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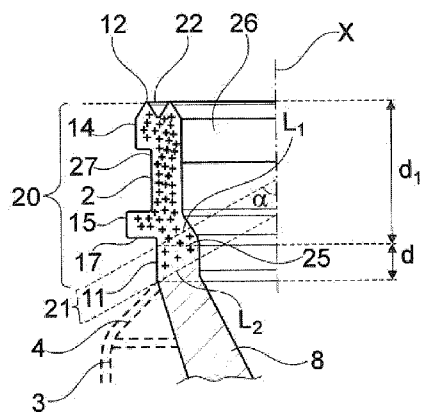


Fig. 5A

(57) Abstract: Aerosol bottle (1) made of crystallizable polymer material produced, notably by blow-moulding, from a preform (10) comprising a neck (2) and a tubular body (8) closed at one end (9) and extending along a longitudinal axis (X), the preform (10) comprising, in the neck (2), a first zone (20) and a second zone (21) that is intermediate between the first zone (20) and the tubular body (8), having a degree of crystallinity lower than that of the first zone (20) and higher than that of the tubular body (8), this second zone (21) extending axially over a height (d) of at least 0.5 mm, the polymer material of the tubular body (8) being in an amorphous state.

AEROSOL BOTTLE

Technical field

The present invention relates to an aerosol bottle made of a crystallizable polymer material, produced, notably by blow-moulding, from a preform comprising a neck and a tubular body closed at one end and extending along a longitudinal axis. Such a bottle is configured to be surmounted by an aerosol valve, the latter being fixed to the neck, for example by crimping, bonding, welding or tube expanding.

The invention also relates to a method for manufacturing such a bottle and to a preform for producing such a bottle.

Technological background

In the field of the invention it is necessary for the aerosol bottle to be mechanically strong because, on account of its aerosol function, it is subjected to high pressures or temperatures. The regulations currently in force notably dictate that this type of bottle be able to withstand a temperature of 65°C.

The known WO 2013/019784 relates to an aerosol bottle made from a plastics material with a neck that has undergone crystallization whereas the rest of the bottle is not crystallized.

The known JPH07156976 moreover describes a container secured to a cap and comprising a neck part that is crystallized above a line.

WO 2014/116904 discloses a pressurized container usable for a pressurizable contain, such as an aerosol dispenser, an aerosol dispenser made therewith and preform therefor. The preform/container/dispenser has a neck at the top. The neck has upper and lower portions. The lower portion transitions into a shoulder, which flares outwardly. The shoulder, in turn, transitions into a sidewall. The lower neck portion/shoulder and/or upper part of the sidewall are crystallized.

EP1352730 discloses a container, a container preform and a method of making the container in which the finish of the preform or container is at least partially of crystallizable polymer construction, and has a first end portion remote from the body of the preform or container, a second end portion adjacent to the body of the preform or container, and a mid portion between the end portions. The first end portion of the finish forms an end surface, and the end and mid portions of the finish form continuous inner and outer surfaces.

The polymer material in at least one of the end, inner and outer surfaces is crystallized, and crystallization in the finish in a direction perpendicular to such surface is graded from crystallization at the surface to an essential absence of crystallization at a position within the finish spaced from the surface.

- 5 There is a need to improve the mechanical strength of an aerosol bottle made of polymer material still further.

Summary of the invention

Aerosol bottle

- 10 In a first aspect, the present invention thus relates to an aerosol bottle made of crystallizable polymer material produced, notably by blow-moulding, from a preform comprising a neck and a tubular body closed at one end and extending along a longitudinal axis, the preform comprising, in the neck, a first zone and a second zone that is intermediate between the first zone and the tubular body, having a degree of crystallinity lower than that of the first zone and higher than that of the tubular zone, this second zone extending axially
15 over a height of at least 0.5 mm, the polymer material of the tubular body being in an amorphous state.

- The mass-fraction degree of crystallinity in the first zone of the neck is advantageously higher than 20%. The mass-fraction degree of crystallinity in the second zone of the neck is preferably comprised between 8% and 20%. The degree of crystallinity
20 in the tubular body is preferably below 8%.

- By virtue of the invention, there is obtained an aerosol bottle that has mechanical strength able to meet the regulatory requirements, and even exceed them, notably in terms of mechanical strength at the temperature of 65°C. The design of the bottle may allow it to withstand up to a temperature of 75°C using liquefied gas formulas. The transition zone
25 between the neck zone with the highest degree of crystallinity and the tubular body zone with the degree of crystallinity close to zero improves the mechanical strength and limits the extent to which the neck deforms during the temperature test. This allows the product to be kept intact.

- Tests have been carried out on necks with various degrees of crystallinity levels
30 and various heights of crystallized zone including the first and second zone so as to be able to withstand the high temperature test better known by its English name of “hot air test 75°C” with a formula using liquefied gas. The results indicate that a bottle with a degree of

crystallinity, in the first zone, of below 20%, and an overall combined height of first and second zone of 9 mm, proves to be non-compliant after the test. By contrast, a bottle with a degree of crystallinity, in the first zone, of above 25%, and an overall combined height of first and second zone of 11 mm, is compliant after the test.

5 The neck of the bottle, which defines an opening of the bottle, is configured to accept a valve of aerosol type, by crimping, bonding, tube expanding or some other type of fixing, in a way known per se. In particular for this purpose a free upper end of the neck may comprise a portion in relief around its entire periphery, such as an annular bulge. The aerosol bottle may comprise an aerosol valve.

10 The preform with the neck and the tubular body is preferably produced in a single piece so that the bottle is likewise produced in a single piece.

