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Description

The present invention relates to a stable evacuable mold with a shape which by virtue of thermoforming corresponds to the respective fiber-composite plastics component to be produced therewith, and made of a vacuum-tight thermoplastic film made of a layer a) as surface layer made of at least one thermoplastic polyamide or copolyamide optionally having functional groups and a layer b) as release layer on the internal side of the mold made of at least one thermoplastic tetrafluoroethylene copolymer, which has functional groups. WO2015067440 discloses a mold of this type which has a two-layer structure.

It is known that the technique known as vacuum packing can be used to produce fiber-composite plastics components, including those of complicated shape, for a very wide variety of applications, e.g. for aerospace, the vehicle industry or the wind-turbine industry. In this technique, laminates made of reinforcing fibers, preferably carbon fibers or glass fibers, saturated with a hardenable plastics resin, are packed together with a vacuum-tight shaping mold into a vacuum-tight capsule. Evacuation not only forces the laminate into the vacuum-tight shaping mold but also provides sufficient compaction of the laminate therein, thus minimizing the number of cavities in the laminate and permitting escape of gas inclusions or air inclusions. The entire evacuable apparatus comprising a packing capsule and a shaping mold, with the molded fiber-containing plastics laminate, is then placed in an autoclave under pressure with heating to the hardening temperature of the plastics resin until the hardenable plastics resin has been hardened and the finished fiber-composite plastics component can be removed from the apparatus.

The vacuum-tight packing capsule for the fiber-plastics-resin laminate that is to be molded and hardened usually comprises not only a vacuum-tight plastics film as external packing capsule but also, alongside the shaping mold equipped with a release layer, a layer structure arranged on the vacuum-tight plastics film and made of, from the outside to the inside, a layer of an air-permeable nonwoven fabric, a release layer, optionally a layer adjoining same to absorb the excess

plastics resin forced out of the fiber-plastics-resin laminate by the vacuum, and a further, preferably perforated, release layer directly adjoining the laminate to be hardened. This process for the production of fiber-composite plastics components is therefore not only relatively complicated but also time-consuming and costly because of the abovementioned materials and work involved.

There is therefore a need to simplify the abovementioned vacuum-packing technology while avoiding any losses of quality in the resultant fiber-composite plastics components.

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It was therefore an object of the present invention to maximize simplicity of vacuum-packing technology for the production of fiber-composite plastics components, and thus reduce costs, while not in any way impairing the quality of the fiber-composite plastics components, which satisfies extremely stringent safety requirements.

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This object is achieved via the use of a stable evacuable mold with a shape which by virtue of thermoforming corresponds to the respective fiber-composite plastics component to be produced therewith, and made of a vacuum-tight plastics film made of

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- a) a surface layer made of at least one thermoplastic polyamide or copolyamide which optionally has functional groups and
- b) a release layer forming the internal side of the mold and made of at least one thermoplastic tetrafluoroethylene copolymer, which has functional groups, where the plastics film has no tie layer between the layer a) and the layer b), and with the structure defined in Claim 1.

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The vacuum-tight thermoplastic film used in the invention can be used to produce stable evacuable molds by thermoforming, the shape of which respectively corresponds precisely to the fiber-composite plastics component to be used. There is moreover then no need for the abovementioned further layer structure which is conventionally required in vacuum-packing technology for the production of fiber-composite plastics components and is made of additional

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release layers, plastics-resin-absorption layers and air-permeable nonwoven-fabric layers.

5 The mold of the invention has the necessary vacuum-tight property for the required evacuation to compact the laminate arranged in the pack and made of fibers and of hardenable plastics resin, for shaping of said laminate to give the precise required shape of fiber-composite plastics components, including those of complicated shape.

