(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 777 563 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
26.01.2000 Bulletin 2000/04

(21) Application number: **95928513.1**

(22) Date of filing: **16.08.1995**

(51) Int Cl.[7]: **B29C 44/20**
// C08J9/12

(86) International application number:
PCT/FI95/00433

(87) International publication number:
WO 96/06718 (07.03.1996 Gazette 1996/11)

(54) **PROCEDURE FOR THE MANUFACTURE OF A FOAMED PLASTIC PRODUCT**

VERFAHREN ZUM HERSTELLEN VON GESCHÄUMTEN KUNSTOFFGEGENSTÄNDEN

PROCEDE DESTINE A FABRIQUER UN PRODUIT EN PLASTIQUE EXPANSE

(84) Designated Contracting States:
BE CH DE DK FR GB IT LI NL SE

(30) Priority: **29.08.1994 FI 943957**

(43) Date of publication of application:
11.06.1997 Bulletin 1997/24

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EP 0 777 563 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a procedure for the manufacture of a foamed plastic product as defined in claim 1.

[0002] Foamed plastic films and blanks can be manufactured primarily by using foaming agents added directly into the film production process or by orientation stretching at a suitable temperature of a film structure containing special additives. With normal extrusion foaming methods, foaming degrees exceeding 50% are seldom achieved.

[0003] E.g. US patent 4 473 665 presents methods for pressurizing solid plastic with gas to achieve foaming. However, these methods require pressures of several tens, even hundreds of MPa.

[0004] The object of the present invention is to produce a procedure for pressure inflation of a prefoamed plastic film that makes it possible to manufacture strongly foamed film products, involving a high foaming degree and allowing the thickness of the product to be increased without increasing the amount of plastic material.

[0005] In the procedure of the invention, a polymer to be inflated contains a structural boundary layer or micropore in which a bubble is nucleated and which is inflated during a pressurizing processs. The details of the features characteristic of the procedure of the invention are presented in the attached claims.

[0006] Films inflated by the pressurizing method are visually more dull and have an increased opacity and untransparency as compared with uninflated products. In practice, the change in the visual characteristics of the film improves its properties relating to printability. The films have more paper-like rigidity characteristics, and the product is more elastic and has a better (thermal, optical) insulating capability than an uninflated film.

[0007] By the pressurizing method, using biaxially oriented polypropylene films prefoamed to 30%, it is possible to produce homogeneous foamed films and sheets with an 80-% foaming degree. Since the inflation of the foam bubbles occurs at a temperature lower than the melting point of the polymer, the bubble walls of the structure are oriented simultaneously. The orientation increases the structural strength of the final product.

[0008] The pressure required in the procedure of the invention is of the order of only 1 MPa and accordingly the pressurization chambers needed are structurally light, thus making the procedure economical.

[0009] In the following, the invention is described in detail by the aid of an example by referring to the attached drawing, in which

[0010] Fig. 1 presents an uninflated film (prefabricated product), Fig. 2a - 2 c illustrate the manufacture of foamed plastic films by the method of the invention and Fig. 3 presents an inflated film.

[0011] The basic film/blank 1 presented by Fig. 1 contains discontinuities 2 which may consist of prefoamed bubbles or boundary layers/spaces (boundary layer in a lamellar structure) formed by solid particles where a gas can be diffused and stored.

[0012] The basic film/blank 1 may have a thickness of the order of D = 5 μm - 1000 μm. The basic film/blank 1 may be in an unoriented state or in a biaxially oriented state. In this context, orientation refers to a method of processing of the plastic film/blank whereby the product is melted and then precooled to a temperature below the crystallization point and heated again to the orientation temperature for the time required by the stretching. The orientation temperature is lower than the melting point of the polymer.

[0013] The foamed structure in the basic film/blank 1 may be a lenslike structure produced by adding foaming agents into the process. It may also be a "shredded" or cavitated foamed structure resulting from internal shredding of the structure during orientation stretching, caused by solid additives or particles added into the polymer.

