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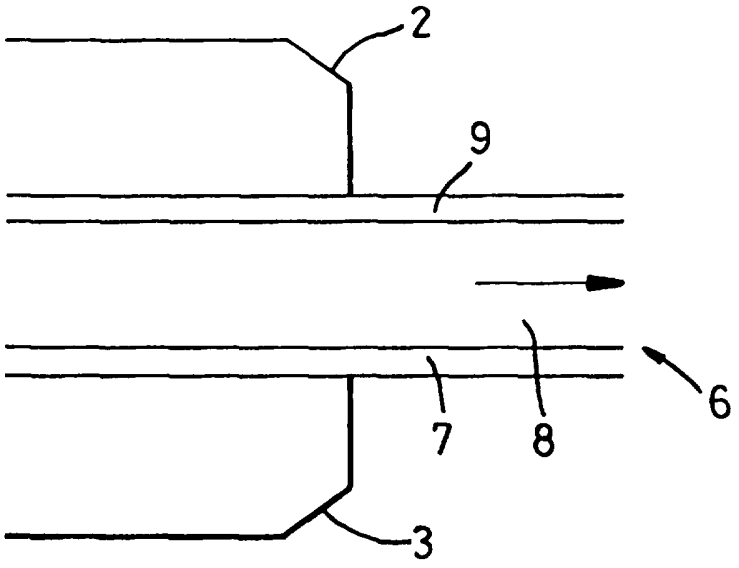
(57) Abstract

A thermoplastic solid backing film manufactured by the co-extrusion of three polymer compositions wherein die-lip build-up is avoided by adjusting the amount of filler present in each polymer composition. The first and third polymer compositions are such that substantially no die-lip build-up occurs when these compositions are extruded through a die, however the second polymer composition is such that there would be substantial die-lip build-up if it was extruded adjacent a die-lip. The presence of the first and third polymer compositions prevents the second polymer composition from contacting the die-lip during manufacture of the backing film. The thermoplastic solid backing film can be incorporated in a resilient floor covering and in floor tiles.



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FLOOR COVERINGS AND FILMS FOR USE THEREIN

This invention relates to the manufacture of extruded films, to the extruded films so made and to floor coverings, particularly resilient floor coverings, containing such films as backing films.

Resilient floor coverings are well-known and are described for example in an article entitled "Flooring Materials" in Encyclopaedia of Polymer Science and Engineering, Wiley-Interscience, 3rd edition, Volume 7 (1987), pages 233-247, and in an article entitled "Floor Coverings" in Ullmann's Encyclopaedia of Industrial Chemistry, VCH Publishing, 5th edition, Volume All (1988), pages 270-274. Resilient floor coverings are commonly composite laminates constructed from a number of plastics film layers, each layer being specially formulated for a particular duty. Thus, the topmost film, which is commonly called the wear layer, is formulated for good resistance to abrasion and wear. The wear layer may be transparent, so that the colouring or patterning of one or more lower films can be seen through it, in which case it is commonly called a clear wear layer. Such a clear wear layer generally overlies a pigmented film which is solid in colour, for example white. Such a pigmented film is commonly called a face ply. A printed patterned film is generally interposed between the clear wear layer and the face ply, the presence of the face ply serving to enhance the visual appearance of the pattern as seen through the wear layer. The undermost film of the composite is commonly referred to as the backing layer and is often pigmented black. It may be embossed on the underside with a pattern, produced for example by pressing against a fabric belt, to provide good adhesion to the underlying floor. Alternatively, the floor covering may comprise a backing fabric adhered to the underside of the backing layer. In the construction known as cushion flooring the composite may contain

a foam layer between the face ply and the undermost backing. The solid backing films, which include the face ply and the backing layer, are generally highly-filled thermoplastic materials. The films which lie between the wear layer and the backing may be referred to as interior films. The compositions of all the layers in the composite must be balanced to ensure that the floor covering has the correct balance of properties; for example insulating and sound-absorbing properties, and in particular freedom from a tendency to curl. Economic factors must also be borne in mind.