Advantageously, the height of the second zone along the longitudinal axis is comprised between 0.5 mm and 4 mm. Thus, this intermediate zone is visible to the naked eye. In the case of a colourless transparent bottle, for example made of PET, the first zone
15 of the neck may be white in colour, the tubular body for its part being able to remain substantially transparent, while the second zone of the neck, which is intermediate, may have a milky appearance, with tones in the beige-grey spectrum. It should be noted that the bottle may be transparent and coloured or opaque and coloured, prior to crystallization or in the absence of crystallization. In this case, the appearance of the first and second zones after
20 crystallization may differ without departing from the scope of the invention.

The total overall height of the first and second zones may be comprised between 9 and 13 mm, approximately.

Degree of crystallinity

The degree of crystallinity is determined for example by infrared
25 spectrophotometry analysis, using as reference the transmission of light at certain wavelengths in the amorphous state, or amorphous phase, which means to say the more transparent phase.

In the case of polyethylene terephthalate (PET), the frequencies used for measurement are preferably 11, 1344, 970 and 847 cm⁻¹.

30 The measurement of the transmission T% at these frequencies yields a quantity indicative of the degree of crystallinity.

An example of such a spectrum is given in Figure 6. Figure 7 more particularly depicts the percentage transmission at 973 cm^{-1} .

It may be seen that the percentage transmission differs for the first and the second zones and for the polymer material at the base of the neck which is transparent, just like the body of the bottle.

What is meant within the meaning of the invention by the polymer material of the tubular body being said to be in the amorphous state, is a minimal state of crystallization of the polymer material, allowing the preform to be blown, for example a degree of crystallinity less than or equal to 8%.

First and second zones

The first zone corresponds to the one where the degree of crystallinity is the highest. The second zone corresponds to a degree of crystallinity lower than that of the first. Figure 8 schematically depicts how the degree of crystallinity of the polymer material of the preform evolves with position along the longitudinal axis X, from the upper end of the neck ($x=0$) towards the bottom of the preform.

This degree may also vary according to the thickness, from the exterior surface ($r=0$) inwards. By way of example, Figure 9 illustrates such a variation in the second zone.

The degree of crystallinity may thus be expressed in the form $T_c(x, r)$.

The degree of crystallinity may exhibit symmetry of revolution, which means to say $T_c(x, r)$ is constant regardless of the azimuth θ about the longitudinal axis X. As an alternative, $T_c(x, r)$ varies with the angle θ .

The transition between the first zone and the second zone, for a given r , may be considered by definition to extend axially between $0.9 T_{c\text{ max}}$ and $1.1 T_{c\text{ min}}$, where $T_{c\text{ max}}$ denotes the highest degree of crystallinity of the first zone, and $T_{c\text{ min}}$ the lowest degree of crystallinity of the tubular zone.

It is thus possible to obtain a boundary surface defined by the points in which

$T_c(x) = 0.9 T_{c\text{ max}}$ when r varies,

and another boundary surface defined by the points in which

$T_c(x) = 1.1 T_{c\text{ min}}$ when r varies.

Each of these boundary surfaces may be substantially conical with a half vertex angle α with respect to the axis X.

The bottle may comprise a flange formed on the circumference of the neck in a lower part of the first zone, notably at the lower end of the first zone, which in such an instance may define the boundary with the second zone. This flange is preferably produced as a single piece with the rest of the neck and of the bottle.

5 The mass-fraction degree of crystallinity of the neck in the first zone is preferably comprised between 20% and 80%, notably between 25% and 50%, preferably between 25% and 40%, the mass-fraction degree of crystallinity of the neck in the first zone preferably being substantially uniform both axially and radially. The degree of crystallinity may be substantially uniform over the entire height of the first zone, which may be comprised
10 between 7 mm and 11 mm, being for example equal to 9 mm, namely axially and/or over the entire thickness of the neck, which is to say radially, from an interior surface towards an exterior surface.

 The mass-fraction degree of crystallinity in the second zone of the neck is for example comprised between 8% and 20%. Degree of crystallinity may exhibit an axial
15 gradient within the second zone, the degree of crystallinity preferably decreasing from a first end of the second zone in contact with the first zone towards a second end of the second zone in contact with the tubular body.

 In that case, the degree of crystallinity may vary linearly according to the position on the longitudinal axis in the second zone, from the first end towards the second
20 end. As an alternative, the degree of crystallinity varies nonlinearly in the axial direction.

 The degree of crystallinity may exhibit a radial gradient within the second zone, the degree of crystallinity preferably decreasing from an exterior surface of the preform towards an interior surface of the preform.

 In this case, the degree of crystallinity may vary substantially linearly in the
25 second zone in the radial direction between the interior surface of the preform and the exterior surface of the preform. As an alternative, the degree of crystallinity varies nonlinearly in the radial direction.

 It is the diffusion of heat through the material which governs this variation in the degree of crystallinity within the thickness starting from the highest degree of crystallinity
30 on the outside.

 In one particular embodiment, the degree of crystallinity has an axial and radial gradient in the second zone.

The crystallizable polymer may be selected from the group consisting of polyethylene terephthalate (PET), polyethylene naphthalate (PEN), poly(cyclohexylene dimethylene terephthalate) copolymerized with another diacid (phthalate) (PCTA), poly(cyclohexylene dimethylene terephthalate) copolymerized with another diol (glycol) (PCTG), a mixture of PET and isosorbide, polyamide (PA), polypropylene (PP) and a mixture of several of these materials, notably a mixture of PET and PEN.

Method of manufacture

Another subject of the invention, according to another aspect, notably in combination with the aforementioned, is a process for producing an aerosol bottle made of crystallizable polymer material, comprising the following steps:

- creation of a preform comprising a neck and a tubular body closed at one end and extending along a longitudinal axis, by injection of a crystallizable polymer into a mould,

- crystallization of the neck of the preform by heating then cooling of the neck, the crystallization step being carried out in such a way as to obtain, in the neck, a first zone and a second zone, intermediate between the first zone and the tubular body, that has a degree of crystallinity lower than that of the first zone, this second zone extending axially over a height of at least 0.5 mm, and in such a way that the polymer material of the tubular body remains in an amorphous state,

- possibly heating of the body of the preform, with the exception of the crystallized neck, prior to transfer into a blow-moulding mould, notably if the preform is to undergo intermediate storage,

- blow-moulding of the tubular body of the preform so as to obtain the bottle.

