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DESCRIPTION

[0001] The invention relates to a method for producing a semi-finished product for the manufacture of a composite moulded part, in particular a fibre composite moulded part. The invention particularly relates to composite moulded parts or a fibre composite moulded parts as a lightweight construction. The term "composite moulded part" means that reinforcing material or non-molten reinforcing material is embedded in a matrix of thermoplastic material. The term "fibre composite moulded part" means that fibres or non-molten fibres are present in the composite moulded part or in the matrix of thermoplastic material. The composite moulded parts or fibre composite moulded parts produced according to the invention can on the one hand have a two-dimensional form, in particular the shape of a plate or the like. The composite moulded parts or fibre composite moulded parts produced according to the invention preferably have a three-dimensional shape.

[0002] Methods, semi-finished products and composite moulded parts of the type mentioned initially are already known from practice in various embodiments. In the known methods, firstly semi-finished products are produced that consist of a matrix of thermoplastic material and reinforcing fibres embedded therein. To this end, the reinforcing fibres — for example glass fibres — are firstly combined with films, powders, fibres or melts of thermoplastic material. The thermoplastic material is melted by the application of heat and pressure and in this way the reinforcing fibres are impregnated with the melt, so that ultimately the semi-finished product made of the thermoplastic matrix with the embedded reinforcing fibres is obtained. These semi-finished products are also known as organic sheets and they are generally produced in the form of plates. For producing a fibre composite moulded part having a three-dimensional shape the plates must be heated again in a subsequent additional processing step before they can be formed into the desired fibre composite moulded part. The known methods and semi-finished products have a number of disadvantages. Firstly in the manufacture of semi-finished products — in particular when using films of thermoplastic material — the extent of the penetration or impregnation of the reinforcing fibres with the thermoplastic material leaves something to be desired. Furthermore air inclusions are frequently produced and as a result weak points are formed in the composite moulded part or fibre composite moulded part that is produced. Moreover, the semi-finished products that are produced are frequently characterized by insufficient draping properties. Therefore the manufacture of three-dimensional or multi-dimensional composite moulded parts or fibre composite moulded parts is subject to limitations. Furthermore, the recycling of known fibre composite materials is difficult when a thermoplastic matrix is reinforced with reinforcing fibres that are inorganic or difficult to melt. Moreover the recycling of thermosetting plastics is also difficult and costly in the case of composite moulded parts or fibre composite moulded parts produced according to the known measures.

[0003] A method of the type mentioned initially is known from EP 0 420 772 A1. In this case, a higher-melting reinforcing material is combined with lower-melting fibres of thermoplastic material to form a laminate. The lower-melting fibres are spun and then combined with the higher-melting reinforcing material to form the laminate forming the semi-finished product. This known method has not been widely used. Inter alia, the recycling of composite moulded parts leaves something to be desired.

[0004] On the other hand, the invention is based on the technical problem of providing a method of the type mentioned initially, in which the previously described disadvantages can be avoided in an effective and functionally reliable manner.

[0005] In order to solve this technical problem, the invention teaches a method for producing a semi-finished product for the manufacture of a composite moulded part, in particular a fibre composite moulded part, according to patent claim 1. Preferred embodiments of the method according to the invention are claimed in patent claims 2 to 12.

[0006] It is also possible, in order to produce a semi-finished product for the manufacture of a composite moulded part, in particular a fibre composite moulded part, to combine a higher-melting reinforcing material, in particular higher-melting reinforcing fibres with lower-melting fibres made of thermoplastic material to form a laminate, wherein the lower-melting fibres are spun and are combined at a fibre temperature T_F with the higher-melting reinforcing material, in particular with the higher-melting reinforcing fibres to form the laminate forming the semi-finished product, wherein the fibre temperature T_F lies in a temperature range between a temperature of 25°C below the heat distortion temperature T_W to 55°C above the heat-distortion temperature T_W of the thermoplastic material of the lower-melting fibres. It thus holds that: $T_W - 25°C \leq T_F \leq T_W + 55°C$. It is within the scope of the invention that the fibre temperature T_F is lower than the melting point of the thermoplastic material of the lower-melting fibres. It is also within the scope of the invention that the lower-melting fibres are spun and after the spinning are combined at a fibre thickness <10 den, preferably <3 den and particularly preferably <1.5 den and at the fibre temperature T_F, with the higher-melting reinforcing material, in particular with the higher-melting reinforcing fibres, to form the laminate forming the semi-finished product.

[0007] Within the scope of the invention, higher-melting means that the higher-melting component has a higher melting point than the lower-melting component, wherein the two melting points are measured under the same external conditions. Within the scope of the invention, higher-melting reinforcing material also encompasses non-melting reinforcing material and accordingly within the scope of the invention the term higher-melting reinforcing fibres also encompasses non-melting reinforcing fibres. It is recommended that the reinforcing material and in particular the reinforcing fibres are used as laid fabric and/or woven fabric and/or braided fabric and/or knitted fabric and/or meshes or the like. A preferred embodiment is characterized in that at least one laid fabric and/or at least one woven fabric made of reinforcing fibres forms/form the at least one layer of higher-melting reinforcing fibres. Within the scope of the invention, higher-melting foams or honeycombs can be used as higher-melting reinforcing material. It is within the scope of the invention that the melting point of the higher-melting reinforcing material or the higher-melting reinforcing fibres is at least 1°C, preferably at least 5°C higher than the melting point of the lower-melting fibres. According to an embodiment of the invention, the melting point of the higher-melting reinforcing material or the higher-melting reinforcing fibres is at least 20°C, preferably at least 30°C and preferably at least 50°C higher than the melting point of the lower-melting fibres.

