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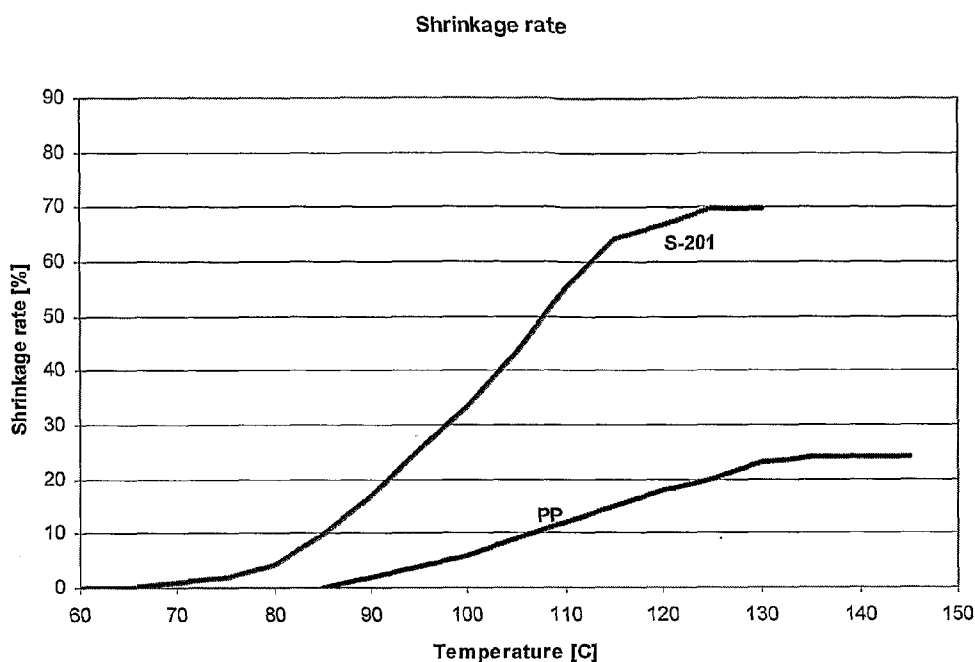
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(54) Title: THERMOPLASTIC SHRINKABLE POLYMERIC FILM



(57) Abstract: A thermoplastic polymeric film which shrinks in a monoaxial direction by less than 5% when heated to a first temperature and by at least 25% when heated to a second temperature. The first temperature and second temperature having a temperature interval of no more than 30 C. The film may be used to envelop an outer surface portion of a container. The enveloping of the outer surface portion may closely and substantially uniformly follow the contour thereof.



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

THERMOPLASTIC SHRINKABLE POLYMERIC FILM

5 FIELD OF THE INVENTION

The present invention is in the field of polymeric films and sheets for use in wrapping and labeling industries.

BACKGROUND OF THE INVENTION

It is known in the art that the behavior of a thermoplastic sheet may be improved if the sheet is subjected to a unidirectional longitudinal stretching operation. This operation is described, *inter alia*, in US 3,796,785. In general, a rotating heated first roller and an adjacent and parallel rotating heated second roller are provided with a stretching gap therebetween, the rollers rotating oppositely to each other with the first roller having a first radius and rotating at a first radial velocity which is sufficiently smaller than that of the second roller to provide a stretching effect on a sheet passing from the first roller to the second roller through the stretching gap.

A "*short-gap-stretching operation*" defines in principle the same process, however, with a gap between the first and second rollers being as small as possible. Two publications that describe such processes are: US 5,184,379 and US 6,375,781.

DESCRIPTION OF THE INVENTION

The present invention is based on the finding that some films, produced by short-gap-stretching operations, are characterized by a narrow temperature window in which they shrink and that this narrow temperature window has an advantage in wrapping and labeling techniques and industries.

- 2 -

Thus, according to a first aspect, there is provided thermoplastic polymeric film which shrinks in a monoaxial direction by less than 5% when heated to a first temperature and by at least 25% when heated to a second temperature, said first temperature and said second temperature being different in no more than 30°C, preferably no more than 20°C. This behavior of the polymeric film of the invention is referred to herein as shrinking in a narrow temperature window.