The method may alternatively include the step of stretching during the blow-moulding. Longitudinal stretching with a stretch rod and radial stretching by blowing under very high pressure allows the chains of polymer, notably of PET, to become oriented, conferring increased mechanical strength.

The heating is advantageously performed using a heating device that comprises at least one infrared radiation lamp. The heating device is designed for example to heat the first zone and possibly the second zone in such a way as to obtain the degree of crystallinity desired in each of these zones. The heating device is preferably set up in such a way as to apply a temperature gradient to make it possible to obtain the desired degrees of crystallinity.

The heating temperature can be nonuniform. The distance between the heating device and the preform may be set. The heating device is preferably arranged in such a way as to prevent crystallization of the tubular body which will be heated later and then subjected to the blowing operation.

5 At least one cooling rod may be brought in close to the preform from the outside thereof, simultaneously with the heating. In an alternative form or additionally, it may be introduced simultaneously with the heating into the preform, notably via the opening in the neck of the preform. Such a cooling rod serves to cool the zone that is not to be crystallized and also to achieve a gradient between the heated zone where the maximum degree of
10 crystallinity is obtained and the non-heated zone where the degree of crystallinity is minimal. Another cooling system, different from a cooling rod, may be provided for the same purpose without departing from the scope of the invention.

 During the heating, an axial and/or radial gradient for the heating temperature is advantageously created in the space around the preform. That can be obtained through the
15 presence of the cooling rod or some other cooling system and/or through the positioning of the infrared radiation lamp or lamps or other system of the heating device with respect to the preform that is to be crystallized.

 The post-heating cooling may be achieved by natural convection, namely relatively slowly.

20 The cooling time is, for example, longer than 30 s, notably comprised between 30 s and 10 min. The cooling is therefore slow, at ambient temperature.

Preform

 Another subject of the invention, notably in combination with the foregoing, and according to another aspect, is a preform for the creation of an aerosol bottle made of
25 crystallizable polymer material, comprising a neck and a tubular body closed at one end and extending along a longitudinal axis, the preform comprising, in the neck, a first zone and a second zone that is intermediate between the first zone and the tubular body, having a degree of crystallinity lower than that of the first zone, this second zone extending axially over a height of at least 0.5 mm, the polymer material of the tubular body being in an amorphous
30 state.

 The shape of the first and second zones may be substantially identical to that of the bottle. That means that during the blowing step, no appreciable change is made to the

neck of the preform. Only the tubular body is modified, notably blown, when the preform is converted to obtain the aerosol bottle.

Brief description of the figures

The invention may be understood better from reading the following detailed description of nonlimiting exemplary embodiments thereof and from studying the appended drawing, in which:

- Figure 1 is a schematic perspective view of an example of an aerosol bottle according to the invention,

- Figure 2 is a perspective and partial top view of the neck of the bottle of Figure 1,

- Figure 3 is a perspective and partial schematic view of the neck of the bottle of Figure 1, fitted with an aerosol valve,

- Figure 4 is a schematic axial cross section view of a preform according to the invention,

- Figure 5A is a partial schematic enlarged view of Figure 4;

- Figure 5B is a partial and annotated photograph of a view in longitudinal section of the neck of the bottle of Figure 1,

- Figure 6 is a graph illustrating the light transmission spectrum as a function of wavelength at three points on the preform,

- Figure 7 is a graph illustrating the light transmission spectrum as a function of wavelength at three points on the preform around the value of 973 cm^{-1} ,

- Figure 8 is a schematic graph illustrating an example of how the degree of crystallinity varies as a function of the axial x-coordinate in the preform,

- Figure 9 is a schematic graph illustrating an example of how the degree of crystallinity varies as a function of the radial r-coordinate in the preform,

- Figure 10 is an example of a heating device that can be used to crystallize the neck of the preform of Figure 4,

- Figure 11 schematically illustrates an alternative form of embodiment of at least certain mirrors of the device of Figure 10,

- Figure 12 is a schematic view of another example of heating device that can be used to crystallize the neck of the preform of Figure 4, and

- Figure 13 schematically and in cross section illustrates the various sub-steps of the blow-moulding step of the method according to the invention.

Detailed description of embodiments of the invention

In the rest of the description, identical elements or elements having identical functions bear the same reference sign. In order to make the present description concise, they are not described for each of the figures, only the differences between the embodiments being described.

Figure 1 depicts an aerosol bottle 1 made from a crystallizable polymer material starting from a preform 10 visible in Figure 3, using blow-moulding. In the example illustrated, the polymer chosen is polyethylene terephthalate PET. It would not constitute a departure from the scope of the invention if a different crystallizable polymer were used.

The bottle 1 comprises a neck 2 and a reservoir 3 to contain a product, notably a cosmetic product, as well as a pressurized propellant gas. A shoulder 4 separates the zone of the neck 2 from that of the reservoir 3. The reservoir 3 and the neck 2 extend along the longitudinal axis X.

This aerosol bottle 1, in its final version, comprises an aerosol valve 16 which is fixed by crimping, bonding, tube-expanding or some other type of fixing, in a way known per se and as visible in Figure 3, to the neck 2 of the bottle 1 and which allows the product to be dispensed in the form of a spray, foam or mousse, or gel, when the aerosol valve 16 is actuated. The bottle 1 is produced with the neck 2 and the reservoir 3 in a single piece. In Figure 1, the bottle 1 is depicted without the aerosol valve.