10 The mold moreover retains adequate stability during the hardening process, which takes place under pressure and at elevated temperature for a number of hours to convert the fiber-plastics-resin laminate to the finished component, and can be removed without difficulty from the fiber-composite plastics component obtained after hardening of the plastics resin. One of the reasons for the smooth
15 running of this procedure is that the plastics film used for the production of the stable evacuated mold exhibits excellent adhesion between the layer a) and the layer b), without any need for a tie layer between the layer a) and the release layer b). Nor is the adhesion impaired during the lengthy hardening of the fiber-plastics laminate. Accordingly, the surface structure of the hardened fiber-
20 composite plastics component exhibits no damage and satisfies the stringent requirements relating to appearance and safety.

The plastics film used in the invention moreover has a softening point $\leq 240^{\circ}\text{C}$, and the evacuable mold of the invention can therefore be produced by a
25 thermoforming process in conventional thermoforming plants, e.g. by deep-draw methods, preferably under vacuum and/or with use of mechanical action, even when the shape of the fiber-composite plastics component to be produced by the mold is complicated.

30 The at least two-layer thermoplastic film used in the invention is vacuum-tight, and the vacuum-tight properties here are obtained not only via the polyamide layer a) but also via the release layer b). Accordingly, the mold of the invention

is also amenable to evacuation for long periods, or can be rendered vacuum-tight for long periods.

5 The thermoplastic film used has a softening point that is higher by at least 10°C than the hardening temperature of the fiber-reinforced, hardenable plastics laminate from which the fiber-composite plastics component is produced, and the mold of the invention therefore also remains stable during the hardening phase, and retains its shape. Adequate stability of the mold of the invention is moreover ensured in that the plastics film used for the production of the mold of
10 the invention has an excellent modulus of elasticity.

The plastics film used in the invention preferably has two layers, and preferably exhibits adhesion that is sufficient to prevent separation of the layers under the conventional test conditions for determining adhesion, thus preventing, as stated
15 above, delamination of the layer a) from the layer b) when the plastics film used in the invention is subjected to stress conditions. There is no need for any separate tie layer between the layer a) and the layer b), and there is therefore no tie layer present.

20 Said adhesion is achieved in the plastics film used in the invention, which has no tie layer between the layer a) and the layer b), in that the thermoplastic tetrafluoroethylene copolymer used for the production of the layer b), and also optionally the polyamide or copolyamide of the layer a), have functional groups, where preferably the functional groups of the two layers can, and are intended
25 to, react with one another.

Accordingly, the layer a) can be based on at least one thermoplastic, aliphatic, semiaromatic or aromatic polyamide or copolyamide, or on a mixture of at least two of the polymers mentioned, where the polyamide or the copolyamide can
30 optionally be composed of at least one at least trifunctional polyamine or an at least trifunctional polycarboxylic acid in a quantity of from 0.01 to 5 mol%.

It is preferable that the layer a) is composed of at least one thermoplastic aliphatic polyamide or copolyamide, preferably made of an alkylenediamine having from 4 to 8 C atoms and an aliphatically carboxylic acid having from 6 to 14 C atoms, and/or made of a lactam, preferably having from 4 to 6 C atoms, particularly preferably of an ϵ -caprolactam (PA-6), or of a polyamide made of hexamethylenediamine and adipic acid (PA-6,6), of a hexamethylenediamine and sebacic acid, or of a hexamethylenediamine and dodecanedioic acid, or of a copolyamide made of hexamethylenediamine, adipic acid and ϵ -caprolactam, preferably having from 5 to 50% by weight of ϵ -caprolactam units (PA-6,6/6), of a semiaromatic polyamide made of an alkylenediamine having from 4 to 6 C atoms and terephthalic acid or isophthalic acid, preferably a polyamide made of hexamethylenediamine and terephthalic acid (PA-6T) or of hexamethylenediamine and isophthalic acid (PA-6I), or of a thermoplastic, aromatic polyamide composed of aromatic diamines and aromatic dicarboxylics, preferably of isophthalic acid or terephthalic acid and phenylenediamine, where the softening point of the respective polyamide or copolyamide must be $\leq 240^{\circ}\text{C}$.