Resilient floor coverings based on plasticised PVC, which are commonly known as vinyl sheet and tile flooring, have enjoyed considerable commercial success but suffer from a number of disadvantages. PVC is slightly yellow and tends to become more yellow on exposure to the amounts of UV light commonly occurring in interior environments. The clarity of clear PVC wear layers and the visual appearance of patterned printed layers seen through such wear layers are not as great as could be desired. The resistance of vinyl floor coverings to wear, abrasion, scratching and scuffing is not as great as could be desired. The use of vinyl floor coverings has been objected to on environmental grounds, both in that they contain the chlorinated polymer PVC and in that they contain volatile organic compounds such as plasticisers. Proposals have been made for the manufacture of resilient floor coverings which overcome some of these disadvantages, in particular by reason of being based on thermoplastic polymer compositions which are essentially chlorine-free, as described for example in WO-A-95/08593.

In the manufacture of vinyl flooring, films, including the solid backing films, are commonly made by calendering techniques.

Calendering is well-suited to the manufacture of highly-filled vinyl films. In contrast, many of the polymers suitable for the manufacture of chlorine-free resilient floor coverings can be extruded, but cannot readily be calendered. The extrusion of highly-filled films of such polymers has been found to present practical difficulties. Polymer, often enriched with filler, tends to accumulate on the outer surface of the lips of the extrusion die in the phenomenon known as die-lip build-up. The accumulated polymer tends to become degraded as a consequence of remaining exposed at the hot exterior surfaces of the die lips. The accumulated polymer tends from time to time to break away from the lips of the die, whereupon it may become embedded in the surface of the film, thereby degrading film quality. The minimum proportion of filler at which this effect occurs depends to some extent on the nature of the composition, including the type of polymer and filler employed, and on the extrusion conditions, but we have determined that it is often of the order of 30 or 40 percent by weight for spherical fillers or of the order of 20 or 25 percent for plate-like fillers. It is an object of the invention to provide a method of manufacturing highly-filled extruded films for use as solid backing films in resilient flooring coverings which does not suffer from the problem of die-lip build-up.

EP-A-228041 describes a coextruded multilayer material having a thermoplastic core layer with at least one inorganic or organic constituent dispersed therein, sandwiched between thermoplastic outer layers substantially free of such particles. This form of construction serves to reduce the tendency of colorants, especially organic dyes, to migrate to the surface of a monolayer extruded article during and after the extrusion process, which may result in damage to the extruder, cross-contamination and colour defects. It also serves to reduce the tendency of reinforcing agents to break through the surface of a monolayer extruded article during

extrusion, which may result in poor quality product and ultimately in damage to the extruder. The total amount of inorganic or organic constituents generally ranges from about 1 to about 40 percent by total weight of the multilayer material.

EP-A-347745 describes a coextruded multilayer film structure containing a high percentage of fillers. The fillers are concentrated in a filler-containing layer which amounts to no more than about 5 to about 20 percent, preferably no more than about 10 percent, of the thickness of the total multilayer film. The filler-containing layer may contain about 15 to about 60 percent by weight filler. The filler-containing layer may be joined to a relatively thick base layer or may be sandwiched between two such relatively thick base layers. The base layers may contain 1 to 15 percent by weight conventional whiteners such as titanium dioxide or calcium carbonate. The base layer or layers serve to support the filler-containing layer, which is brittle and easily torn.

According to the present invention there is provided a thermoplastic solid backing film for inclusion in a floor covering, characterised in that it is a coextruded film comprising in sequential order:-

(1) A first lamina having a first thermoplastic polymer composition with a first proportion of filler;

(2) A second lamina having a second thermoplastic polymer composition with a second proportion of filler;

(3) A third lamina having a third thermoplastic polymer composition with a third proportion of filler;

the first and third thermoplastic compositions being such that when the first and third laminae were extruded through the die there was substantially no die-lip build up, and the second thermoplastic composition being such that if the second lamina were to be extruded adjacent a die lip there would be significant die lip build up, the first and third laminae having prevented the second lamina from contacting the die during manufacture of the film.