[0014] Fig. 2 presents an apparatus comprising an unwinding roller 3 and an end roller 4 for a film web 1, placed in a chamber 5. On the unwinding roller's side of the chamber 5 (on the right in Fig. 2a) there is also a guide roller 6 and after that two rollers 7,8 placed one upon the other, the upper one 7 of these rollers being movable in the vertical direction (as indicated by the vertical double-headed arrow) by means of a drive mechanism in such a way that, when roller 7 is in its low position, the gap between the rollers 7,8 forms a nip 9 as shown in Fig. 2a. The film has a thickness of D.

[0015] During gas treatment A as illustrated by Fig. 2a, the upper roller 7 is in its high position, leaving a large gap between the two rollers 7,8 placed one over the other. The foamed film/blank 1 is placed in the chamber 5, which can be pressurized. For pressurization, nitrogen, air or other gas can be used. In the chamber 5, the films 1 can be handled as a weblike product, the product 1 being wound from the unwinding roller 3 to the end roller so that it runs from the unwinding roller 3 obliquely upwards to an upper guide roller 10 placed at a higher level and further to guide roller 6. From here, the film 1 is passed around the upper roller 7 onto the lower roller 8, after which the film runs obliquely downwards to a lower guide roller 11 below and further to the end roller 4 as indicated by the arrows in Fig. 2b.

[0016] In the pressurized space 5, the internal boundary layers in the film/blank 1 are filled with gas. The amount of gas diffused into the film 1 and the rate of diffusion can be increased by heating the film 1 inside the chamber 5, lowering the rolling speed, increasing the pressure or by increasing the free-run distance travelled by the film 1 by passing it over auxiliary rollers. Auxiliary rollers and heating also improve the homogeneity of the diffusion process. Cooling the film 1 before its wound onto the end roller retards the diffusion of the gas from the film material 1.

[0017] After the winding in the chamber 5 under pos-

itive pressure, the chamber is depressurized and the finished roll is inflated (B, Fig. 2c). It is subjected to a new heat treatment, during which it is heated over the distance between the unwinding and end rollers. In Fig. 2c, the film is wound in the opposite direction as compared with Fig. 2b, as indicated by the arrows. The heating of the film 1 can be effected by using radiated heat or, to achieve a better thickness control of the end product, in the nip 9 between two heat rollers 7,8. The heat treatment performed after the film has been wound under positive pressure results in a permanent inflation of the product. The film 1 can also be inflated temporarily without heating, but such inflation will not be permanent because, due to the elastic properties of the polymer, the product is flattened to its original state after the gas has diffused away from the structure. Inflation effected between heating rollers 7,8 results in a very uniform thickness profile of the film/blank 1.

[0018] The thickness and the degree of inflation of the final product and can be adjusted by adjusting the nip distance and the distance travelled by the film on the heating rollers 7, 8. The inflation is performed at a temperature below the melting point of the polymer.

[0019] To reduce the costs, the same equipment can be used to wind the film under positive pressure and to wind it for inflation. The inflation efficiency can be further enhanced by creating a negative pressure in the chamber 5.

[0020] Fig. 3 illustrates a final product 1 as provided by the invention, in which the lamellar boundary layers 2 have been inflated to form lamellar gas gaps, making the product extremely elastic in its thicknesswise direction.

[0021] It is obvious to a person skilled in the art that different embodiments of the invention are not restricted to the example described above, but that they may instead be varied within the scope of the following claims.

Claims

1. Procedure for the manufacture of a foamed filmlike plastic product,

in which the product (1) is pressurized (A) with a desired gas, such as nitrogen or air, under a positive pressure, causing the gas to diffuse into the product (1), and

in which the product (1) is then inflated (B) by subjecting it to a heat treatment during which the product is heated at a temperature below its melting point and under a reduced pressure,

characterized in that

the filmlike plastic product (1) to be inflated contains lamellar structural boundary layers.