Mixtures made of PA-6 or PA-6,6 and respectively preferably from 5 to 20% by weight, based on the entire mixture, of a semiaromatic polyamide, preferably of a PA-6I, feature in particular improved thermoformability.

The polyamides or copolyamides or mixtures thereof can optionally respectively have the abovementioned functional groups, insofar as at least trifunctional starting compounds are used concomitantly during the polycondensation process.

As mentioned above, the layer b) is based on a thermoplastic tetrafluoroethylene copolymer.

Suitable fluorocopolymers are in particular tetrafluoroethylene copolymers which have

α) copolymerized units of tetrafluoroethylene,

δ) copolymerized units of at least one fluorinated monomer differing from tetrafluoroethylene, selected from the group consisting of

5 $\text{CF}_2=\text{CFOR}^1$, where R^1 is a C_{1-10} perfluoroalkyl moiety which can comprise an oxygen atom,

of $\text{CF}_2=\text{CF}(\text{CF}_2)_p\text{OCF}=\text{CF}_2$, where p is 1 or 2,

10 of perfluoro (2-methylene-4-methyl-1,3-(dioxolane) and

$\text{CH}_2=\text{CX}^3(\text{CF}_2)_Q\text{X}^4$, where X^3 is a hydrogen atom or a fluorine atom, Q is an integer from 2 to 10 and X^4 is a hydrogen atom or a fluorine atom,

β) copolymerized units of nonfluorinated monomers, preferably C_2 - C_4 olefins,
15 preferably of ethylene or propylene or of vinyl ester or vinyl ether, preferably vinyl acetate and

γ) copolymerized units of monounsaturated aliphatic dicarboxylic acid or cyclic anhydrides thereof,

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where a tetra fluoroethylene copolymer used in the invention must not necessarily be composed of all of the copolymerized units α)- γ) mentioned.

It is preferable that the functional groups of the tetrafluoroethylene copolymer,
25 derive from polymerized units of γ) monounsaturated, aliphatic dicarboxylic acids, for example itaconic acid, citraconic acid, or maleic acid, or cyclic anhydrides thereof, for example maleic anhydride, itaconic anhydride or citraconic anhydride. The proportion of these polymerized units is preferably from 0.01 to 5 mol%, where the entirety of polymerized units must always give
30 100 mol%.

A layer b) is thus composed of a tetrafluoroethylene copolymer, composed of polymerized units of α) tetrafluoroethylene, β) C₁-C₄-olefins, preferably ethylene, and γ) monounsaturated polycarboxylic acids or cyclic anhydrides thereof, preferably itaconic acid, itaconic anhydride, citraconic acid, citraconic anhydride, maleic acid or maleic anhydride, where the tetrafluorocopolymer is composed of from 50 to 90 mol% of α)-units, of from 10 to 50 mol% of β)-units, preferably ethylene units, and of from 0.01 to 5 mol% of γ)-units, where the entirety of the units α) + β) + γ) must always give 100 mol%.

For the structure of the layer b), preference is likewise given to a tetrafluoroethylene copolymer made of polymerized units α), γ) and δ), where the copolymer is composed of from 50 to 99.8 mol% of α)-units, from 0.01 to 5 mol% of γ)-units and from 0.1 to 49.99 mol% of δ)-units, based in each case on α), γ) and δ).

Another preferred tetrafluoroethylene copolymer for the structure of the layer b) is a tetrafluoroethylene copolymer made of polymerized units α), β), γ) and δ), where the copolymer is composed of from 50 to 90 mol% of α)-units, from 5 to 35 mol% of β)-units, from 0.1 to 20 mol% of δ)-units and from 0.01 to 5 mol% of γ)-units, based in each case on α)- δ).