The term "*thermoplastic polymeric film*" denotes a thin layer of polymeric material which is capable of repeatedly softening when heated and hardening when cooled, thereby allowing the repeated stretching or shrinking of the film upon heating. Typical of the thermoplastics family are the styrene polymers, acrylics, polyolefins (e.g. polyethylenes, polypropylenes), cyclic olefinic copolymers, vinyls (e.g. polyvinylchloride) polyamides, polystyrenes, polyesters, as well as copolymers of the above (block copolymers, random copolymers etc.), various fluorocarbon materials etc.

A preferred polymeric film according to one embodiment of the invention is polystyrene.

According to yet another embodiment of the invention, a preferred polymeric film is a film selected from polyolefins, such as polyethylene, polypropylene, and many others.

According to one embodiment the shrinking by at least 25% when heated to the second temperature is in the same direction of shrinking by less than 5% when heated to the first temperature.

Furthermore, the thermoplastic polymeric film according to the invention may constitute a blend of polymers, such as those mentioned above. According to one example, the blend may comprise polystyrene and polyethylene. It has been established that blends, such as that comprising polystyrene and polyethylene also exhibit the above-defined shrinking in a narrow temperature window.

- 3 -

It should be understood that the thermoplastic polymer of the invention may be any chemical derivative of the above mentioned polymers. The term "derivatives" include any chemical modification of the above polymers, including substitution of a chemical group on the backbone of the polymer (such as in the case of polyvinylchloride), as long as the blend has also a narrow temperature window shrinking behavior.

Thermoplastic polymeric films may stretch or shrink either in a biaxial direction (longitudinal and traverse directions) or in a monoaxial direction. In a preferred embodiment, the thermoplastic polymeric film of the invention is monoaxially shrinkable along the longitudinal direction of the film (also called in the field *the machine direction*). According to this embodiment, the original dimension of the film along the traverse direction shrinks by no more than 5%, preferably no more than 1%, and most preferably it essentially does not shrink at all in that direction.

The degree of monoaxial shrinkage may be between about 25% to about 90% from the dimension of the thermoplastic polymeric film before heating.

The polymeric film may consist of a monolayer or of a plurality of layers (multilayer film) according to need. The layer, either in the single layer construction or multilayer construction may comprise a single polymer, a blend of polymers, or, in the multilayer construction, a combination of single/blend polymeric layers.

When using a multi-layer film, it may be constructed from layers stretchable/shrinkable in the same monoaxial direction, or a combination of a first layer stretchable in a monoaxial direction (longitudinal stretching) and one or more additional layers, either non-stretchable or being capable of stretching in a biaxial orientation. The plurality of layers may be associated by any means known in the art, such as lamination, co-extrusion and the like. In any case, the film has a thickness typically within the range of 15-100 μ .

- 4 -

The thermoplastic polymeric film of the invention is produced by a short-gap stretching operation, using rollers having between them a gap at least ten times smaller than the width of the film (or of the rollers), to produce a film which heat shrinks mainly along the film's longitudinal direction, while in other directions
5 shrinking is practically impaired. The distance between the rollers is preferably smaller than the width of the film in a factor of between 10 and 5000, preferably between about 50 and about 2500.

Films produced by short-gap-stretching operation may have a variety of applications. It has been found by the inventors that the heat shrinkable film of the
10 invention is applicable for wrapping container(s) in wrap-around technique utilized, *inter alia*, in labeling industries. In general, a yarn of heat shrinkable film is loosely arranged around the container(s) and upon heating to a shrinking temperature of the film, shrinks at least in one direction such that the resulting product comprises the container(s) wrapped with the film. The heating medium may be hot air, radiant
15 heat or steam. Wrapping around of the container(s) may be performed using either a shrinkable film supplied on a roller, as one long continuous sheet which is cut to the appropriate length, then enveloping the container with the ends (edges) of the sheet being adhered to each other by the use of an appropriate glue (and optionally at least one edge adhered to the container). Then heat is applied causing the film to
20 shrink around the container. The heat causes the film to mould itself to the shape of the container. Shrink films are of particular interest for use on unusually shaped containers, especially where full height coverage is required.

The thermoplastic polymeric film of the invention is preferably used in product labeling industry. The polymeric substance may be combined, preferably
25 before shrinking, with additives. Non-limiting examples of additives which may be added to the polymeric material include lubricants, anti-blocking agents, antistatic agents and anti-fogging agents.

