Patent claims

1. Method for the continuous production of laminates made of at least two fibre bands (1, 1', 1'') made of fibres which are embedded unidirectionally in a plastic material matrix, having the following steps:

   a) transport of the fibre bands (1, 1', 1'') from respectively one material store (2, 2', 2'') by at least one transport roller (3a, 3b, 3a', 3b', 3a'', 3b'') to a joining station (4),

   b) layer-like combining of the fibres bands (1, 1', 1'') in the joining station (4) by at least two consolidation units,

   c) joining the fibre bands (1, 1', 1'') by means of the two consolidation units to form a continuous laminate (6) and also

   d) solidification of the laminate (6).

2. Method according to claim 1,
   characterised in that, before or during step d), shaping of the laminate (6) is effected by means of at least two shaping units, in particular shaping rollers (9, 9'), the shaping units (9, 9') being positioned behind the consolidation units, in particular consolidation rollers (5, 5'), such that different shapes of the laminate (6) are produced during solidification of the laminate (6) due to the stressing of the laminate (6).

3. Method according to claim 2,
characterised in that the consolidation rollers (5, 5') are operated at a different circumferential speed, it is thereby preferred that the absolute value of the circumferential speeds differs by no more than 100%.

4. Method according to one of the preceding claims,
characterised in that the fibre bands (1, 1', 1'') are prepared in a pretreatment station (7) which is disposed between the transport rollers (3a, 3b, 3a', 3b', 3a'', 3b'') and the joining station (4), for the joining process.

5. Method according to claim 4,
characterised in that, in the pretreatment station (7), a thermal treatment, in particular by means of hot air, hot gas, in particular nitrogen, ultrasound, friction, flame treatment, laser and/or irradiation, preferably infrared irradiation, of the fibre bands (1, 1', 1'') is effected for the melting, at least in regions, of the plastic material matrix, joining is effected, in the joining station (4), by bringing in contact the molten regions of the fibre bands (1, 1', 1'') and by compression between the consolidation units and the solidification is accompanied by cooling of the laminate (6).

6. Method according to claim 4,
characterised in that, in the pretreatment station (7), an adhesive is applied on at least one fibre band (1, 1', 1''), at least in regions, in particular epoxides, silane-based adhesives, polyurethanes, methacrylic acid esters, melt adhesives and/or mixtures thereof and joining is effected, in the joining station, by bringing in contact the regions of the fibre bands (1, 1', 1'') which have the adhesive and solidifying the fibre bands by drying the adhesive.

7. Method according to one of the preceding claims,
characterised in that the fibre bands (1, 1', 1'') are guided between the transport rollers (3a, 3b, 3a', 3b', 3a'', 3b'') and the pretreatment station (7) by at least one guide unit, in particular at least one guide roller (8, 8', 8'').

8. Method according to one of the preceding claims,
characterised in that, after step d), separation of the laminate (6) into partial pieces is effected, in particular by cutting, laser treatment, squeezing, sawing, water jet, bending or combinations hereof.

9. Method according to one of the preceding claims,
characterised in that the plastic material matrix is a thermoplastic plastic material matrix selected from the group consisting of acetal resins, liquid-crystalline polymers, polyacrylates, polymethacrylates, olefinic and cycloolefinic polymers, polyamides, polyamide elastomers, in particular polyester amides, polyether amides and polyether ester amides, polyamide imides, polyaryl ethers including polyphenyl ethers, polycarbonates, polysulphones, polyether imides, polyimides, polyesters, polyester polycarbonates, polyethers, polyoxyethylenes, polystyrene, polysulphones, vinyl polymers such as polyvinyl chloride and polyvinyl acetate or mixtures of one or more of the listed materials, in particular ABS, MBS and SAN, PC, PMMA.

10. Method according to claim 5,
characterised in that the plastic material matrix is a duroplastic plastic material matrix selected from the group consisting of melamine resins, phenoplastics, polyester resins, aminoplastics, epoxy resins, polyurethanes, crosslinked polyacrylates and/or mixtures or blends thereof.