It is moreover also possible to equip the tetrafluoroethylene copolymer with functional groups by using chemical treatment, corona discharge treatment or plasma discharge treatment to provide free radicals to the surface of the layer b) before bonding to the layer a) and using a conventional method to graft unsaturated dicarboxylic acids, cyclic anhydrides thereof and/or epoxides or hydroxy groups thereto in a manner such that the functional groups constitute a proportion of from 0.01 to 5 mol%, based on 100 mol% of the tetrafluoroethylene copolymer.

As mentioned above, the plastics film used in the invention preferably has two layers, and has no tie layer. Insofar as both the layer a) and the layer b) have

functional groups, it is therefore advisable that functional groups present in each case are of types that can react with one another. Examples of these are carboxy groups, hydroxy groups, cyclic anhydride groups and amino groups.

- 5 The thermoformability and stability of the plastics film used in the invention are influenced by the overall thickness and the thickness ratio of the layer a) to the layer b). The total thickness of the unthermoformed plastics film is preferably at least 250 μm , particularly preferably at least from 400 to 700 μm , where the thickness ratio of the layer a) to the layer b) is in the range from 95:5 to 70:30.

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The plastics film used in the invention can be produced by an extrusion, preferably by coextrusion. It is particularly preferable that the plastics film used in the invention is produced in the form of cast film by extrusion, preferably coextrusion, through flat-film die, whereupon excellent adhesion is obtained.

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The plastics film used in the invention is hygroscopic because of the polyamide layer a), and is preferably stored in a pack impermeable to moisture, after drying, and preferably again dried before thermoforming. Immediately after the mold of the invention has been produced and cooled, this is moreover likewise stored

20 under conditions that exclude moisture, and optionally again dried before use for the production of a fiber-composite plastics component.

The presence of the unfluorinated units of the tetrafluoroethylene copolymer brings the softening point of the plastics film used in the invention to $\leq 240^\circ\text{C}$.

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It is thus possible to mold the plastics film in conventional forming machines, preferably by deep-draw thermoforming with heating to the forming temperature, to give the mold of the invention, where the thermoforming mold has a shape corresponding to the fiber-composite plastics component to be produced in the

30 mold of the invention. The temperature for thermoforming of the plastics film is preferably $\leq 240^\circ\text{C}$, particularly preferably in the range of from 210 to 240°C .

The forming in the thermoforming procedure can take place under vacuum and optionally with use of mechanical action from, for example, a ram.

5 The plastics film used in the invention is preferably transparent, and it is therefore also possible to provide transparent molds for the production of fiber-composite plastics components. This permits inspection during hardening of the impregnated fiber-plastics laminates, to ensure defect-free production.

10 In order to avoid embrittlement of the mold during thermoforming, it is advantageous to equip the polyamide with antioxidants, e.g. sterically hindered phenols, phosphites or sterically hindered amines. This provides long-term antioxidative thermal stabilization, i.e. prevention of thermal polymer degradation which can lead to embrittlement of the mold during hardening of the fiber-composite plastics component. Thermal stabilization can also be achieved
15 by adding Cu(II) compounds, such as Cu(II)KI complexes. Addition of as little as from 1 to 10% by weight, preferably from 1 to 5% by weight, of the additives mentioned can achieve adequate stabilization in respect of embrittlement and any undesired discoloration of the mold. The thermoformability of the composite film of the invention can also be additionally improved by concomitant use of one
20 of the abovementioned mixtures of polyamides comprising a high-viscosity amorphous polyamide such as PA-6I for the production of the polyamide layer a).

It is thus possible to prevent any undesired softening or disruption of the film web that might occur during thermoforming.

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It is moreover possible to add conventional qualities of conventional processing aids such as lubricants or antistatic agents in the film used in the invention.

30 It is particularly preferable that the total thickness of the thermoplastic film that has not yet been thermoformed is at least 250 μm , preferably up to 700 μm , where the thickness ratio of the layer a) to the layer b) is in the range from 95:5 to 70:30.

Another possibility for the production of large-surface-area fiber-composite plastics moldings which may have a repeating shape is, for these molds, to juxtapose identically shaped mold segments which can be bonded to one another in the overlapping region of two segments, preferably by heat-sealing.

