

This invention relates to a method, or more precisely two variants of a method, for producing three-dimensional reinforcing elements from fusible plastics powder or from powder mixtures containing fusible plastics powder, in which the powder or powder mixture is applied to an auxiliary substrate, sintered by means of heat and pressure and transferred to a substrate which is to be reinforced, particularly to parts of a shoe upper, and is attached to the substrate, and to an apparatus for carrying out this method.

The use of thermoplastic reinforcing material in the footwear, clothing and handbag and luggage industry has already been known for some time. In most cases, it is produced in web form and is used in the form of blanks produced therefrom, e.g. in the footwear industry, for reinforcing the heel region, and possibly also the toe region. To this end, the blanks, also referred to here as reinforcing elements and reinforcing parts, are cut out of the web material by means of cutting knives and are further thinned (skived) at least on the side not situated in the "lasting margin". The blanks are deformable under the influence of heat and after deformation and cooling should guarantee both good flexibility and good shape retention.

The reinforcing part is activated and fixed to the leather upper as a function of the properties of the thermoplastic either by the influence of heat or by solvent treatment. When used for reinforcing toes, the reinforcing parts are often further provided on one or both sides with a coating of hot melt adhesive and can then be fused on to the part of the upper which is to be reinforced by a hot pressing die.

It is known that the thermoplastic reinforcing material in web

web form can be produced in various ways, e.g. by coating or impregnating textile structures, such as woven fabrics, knitted fabrics, non-woven fabrics or tangles, with dispersions, solutions or melts of thermoplastics. According to US-A 3 427 733, the webs can also be produced by the extrusion of thermoplastics or by the extrusion coating of textile webs.

DE 26 21 195 A1 further discloses reinforcing materials and parts produced by melting powdered mixtures of plastic, filler and possibly further additives on to textile substrates. Moulded parts can also be produced from the powdered mixtures without a substrate material.

The essential characterising feature of this invention is that the particle size distribution of the fillers and the fusible powdered plastics is comparable. In this manner, the quantity of filler can be considerably increased to up to 100 % by volume in relation to the volume of the plastics powder. Reinforcing materials can of course only be produced in web form according to this method. The stiffeners ready for use must then be produced from these webs by cutting and skiving.

It is also already known from US-A 3 973 285 to apply the reinforcing material in the molten state to a shoe upper part which is clamped at the margin and held. This eliminates the "web material production", "hot melt adhesive coating", "cutting", "skiving" and "fusing" stages of the method.

Although the aforementioned method is used in practice for producing inexpensive shoes, it has a number of deficiencies as a result of the low viscosity of the reinforcing material at 190°C, e.g. inter alia, the appearance of cracks in the melt

during stoppage of the machine, thread formation, poor adhesion.

Very narrow limits are furthermore imposed on the person skilled in the art when selecting the polymer melts as a result of various extremely critical method parameters. Suitable substances to this end are not generally used in practice for economic reasons.

Finally, DE-A 2 159 226 also discloses a method in which the molten reinforcing material is first poured into a mould in the first station of a machine in order to form the desired stiffener. The mould is then brought into the second station in which the non-cooled, still tacky region of the stiffener is bonded under pressure to the shoe upper part which is to be reinforced. This method does not work in a satisfactory manner either and still has considerable disadvantages.

According to DE 33 47 237 A1, the disadvantages of the prior art are supposed to be overcome by a machine in which, instead of the molten plastic used hitherto, a fusible plastics powder can be used for producing reinforcing elements of a predetermined configuration. As in the method of DE 26 21 195 A1, the method is carried out in three stages on the machine, i.e. application of the powder in a specific configuration, heating until melting and cooling under pressure. In the screen printing process according to the prior art, the fusible powder is applied to a receiving belt (auxiliary substrate) in the form of the desired reinforcing element, then is melted in the heating station of the machine and finally in the pressing station is bonded to the blank for a shoe upper part which is to be reinforced and is cooled under pressure, the receiving

side of the blank which is to be reinforced of course facing downwards. This can be regarded as a disadvantage.

As a result of the problems observed after the application of the powder, long cycle times in the heating station as well as high melting points and positioning problems when transferring the reinforcing element from the receiving belt (auxiliary substrate) to the shoe upper part which is to be reinforced, the production of reinforcing elements on this machine is still problematical in many cases and is not solved in a satisfactory manner. The high melting points of the plastics powder (191 to 260°C) require, e.g. heating-up periods of up to approximately 25 seconds and more.

Methods for aligning the substrates which are to be reinforced when working on the aforementioned machines are described in DE 34 44 365 A1. However, the constructional expenditure for transferring the molten reinforcing material from the auxiliary substrate to the receiving side of the upper part which is to be reinforced is considerable and is in many cases not economically justifiable.

This invention therefore relates to a new method for producing a three-dimensional reinforcing element from a fusible plastics powder or from a powder mixture containing fusible plastics powder, which is applied to an auxiliary substrate by the stencil printing method and then the reinforcing element formed is transferred to the substrate which is to be reinforced, particularly to parts of a shoe upper, and to an apparatus for carrying out this method. The problems described at the outset can be substantially eliminated in a surprising manner by the new method.