11. Method according to one of the preceding claims,
characterised in that the fibres are endless fibres or staple fibres with supercritical fibre length, in particular carbon-, glass-, mineral- or aramide fibres, preferably carbon fibres or glass fibres, with a flat or round cross-section and for particular preference carbon fibres.

12. Method according to one of the preceding claims,
characterised in that the fibre bands comprise additives selected from the group consisting of inorganic stabilisers, organic stabilisers, lubricants, defoamers, chain-lengthening additives, optical brighteners, plasticisers, adhesion promoters, halogen-containing flame retardants, halogen-free flame retardants, impact modifiers, particles, fillers and reinforcers, colourants, pigments and/or mixtures thereof.

13. Method according to one of the preceding claims,
characterised in that each individual fibre band (1, 1', 1'') is supplied via at least one separate transport roller (3a, 3b) or (3a', 3b') or (3a'', 3b''), the at least one transport roller (3a, 3b) or (3a', 3b') or (3a'', 3b'') being able to be actuated respectively separately.

14. Method according to one of the preceding claims,
characterised in that the consolidation units have a surface structuring, in particular in the form of grooves, intersecting notches, knurled structures or combinations hereof,
and/or a coating, in particular rubber, hard rubber or materials for improving the separation properties, particularly Teflon, for producing an embossed pattern on the outsides of the fibre bands.

15. Laminate (6) producible according to one of the claims 1 to 14.

16. Laminate (6) producible according to one of the claims 2 to 14, characterised in that the laminate has a shape memory.

17. Use of a laminate (6) according to one of the claims 15 or 16 as leaf springs, or for local reinforcement of an injection moulded part which are selected in particular from the following group:

- pressure containers, preferably water meters or pump housings;

- automobile parts, preferably running gear components, struts, interior parts, exterior parts, transmission components and wheel rims;

- industrial and consumer goods, preferably levers, fixings, garden implements, tools, household appliances, sanitary components, racquets, bows and shoes.

Patent claims

1. Method for the continuous production of laminates made of at least two fibre bands (1, 1', 1'') made of fibres which are embedded unidirectionally in a plastic material matrix, having the following steps:

   a) transport of the fibre bands (1, 1', 1'') from respectively one material store (2, 2', 2'') by at least one transport roller (3a, 3b, 3a', 3b', 3a'', 3b'') to a joining station (4),

   b) layer-like combining of the fibres bands (1, 1', 1'') in the joining station (4) by at least two consolidation units,

   c) joining the fibre bands (1, 1', 1'') by means of the two consolidation units to form a continuous laminate (6) and also

   d) solidification of the laminate (6), whereby

   before or during step d), shaping of the laminate (6) is effected by means of at least two shaping units (9, 9'), the shaping units (9, 9') being positioned behind the consolidation units, such that different shapes of the laminate (6) are produced during solidification of the laminate (6) due to the stressing of the laminate (6).

2. Method according to claim 1,
   characterised in that, the at least two shaping units are shaping rollers (9, 9'), and the consolidation units are particular consolidation rollers (5, 5').

3. Method according to claim 2,

characterised in that the consolidation rollers (5, 5') are operated at a different circumferential speed, it is thereby preferred that the absolute value of the circumferential speeds differs by no more than 100%.

4. Method according to one of the preceding claims,
characterised in that the fibre bands (1, 1', 1'') are prepared in a pretreatment station (7) which is disposed between the transport rollers (3a, 3b, 3a', 3b', 3a'', 3b'') and the joining station (4), for the joining process.