The preform 10 comprises the neck 2 and a tubular body 8 closed at an end 9 opposite to the upper end 11 of the tubular body 8 produced as a single piece with the neck 2, also extending along the longitudinal axis X, as visible in Figure 4.

The preform 10 is produced as a single piece by injection moulding of polymer material.

It should be noted that as the preform 10 is converted into a bottle 1 by blow-moulding, the neck 2 part remains substantially unchanged. The tubular body 8 by contrast is converted to become the reservoir 3 of the bottle 1, with the shoulder 4, as visible partially and in dotted line in Figure 5A.

In the example illustrated, the neck 2 comprises a free upper end 12 below which there is a portion 14 in relief forming an annular bulge, extending radially around the entire

periphery of the neck 2. The neck 2 also comprises, some distance away from the relief portion 14, a circular flange 15. The presence of this flange 15 is beneficial for blow-moulding, enabling the creation of an end-stop resting against the blow-moulding mould as will be detailed hereinafter. The flange 15 is used for conveying, as will be explained
5 hereinafter, during the preheating of the preform and/or the blow-moulding and/or after the blow-moulding during the cooling phase. It may also be useful during packaging.

The upper end 12 defines an opening 5 of the bottle 1 or of the preform 10. The upper end 12 in this example, and as visible in Figure 5A, has teeth for crimping to the aerosol valve. These teeth, also referred to as gadroons, are in fact used to seal against the
10 valve seal which is crimped onto the neck of the bottle.

The neck 2 extends radially between an interior surface 26 and an exterior surface 27.

The neck 2 corresponds substantially to the part that remains unchanged by the blow-moulding of the preform 10. The neck 2 comprises, as visible in Figures 4 and 5, two
15 axially superposed zones, namely a first zone 20 and a second zone 21. The first zone 20 lies between the upper end 12 and a lower end at the boundary with the upper end of the second zone 21. This boundary between the first zone 20 and the second zone 21 is embodied, in a virtual manner in Figure 5A, by a line L_1 consisting of a boundary surface between these two zones 20 and 21. The second zone 21 is delimited at the top by this line L_1 and at the
20 bottom by the line L_2 , which is a virtual line, consisting of a boundary surface between the second zone 21 and the tubular body 8. The second zone 21, even though it belongs to the neck 2 of the preform 10, constitutes an intermediate zone between the neck 2 and the tubular body 8. The boundary surfaces L_1 and L_2 are not perpendicular to the longitudinal axis X but form a conical surface exhibiting a half cone angle α equal to approximately 60° with the
25 axis X, as can be seen.

The two boundary surfaces in this example have the same angle α , but the situation could be otherwise without departing from the scope of the invention.

The height d_1 along the axis X of the first zone 20 is approximately 9 mm, whereas the height d along the axis X of the second zone 21 is comprised between 0.5 mm
30 and 2 mm, being of the order of 1 mm in this example. The second zone 21 is thus visible to the naked eye.

The second zone 21 also, in this example, exhibits an interior part 25 which bulges inwards in order to have sufficient thickness in the neck region after the blow-moulding.

The first zone 20 of the preform 10 has a mass-fraction degree of crystallinity for example of 40%, which is preferably uniform throughout the first zone 20, whereas the second zone 21 has a degree of crystallinity lower than that of the first zone 20 and which is preferably not uniform within the second zone 21. The mass-fraction degree of crystallinity of the tubular body 8 is close to zero, the polymer material being in an amorphous state in this part of the preform 10.

The crystallization is indicated by small crosses in Figure 5A. The variation in the degree of crystallinity in the first and second zone may be as illustrated in Figures 8 and 9, and as explained hereinabove. The variation in the degree of crystallinity can also be seen in Figure 5B. In the transparent PET bottle 1 of the example being considered, the first zone 20 of the neck is white in colour, the tubular body 8 and therefore the reservoir 3 themselves remaining substantially transparent, whereas the second zone 21 of the neck, which is intermediate, exhibits a milky appearance, with tones in the beige–grey spectrum, with its visual appearance potentially being nonuniform.

The second zone 21 thus forms not only an intermediate zone between the first zone 20 and the tubular body 8 but also a transition zone in terms of the degrees of crystallinity because this degree of crystallinity is at a maximum in the first zone 20 and at a minimum in the tubular body 8. The presence of this transition zone makes it possible to improve the mechanical properties, notably the mechanical strength, of the bottle. The bottle 1 derived from the preform 10 may thus be able to withstand the temperature of 75°C.

The degree of crystallinity in the second zone 21 is preferably nonuniform, varying within this zone, either linearly or nonlinearly, in the radial and/or axial direction(s).

In the example illustrated, the degree of crystallinity in the second zone 21, in the axial direction, decreases substantially linearly from the line L1 towards the line L2. Likewise, in the example illustrated, the degree of crystallinity in the second zone 21, in the radial direction, decreases substantially linearly from the exterior surface 27 towards the interior surface 26.

Thus, in this example, the degree of crystallinity varies axially and radially in the second zone 21.

In Figure 7, explained hereinabove, the light transmission percentage is higher in the zone of the tubular body 8 than in the second zone 21, which itself has a light transmission percentage that is higher than in the first zone 20, as can be seen, at the wavelength of 973 cm^{-1} . This is connected with the fact that the higher the degree of crystallinity, the lower the light transmission percentage.

Figure 10 depicts one example of a heating device 100 which may heat the first zone 20 and partially heat the second zone 21 so as to cause at least partial crystallization of the polymer.

The heating device 100 comprises a plurality of mirrors 42 making it possible to limit the heating achieved by the infrared radiation lamps 43 to the intended zones. The preform 10 is capped by an oven mandrel 44 inserted into the opening in the neck 2 and extending inside the neck 2 as far as the lower limit of the first zone 20. In an alternative form, one or more mirrors 42 have indentations, as illustrated in Figure 11, so as to encourage the crystallinity gradient in the second zone 21.