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The mold of the invention has at least one evacuation apparatus and, after charging of the plastics-resin-impregnated fiber laminate, is sealed with a further, vacuum-tight mold, the sealing mold, to give the entire vacuum-tight mold.

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The design of this second (sealing) mold for the vacuum-tight sealing of the mold of the invention can preferably differ from that of the mold of the invention.

This "sealing mold" preferably has the shape of a panel or of a shaping mold on which the plastics-impregnated fiber laminate is first placed before vacuum-tight sealing with the mold of the invention. To this end, the said sealing mold must have a surface provided with release agents, and must maintain its original flexural strength during the entire production process, in particular in the evacuated condition of the entire mold, in order to avoid impairment of the mold of the invention and thus of the composite component to be produced. If the flexural stiffness of the sealing mold is not sufficient, there is specifically the risk that the fiber-composite plastics molding will not have the desired shape.

Another possibility, however, if the fiber-composite plastics component is to have a different shape on its two surfaces, is to use a sealing mold likewise made of a plastics film used in the invention with its shape appropriate to the shape of the second surface. It is likewise possible to introduce the plastics film of the invention between the shaping mold and the laminate, for example in order to omit use of conventional release agents (solvent-containing or water-based release agents). It is of course also possible, if necessary, that the entire sealing mold has a concave or convex shape, if this is necessary for the shaping of the fiber-composite plastics component. Shaping can be achieved by folding, or folding-together, of appropriate mold halves.

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As stated above, production of the fiber-composite plastics component proceeds as follows: the fiber laminate impregnated with the hardenable plastics resin, preferably a hardenable epoxy resin, is provided on the enclosing mold, and then the mold of the invention is combined with the enclosing mold, to give the entire mold, and the system is sealed so that it is vacuum-tight. A vacuum is applied in order to compress the mold of the invention, with compaction of the fiber material. While the vacuum is maintained, the entire mold with the molded laminate is placed in an autoclave and heated to the hardening temperature of the hardenable plastics resin, and retained for the entire hardening time, mostly a number of hours.

Other possibilities alongside the process using an autoclave are to operate with pressure in a press or to operate under atmospheric pressure (i.e. oven curing). Curing can moreover also be achieved by the action of microwave radiation.

After the hardening time, and after cooling, the fiber-composite plastics component is removed from the entire mold and, as far as possible with exclusion of moisture, packed to await final use.

Fibers used for the production of the composite components are preferably carbon fibers or glass fibers.

The mold of the invention can be used to produce fiber-composite plastics components, preferably carbon-fiber composite plastics components, which in particular can be used as components for means of transport of any type, preferably for aircraft, spacecraft, trains or motor vehicles, or as components for wind turbines, preferably as rotor blades.

Determination of adhesion

Adhesion between the layer a) and the layer b) is determined by testing test strips of a multilayer film used in the invention, each with width 15 mm and length about 150 mm. Each test strip is secured in a tensile tester in such a way that

the angle formed by the strips to be separated from one another (layer a) and layer b)) is about 180°C, and the strips are then separated from one another. The maximal and average separation force is determined across the measurement distance. The measurement equipment used for the test is a computer-controlled tensile tester. Adhesion is determined here by plotting force against displacement. The force measured in N corresponds to the force required to achieve full separation of the layers (layer a) and layer b)) of the test strip.

10 Example

A two-layer cast film is produced by coextrusion of PA-6 comprising 5% by weight of PA-6I as layer (a) and of an ethylene/tetrafluoroethylene copolymer with 0.5 mol% of γ - and δ -units incorporated into the polymer. The thickness of the polyamide layer a) is 400 μm and the thickness of the release layer b) is 100 μm . The coextruded film could be thermoformed very successfully at 229°C, and exhibits excellent adhesion: it could not be separated into two layers in the "Determination of adhesion" test described above, either mechanically or with the aid of test adhesive tapes. Delamination was not possible.