The film is preferably produced by coextruding through a die in the following order:

(1) a first lamina which consists of a first thermoplastic polymer composition comprising from zero to about 30 percent by weight infusible filler;

(2) a second lamina which consists of a second thermoplastic polymer composition comprising about 50 to about 75 percent by weight infusible filler; and

(3) a third lamina which consists of a third thermoplastic polymer composition comprising from zero to about 30 percent by weight infusible filler, whereby the occurrence of die-lip build-up is avoided.

A method of manufacturing a thermoplastic solid backing film for inclusion in a floor covering, the film being produced by co-extruding through a die in the following order;

(1) A first lamina having a first thermoplastic polymer composition with a first proportion of filler;

(2) A second lamina having a second thermoplastic polymer composition with a second proportion of filler;

(3) A third lamina having a third thermoplastic polymer composition with a third proportion of filler;

the first and third thermoplastic compositions being such that as the first and third laminae are extruded through the die there is substantially no die-lip build up, and the second thermoplastic composition being such that if the second lamina were to be extruded adjacent a die lip there would be significant die lip build up, the first and third laminae ensuring that the second lamina does not contact the die lip avoiding any die lip build up of the second thermoplastic polymer composition.

The thermoplastic solid backing film for inclusion in a floor covering is preferably a coextruded film comprising in sequential order:

(1) a first lamina which consists of a first thermoplastic polymer composition comprising from zero to about 30 percent by weight infusible filler;

(2) a second lamina which consists of a second thermoplastic polymer composition comprising about 50 to about 75 percent by weight infusible filler; and

(3) a third lamina which consists of a third thermoplastic polymer composition comprising from zero to about 30 percent by weight infusible filler.

In the method or backing film of the first or second aspect of the invention the first composition (layer) may have from 1 to 30 percent by weight infusible filler, or from 5 to 30, or from 15 to 30 percent by weight infusible filler. Similarly, the third composition (layer) may have the same range of filler.

The film may have at least 50% or at least 60% or at least 70% by weight infusible filler. The filler may in any polymer composition (or in more than one of them) be disposed in a thermoplastic matrix.

The thermoplastic polymers utilised in the first, second and third laminae may be the same or different and may be any extrudible polymer suitable for use in solid backing films for inclusion in resilient floor coverings. Examples of suitable polymers include ethylene/vinyl acetate copolymers and ethylene/alkyl acrylate, for example methyl or butyl acrylate, copolymers. The first and third thermoplastic polymer compositions may be the same or different. The first and third polymer compositions may additionally comprise a small proportion, for example 5 to 10 percent by weight, of a binder polymer, for example an ethylene/alkyl acrylate/maleic anhydride terpolymer, to provide good adhesion to adjacent films in a composite laminate floor covering. The polymer compositions may additionally comprise minor proportions of substances such as lubricants, antioxidants and stabilisers known in the art.

The infusible filler may comprise any filler or mixture of fillers known in the art. Examples of suitable fillers include inorganic substances such as calcium carbonate, hydrated aluminium oxide, kaolin and other particulate and fibrous materials. The infusible filler may additionally comprise a proportion, generally a minor proportion, of one

or more pigments, for example a white pigment such as titanium dioxide or a black pigment such as carbon black. For example, a lamina in the film of the invention may comprise 1 to 20 percent by weight titanium dioxide or 1 to 5 percent by weight carbon black as part of the infusible filler. It will be appreciated that, although many such fillers and pigments melt (fuse) at high temperatures, they are infusible at the temperatures encountered during the extrusion of plastics materials, and the word "infusible" is to be understood herein in the latter sense.

The thickness of a coextruded film according to the invention is commonly in the range 100 to 2000 micron, often 500 to 1500 micron.