Another example of a heating device 100 has been illustrated in Figure 12. In this example, an infrared radiation lamp 43 is positioned on the outside of the preform 10 in the zone situated around the neck 2. A cooling rod 47 is brought up close to the preform from the outside, under the flange 15. In this example, a rod 46 has been inserted through the opening 5 of the neck 2 along the longitudinal axis X and is present inside the tubular body 8. The rod 46 causes the preform to rotate on itself in such a way that the entire perimeter is heated uniformly and cooled uniformly.

During heating, an axial heating-temperature gradient is created in the space around the preform, because of the cooling rod 47, so as to limit the spread of heat into the material.

The cooling of the preform after heating may be performed using natural convection, namely relatively slowly, for example taking around 1 min, so as to finalize crystallization.

In order to create the bottle 1, a crystallizable polymer material is injected into a first mould for the manufacture of the preform 10. The neck 2 of the preform 10 is heated in the first zone 20 and partially in the second zone 21 using the heating device 100. A cooling of the preform 10, preferably using natural convection, which may take around 1 min, is provided. Finally, the bottle 1 is produced from the preform 10 by blow-moulding the tubular

body 8 to form the reservoir 3 in a second mould. When the preform 10 is stored before the bottle is produced by blow-moulding, a preliminary step of heating the preform is performed prior to the blow-moulding. If the bottle is produced just after the preform 10 is produced, this heating step can be omitted because it is not needed.

5 The blow-moulding step is illustrated in Figure 13. This figure shows four sub-steps of this step, starting from top left, then to top right, then to bottom left and finally bottom right in Figure 13.

 The first sub-step is to procure a mould M for blow-moulding the preform 10, comprising an opening 51 delimited by a circular wall 52, the smaller-diameter upper part
10 of which has a height letter H. Then, in the second sub-step, the preform 10 is placed through the opening 51, which is sized so that the flange 15 rests on the exterior upper edge 50 of the mould M in order to hold the preform in place. The height H is substantially equal to the height d of the second zone 21. A blow-moulding valve S is, in the third sub-step, introduced into the opening 5 of the neck 2 of the preform 10. This blow-moulding valve S has a central
15 axial opening O, notably to allow the passage of a stretch rod B which, as illustrated in the fourth sub-step, enters the preform 10 and allows the latter to be stretched along its tubular body 8 as far as the bottom of the mould M, at the same time as the blowing is applied in order to form the reservoir of the bottle 1. At the end of this blow-moulding step, a bottle 1 according to the invention is obtained. Longitudinal stretching with a stretch rod and radial
20 stretching by blowing under very high pressure allows the chains of polymer, notably of PET, to become oriented, conferring increased mechanical strength. The stretching in fact serves to stretch out the chains in the longitudinal sense in the same direction and therefore to enhance the mechanical properties of the bottle.

 In Figure 13, it should be noted that the mould M does not have the shape of the
25 one used for producing the bottle 1 in Figure 1. It may be seen for example that the shoulder 4 of the bottle 1 of Figure 1 is smaller than the shoulder that will be produced using the mould M of Figure 13. The preform 10 remains unchanged during the blow-moulding in the part of its neck 2 that incorporates the first zone 20 and the second zone 21, being changed only in its tubular body part 8.

30 The invention is not limited to the examples that have just been described. In particular, the law governing the variation in the degree of crystallinity in the second zone

21 may be different, being radial and/or axial, linear or non-linear, without departing from the scope of the invention.

CLAIMS

1. Aerosol bottle (1) made of crystallizable polymer material produced from a preform (10) comprising a neck (2) and a tubular body (8) closed at one end (9) and
5 extending along a longitudinal axis (X), the preform (10) comprising, in the neck (2), a first zone (20) and a second zone (21) that is intermediate between the first zone (20) and the tubular body (8), having a degree of crystallinity lower than that of the first zone (20) and higher than that of the tubular body (8), this second zone (21) extending axially over a height (*d*) of at least 0.5 mm, the polymer material of the tubular body (8) being in an amorphous
10 state.
2. Bottle (1) according to Claim 1, in which the height (*d*) of the second zone (21) along the longitudinal axis (X) is comprised between 0.5 mm and 4 mm.
3. Bottle (1) according to Claim 1 or 2, in which the mass-fraction degree of crystallinity of the neck in the first zone (20) is comprised between 20% and 80%, notably
15 between 25% and 50%, preferably between 25% and 40%, the degree of crystallinity of the neck (2) in the first zone (20) preferably being substantially uniform both axially and radially.
4. Bottle (1) according to any one of the preceding claims, in which the mass-fraction degree of crystallinity in the second zone (20) of the neck (2) is comprised between
20 8% and 20%.
5. Bottle (1) according to any one of the preceding claims, in which the degree of crystallinity exhibits an axial gradient within the second zone (21), the degree of crystallinity preferably decreasing from a first end of the second zone (21) in contact with the first zone (20) towards a second end of the second zone (21) in contact with the tubular
25 body (8).
6. Bottle (1) according to Claim 5, in which the degree of crystallinity varies linearly according to the position on the longitudinal axis (X) in the second zone (21), from the first end to the second end.
7. Bottle (1) according to any one of the preceding claims, in which the degree
30 of crystallinity exhibits a radial gradient within the second zone (21), the degree of crystallinity preferably decreasing from an exterior surface (27) of the preform (10) towards an interior surface (26) of the preform (10).

8. Bottle (1) according to Claim 7, in which the degree of crystallinity varies substantially linearly in the second zone (21) in the radial direction between the interior surface (26) of the preform (10) and the exterior surface (27) of the preform (10).