The new method is characterised, on the one hand, in that the powder is applied with the aid of a template and the pressure and heat are applied by means of a pressing die, the reinforcing element is lifted away from the auxiliary substrate by the pressing die and is further heated on the pressing die and, by subsequently lowering the pressing die, the reinforcing element is transferred to the substrate, which has been placed below the pressing die, and is attached thereto.

According to a second variant of the method, the powder is applied with the aid of a template and the pressure and heat are applied by means of a pressing die, the reinforcing element is lifted away from the auxiliary substrate by the pressing die and is further heated on the pressing die, the reinforcing element is transferred to an auxiliary substrate and, after the auxiliary substrate has been detached from the reinforcing element, the reinforcing element is transferred to the substrate and attached thereto.

The new method, which is a double transfer method, is based on the knowledge that a method of this kind can be carried out successfully if

- a) the adhesion of the partly fused sintered reinforcing element to the surface of the pressing die when the hot pressing die is lifted away is greater than the adhesion of the sintered reinforcing element to the auxiliary substrate and the cohesive forces of the sintered powder particles are already greater than the adhesive forces to the auxiliary substrate and to the surface of the pressing die;
- b) the adhesion to the surface of the pressing die during the

residence time of the reinforcing element on the pressing die is greater than the mass of the reinforcing element, which must also be less than the cohesive forces in the melt, and

- c) when transferring the molten reinforcing element to the substrate or auxiliary substrate which is to be reinforced, the adhesion of the melt to the latter is greater than to the surface of the pressing die and the cohesive forces in the molten reinforcing element are greater than its adhesion to the surface of the pressing die.

The double transfer method can therefore be carried out in a particularly advantageous manner if the weight of the substrate which is to be reinforced (receiving substrate) and the reinforcing element is greater than the adhesion of the molten reinforcing part to the surface of the pressing die. In an embodiment of this kind, the receiving substrate does not even need to be supported on the underlayer.

The advantage of the new method consists above all in that both the method and the apparatus for carrying it out become more operationally reliable and substantially simpler as a result of the double transfer of the reinforcing element. In the double transfer method, the substrate (shoe part) which is to be reinforced is always situated on a stable underlayer so that the reinforcing element which is to be transferred is always pressed on from the top to the bottom and not from the bottom to the top. Positioning the substrate and fusing the reinforcing element on to the substrate therefore become straightforward.

According to the invention, in the second transfer stage, the molten reinforcing element can also first be transferred to an auxiliary substrate (e.g. paper), from which the element can be lifted away in a simple manner after cooling. Reinforcing elements produced in this manner can later be applied separately to receiving substrates with appropriate activation, e.g. fusing or gluing in with the aid of adhesives or solvents.

Particularly suitable auxiliary substrates for the first transfer stage are webs or plates of silicone rubber. The auxiliary substrates below the template can also be concave, i.e. can have depressions, resulting in curved reinforcing elements. Auxiliary substrates of other designs can also be used, e.g. hollowed in a wedge-shaped manner. The method is not limited to flat auxiliary substrates.

Both webs and plates are suitable as auxiliary substrates in the second transfer stage for transferring the hot reinforcing material from the pressing die, e.g. auxiliary substrates of PVC or PUR transfer coating paper, aluminium or polyester (Mylar^R or polyethyleneterephthalate, e.g. Hostaphan^R).

The contact side of the pressing die is preferably provided with a coating of polytetrafluoroethylene (Teflon^R), although the subject matter of the invention is not limited to these embodiments.

According to another embodiment of the invention, the molten reinforcing element can also be fixedly attached to a textile substrate part in the second transfer stage, in such a manner that, after the reinforcing part has been transferred to the substrate or auxiliary substrate which is to be reinforced, the

textile part is pressed on to the reinforcing element and fixed in an additional stage of the method (operating cycle). The textile part can in this case also be the shoe lining.

According to a particularly simple embodiment of the invention, the template required for the application of the powder is produced by means of a cutting knife available in many variant forms at the reinforcing parts manufacturer's or in the shoe factories, in such a manner that the desired reinforcement shape is cut out of the template material, e.g. a glass fibre reinforced polypropylene plate, by means of an appropriate cutting knife.

E.g. a mixture of fusible plastics powder and powdered filler according to the specifications of DE 26 21 195 A1 can be used as a free-flowing plastics powder mixture, the powdered filler having a particle size distribution of 50 to 600 μm , particularly 100 to 400 μm , comparable with the particle size distribution of the plastics powder. According to the invention, however, the plastics powder can also be used without a filler or mixed with other polymer particles. The "other" polymer particles used in the last-mentioned embodiment are polymers which melt in a relatively high temperature range and thus take over the function of a filler in the undissolved state. Examples of suitable mixtures are mixtures of low density and high density polyethylene and mixtures consisting of an ethylene-vinyl acetate copolymer and a polyethylene. Polycaprolactone and ionomer resins can also be mentioned as suitable low-melting plastics at this point.