According to a further aspect of the invention there is provided an article comprising:

– 5 –

– a container having an outer surface; and

– a film having a first end and a second end, the film circumferentially enveloping at least a portion of said container such that said first end and said second end have an overlapping area and the first end and second end are associated at said overlapping area by adhesive means, wherein at least a portion of said film is capable of shrinking in a monoaxial direction by less than 5% when heated to a first temperature and by at least 25% in the same direction when heated to a second temperature, said first temperature and said second temperature having a temperature interval of no more than 30°C.

The film portion enveloping the container has essentially the same characteristics as the thermoplastic polymer film of the invention, as defined hereinbefore. Such film portions are typical when enveloping non-uniformly shaped containers, i.e. which have variable cross-sectional areas along the container's longitudinal axis. These portions of the film will typically be those which cover wider areas of the container, i.e. with the relatively larger cross-sectional area.

The term "*container*" as used herein includes a receptacle of any shape or dimension, having a uniform or a non-uniform outer surface configuration, at least at the portion to be enveloped by the thermoplastic polymeric film of the invention. Non-limiting examples of uniformly shaped containers include cups, pipes or tubes, electrical wires, batteries, cubic packages and the like. Non-limiting examples of non-uniformly shaped containers include drink-containing bottles, which may have varying cross-sectional areas along their longitudinal axis, with a wall typically converging towards the opening of the bottle; cans having circumferentially formed threads or patterns, as well as other containers, as will be appreciated by those versed in the wrap-around technology.

Preferably, the container is a cylindrical container, most particularly a cylindrical container with non-uniform diameter such as drink-containing bottles, drinking cans, containers for liquid soap, shampoo containers, batteries, chemicals, detergents, medications, bottles with tamper evidence seals, etc.

- 6 -

The term "*container*" according to the invention may also refer to a bundle of articles, such as a bundle of wires, packages and the like.

The term "*enveloping*" which is used herein interchangeably with the term "*wrap-around*" denotes the formation of circumferential cover over at least a portion of the outer surface of the container, where the cover is essentially stretched over and closely follows the contour of the outer surface of the container at said portion.

Further in accordance with the invention "*enveloping*" or "*wrapping around*" includes the circumferential cover of the outer surface of the container with the film. It is preferable that the association includes at least one, preferably several, points on the outer surface of the container at which the film and container are associated by adhesive means. The latter prevents the enveloping material from displacing before it is subjected to heat (resulting in its shrinkage).

According to one embodiment of the invention, at least one end of the film is associated with a minority of said portion of the container by adhesive means, preferably, the same adhesive means used to associate between the first and second end of the film.

The invention also provides an article comprising a container having an outer surface and a film having a first end and a second end, the film circumferentially enveloping at least a portion of said container such that said first end and said second end have an overlapping area and the first end and second end are associated at said overlapping area by adhesive means, wherein essentially all adhesive is concealed and the film closely and substantially uniformly follows the contour of said outer surface portion.

The term "*concealed*" as used herein denotes that essentially no adhesive matter is exposed from between the two layers of the film, and/or from the interface between the film and the container's outer surface. According to one preferred embodiment, no adhesive matter is exposed.

- 7 -

According to the invention the film uniformly follows the outer surface of the container, i.e. the film adapts essentially the same contour of the outer surface of the container, with essentially no visually observed defects, such as voids (e.g. bubble-like formations) between the film cover and the outer surface of the container, inadvertent film overlapping areas, defects in the adhesion area, etc.

Further, in accordance with the invention, the first end and second end are associated by adhesive means such that essentially all adhesive is concealed between said first end and second end, at the overlapping area.

According to a preferred embodiment, the article of the invention is obtainable by:

(i) providing a container having an outer surface, and a thermoplastic polymeric film which shrinks in a monoaxial direction by less than 5% when heated to a first temperature and by at least 25% when heated to a second temperature, said first temperature and said second temperature being different in no more than 30°C, preferably no more than 20°C, the film having a first end and a second end, the polymeric film circumferentially enveloping a portion of the outer surface of the container such that said first end and said second end have an overlapping area and the first end and second end are associated at said overlapping area by adhesive means; and

(ii) subjecting the container and polymeric film associated therewith to heat, thereby allowing the film to shrink towards the container.