5 9. Bottle (1) according to any one of the preceding claims, in which the degree of crystallinity has an axial and radial gradient in the second zone (21).

10 10. Bottle (1) according to any one of the preceding claims, in which the crystallizable polymer is selected from the group consisting of polyethylene terephthalate (PET), polyethylene naphthalate (PEN), poly(cyclohexylene dimethylene terephthalate) copolymerized with another diacid (phthalate) (PCTA), poly(cyclohexylene dimethylene terephthalate) copolymerized with another diol (glycol) (PCTG), a mixture of PET and isosorbide, polyamide (PA), polypropylene (PP) and a mixture of several of these materials, notably a mixture of PET and PEN.

11. Process for producing an aerosol bottle (1) made of crystallizable polymer material, comprising the following steps:

15 – creation of a preform (10) comprising a neck (2) and a tubular body (8) closed at one end (9) and extending along a longitudinal axis (X), by injection of a crystallizable polymer into a mould,
– crystallization of the neck (2) of the preform (10) by heating then cooling of the neck (2), the crystallization step being carried out in such a way as to obtain,
20 in the neck (2), a first zone (20) and a second zone (21), intermediate between the first zone (20) and the tubular body (8), that has a degree of crystallinity lower than that of the first zone (20), this second zone (21) extending axially over a height (d) of at least 0.5 mm, and in such a way that the polymer material of the tubular body (8) remains in an amorphous state,
25 – blow-moulding of the tubular body (8) of the preform (10) so as to obtain the bottle (1).

12. Process according to Claim 11, comprising the step of stretching during the blow-moulding.

30 13. Process according to one of Claims 11 and 12, in which the heating is performed using a heating device (100) that comprises at least one infrared radiation lamp (43).

14. Process according to any one of Claims 11 to 13, in which at least one cooling rod (47) is brought in close to the preform (10) from the outside thereof, simultaneously with the heating.

5 15. Process according to any one of Claims 11 to 14, in which, during the heating, an axial and/or radial heating temperature gradient is created in the space around the preform (10).

16. Process according to any one of Claims 11 to 15, in which the post-heating cooling is achieved by natural convection.

10 17. Process according to any one of Claims 11 to 16, in which the cooling time is longer than 30 s, notably comprised between 30 s and 10 min.

15 18. Preform (10) for creating an aerosol bottle (1) made of crystallizable polymer material, comprising a neck (2) and a tubular body (8) closed at one end (9) and extending along a longitudinal axis (X), the preform (10) comprising, in the neck (2), a first zone (20) and a second zone (21) that is intermediate between the first zone (20) and the tubular body (8), having a degree of crystallinity lower than that of the first zone (20), this second zone (21) extending axially over a height (d) of at least 0.5 mm, the polymer material of the tubular body (8) being in an amorphous state.

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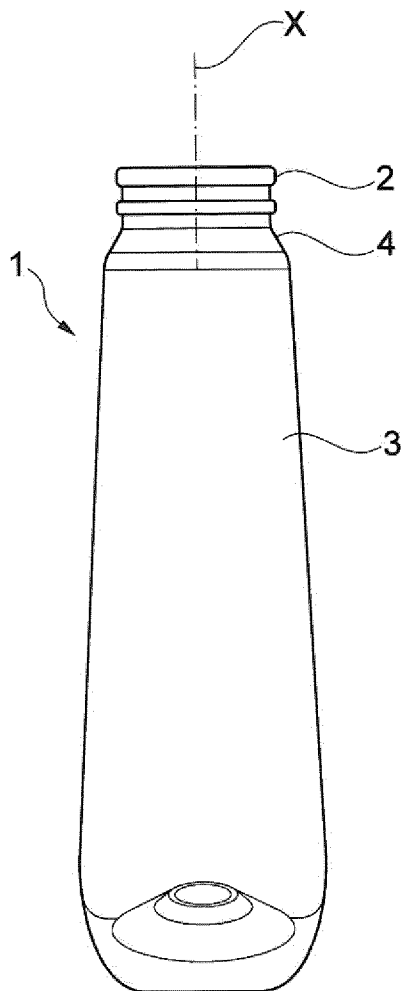