Patentkrav

1. Evakuerbar, stabil form der har en udformning som er opnået ved termoforgivning ved temperaturer ≤ 240 °C og som svarer til den respektive fiberkompositplastkomponent, der skal fremstilles dermed, og er fremstillet af en
- 5 mindst 2-lags, termoplastisk, vakuumtæt plastfilm, hvilken form omfatter:
- a) et overfladelag lavet af mindst et termoplastisk polyamid eller copolyamid, der eventuelt omfatter funktionelle grupper, og
 - b) et grænselag der danner den indvendige side af formen og som er fremstillet af mindst en termoplastisk tetrafluorethylencopolymer, der om-
 - 10 fatter funktionelle grupper, og er sammensat af
 - b1)
 - α) copolymeriserede enheder af tetrafluorethylen og
 - γ) copolymeriserede enheder af monoumættede, alifatiske dicarboxylsyrer eller deres cykliske anhydrider, såvel som
 - 15 δ) copolymeriserede enheder af mindst en fluoreret monomer der er forskellig fra tetrafluorethylen, som er valgt fra gruppen der består af:

$$\text{CF}_2=\text{CFOR}^1$$
 hvor R^1 står for en C_{1-10} -perfluoralkylgruppe, der kan omfatte et oxygenatom,
 - 20 $\text{CF}_2=\text{CF}(\text{CF}_2)\text{POCF}=\text{CF}_2$, hvor p står for 1 eller 2, perfluor-(2-methylen-4-methyl-1,3-dioxolan og

$$\text{CH}_2=\text{CX}^3(\text{CF}_2)_Q\text{X}^4$$
 hvor X^3 står for et hydrogenatom eller et fluoratom, Q står for et heltal fra 2 til 10 og X^4 står for et hydrogenatom eller et fluoratom, og/eller
 - 25 β) copolymeriserede enheder af C_2 - C_4 -olefiner, eller
 - b2) en olefin/tetrafluorethylen-copolymer der er modificeret ved fri radikal podning af fra 0,01 til 5 mol-% carboxylgrupper, hydroxygrupper, estergrupper, isocyanatgrupper, epoxygrupper, amidgrupper eller cykliske anhydridgrupper,
 - 30 hvilken plastfilm ikke har noget bindemiddellag mellem lagene (a) og (b).

2. Formen ifølge krav 1, **kendetegnet ved, at** laget (a) er baseret på mindst et termoplastisk, alifatisk, semiaromatisk eller aromatisk polyamid eller copolyamid eller af en blanding af mindst to af de nævnte polyamider, fortrinsvis af PA-6, PA-6,6 eller PA-6,12, et copolyamid af hexamethylendiamin, adipinsyre og ϵ -caprolactam eller en blanding af PA-6 eller PA-6,6 og fra 5 til 20 vægt-% af et semiaromatisk polyamid, fortrinsvis en PA-6I, med en blødgøringsstemperatur ≤ 240 °C, hvor polyamid- eller copolyamidenhederne er sammensat af en mindst trifunktionel polyamin eller en mindst trifunktionel polycarboxylsyre i en mængde fra 0,01 til 5 mol-%, der er baseret på 100 mol-% copolyamid.
- 10
3. Form ifølge krav 1 eller 2, **kendetegnet ved, at** laget (b) er sammensat af en tetrafluorethylen-copolymer der er fremstillet af polymeriserede enheder af (α) tetrafluorethylen, (β) C2-C4-olefiner, fortrinsvis ethylen, og (γ) monoumættede polycarboxylsyrer eller deres cykliske anhydrider, fortrinsvis itaconsyre, itaconsyreanhydrid, citraconsyre, citraconsyreanhydrid, maleinsyre eller maleinsyreanhydrid, hvor tetrafluorocopolymeren er sammensat af fra 50 til 90 mol-% (α)-enheder, fra 10 til 50 mol-% (β)-enheder, fortrinsvis ethylen-enheder, og eventuelt fra 0,01 til 5-mol-% (γ)-enheder, hvor summen af enhederne (α) + (β) eller (α) + (β) + (γ) altid skal give 100 mol-%.
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- 20
4. Form ifølge krav 1 eller 2, **kendetegnet ved, at** laget (b) er sammensat af en ethylen/tetrafluorethylen-copolymer, der er modificeret ved fri radikal podning af mindst fra 0,01 til 5 mol-% carboxylgrupper, hydroxygrupper, estergrupper, isocyanatgrupper, epoxygrupper, amidgrupper eller maleinsyre-anhydridgrupper.
- 25
5. Form ifølge krav 1 eller 2, **kendetegnet ved, at** laget (b) er sammensat af en termoplastisk tetrafluorethylencopolymer af
- a) copolymeriserede enheder af tetrafluorethylen,
- b) copolymeriserede enheder af mindst en fluoreret monomer, der adskiller sig fra tetrafluorethylen, som er valgt fra gruppen der består af:
- 30 $\text{CF}_2=\text{CFOR}^1$
- hvor R1 står for en C₁₋₁₀ perfluoralkylgruppe, der kan omfatte et oxygenatom,