[0008] The fibre temperature T_F of the lower-melting fibres in their combination with the reinforcing material or with the reinforcing fibres in the range specified there is lower than the heat-distortion temperature T_W or in the range specified there is higher than the heat-distortion temperature T_W of the thermoplastic material of the lower-melting fibres. Naturally it can also correspond to the heat-distortion temperature T_W. The fibre temperature T_F of the lower-melting fibres when deposited or when combined with the reinforcing material can be measured as process temperature or air temperature during the deposition or combination of the lower-melting fibres in the current method. The heat distortion or the heat-distortion temperature T_W of the thermoplastic material of the lower-melting fibres is a measure of the temperature stability of this thermoplastic material. The heat-distortion temperature can be measured according to DIN EN ISO 75-2:2004, method B (heating rate 50 K/h) on an untempered test piece.

[0009] A particularly preferred embodiment of the method according to the invention is characterized in that the fibre temperature T_F of the lower-melting fibres in combination with the reinforcing material lies between a temperature T_F of 20°C - preferably 15°C - below the heat-distortion temperature T_W to 50°C - preferably 45°C - above the heat-distortion temperature T_W of the thermoplastic material of the lower-melting fibres. As already demonstrated above, however, it is within the scope of the invention that the fibre temperature T_F lies below the melting point of the thermoplastic material of the lower-melting fibres.

[0010] Expediently in the method according to the invention, after the spinning, the lower-melting fibres are continuously delivered to the reinforcing material or the reinforcing fibres. In this case the lower-melting fibres preferably retain the fibre temperature T_F from the heating during the spinning process. Thus it is recommended that a treatment or cooling of the lower-melting fibres only takes place to the extent that the fibre temperature T_F according to the invention according to the patent claim 1 lies in the range specified there. It is within the scope of the invention that the reinforcing material has interstices or that interstices are formed between the reinforcing fibres and that during the combination of the lower-melting fibres with the reinforcing material or with the reinforcing fibres the fibres or the fibre sections of the lower-melting fibres can penetrate into the interstices. In this respect, the invention is based on the finding that the lower-melting fibres combined according to the invention with the reinforcing material with the reinforcing fibres having the fibre temperature T_F are sufficiently flexible or malleable or soft that they can penetrate into the interstices of the reinforcing material or between the reinforcing fibres without problems at least with fibre sections. This results in a sort of entanglement of the reinforcing material or the reinforcing fibres with the lower-melting fibres. Furthermore, the invention is based on the finding that the laminate produced in the manner described previously is sufficiently stable and consistent in shape or is already sufficiently consolidated, so that it can be delivered directly to the manufacture of the composite moulded part or of the fibre composite moulded part without special consolidation measures. In this case it is within the scope of the invention that the laminate that can already be used as a semi-finished product is delivered for further processing to the composite moulded part or fibre composite moulded part without consolidation, in particular without thermal consolidation or without calendering and/or without needling and/or without stitching and/or without adhesion and/or without chemical consolidation. In this case "without consolidation" means in particular that the laminate or the semi-finished product can in principle be easily compacted or can be easily compacted by compacting rollers, but is not subjected to any special consolidation method, in particular no thermal consolidation or needling or stitching or adhesion. In this respect, the invention is based on the finding that a special consolidation is not necessary if lower-melting fibres at the fibre temperature T_F according to the invention are combined with the reinforcing material or with the reinforcing fibres to form the laminate or to form the semi-finished product.

[0011] In the method according to the invention the higher-melting reinforcing material or the higher-melting reinforcing fibres on the one hand and the lower-melting fibres on the other hand are made of the same plastic. Thus for example, higher-melting polypropylene fibres can be used as reinforcing fibres and lower-melting polypropylene fibres can be used as lower-melting fibres for producing the semi-finished product according to the invention. Thus within the scope of the method according to the invention for example, higher-melting polypropylene fibres can be used as reinforcing fibres and lower-melting polypropylene fibres can be used as lower-melting fibres.

[0012] Expediently the lower-melting fibres or at least a layer of lower-melting fibres are used in the form of a nonwoven fabric or in the form of a random nonwoven. It is within the scope of the invention that the lower-melting fibres are produced or spun as continuous filaments. As is explained in greater detail below, according to a particularly recommended embodiment of the invention the lower-melting fibres are spun as melt-blown fibres and particularly preferably as biax melt-blown fibres. The lower-melting fibres then preferably have a fibre diameter from 1 to 10 µm. In principle, the lower-melting fibres can also be produced as a spunbond nonwoven made of continuous filaments by a spunbond method. This method is also explained in greater detail below. According to another embodiment, the lower-melting fibres can also be produced in the context of a hot-melt method with the aid of a hot-melt blow head.