Fig. 1

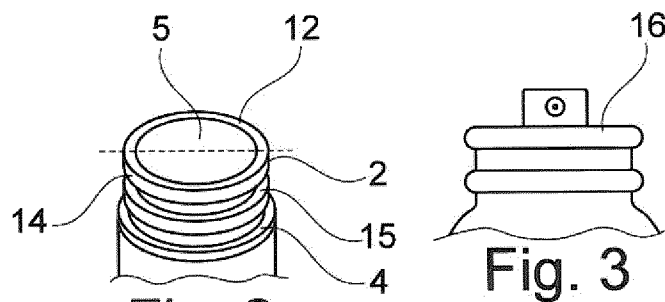


Fig. 2

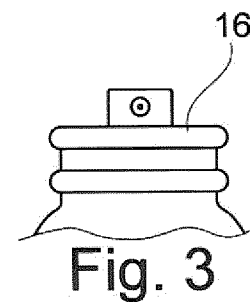


Fig. 3

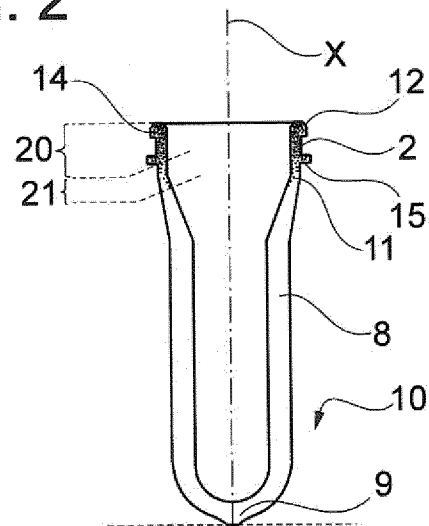


Fig. 4

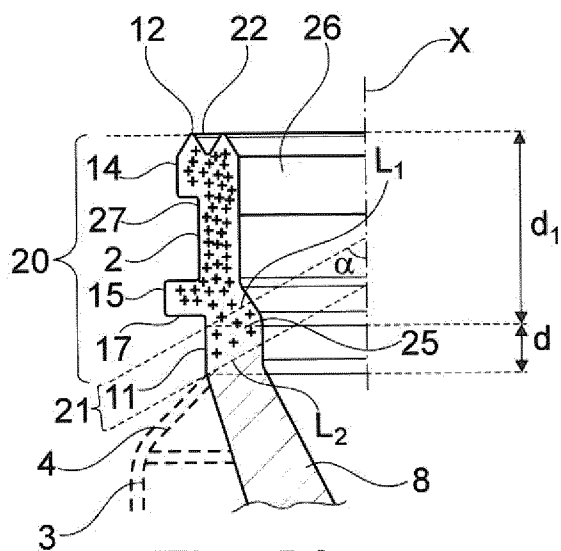


Fig. 5A

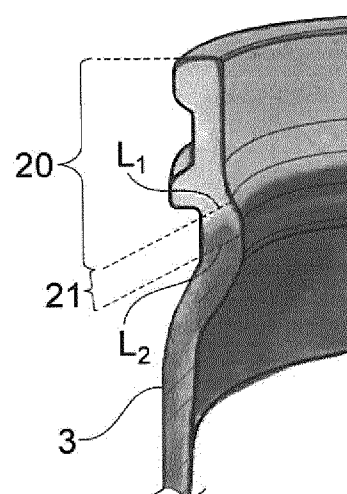


Fig. 5B

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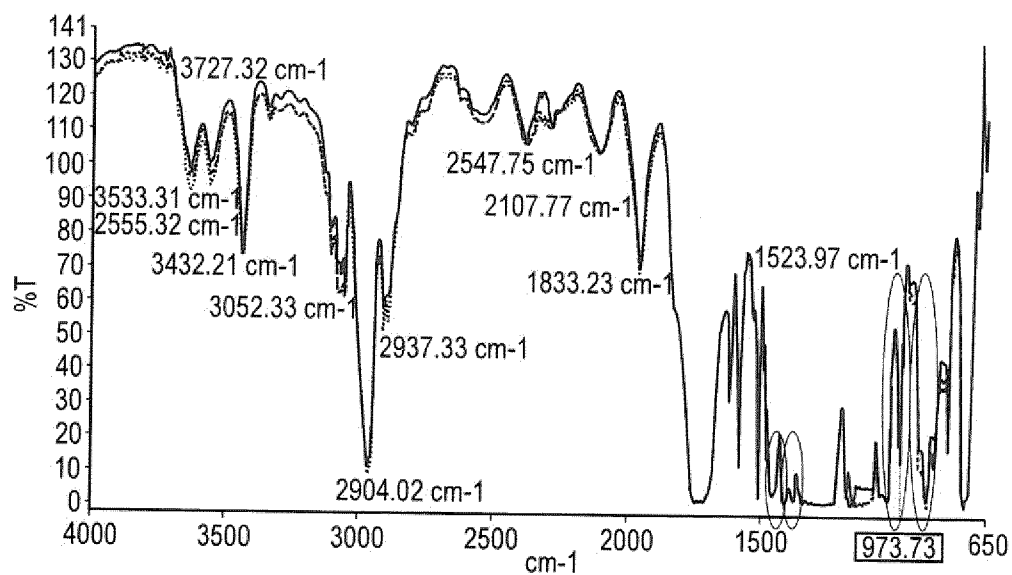