Optionally, at least one of said first end or said second end may also be associated with a minority of said portion of the container by adhesive means.

A preferred heating medium according to the invention is that providing a heating temperature between about 80°C and about 120°C, depending on the type of polymer used, and more preferably below 100°C. A preferred heating medium suitable for providing the above temperatures is steam.

- 8 -

According to one embodiment the film is subjected to UV radiation prior to heating to the above temperatures. This may assist in the cross-linking process of the adhesive.

5 A unique feature of the film of the invention is that it shrinks to the desired dimensions at a temperature which is relatively close, albeit above, the temperature used with hot adhesives (when associating the film ends to the each other). A relatively close temperature, in the context of the invention, is a temperature which is not more than 30°C higher than the gluing temperature.

10 The thermoplastic polymeric film according to the invention is preferably used to wrap containers. The preferred wrapping technique involves providing the film of the invention as a long continuous sheet coiled around a roller, the film being cut to the appropriate length so as to enable the wrapping around, albeit with a loose fit, of a container. The film is preferably adhered to the container as described above, to prevent displacement of the film along its longitudinal axis
15 before and while shrinking. This technique is known in the art by the term "*The wrap-around technique*".

Thus, the combination of the thermoplastic polymeric film of the invention with the above described wrap-around technique enables the gluing of at least the film's ends to each other at a first temperature, being it the range of between about
20 70°C and about 90°C (depending on the specific type of adhesive material used), following by heating to a second temperature of between about 80°C and 120°C (depending on the specific type of film used), preferably by the use of steam as the heating medium.

DESCRIPTION OF THE FIGURE

25 **Fig. 1** is a graph showing the rate of shrinkage of two thermoplastic films, S-201 and PP when subject to heat.

- 9 -

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

In order to understand the invention and to see how it may be carried out in practice, an exemplary embodiment will now be described.

Production of a thermoplastic polymeric film

5 A multi-layered polymeric film (referred to herein as the S-201 film), 50 micrometers in thickness, was produced by a blown film process from three resins: (i) General Purpose Polystyrene (GPPS) produced by Dow Plastics and sold under the trade-name of STYRON, and (ii) Styrene-butadiene Copolymer (SBC) produced by CHEVRON PHILLIPS and sold under the trade-name of K-RESIN,
10 and (iii) High Impact Polystyrene (HIPS) produced by CHEVRON PHILLIPS and sold under the trade-name of Valtra MA8000.

The multi-layer was processed in a short-gap-stretching machine [Lenzing Aktiengesellschaft] as described in US 5,184,379, at a heating temperature of between 80°C – 110°C and a stretch ratio of 1:3, to produce a monoaxially heat
15 shrinkable film.

This film thereby produced was characterized by the following features:

- it shrinks in a monoaxial direction;
- it shrinks by less than 5% upon heating to 80°C; and
- it shrinks by about 30% upon heating to 100°C.

20 **Fig. 1** is a graph showing the rate of shrinkage of two films, S-201, produced as described above, and a reference polymer conventionally used in the *wrap-around* labeling industry, polypropylene ((PP) ROSO, Exxon Mobile, USA) film when subject to heat. As shown, the thermoplastic polymer, S-201 shrunk by up to 70% at a very narrow window of temperatures. A specifically unique
25 observation is that at a temperature of about 100°C, the film already shrunk by 30%.

– 10 –

A further unique and unexpected feature immediately observed from the above results is that the polymer films begins shrinking at a temperature which is relatively close, albeit above, the temperature required for activating hot adhesives.

Labeling with thermoplastic polymeric film

5 The polymeric film thus obtained was used for wrapping a plastic bottle having an outer counter resembling a feminine figure, with a maximal cross sectional diameter of 6.84 cm and minimal cross sectional diameter of 6.05 cm. The wrapping was carried out on a KRONES roll-fed shrink labeling systems [Krones Controll 720-12] operating at a rate if 18,000 bottles per hour and in a steam tunnel
10 at a temperature of 100°C.