2. Procedure as defined in claim 1, **characterized** in that the plastic product (1) to be inflated has been biaxially oriented.

3. Procedure as defined in claim 1, **characterized** in that the plastic product (1) to be inflated has been prefoamed.

4. Procedure as defined in claim 1, **characterized** in that the product (1) is wound under positive pressure from one roller (3) to another (4), and that the inflation of the product (1) is performed by means of heatable rollers (7,8) while the product is being wound in the opposite direction.

5. Procedure as defined in claim 1, **characterized** in that the plastic product (1) is prefoamed e.g. by using foaming agents or solid particles added into the manufacturing process, in such a way that lamellar discontinuities (2) are created in the product (1), said discontinuities consisting e.g. of prefoamed bubbles or gaps resulting from shredding.

6. Procedure as defined in claim 1, in which the heat treatment is implemented as radiation heating or in the nip (9) between two heating rollers (7,8), **characterized** in that the thickness and the degree of inflation of the final product and can be adjusted by adjusting the nip distance and the distance travelled by the film on the heating rollers (7,8).

7. Procedure as defined in claim 1, **characterized** in that the product (1) is subjected to negative pressure during the heat treatment.

Patentansprüche

1. Verfahren zur Herstellung eines aufgeschäumten folienartigen Plastikprodukts, bei dem das Produkt (1) unter Druck (A) mit einem gewünschten Gas, wie Stickstoff oder Luft, unter Überdruck gesetzt wird, was zur Diffusion des Gases in das Produkt (1) führt, und bei dem das Produkt (1) dann, indem es einer Hitzebehandlung unterworfen wird, aufgeblasen wird (B), während das Produkt auf eine Temperatur unterhalb des Schmelzpunkts und bei reduziertem Druck erhitzt wird, **dadurch gekennzeichnet**, daß das aufzublasende folienartige Plastikprodukt (1) lamellare strukturelle Grenzschichten enthält.

2. Verfahren gemäß Anspruch 1, dadurch gekennzeichnet, daß das aufzublasende Plastikprodukt (1) biaxial orientiert wurde.

3. Verfahren gemäß Anspruch 1, dadurch gekennzeichnet, daß das aufzublasende Plastikprodukt (1)

vorgeschäumt wurde.

4. Verfahren gemäß Anspruch 1, dadurch gekennzeichnet, daß das Produkt (1) unter Überdruck von einer Rolle (3) zu einer anderen (4) gewickelt wurde und daß das Aufblasen des Produkts (1) mit Hilfe von heizbaren Rollen (7, 8) durchgeführt wird, während das Produkt in die entgegengesetzte Richtung aufgewickelt wird.

5. Verfahren gemäß Anspruch 1, dadurch gekennzeichnet, daß das Plastikprodukt (1) vorgeschäumt ist, z.B. durch Aufschäummittel oder feste Partikel, die bei dem Herstellungsverfahren hinzugefügt wurden, so daß lamellare Unregelmäßigkeiten (2) in dem Produkt (1) erzeugt werden, diese Unregelmäßigkeiten bestehen z.B. aus vorgeschäumten Bläschen oder Zwischenräumen, die aus Schreddern resultieren.

6. Verfahren gemäß Anspruch 1, bei dem die Hitzebehandlung durch Strahlungserhitzung oder in dem Abstand (nip) (9) zwischen den zwei Heizrollen (7, 8) durchgeführt wird, dadurch gekennzeichnet, daß die Dicke und der Grad an Aufblasung des Endprodukts durch Einstellung des Abstands der Walzen und der Distanz, die die Folie auf den Heizrollen (7, 8) zurücklegt, eingestellt wird.

7. Verfahren gemäß Anspruch 1, dadurch gekennzeichnet, daß das Produkt (1) einem Unterdruck während der Hitzebehandlung unterzogen wird.