The thickness of the second lamina is as a rule at least about 45% and generally amounts to at least about 80%, preferably at least about 90%, of the total thickness of the coextruded film. This permits the manufacture of films with desirably high overall contents of infusible filler, for example at least 50, 55 or 60 percent by weight, and up to 70 or 75 percent by weight. The thickness of the first and third laminae may be the same or different and is generally in the range 10 to 100 micron, preferably 20 to 50 micron. The first and third laminae may be any colour including black. The thickness of the first and third laminae must be such that the laminae are opaque. When it is desirable to change the colour of the first laminae the new colour may be added to the formulation of the third lamina before the supply of the original colour to the first lamina is stopped so that the new colour is well established in the third lamina before the colour of the first lamina fades. The film can then be turned over such that the third lamina, being the desired new colour, forms the coloured first lamina of the backing film and the original first layer forms the third lamina.

To enable the first and third laminae of the backing film to be intechangeable it is desirable to have substantially the same amount of filler in each of the first and third polymer compositions. Having a high proportion of filler, such as 70% by weight, in the first and third laminae may cause the film to curl. In an embodiment of the invention the film is extruded with a filer content of 70% by weight in the first lamina and 50% by weight in the third lamina to overcome the problem of the film curling. When a new colour is added to the third lamina the filler content may also be altered, to ensure that when the film is turned over the new first (third) lamina has a higher filler content than the new third (first) lamina.

It will be understood that the backing film of the invention may comprise one or more interior laminae additional to the second lamina, provided always that the first and third laminae are disposed at the exterior of the film. Particularly when adjacent laminae comprise different polymers, the film of the invention may additionally comprise a layer of extrudible polymeric adhesive between such adjacent laminae, in the manner known in coextrusion technology.

The method of the invention may be implemented by means of conventional coextrusion equipment.

The invention further provides a composite laminate resilient floor covering characterised in that it comprises at least one coextruded backing film of the invention or made by the method of the invention.

The invention provides a floor tile that comprises at least one coextruded backing film of the invention or made by the method of the invention.

The tile may have two backing layers.

The tile may have a transparent or translucent wear layer.

The tile may have a decorative patterned layer.

The invention further provides a box of more than one floor tile wherein each floor tile comprises at least one coextruded backing film of the present invention or made by the method of the invention.

The invention will now be described with regard to the accompanying drawings, in which:

Figure 1 is a schematic cross-sectional illustration of the extrusion of a filled backing film according to the prior art, exemplifying the problem of die-lip build-up; and

Figure 2 is a schematic cross-sectional illustration of the extrusion of a filled backing film according to the invention;

Figure 3 is a graphical representation of the results of an experiment carried out to determine the effect of increased filler levels in the first and third polymer compositions on the die-lip build up;

Figure 4 is a cross section of a tile having a backing film according to the invention.

Referring to Figure 1, a film 1 of a highly-filled thermoplastic polymer composition containing for example 50 or 60 percent by weight filler is extruded in the direction of the arrow through a die having lips 2, 3. Filler-enriched portions of the polymer 4, 5 accumulate on the outer surface of the die lips 2, 3 (die-lip build-up). where they tend to become degraded and from where they tend to break away from time to time.

Referring to Figure 2, a film 6 comprising in sequential order three laminae 7, 8 and 9 consisting respectively of first, second and third thermoplastic polymer compositions is coextruded in the direction of the arrow through a die having lips 2, 3. The first and third polymer compositions comprise relatively low proportions of filler, for example about 5 to about 30 percent by weight. The second polymer composition comprises a relatively high proportion of filler, for example about 50 to 75 percent by weight. The overall filler content of the film is for example 50 or 60 percent by weight. The highly-filled interior lamina 8 provides about 80% of the total thickness of the film. The die lips 2, 3 are free from die-lip build-up.

Table 1 below shows the bead size in millimetres (mm) of the die-lip build up occurring over a period of 6hrs when the amount of filler in the first and third polymer compositions is changed from 5% by weight through to 40% by weight. It can be seen from the results that levels of filler above 30% by weight cause the bead size of the die-lip build up to increase dramatically.