 The film was wrapped around a bottle, cut to form a label, and hot glue (CONTOURTM, National Starch & Chemical, USA) was applied to the label's edges. The label was wrapped around a portion of the bottle such that the ends of the label were glued to each other (one on top of the other, thereby forming a
15 cylinder) and one end also glued to the bottle.

 The wrapped bottle was then heated in the steam tunnel to a temperature of 90-100°, allowing the label to shrink towards the bottle. The bottles were also subjected to UV radiation prior to exposure to the heat source.

 The resulting wrapped bottle was visually investigated for determining
20 defects in the labeling. It was determined that the label is firmly fixed to the bottle at all areas of coverage, with no visually apparent voids between the label and the outer surface of the bottle. Further, no wrinkles in the label or overlaying of the label were observed. A further characteristic of the resulting product was reflected by the lack of exposure of the glue from between the edges of the film from
25 between the film and the bottle's outer surface, a phenomenon which typically occurs when a high degree of shrinkage occurs during the labeling process.

- 11 -

The above results clearly show the unexpected advantage of using the thermoplastic polymeric films of the present invention in labeling processes which allows the use of hot glue in combination with steam as the heat shrinking medium.

Those skilled in the art to which this invention pertains will readily
5 appreciate that numerous changes, variations and modifications can be made without departing from the scope of the invention *mutatis mutandis*.

CLAIMS:

1. A thermoplastic polymeric film which shrinks in a monoaxial direction by less than 5% when heated to a first temperature and by at least 25% when heated to a second temperature, said first temperature and said second temperature having a temperature interval of no more than 30°C.
2. The thermoplastic polymeric film of Claim 1, wherein said interval is of no more than 20°C.
3. The thermoplastic polymeric film of Claim 1, wherein said first temperature is between 70°C to 90°C.
4. The thermoplastic polymeric film of Claim 1, wherein said second temperature is less than 100°C.
5. The thermoplastic polymeric film of Claim 1, which when heated to said second temperature, shrinks by at least 30%.
6. The thermoplastic polymeric film of any one of Claims 1 to 5, which when subjected to the second temperature shrinks in the same direction of shrinkage when subjected to the first temperature.
7. The thermoplastic polymeric film of any one of Claims 1 to 6, comprising a polymer selected from polystyrene, polyolefin, polyvinyl, polyamide, Polyester, nylon, derivatives, copolymers and mixtures thereof.
8. The thermoplastic polymeric film of Claim 7, selected from polyolefins.
9. The thermoplastic polymeric film of Claim 7, comprising polystyrene.
10. The thermoplastic polymeric film of Claim 1, wherein said film further comprises a first end and a second end, said film being capable of enveloping an article comprising a container having an outer surface, by circumferentially enveloping at least a portion of said container such that said first end and said second end have an overlapping area, the first end and second end being associated at said overlapping area by adhesive means.

– 13 –

11. The thermoplastic polymeric film of Claim 10, wherein essentially all adhesive is concealed and the film closely and substantially uniformly follows the contour of said outer surface portion.
12. An article comprising:
 - a container having an outer surface; and
 - a film having a first end and a second end, the film circumferentially enveloping at least a portion of said container such that said first end and said second end have an overlapping area, the first end and second end being associated at said overlapping area by adhesive means, wherein at least a portion of said film is capable of shrinking in a monoaxial direction by less than 5% when heated to a first temperature and by at least 25% when heated to a second temperature, said first temperature and said second temperature having a temperature interval of no more than 30°C.
13. The article of Claim 12, wherein at least one of said first end or said second end is associated with a minority of said portion of said container by adhesive means.
14. The article of Claim 12 or 13, wherein said adhesive means comprises hot adhesive.
15. The article of Claim 12 or 13, wherein said adhesive means comprises UV-cured adhesive.
16. The article of any one of Claim 12 to 15, wherein said portion of the film is selected from polystyrene, polyolefin, polyvinyl, polyamide, Polyester, derivatives, copolymers and mixtures thereof.
17. The article of Claim 16, wherein said portion of the film is a polyolefin.
18. The article of Claim 16, wherein said portion of the film comprises polystyrene.
19. The article of any one of Claims 12 to 18, wherein said portion of the container has a non-uniformly shaped outer surface.