Revendications

1. Mode opératoire pour la fabrication d'un produit en matière plastique de type film expansé,

   dans lequel le produit (1) est mis sous pression (A) avec un gaz souhaité, tel que de l'azote ou de l'air, sous une pression positive, pour provoquer la diffusion du gaz à l'intérieur du produit (1), et
   dans lequel le produit (1) est ensuite gonflé (B) en étant soumis à un traitement thermique lors duquel le produit est chauffé à une température inférieure à son point de fusion et sous une pression réduite,

   caractérisé en ce que

   le produit (1) en matière plastique de type film devant être gonflé contient des couches frontières structurelles lamellaires.

2. Mode opératoire selon la revendication 1, caractérisé en ce que le produit (1) en matière plastique devant être gonflé a été orienté biaxialement.

3. Mode opératoire selon la revendication 1, caractérisé en ce que le produit (1) en matière plastique devant être gonflé a été pré-expansé.

4. Mode opératoire selon la revendication 1, caractérisé en ce que le produit (1) est enroulé sous pression positive d'un rouleau (3) vers un autre rouleau (4), et que le gonflage du produit (1) est effectué au moyen de rouleaux chauffants (7, 8) pendant que le produit est enroulé en sens opposé.

5. Mode opératoire selon la revendication 1, caractérisé en ce que le produit (1) en matière plastique est pré-expansé, par exemple par utilisation d'agents ou de particules solides d'expansion ajoutés au traitement de fabrication, de telle façon que des discontinuités (2) lamellaires soient créées dans le produit (1), lesdites discontinuités étant par exemple constituées de bulles ou d'interstices pré-expansés résultant d'un cisaillement.

6. Mode opératoire selon la revendication 1, dans lequel le traitement thermique est mis en oeuvre sous la forme d'un chauffage par rayonnement ou dans le pincement (9) entre deux rouleaux chauffants (7, 8), caractérisé en ce que l'épaisseur et le degré de gonflage du produit final peuvent être ajustés par ajustement de la distance de pincement et de la distance parcourue par le film sur les rouleaux chauffants (7, 8).

7. Mode opératoire selon la revendication 1, caractérisé en ce que le produit (1) est soumis à une pression négative pendant le traitement thermique.