Figure 3 is a graphical representation of the results of Table 1.

Table 1

Filler Level in % by weight	Bead size in mm per 6 hours
5	0.5
10	0.6
15	0.7
20	1
30	2
40	10

Figure 4 illustrates a floor tile having a wear layer 10, a decorative layer 11 and a backing film 6 comprising three laminae 7,8,9 made by the method illustrated by Figure 2.

The invention is illustrated by the following Examples, in which parts and proportions are by weight except where otherwise specified:-

Comparative Example

A thermoplastic polymer composition comprising 60 parts of a blend of ethylene/methyl acrylate (EMA) and ethylene/butyl acrylate (EBA) copolymers (Lotryl, Trade Mark, available from Elf-Atochem) (such copolymers and blends thereof commonly being designated EDA), and 40 parts calcium carbonate (Calmote MG, Trade Mark, available from Croxton & Garry Limited) was extruded at temperatures in the range 200-260°C at melt pressures in the range 25-50 bar through a rectangular die at a velocity of 10 m/min to produce a film of thickness 915 micron (36

thou). Die-lip build-up occurred at such a rate that rolls of material 2 mm in diameter formed and gathered at the exterior lips of the die within 10-15 minutes.

Example

Three thermoplastic polymer compositions were coextruded under similar conditions to those of the Comparative Example to produce a film consisting of the following laminae:

(1) 50 micron (2 thou) thick, consisting of EMA (75 parts; Lotryl 18MA02 , Trade Mark, available from Elf -Atochem) , calcium carbonate filler (20 parts; Calmote MG, Trade Mark) and titanium dioxide (5 parts);

(2) 840 micron (33 thou) thick, consisting of EMA (100 parts), Calmote MG (150 parts) china clay (70 parts; a plate-like filler; B-Clay, Trade Mark, available from ECC Limited) and carbon black (10 parts); and

(3) 20 micron (0.8 thou) thick, consisting of polyethylene (77 parts; Lacqtene LD0304. Trade Mark, available from Elf -Atochem) , Calmote MG (20 parts) and carbon black (3 parts).

Extrusion was continued for 90 minutes. No die-lip build-up was observed at any time.

CLAIMS

1. A thermoplastic solid backing film for inclusion in a floor covering, the film being produced by co-extruding through a die in the following order;

1) a first lamina having a first thermoplastic composition with a first proportion of filler;

2) a second lamina having a second thermoplastic composition with a second proportion of filler;

3) a third lamina having a third thermoplastic composition with a third proportion of filler;

the first and third thermoplastic compositions being such that when the first and third laminae were extruded through the die there was substantially no die-lip build up, and the second thermoplastic composition being such that if the second lamina were to be extruded adjacent a die lip there would be significant die lip build up, the first and the third lamina having prevented the second lamina from contacting the die during manufacture of the film.

2. A thermoplastic solid backing film for inclusion in a floor covering according to claim 1, comprising in sequential order:

(1) a first lamina which consists of a first thermoplastic polymer composition comprising from zero to about 30 percent by weight infusible filler;

(2) a second lamina which consists of a second thermoplastic polymer composition comprising about 50 to about 75 percent by weight infusible filler; and

(3) a third lamina which consists of a third thermoplastic polymer composition comprising from zero to about 30 percent by weight infusible filler, whereby the occurrence of die-lip build-up is avoided.

3. A thermoplastic solid backing film according to claim 1 or 2, wherein the first and third thermoplastic polymer compositions have from 1 to 30 percent by weight infusible filler.

4. A thermoplastic solid backing film according to claim 1 or 2, wherein the first and third thermoplastic polymer composition have from 5 to 30 percent by weight infusible filler.

5. A thermoplastic solid backing film according to claim 1 or 2 wherein the first and third thermoplastic polymer compositions have from 15 to 30 percent by weight infusible filler.

6. A thermoplastic solid backing film according to claim 1 to 5, wherein the film comprises at least 50% by weight infusible filler.