[0013] A recommended embodiment of the invention is characterized in that the layer of higher-melting reinforcing material — in particular the layer of higher-melting reinforcing fibres — is arranged between at least two layers and in particular between two layers of lower-melting fibres of thermoplastic material to form the laminate. Thus according to one embodiment of the invention, a three-layer laminate is provided. In principle, in the laminate produced within the scope of the invention further layers of reinforcing material/reinforcing fibres and/or of lower-melting fibres are possible.

[0014] The invention also relates to a method for producing a semi-finished product for the manufacture of a composite moulded part, in particular a fibre composite moulded part, wherein a higher-melting reinforcing material, in particular higher-melting reinforcing fibres, are combined with lower-melting fibres of thermoplastic material to form a laminate, wherein the lower-melting fibres are spun and after spinning are combined with the higher-melting reinforcing material, in particular with the higher-melting reinforcing fibres to form the laminate forming the semi-finished product, and wherein the higher-melting reinforcing material or the higher-melting reinforcing fibres and the lower-melting fibres are made of the same plastic. Expediently, after spinning the lower-melting fibres having a fibre thickness of <10 den, preferably <3 den and particularly preferably <1.5 den are combined with the higher-melting reinforcing material, in particular with the higher-melting reinforcing fibres, to form the laminate forming the semi-finished product.

[0015] The higher-melting reinforcing material or the higher-melting reinforcing fibres and also the lower-melting fibres can consist of the same polyolefin or of the same polyester or of the same polyamide. Thus both the higher-melting reinforcing fibres and also the lower-melting fibres consist of polypropylene or of polyethylene or of polyethylene terephthalate (PET) or of polybutylene terephthalate (PBT).

[0016] In the use of the same plastics according to the invention, the higher melting point of higher-melting reinforcing fibres can be achieved whereby the higher-melting reinforcing fibres have a higher crystallinity than the lower-melting fibres. The higher-melting reinforcing fibres can be stretched more strongly than the lower-melting fibres. However, the lower melting point of the lower-melting fibres can also be achieved by additions — for example by the addition of a copolymer having a lower melting point.

[0017] The melting point of the higher-melting reinforcing material or of the higher-melting reinforcing fibres is preferably at least 1°C, preferably at least 5°C higher than the melting point of the lower-melting fibres. According to one embodiment, the difference between the melting points is at least 10°C or at least 20°C.

[0018] The use according to the invention of the same plastic in the higher-melting reinforcing material, on the one hand, and in the lower-melting fibres, on the other hand, is characterized in an advantageous manner by problem-free recycling. In the recycling of the composite moulded parts or fibre composite moulded parts produced from the semi-finished product according to the invention a costly separation of the individual components is not necessary. This is very advantageous particularly for composite moulded parts in the automotive industry, since a high recycling rate is required here. Furthermore the spun lower-melting fibres can be combined in a simple and particularly effective manner with the higher-melting reinforcing material or with the higher-melting reinforcing fibres, so that relatively stable laminates are obtained for which very energy-intensive consolidation measures are not necessary in principle. It is within the scope of the invention that the semi-finished product is delivered to further processing to form the composite moulded part, in particular to form the fibre composite moulded part, without consolidation, in particular without calendering and/or without needling and/or without stitching and/or without thermal bonding with hot air and/or without adhesion and/or without chemical consolidation.

[0019] Nevertheless it is, however, also within the scope of the invention that in this embodiment the laminate consisting of the at least one layer of higher-melting reinforcing material — in particular of higher-melting reinforcing fibres — and the at least one layer of lower-melting fibres is consolidated before the further processing to form the composite moulded part or to form the fibre composite moulded part. In this case consolidation of the laminate means in particular the bonding and/or the entanglement of the higher-melting and lower-melting components. The laminate is preferably consolidated by at least one type of consolidation from the group "mechanical needling, water jet consolidation, calendering, thermobonding with hot air, adhesion, chemical bonding." Adhesion here means in particular adhesion by means of hot-melt, in particular from the same group of substances as the reinforcing material and the lower-melting fibres. As a result of the additional consolidation, the laminate is particularly easy to handle and is characterized by good draping properties, so that the laminate can also be used without problems as material on a roll.

[0020] An embodiment that is particularly important within the scope of the invention is characterized in that the at least one layer of lower-melting fibres of thermoplastic material is a nonwoven fabric. It is within the scope of the invention that the nonwoven fabric is a random nonwoven. In the laminate according to the invention, all layers are expediently made of lower-melting fibres of thermoplastic material nonwoven fabrics. According to a particularly recommended embodiment of the invention, a nonwoven fabric made of lower-melting fibres is a spunbond nonwoven made of continuous filaments.

[0021] It is within the scope of the invention that such a spunbond nonwoven is produced from continuous filaments by means of a spunbond method. In this case, continuous filaments of thermoplastic material are spun from a spinneret and are then cooled in a cooling chamber. These cooled continuous filaments are then expediently introduced into a stretching unit and finally are preferably deposited on a conveyor belt or a depositing foraminous belt. It is recommended that the continuous filaments of the spunbond nonwoven have a fibre diameter of 10 to 35 μm, and preferably the fibre diameter of the continuous filaments is greater than 10 μm or significantly greater than 10 μm. The melt flow index (MFI) of the polypropylene used to produce a spunbond nonwoven is expediently 10 to 100 g/10 min. Within the scope of the invention, the melt flow index (MFI) is measured according to EN ISO 1133 at a test temperature of 230°C and at a nominal mass of 2.16 kg. According to a preferred embodiment of the invention, a layer made of higher-melting reinforcing material — in particular of higher-melting reinforcing fibres — is arranged between two spunbond nonwovens made of continuous filaments of thermoplastic material.