– 14 –

20. The article of Claim 12, wherein said temperature interval is of no more than 20°C.
21. The article of Claim 12, wherein said first temperature is between about 70°C to about 90°C.
22. The article of Claim 12, wherein said second temperature is less than about 100°C.
23. The article of Claim 12, which when said film is heated to said second temperature, it shrinks by at least 30%.
24. The article of any one of Claims 12 to 23, which when subjected to the second temperature shrinks in the same direction of shrinkage as when subjected to the first temperature.
25. An article comprising:
 - a container having an outer surface; and
 - a film having a first end and a second end, the film circumferentially enveloping at least a portion of said container such that said first end and said second end have an overlapping area, the first end and second end being associated at said overlapping area by adhesive means; wherein essentially all adhesive is concealed and the film closely and substantially uniformly follows the contour of said outer surface portion.
26. The article of Claim 25, wherein at least one of said first end or said second end is associated with a minority of said portion of said container by adhesive means.
27. The article of Claim 25 or 26, wherein said adhesive means comprises hot adhesive.
28. The article of Claim 25 or 26, wherein said adhesive means comprises UV cured adhesive.
29. The article of any one of Claim 25 to 28, wherein said film comprises a polymer selected from polystyrene, polyolefin, polyvinyl, polyamide, Polyester, derivatives, copolymers and mixtures thereof.
30. The article of Claim 29, wherein said film comprises a polyolefin.

– 15 –

31. The article of Claim 29, wherein said film comprises polystyrene.
32. The article of any one of Claims 25 to 31, wherein said portion of the container has a non-uniformly shaped outer surface.

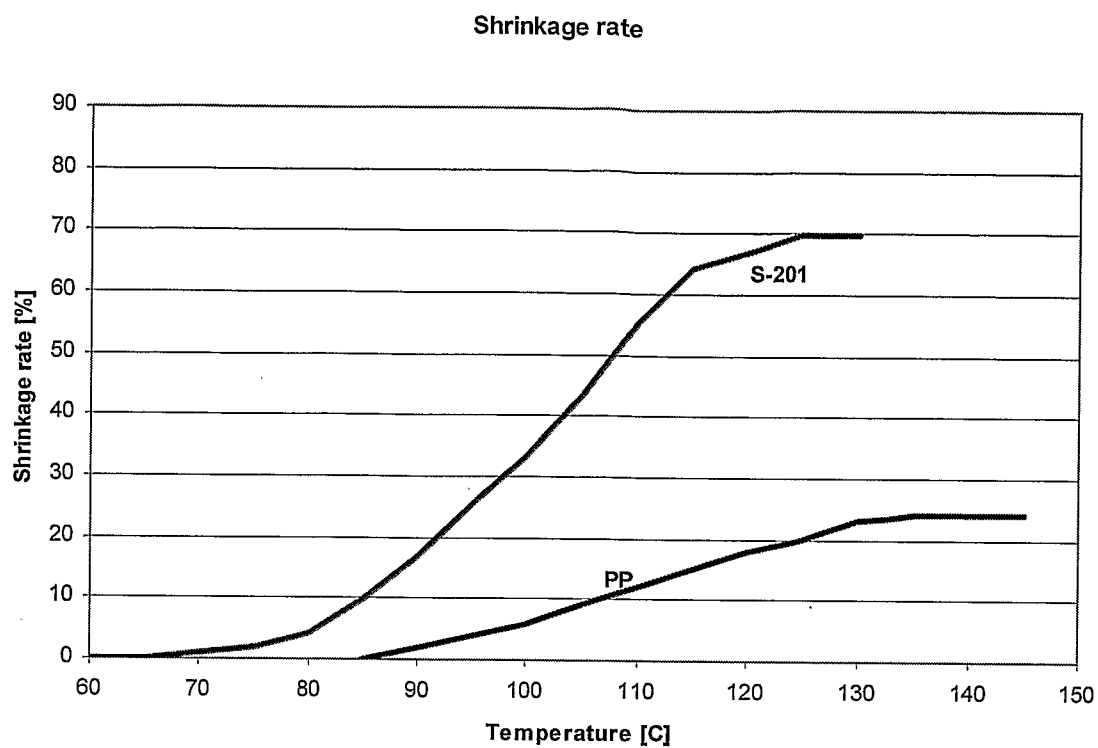


Fig. 1