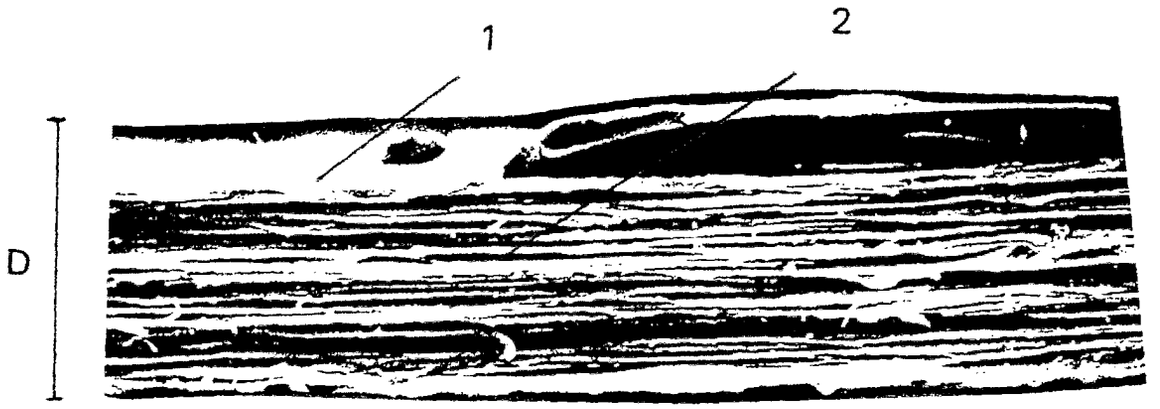

FIG. 1

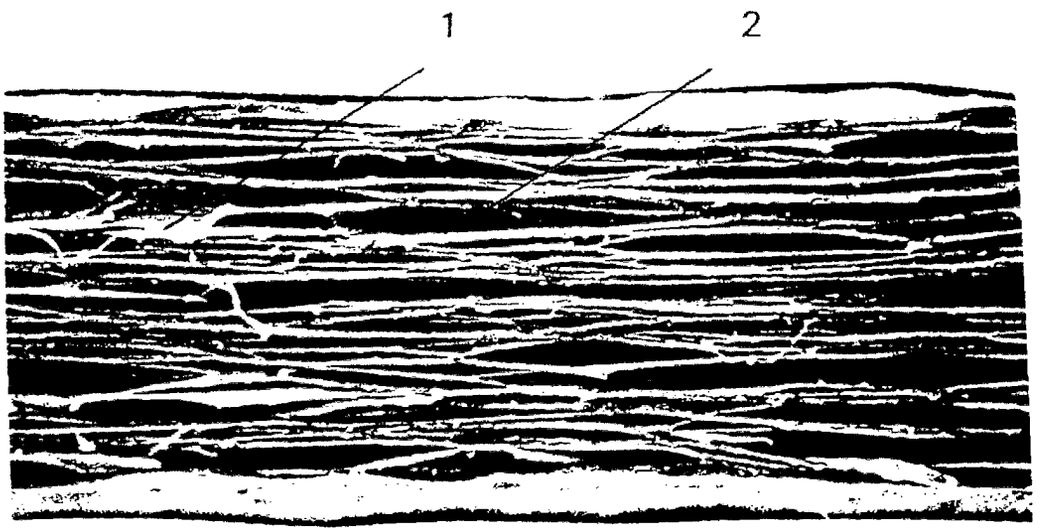

FIG. 3

FIG. 2b

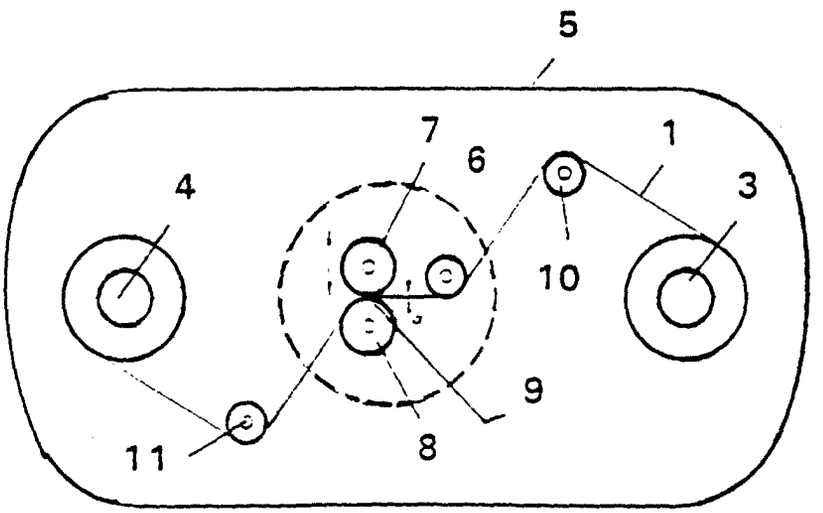

FIG. 2a

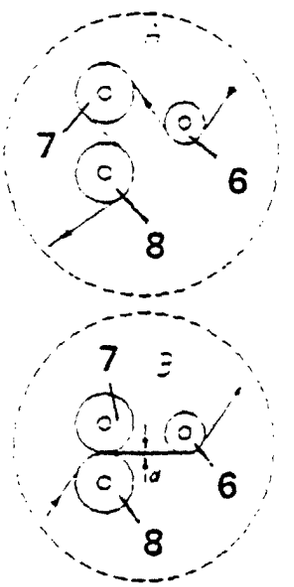

FIG. 2c