[0022] A particularly preferred embodiment in the context of the method according to the invention is characterized in that a melt-blown nonwoven is used as nonwoven fabric and preferably a biax melt-blown nonwoven is used. Melt-blown nonwovens and particularly biax melt-blown nonwovens have proved particularly successful within the scope of the invention. Melt-blown nonwovens are produced in melt-blown machines that have a nozzle head or melt-blown blow head that is equipped with a plurality of nozzle orifices arranged in at least one row. From these nozzle orifices the plastic melt or the molten plastic filaments is/are extruded into a very fast blown air stream. As a result, the melt is converted into fine fibres, consolidated and the fibres are then deposited on a depositing device, in particular on a depositing foraminous belt — to form a fine-fibre melt-blown nonwoven. In the conventional melt-blown method, an extensive blown air stream or extensive blown air streams is/are applied to the curtain of extruded plastic filaments from the side or from opposite sides. In contrast to this, in the biax melt-blown method a separate blown air stream or a blown air stream surrounding the filament in the manner of a sheath is applied to each individual nozzle orifice or each individual extruded plastic filament. Biax melt-blown nonwovens produced by the biax melt-blown method have proved quite particularly successful within the scope of the invention. The melt-blown nonwovens or biax melt-blown nonwovens used in the method according to the invention comprise fibres having a fibre diameter of expediently 1 to 10 µm. A polypropylene with a melt flow index (MFI) of 75 to 2,500 g/10 min is used for example to produce the melt-blown nonwovens or biax melt-blown nonwovens. A melt flow index of 100 to 150 g/10 min has proved quite particularly successful. According to a particularly recommended embodiment of the method according to the invention, a layer made of higher-melting reinforcing material or of higher-melting reinforcing fibres is used which layer is arranged between or directly between two melt-blown nonwovens and preferably between two biax melt-blown nonwovens. In principle, the lower-melting fibres can also be produced within the framework of a hot-melt method with the aid of a hot-melt blow head.

[0023] According to a proven embodiment of the method according to the invention, lower-melting fibres of at least one polyolefin, preferably of polypropylene and/or polyethylene, are used. However, in principle the lower-melting fibres can also consist of other thermoplastics, in particular also of a polyester, for example of polyethylene terephthalate (PET) or of polyamide (PA).

[0024] The higher-melting reinforcing fibres can be used as short fibres and/or long fibres. It is within the scope of the invention that the layer of higher-melting reinforcing fibres is a laid fabric and/or a woven fabric and/or a braided fabric and/or a knitted fabric. Laid fabrics and woven fabrics have proved particularly successful. According to another preferred embodiment of the invention, the layer of higher-melting reinforcing fibres is a nonwoven fabric of higher-melting reinforcing fibres, preferably of higher-melting plastic fibres. Moreover it has proved successful that the reinforcing fibres are mixed with an impregnating agent or with an adhesion promoter in order to achieve a better bonding or adhesion with the molten thermoplastic material.

[0025] According to one embodiment, the at least one layer of reinforcing fibres as material on a roll is combined with the at least one layer of lower-melting fibres or the reinforcing fibres are for example combined in an air-laid method with the at least one layer of lower-melting fibres. The at least two layers can also be combined with one another continuously as material on a roll or applied discontinuously to one another as two-dimensional sheet materials. It is within the scope of the invention that the laminate produced according to the invention can be rolled up into a roll and thus can be further used as material on a roll. This is made possible by the flexible characteristics and by the good draping properties of the laminate produced according to the invention.

[0026] The manufacture of a composite moulded part, in particular a fibre composite moulded part, according to the invention is described hereinafter. In the composite moulded part or fibre composite moulded part, higher-melting reinforcing material or higher-melting reinforcing fibres is embedded in a matrix of thermoplastic material. For producing the composite moulded part or the fibre composite moulded part heat and/or pressure is applied to the laminate or the semi-finished product produced according to the invention, so that the lower-melting fibres of thermoplastic material melt and the non-molten reinforcing material or the non-molten reinforcing fibres are impregnated with the thermoplastic melt or are embedded in the matrix of thermoplastic material. The application of heat and/or pressure to the laminate or to the semi-finished product can take place “inline” or “offline.” It is within the scope of the invention that when heat and/or pressure are applied, the heating temperature is selected or adjusted so that only the lower-melting fibres melt or that substantially only the lower-melting fibres melt. It will be understood that, after the application of heat and/or pressure or after the moulding of the composite moulded part/fibre composite moulded part, a cooling of the matrix of thermoplastic material with the embedded reinforcing material or with the embedded reinforcing fibres takes place. With the method according to the invention, a composite moulded part or fibre composite moulded part is preferably produced as a lightweight construction.