5. Method according to claim 4,
characterised in that, in the pretreatment station (7), a thermal treatment, in particular by means of hot air, hot gas, in particular nitrogen, ultrasound, friction, flame treatment, laser and/or irradiation, preferably infrared irradiation, of the fibre bands (1, 1', 1'') is effected for the melting, at least in regions, of the plastic material matrix, joining is effected, in the joining station (4), by bringing in contact the molten regions of the fibre bands (1, 1', 1'') and by compression between the consolidation units and the solidification is accompanied by cooling of the laminate (6).

6. Method according to claim 4,
characterised in that, in the pretreatment station (7), an adhesive is applied on at least one fibre band (1, 1', 1''), at least in regions, in particular epoxides, silane-based adhesives, polyurethanes, methacrylic acid esters, melt adhesives and/or mixtures thereof and joining is effected, in the joining station, by bringing in contact the regions of the fibre bands (1, 1', 1'') which have the adhesive and solidifying the fibre bands by drying the adhesive.

7. Method according to one of the preceding claims,

characterised in that the fibre bands (1, 1', 1'') are guided between the transport rollers (3a, 3b, 3a', 3b', 3a'', 3b'') and the pretreatment station (7) by at least one guide unit, in particular at least one guide roller (8, 8', 8'').

8. Method according to one of the preceding claims,
characterised in that, after step d), separation of the laminate (6) into partial pieces is effected, in particular by cutting, laser treatment, squeezing, sawing, water jet, bending or combinations hereof.

9. Method according to one of the preceding claims,
characterised in that the plastic material matrix is a thermoplastic plastic material matrix selected from the group consisting of acetal resins, liquid-crystalline polymers, polyacrylates, polymethacrylates, olefinic and cycloolefinic polymers, polyamides, polyamide elastomers, in particular polyester amides, polyether amides and polyether ester amides, polyamide imides, polyaryl ethers including polyphenyl ethers, polycarbonates, polysulphones, polyether imides, polyimides, polyesters, polyester polycarbonates, polyethers, polyoxyethylenes, polystyrene, polysulphones, vinyl polymers such as polyvinyl chloride and polyvinyl acetate or mixtures of one or more of the listed materials, in particular ABS, MBS and SAN, PC, PMMA.

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characterised in that the fibres are endless fibres or staple fibres with supercritical fibre length, in particular carbon-, glass-, mineral- or aramide fibres, preferably carbon fibres or glass fibres, with a flat or round cross-section and for particular preference carbon fibres.

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characterised in that the fibre bands comprise additives selected from the group consisting of inorganic stabilisers, organic stabilisers, lubricants, defoamers, chain-lengthening additives, optical brighteners, plasticisers, adhesion promoters, halogen-containing flame retardants, halogen-free flame retardants, impact modifiers, particles, fillers and reinforcers, colourants, pigments and/or mixtures thereof.

13. Method according to one of the preceding claims,
characterised in that each individual fibre band (1, 1', 1'') is supplied via at least one separate transport roller (3a, 3b) or (3a', 3b') or (3a'', 3b''), the at least one transport roller (3a, 3b) or (3a', 3b') or (3a'', 3b'') being able to be actuated respectively separately.

14. Method according to one of the preceding claims,
characterised in that the consolidation units have a surface structuring, in particular in the form of grooves, intersecting notches, knurled structures or combinations hereof,
and/or a coating, in particular rubber, hard rubber or materials for improving the separation properties, particularly Teflon, for producing an embossed pattern on the outsides of the fibre bands.

15. Laminate (6) producible according to one of the claims 1 to 14.

16. Laminate (6) producible according to one of the claims 1 to 14, characterised in that the laminate has a shape memory.

17. Use of a laminate (6) according to one of the claims 15 or 16 as leaf springs, or for local reinforcement of an injection moulded part which are selected in particular from the following group:

- pressure containers, preferably water meters or pump housings;

- automobile parts, preferably running gear components, struts, interior parts, exterior parts, transmission components and wheel rims;

- industrial and consumer goods, preferably levers, fixings, garden implements, tools, household appliances, sanitary components, racquets, bows and shoes.