$\text{CF}_2=\text{CF}(\text{CF}_2)\text{POCF}=\text{CF}_2$, hvor p står for 1 eller 2,

perfluor-(2-methylen-4-methyl-1,3-dioxolan og

$\text{CH}_2=\text{CX}^3(\text{CF}_2)_Q\text{X}^4$,

hvor X^3 står for et hydrogenatom eller et fluoratom, Q står for et heltal fra

5 2 til 10 og X^4 står et hydrogenatom eller et fluoratom,

β) copolymeriserede enheder af ikke-fluorerede monomerer, fortrinsvis $\text{C}_2\text{-C}_4$ olefiner og

γ) copolymeriserede enheder af monoumættede alifatiske dicarboxylsyrer eller deres cykliske anhydrider.

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6. Formen ifølge krav 5, **kendetegnet ved, at** laget (b) er sammensat af en tetrafluorethylen-copolymer der består af polymeriserede enheder (α), (γ) og (δ), hvor copolymeren omfatter fra 50 til 99,8 mol-% (α)-enheder, fra 0,01 til 5 mol-% (γ)-enheder og fra 0,1 til 49,99 mol-% af (δ)-enheder, der i hvert tilfælde er
15 baseret på (α), (γ) og (δ).

7. Formen ifølge krav 5, **kendetegnet ved, at** copolymeren er sammensat af fra 50 til 90 mol-% (α)-enheder, fra 5 til 35 mol-% (β)-enheder, fra 0,1 til 20 mol-% af (δ)-enheder og fra 0,01 til 5-mol-% (γ)-enheder, der i hvert tilfælde er baseret
20 på (α) – (δ).

8. Form ifølge et hvilket som helst af kravene 1-7, **kendetegnet ved, at** formen omfatter mindst en evakueringsindretning som kan lukkes.

25 9. Anvendelse af en form ifølge et hvilket som helst af kravene 1-8 til fremstilling af en fiberkompositplastkomponent.

10. Anvendelse af en form ifølge krav 9, **kendetegnet ved, at** formen der er fremstillet af den termoplastiske, omfatter en blødgøringsstemperatur der er
30 mindst 10 °C højere end hærdningstemperaturen for den fiberkompositplastkomponent, der er hærdet i formen.

11. Anvendelsen ifølge krav 10, **kendetegnet ved, at** fiberkomposit-plastkomponenten er en carbon-fiberkomposit-plastkomponent, fortrinsvis en komponent til et transportmiddel af en hvilken som helst type, fortrinsvis til fly, rumfartøjer, tog eller motorkøretøjer, eller en komponent til vindhjul, fortrinsvis til
- 5 rotorblade.