[0027] For the application of warmth or heat and/or pressure the laminate or the semi-finished product produced according to the invention is expediently introduced into a pressing tool and is preferably deformed there under the action of heat and the action of pressure. The impregnation of the reinforcing material or the reinforcing fibres with the thermoplastic melt and the embedding of the reinforcing material or of the reinforcing fibres in the matrix of thermoplastic material should take place within the scope of the invention as completely as possible and with minimization of air inclusions.

[0028] A quite particularly preferred embodiment of the method according to the invention is characterized in that the laminate/semi-finished product produced according to the invention is converted into a composite moulded part or fibre composite moulded part by application of heat and/or pressure directly in the course of a thermoforming process and/or an injection-moulding process. Thus, in contrast to the initially described method known from practice, the laminate/semi-finished product is then processed to form the end product directly and without an intermediate melting and hardening process. Thus there is no need for the manufacture of an additional semi-finished product from the reinforcing material or from the reinforcing fibres and a thermoplastic matrix and therefore by comparison with the known method, a processing step can be omitted. Thermoforming process means in particular a deep-drawing process. In the preferred embodiment described previously the laminate/semi-finished product produced according to the invention can therefore be directly deep-drawn. As a result of the good handling properties and good draping properties of the laminate/semi-finished product, three-dimensional or multi-dimensional moulded parts can easily be produced according to the invention.

[0029] According to another embodiment of the method according to the invention, heat and/or pressure is applied to the laminate/semi-finished product in a first step and a further or second semi-finished product is formed with a matrix of thermoplastic material and reinforcing material embedded therein or reinforcing fibres embedded therein. This further or second semi-finished product of thermoplastic matrix and embedded reinforcing material or embedded reinforcing fibres is then converted, only subsequently or in a second step, into a composite moulded part or a fibre composite moulded part by application of heat and/or pressure in the course of a thermoforming process and/or an injection-moulding process. Thus here, as in the method known from practice, firstly in an additional step a further semi-finished product is produced that is then processed subsequently to form the end product, for example by deep-drawing to form a three-dimensional or multi-dimensional moulded part. Expediently the further or second semi-finished product is produced from the thermoplastic matrix and the embedded reinforcing material in the shape of plates.

[0030] In order to produce a composite moulded part, in particular a fibre composite moulded part, a semi-finished product with reinforcing material or reinforcing fibres embedded in a matrix of thermoplastic material can be used, wherein at least one layer of higher-melting reinforcing material — in particular of higher-melting reinforcing fibres — is combined with at least one layer of lower-melting fibres of thermoplastic material to form a laminate. The laminate forms the semi-finished product from which the composite moulded part or fibre composite moulded part can be produced. A distinction is made between the first semi-finished product (laminate) described here and the optional further or second semi-finished product (semi-finished product made of thermoplastic matrix with embedded reinforcing material) described above. The invention is based on the finding that the semi-finished product in the form of the laminate is relatively easy to handle and particularly as a result of its good draping properties it can be wound onto rolls and can be used as material on a roll. In particular, a laminate with at least one melt-blown nonwoven as lower-melting component can frequently be handled without problems without additional consolidation as a result of the good adhesion and can be further processed to form the composite moulded part/fibre composite moulded part directly or for example can be wound onto a roll.

[0031] According to the method according to the invention described above, a composite moulded part, in particular a fibre composite moulded part can be produced, in which a higher-melting reinforcing material — in particular higher-melting reinforcing fibres — is/are embedded in a matrix of lower-melting thermoplastic material and wherein the matrix has been produced from lower-melting fibres of the thermoplastic material.

[0032] The invention is firstly based on the finding that the semi-finished products produced by the method according to the invention are characterized by a particularly effective or firm bonding of the layers forming them. These semi-finished products constitute surprisingly dimensionally stable assemblies that can be further processed or further handled without further consolidation or at least without energy-intensive consolidation measures. The laminates or semi-finished products produced according to the invention are characterized by excellent handling and in particular draping properties. The semi-finished products can expediently be further processed directly to form the composite moulded part or the fibre composite moulded part or can be wound directly on rollers. In this respect the invention is characterized by low complexity and low costs. The semi-finished products can be used without problems as flexible material on a roll and three-dimensional or multi-dimensional moulded parts can be produced in a simple manner. Furthermore the invention is based on the finding that when the measures according to the invention are implemented, an optimal impregnation or wetting of the reinforcing fibres with the melt of thermoplastic material is possible. Air inclusions in the thermoplastic matrix can be avoided or at least largely avoided. In the method according to the invention, the impregnation or wetting and the formation of the moulded parts can take place in a simple manner in a single pressing tool. The composite moulded parts or fibre composite moulded parts produced according to the invention are also characterized by exceptional mechanical properties. Furthermore it should be pointed out that the composite moulded parts or fibre composite moulded parts produced according to the invention can be recycled in a simple and inexpensive manner. In this respect, the method according to the invention is characterized by low costs and low complexity.

[0033] The invention is described in greater detail hereinafter with reference to drawings that show only one exemplary embodiment. In the drawings, in schematic representation:

Fig. 1 shows schematically the manufacture of a laminate forming a semi-finished product according to the invention,

Fig. 2 shows a device for carrying out the method according to the invention,

Fig. 3 is a section through a fibre composite moulded part produced according to the invention, and

Fig. 4 is a perspective view of a fibre composite moulded part produced according to the invention.

