(2 pages)]

1. A high temperature slip agent for polyolefin films
comprising a polyamide blended with the polyolefin film such that
the polyamide constitutes approximately 1 to about 4 percent by
5 weight of the blend.

2. The slip agent of Claim 1 wherein the polyamide is
chosen from the group consisting of nylon 6; nylon 6,6; nylon 11;
and nylon 12.

3. The slip agent of Claim 1 wherein the polyolefin is
10 chosen from the group consisting of high density polyethylene,
medium density polyethylene, low density polyethylene, and
polypropylene.

4. The slip agent of Claim 1 wherein the polyamide has a
refractive index within approximately 0.07 of the refractive
15 index of the polyolefin.

5. The slip agent of Claim 1 wherein the polyamide has a
melt flow index that is not more than approximately 50% different
than the melt flow index of the polyolefin.

6. A film with improved high temperature slip properties
20 comprising:
approximately 96 to about 99 weight percent polyolefin;
and
approximately 1 to about 4 weight percent polyamide
having a melt flow index that is not more than approximately 50%
25 different than the melt flow index of the polyolefin.

7. The film of Claim 6 wherein the polyamide is chosen from the group consisting of nylon 6; nylon 6,6; nylon 11; and nylon 12.

8. The film of Claim 6 wherein the polyolefin is chosen from the group consisting of polyethylene and polypropylene.

5 9. The film of Claim 6 wherein the refractive index of the polyamide and polyolefin does not differ by more than approximately 0.07.

10 10. An overpouch created from a polyolefin film comprising:
 at least one outer layer including a polyolefin and a
polyamide slip agent, the polyamide slip agent having a melt flow
index that is not more than approximately 50% different than the
melt flow index of the polyolefin.

15 11. The overpouch of Claim 10 wherein the film includes two
outer layers and a core layer, the core layer being constructed
from a polyolefin; and the outer layers being constructed from
approximately 96 to about 99% by weight of polyolefin and from
approximately 2 to about 4% by weight polyamide.

20 12. The overpouch of Claim 10 wherein;
 the polyolefin is chosen from the group consisting of
polyethylene and polypropylene; and
 the polyamide is chosen from the group consisting of
nylon 6; nylon 6,6; nylon 11; and nylon 12.

25 13. The overpouch of Claim 10 wherein the refractive index
of the polyolefin and polyamide does not differ by more than
approximately 0.07.

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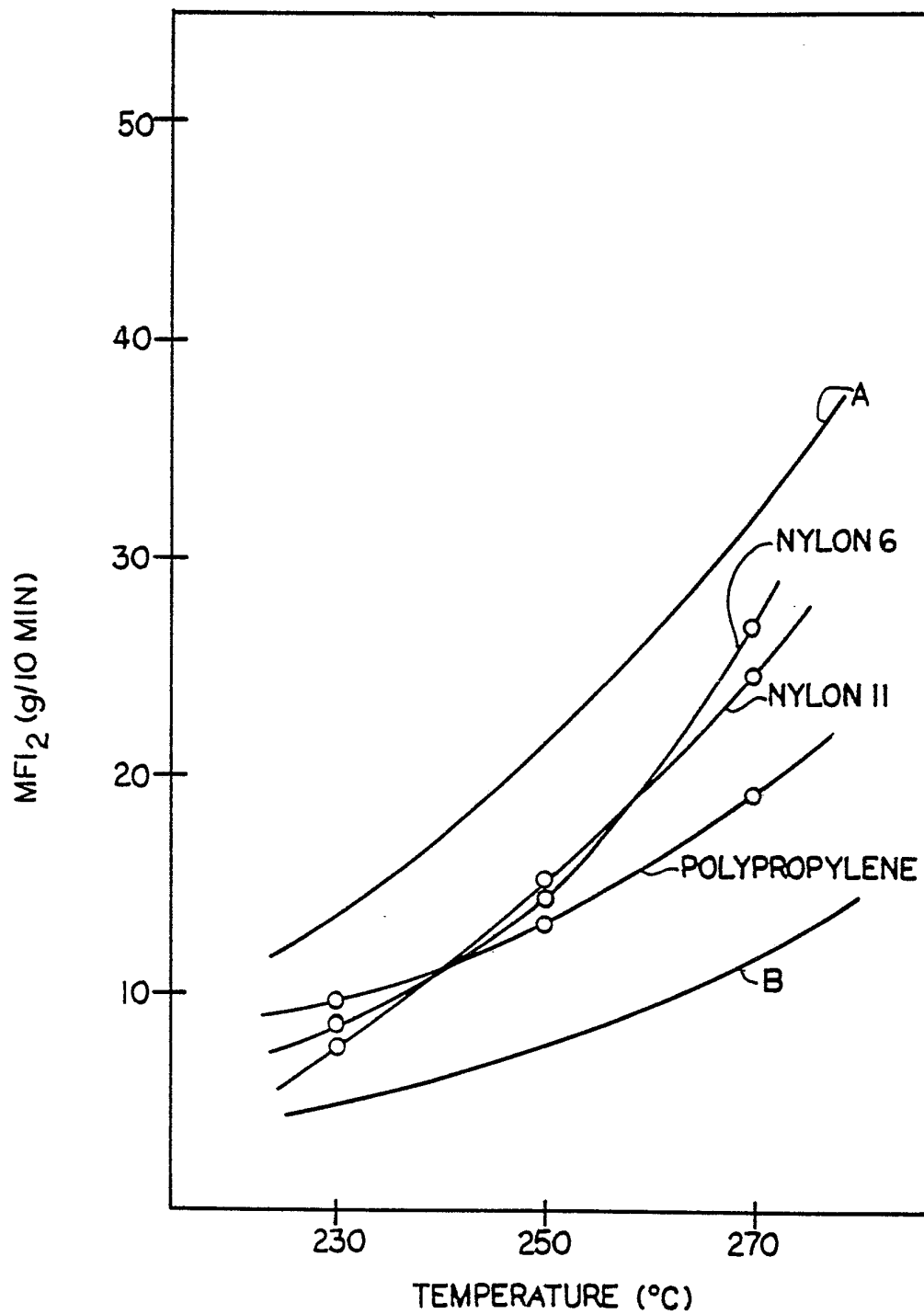