Fig. 6

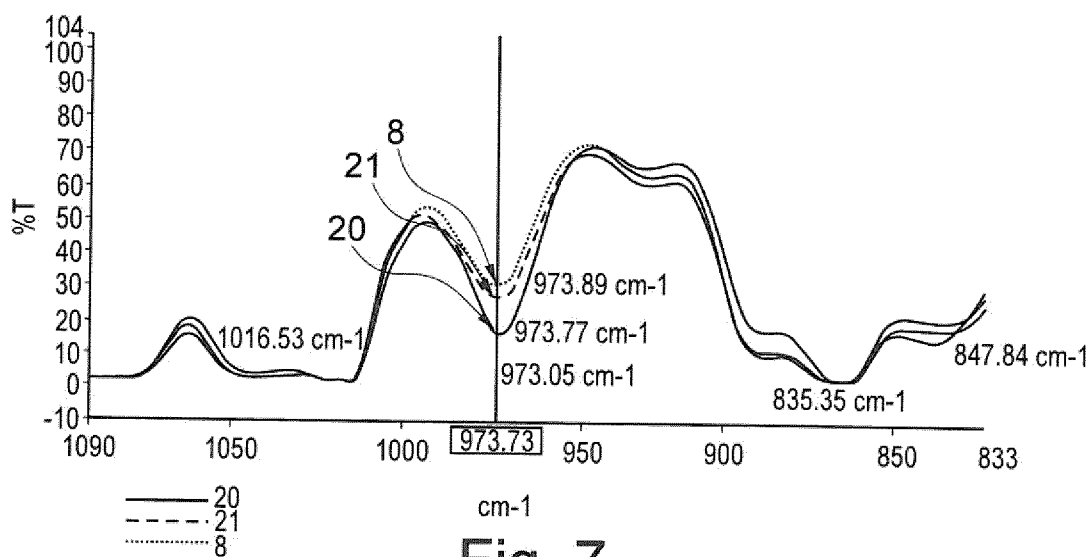


Fig. 7

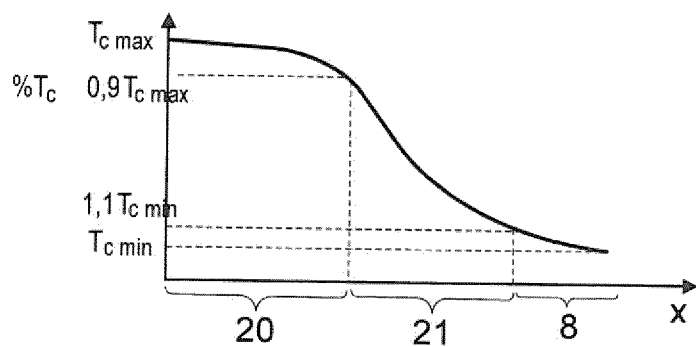


Fig. 8

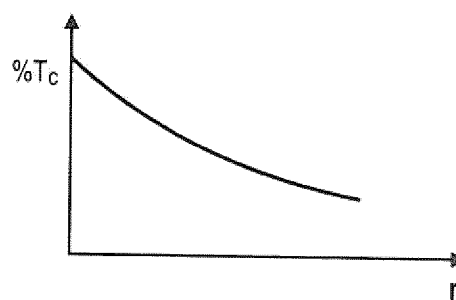
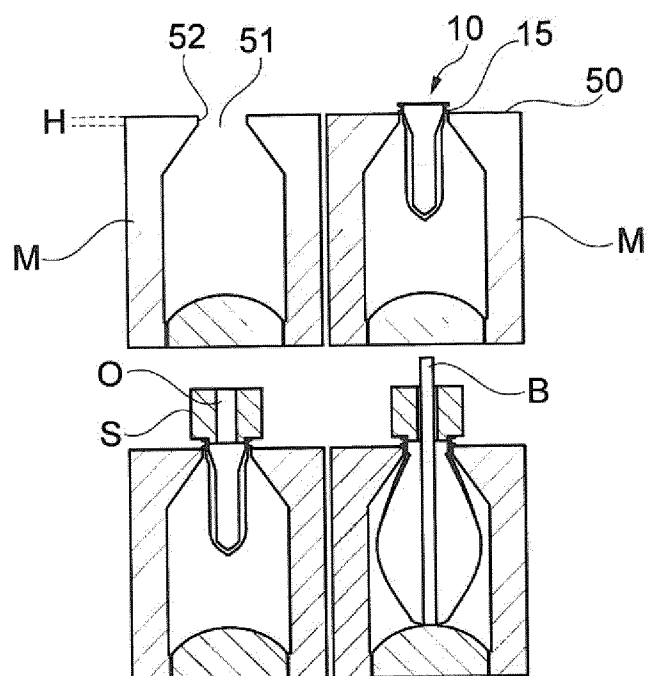
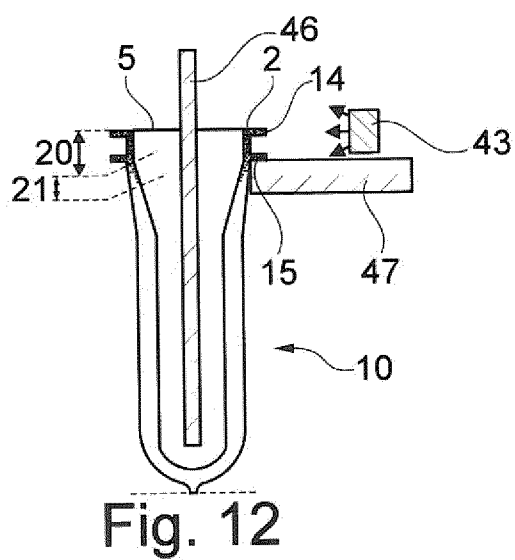
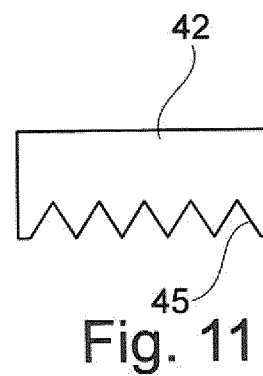
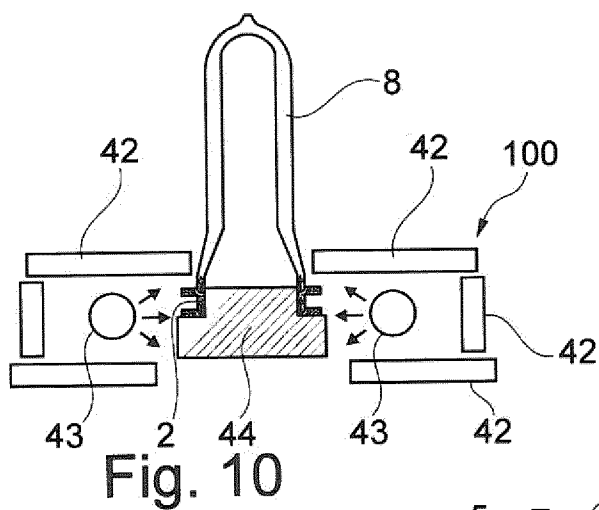


Fig. 9

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/060741

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65D83/38
ADD.

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)
B65D

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 practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2014/116904 A1 (PROCTER & GAMBLE [US]) 31 July 2014 (2014-07-31) page 11, line 1 - page 23, line 4; figures 3A-5	1-3, 5-15,18 16,17
Y A	----- EP 1 352 730 A1 (CONTINENTAL PET TECHNOLOGIES [US]) 15 October 2003 (2003-10-15) paragraph [0003] - paragraph [0021]; figures 1-11 -----	1-3, 5-15,18 4

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Further documents are listed in the continuation of Box C.

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See patent family annex.

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Date of the actual completion of the international search

8 July 2019

Date of mailing of the international search report

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Lohse-Busch, Heike

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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