[0034] Figure 1 shows quite schematically the manufacture of a laminate 4 forming a semi-finished product according to the invention. The laminate 4 here consists of a layer of higher-melting reinforcing fibres in the form of a glass-fibre fabric 5 made of glass fibres 8. Lower-melting fibres 10 are preferably and in the exemplary embodiment produced by means of a biax melt-blown method. These fibres may be lower-melting polypropylene fibres that are combined with the glass fibres 8 or with the glass-fibre fabric 5. Expediently and in the exemplary embodiment a biax melt-blown nonwoven 6 is deposited on the glass-fibre fabric 5. According to the invention, the lower-melting fibres 10 or the polypropylene fibres have a fibre temperature T_F in the region of the heat-distortion temperature T_W of the polypropylene. It can be seen from Fig. 1 that as a result of their fibre temperature T_F, the lower-melting fibres 10 combined with the glass fibres 8 or with the glass-fibre fabric 5 are so soft or flexible and malleable that they penetrate with fibre sections 11 into interstices 12 formed between the glass fibres 8 of the glass-fibre fabric 5.

[0035] In this way an effective entanglement or bonding between the higher-melting glass fibres 8 and the lower-melting fibres 10 is produced. The laminate 4 that is formed can in principle be supplied without special consolidation for further processing to form the composite moulded part or the fibre composite moulded part 7.

[0036] Figure 2 shows very schematically a pressing tool 1 with two platens 2, 3. In the exemplary embodiment a three-layer laminate 4 is between the platens 2, 3. This laminate 4 has a central layer of higher-melting reinforcing fibres in the form of a glass-fibre fabric 5. This glass-fibre fabric 5 is arranged between two biax melt-blown nonwovens 6 made of polypropylene fibres. When the platens 2, 3 are pressed together, heat and pressure is applied to the laminate so that the lower-melting polypropylene fibres melt. The heating temperature is selected so that only the polypropylene fibres melt and the glass fibres 8 of the glass-fibre fabric 5 on the other hand are not melted. On the contrary, the glass fibres 8 are impregnated or wetted by the thermoplastic polypropylene melt and in this way the glass fibres 8 are embedded in a matrix of thermoplastic material (PP). According to a preferred embodiment of the invention, a fibre composite moulded part 7 can be produced directly in the manner described above. A simple pressing tool 1 is shown only very schematically in Fig. 2. In principle within the scope of the invention, three-dimensional or multi-dimensional moulded parts having complicated structures can be produced in a simple manner with special pressing tools. The flexible handling and good draping properties of the laminate 4 contribute to this.

[0037] Figure 3 shows a section through a fibre composite moulded part 7 produced by the method according to the invention after cooling. It can be seen that the glass fibres 8 of the glass-fibre fabric 5 are completely embedded in the thermoplastic polypropylene matrix. Disruptive air inclusions are not observed and they can be avoided in a simple manner when the measures according to the invention are implemented. The fibre composite moulded parts 7 produced in this way according to the invention have optimal mechanical properties. Figure 4 moreover depicts a further fibre composite moulded part 7 having a multi-dimensional structure produced according to the invention. Within the scope of the method according to the invention, multi-dimensional structures can be implemented simply and without problems.

Patentkrav

1. Fremgangsmåde til tilvejebringelse af et halvfabrikat til fremstilling af en formstøbt kompositdel, især en formstøbt fiberkompositdel (7), hvor et højeresmeltende forstærkningsmateriale, især højeresmeltende forstærkningsfibre kombineres med laveresmeltende fibre (10) af termoplastisk kunststof til et laminat (4), hvor de laveresmeltende fibre (10) spindes og efter spindingen kombineres med det højeresmeltende forstærkningsmateriale, især med de højeresmeltende forstærkningsfibre, til det laminat (4), der danner halvfabrikatet,
kendetegnet ved, at
det højeresmeltende forstærkningsmateriale hhv. de højeresmeltende forstærkningsfibre og de laveresmeltende fibre (10) består af det samme kunststof.

2. Fremgangsmåde ifølge krav 1, hvor laminatet (4) befæstes ved hjælp af mindst en befæstningstype fra gruppen "mekanisk nåling, vandstrålebefæstning, kalandrering, termobonding med varm luft, limning, kemisk sammenføjning".

3. Fremgangsmåde ifølge et af kravene 1 eller 2, hvor laminatet (4) eller det befæstede laminat (4) i et første trin påvirkes med varme og/eller tryk, og et yderligere halvfabrikat med en matrix af termoplastisk kunststof og deri indlejret forstærkningsmateriale eller deri indlejrede forstærkningsfibre derved dannes og i et andet trin viderebearbejdes til den formstøbte kompositdel hhv. den formstøbte fiberkompositdel (7).

4. Fremgangsmåde ifølge et af kravene 1 til 3, hvor de laveresmeltende fibre (10) efter spindingen med en fibertykkelse på < 1,11 tex, foretrukket < 0,33 tex og særligt foretrukket < 0,17 tex, kombineres med det højeresmeltende forstærkningsmateriale, især med de højeresmeltende forstærkningsfibre, til laminatet (4), der danner halvfabrikatet.

5. Fremgangsmåde ifølge et af kravene 1 til 4, hvor de laveresmeltende fibre (10) i form af et random-non-woven hhv. i form af et non-woven kombineres med forstærkningsmaterialet hhv. med forstærkningsfibrene.