7. A thermoplastic solid backing film according to claim 1 to 5, wherein the film comprises at least 60% by weight infusible filler.

8. A thermoplastic solid backing film according to claim 1 to 5, wherein the film comprises at least 70% by weight infusible filler.

9. A thermoplastic solid backing film according to any preceding claim, wherein the filler is, in the first, second or third polymer composition, disposed in a thermoplastic matrix.

10. A thermoplastic solid backing film according to any preceding claim, wherein the filler is, in more than one polymer composition, disposed in a thermoplastic matrix.

11. A thermoplastic solid backing film according to any preceding claim, wherein the thermoplastic polymers utilised in the first, second and third laminae are the same.

12. A thermoplastic solid backing film according to any one of claims 1 to 10, wherein the thermoplastic polymers utilised in at least two of the first, second and third laminae are different.

13. A thermoplastic solid backing film according to any preceding claim, wherein the first and third thermoplastic polymer compositions are the same.

14. A thermoplastic solid backing film according to any of claims 1 to 12, wherein the first and third thermoplastic polymers are different.

15. A thermoplastic solid backing film according to any preceding claim, wherein the first and third polymer compositions additionally comprise a small proportion of a binder polymer.

16. A thermoplastic solid backing film according to claim 15, wherein a small proportion of binder polymer is 5 to 10 percent by weight.

17. A thermoplastic solid backing film according to any preceding claim, wherein the polymer compositions additionally comprise minor proportions of substances selected from the group comprising lubricants, antioxidants and stabilisers.

18. A thermoplastic solid backing film according to any preceding claim, wherein the infusible filler additionally comprises a proportion, generally a minor proportion, of one or more pigments.

19. A thermoplastic solid backing film of any preceding claim, wherein the thickness of the coextruded film is in the range 100 to 2000 micron.

20. A thermoplastic solid backing film according to any preceding claim, wherein the thickness of the second lamina is at least about 45% of the total thickness of the coextruded film.

21. A thermoplastic solid backing film according to any of claims 1 to 19, wherein the thickness of the second lamina is at least about 80% of the total thickness of the coextruded film.

22. A thermoplastic solid backing film according to any of claims 1 to 19, wherein the thickness of the second lamina is at least about 90% of the total thickness of the coextruded film.

23. A thermoplastic solid backing film according to any preceding claim, wherein the thickness of the first and third laminae is the same.

24. A thermoplastic solid backing film according to any one of claims 1 to 22, wherein the thickness of the first and third laminae is different.

25. A thermoplastic solid backing film according to any preceding claim, wherein the thickness of the first and third laminae is in the range 10 to 100 microns.

26. A thermoplastic solid backing film according to any preceding claim, which comprises one or more interior laminae additional to the second lamina, provided always that the first and third laminae are disposed at the exterior of the film.

27. A method of manufacturing a thermoplastic solid backing film for inclusion in a floor covering, the film being produced by co-extruding through a die in the following order;

(1) a first lamina having a first thermoplastic polymer composition with a first proportion of filler;

(2) a second lamina having a second thermoplastic polymer composition with a second proportion of filler;

(3) a third lamina having a third thermoplastic polymer composition with a third proportion of filler;

the first and third thermoplastic composition being such that as the first and third laminae are extruded through the die there is substantially no die-lip build up, and the second thermoplastic composition being such that if the second lamina were to be extruded adjacent a die lip there would be significant die lip build up, the first and the third lamina ensuring that the second lamina does not contact the die lip thereby avoiding any die lip build up of the second thermoplastic polymer composition.

28. A method according to claim 27, characterised in that the film is produced by coextruding through a die in the following order:

(1) a first lamina which consists of a first thermoplastic polymer composition comprising from zero to about 30 percent by weight infusible filler;

(2) a second lamina which consists of a second thermoplastic polymer composition comprising about 50 to about 75 percent by weight infusible filler; and

(3) a third lamina which consists of a third thermoplastic polymer composition comprising from zero to about 30 percent by weight infusible filler, whereby the occurrence of die-lip build-up is avoided.