FIG. I

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FIG. 2

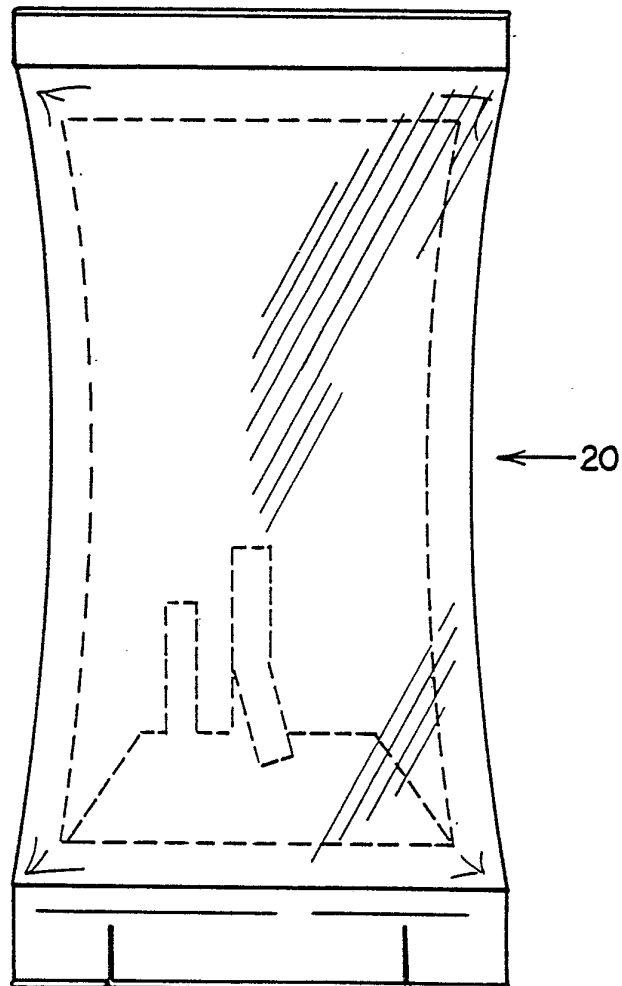
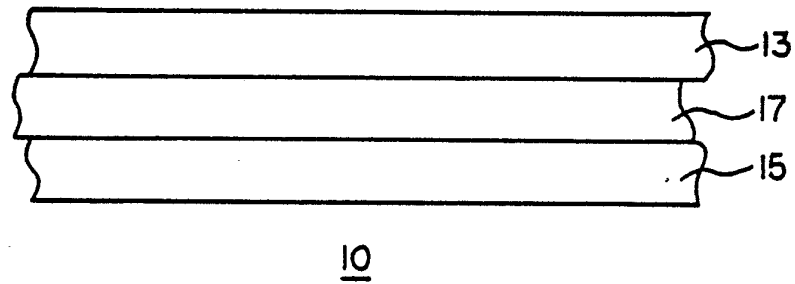
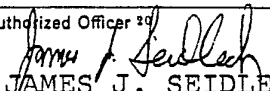


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/US86/02065

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC (4) B32B 27/08; C08L 77/00		
U.S. CL 428/35, 475.5, 476.3; 525/184		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
U.S.	428/35, 475.5, 475.8, 476.1, 476.3, 476.9; 525/184	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	US,A, 3,637,906 (PARATHOEN) 25 JANUARY 1972. See the entire document.	1-17
X	US,A, 4,360,550 (ASAKURA) 23 NOVEMBER 1982. See claim 1.	16,17
X	US,A, 3,840,427 (BRAZIER) 08 OCTOBER 1974 See claim 1.	16,17
Y	US,A, RE. 31,269 (ANDREWS) 07 JUNE 1983.	16-21
Y	US,A, 4,394,474 (MCKINNEY) 19 JULY 1983	16-21
* Special categories of cited documents: ¹⁵ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "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		
Date of the Actual Completion of the International Search ²		Date of Mailing of this International Search Report ³
07 NOVEMBER 1986		24 NOV 1986
International Searching Authority ¹		Signature of Authorized Officer ^{2d}
ISA/US		 JAMES J. SEIDLECK