6. Fremgangsmåde ifølge et af kravene 1 til 5, hvor de laveresmeltende fibre (10) tilvejebringes hhv. spindes som endeløse filamenter.

7. Fremgangsmåde ifølge et af kravene 1 til 6, hvor de laveresmeltende fibre (10) spindes som meltblown-fibre og særligt foretrukket som biax-meltblown-fibre.

8. Fremgangsmåde ifølge et af kravene 1 til 7, hvor smeltepunktet for det højeresmeltende forstærkningsmateriale hhv. for de højeresmeltende forstærkningsfibre ligger mindst 1 ° C, fortrinsvis mindst 5° C højere end smeltepunktet for de laveresmeltende fibre (10).

9. Fremgangsmåde ifølge et af kravene 1 til 8, hvor der anvendes højeresmeltende forstærkningsfibre af i det mindste en fibertype fra gruppen "glasfibre (8), aramidfibre, kulstoffibre, metalfibre, fibre af termoplastisk kunststof".

10. Fremgangsmåde ifølge et af kravene 1 til 9, hvor et lag af det højeresmeltende forstærkningsmateriale - især af højeresmeltende forstærkningsfibre - anbringes mellem to lag af laveresmeltende fibre (10) til laminatet (4).

11. Fremgangsmåde til fremstilling af en formstøbt kompositdel (7), især en formstøbt fiberkompositdel, hvor et halvfabrikat - fremstillet ifølge et af kravene 1 til 10 - påvirkes med varme og/eller tryk, således at de laveresmeltende fibre (10) smelter og forstærkningsmaterialet - især forstærkningsfibrene - imprægneres af smeltemassen hhv. indlejres i matrixen af termoplastisk kunststof.

12. Fremgangsmåde ifølge krav 11, hvor halvfabrikatet omdannes til den formstøbte kompositdel hhv. den formstøbte fiberkompositdel (7) ved påvirkning med varme og/eller tryk i løbet af en termoformningsproces og/eller en sprøjtestøbningsproces.

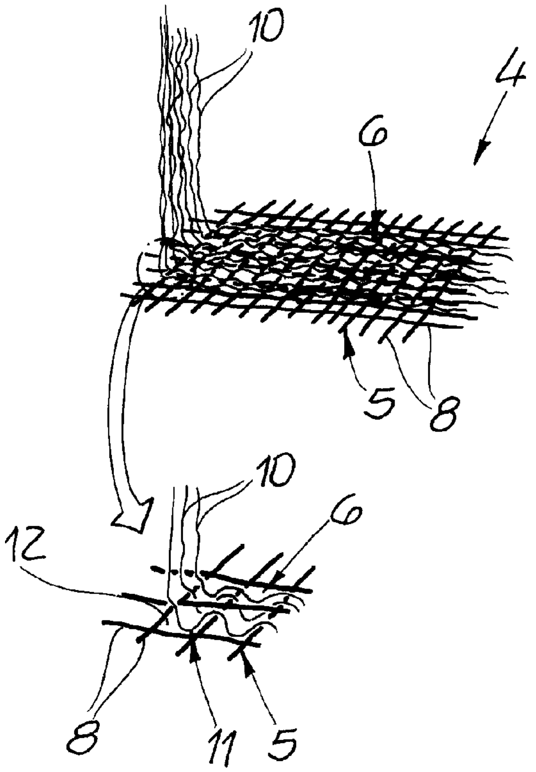
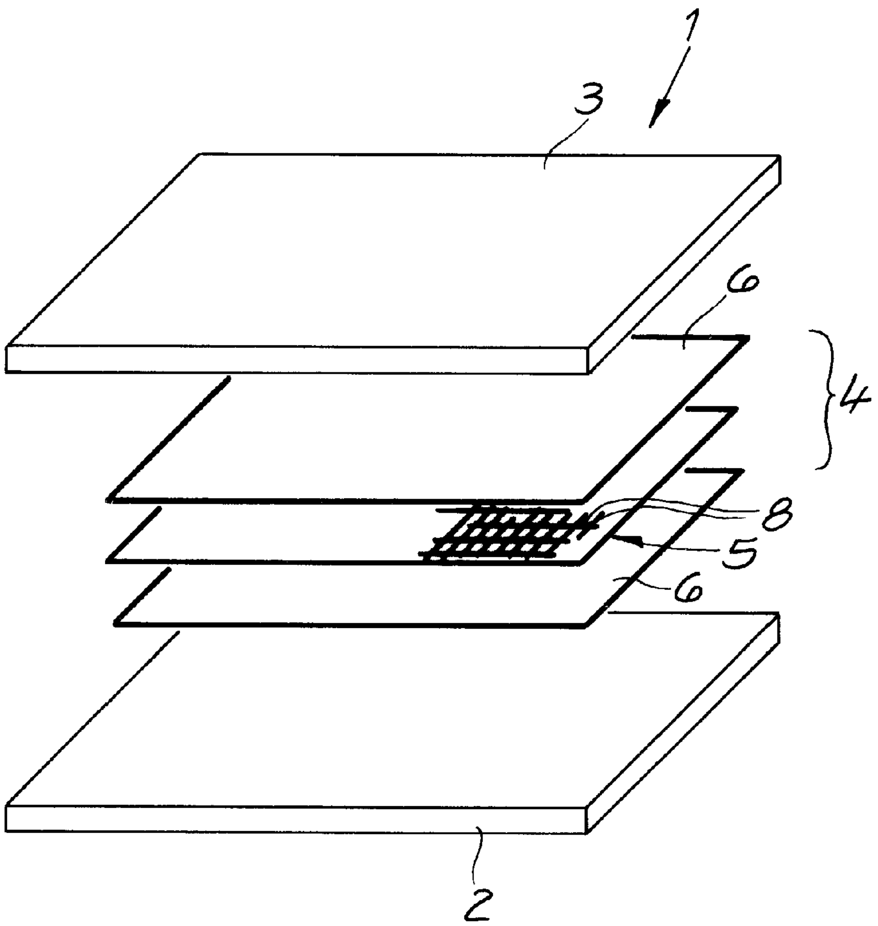