29. A composite laminate resilient floor covering, characterised in that it comprises at least one coextruded backing film of claims 1 to 26, or made by the method of claims 27 or claim 28.

30. A floor tile characterised in that it comprises at least one coextruded backing film according to claims 1 to 26 or made by the method of claims 27 or claim 28.

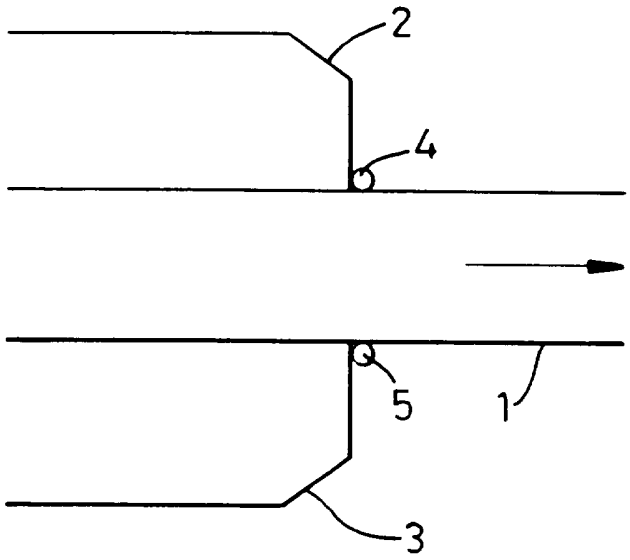

Fig. 1

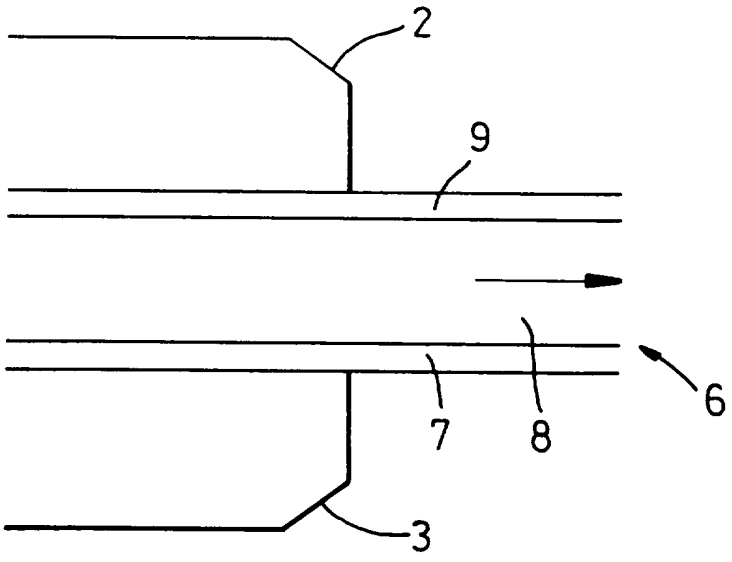

Fig. 2

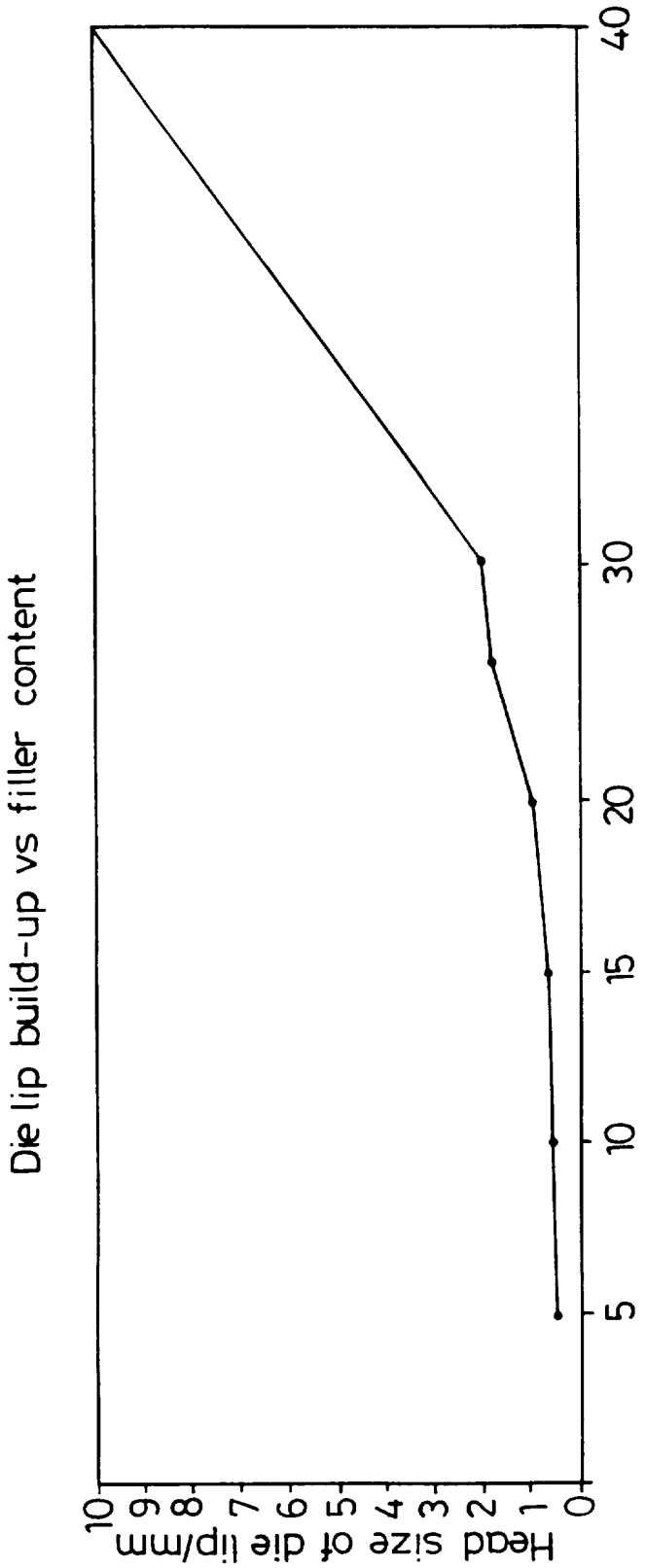
Die lip build-up vs filler content
Head size of die lip/mm
0
1
2
3
4
5
6
7
8
9
10
5
10
15
20
30
40
Filler %

Fig. 3

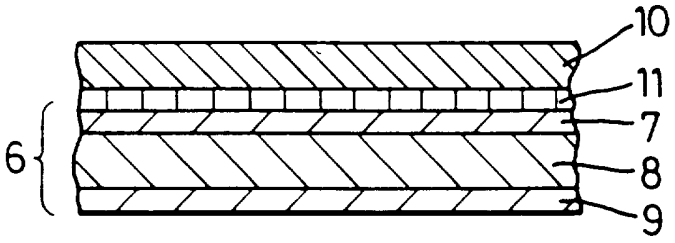

Fig. 4

INTERNATIONAL SEARCH REPORT

national Application No
PCT/GB 96/02859

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B29C47/06 B32B27/20 D06N7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B29C B29D B32B D06N A47G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 621 128 A (TARKETT PEGULAN AG) 26 October 1994 see claims 1-5; figure 2 ---	1-30
Y	US 4 263 080 A (PHILIP C. WHITING, JR.) 21 April 1981 see column 2, paragraph 3; claim 1 ---	1-30
Y	EP 0 228 041 A (GENERAL ELECTRIC COMPANY) 8 July 1987 cited in the application see page 3, line 17 - line 22 see page 5, line 37 - line 39; claims 1,6 --- -/--	1-30

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
21 March 1997	22.04.97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Van Nieuwenhuize, O

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INTERNATIONAL SEARCH REPORT

International Application No
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