Fig.1

Fig.2



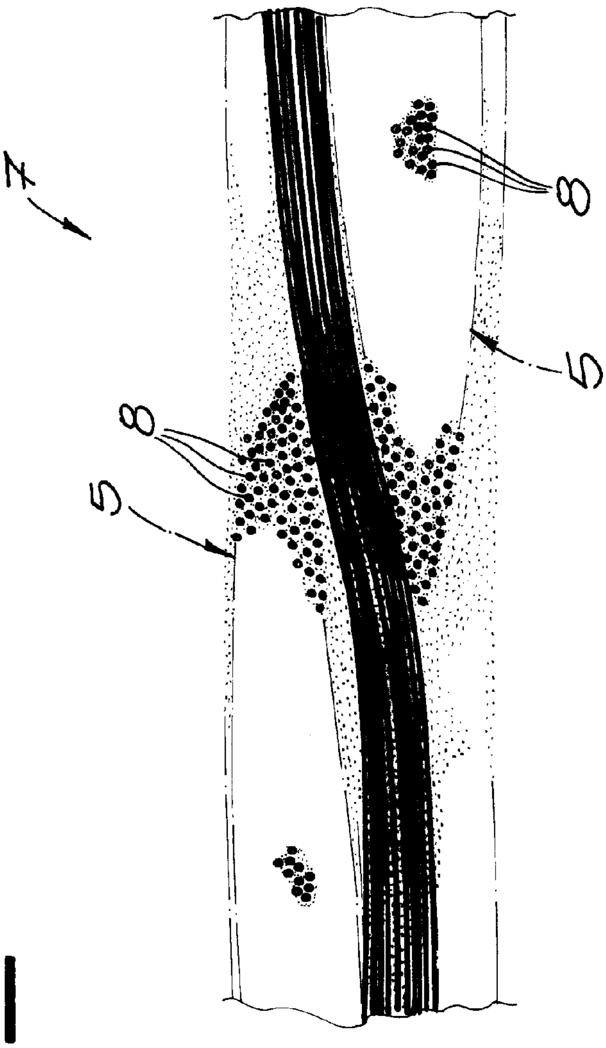


Fig.3

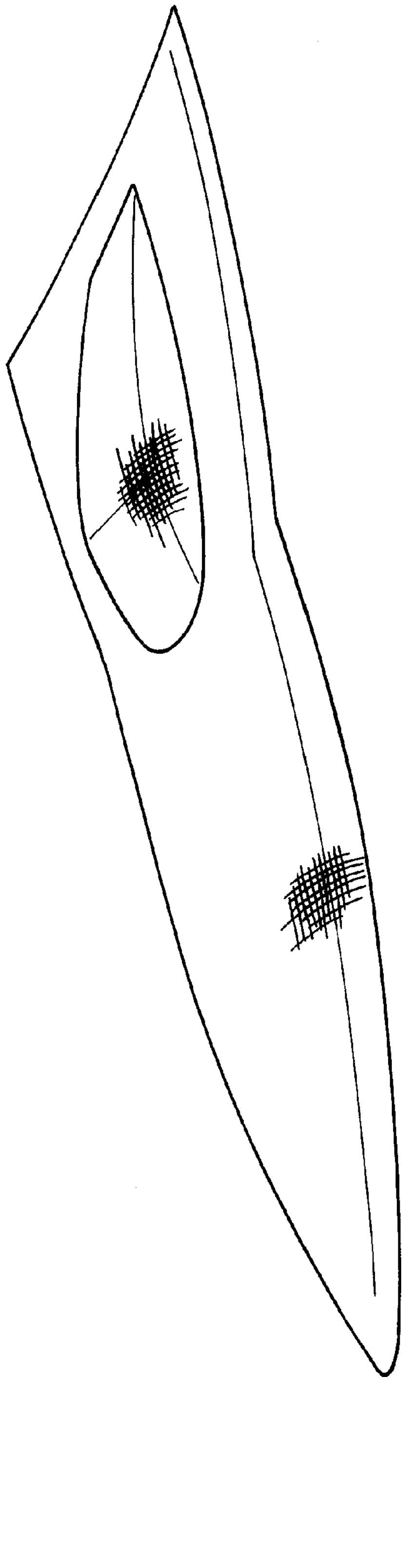


Fig.4