Wood flour, cork powder, chalk, talc, silica and other organic and inorganic substances can of course also be used as fillers,

in a quantity of up to 100 per cent by volume in relation to the volume of the plastics powder.

According to a further advantageous embodiment of the invention, the three-dimensional reinforcing element can also be of multi-layered construction. To this end, identical or different melt layers are pressed on one after another.

The double transfer method can be effected both in a stationary manner and continuously. In the last-mentioned embodiment, the method can be carried out on a production line, consisting, e.g. of an endless conveyor belt (auxiliary substrate) divided into at least two working stations, one working station being provided with a powder application apparatus and the other with a pressing apparatus.

According to one embodiment of the invention, the continuous production line can also consist, e.g. of two endless conveyor belts (auxiliary substrates), between which a heated roll moves, this roll taking the application of powder from one auxiliary substrate and transferring it to the second auxiliary substrate after melting.

The subject matter of the invention will now be described in more detail with reference to the accompanying diagrammatic drawings.

Figures 1 and 2 show an apparatus for carrying out the method according to the claims.

In Figure 2, the powder application apparatus for applying the plastics powder through the shaped cut-out of the template 2 to

the auxiliary substrate (conveyor belt) 3 is designated 1. The endless conveyor belt 3 is driven by the roller 4 and is deflected back into the first working station at the deflection roller 5. The template 2, which in the example is a 1.5 mm thick polypropylene plate reinforced with glass fibres and in which the desired shape of the reinforcing element can be cut by means of cutting knives, can be placed on the conveyor belt. It is fixedly attached to the powder application apparatus 1 and can be lifted away from the conveyor belt after the application of powder 6.

In the example, the powder application apparatus 1 is a doctor blade case of high-grade steel plate which is at least so broad that it traverses the entire width of the template cut-out while filling the cavity with plastics powder and moreover can be guided at both sides in guide rails. The guide rails, designated 10 in Figure 2, extend transversely to the direction of movement of the conveyor belt, the angle α formed by the rail and the direction of movement being 10 to 170°, particularly 85 to 95°.

The doctor blade case is guided at the sides and at the top in guide rails transversely to the direction of movement of the conveyor belt. The case filled with plastics powder is guided once over the cut-out of the template per pressing cycle, a pneumatic cylinder being used as a drive means. After the cavity formed by the conveyor belt and the template cut-out has been filled with plastics powder, the template is lifted away and the application of powder is advanced to the second working station. The return movement of the doctor blade case is then effected by reducing the pressure and there is a further application of powder to the conveyor belt.

In the embodiment shown, in Figure 2, the doctor blade case 1 guided in rails and the template 2 are lifted away from the belt at one side and are pivoted at a point situated slightly behind the roller 4.

If the application of powder 6 is situated in the second working station (Figure 1), it is preheated via the heat radiator 7, which can be any desired heat source, until at least the particles on the surface are bonded together (sintered). This prevents a violent air flow.

In the next "pressing cycle", the application of powder 6 moves into the third working station where it is compressed by the heated pressing die 8, fused with the polymer particles after sintering thereof and lifted away from the conveyor belt. The melting process is continued during the residence time on the pressing die 8, particularly in the upper dead centre, thereby resulting in the desired reduction in viscosity. The shoe part 9 which is to be reinforced is situated below the pressing die 8 and during a further pressing process takes the reinforcing element 6 from the pressing die. After the pressing die has been lifted away, the reinforced shoe part is either bonded to the lining in a new pressing cycle or is advanced for further processing after removal from the belt. It should also be mentioned at this point that the cut-out in the template generally has to be slightly smaller than the desired dimensions of the finished product as the pressing and flow of the plastics powder means that an increase in size is unavoidable.

The subject matter of the invention is of course not limited to the embodiment shown in the drawings. The method according to

the invention can also be carried out with an apparatus of a different design.



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CLAIMS

1. Method for producing a three-dimensional reinforcing element from a fusible plastics powder or from a powder mixture containing fusible plastics powder, in which the powder or powder mixture is applied to an auxiliary substrate, sintered by means of heat and pressure and transferred to a substrate which is to be reinforced, particularly to parts of a shoe upper, and is attached to the substrate, characterised in that the powder is applied with the aid of a template and the pressure and heat are applied by means of a pressing die, the reinforcing element is lifted away from the auxiliary substrate by the pressing die and is further heated on the pressing die and, by subsequently lowering the pressing die, the reinforcing element is transferred to the substrate, which has been placed below the pressing die, and is attached thereto.
2. Method for producing a three-dimensional reinforcing element from a fusible plastics powder or from a powder mixture containing fusible plastics powder, in which the powder or powder mixture is applied to an auxiliary substrate, sintered by means of heat and pressure and transferred to a substrate which is to be reinforced, particularly to parts of a shoe upper, and is attached to the substrate, characterised in that the powder is applied with the aid of a template and the pressure and heat are applied by means of a pressing die, the reinforcing element is lifted away from the auxiliary substrate by the pressing die and is further heated on the pressing die, the reinforcing element is transferred to an auxiliary



substrate and, after the auxiliary substrate has been detached from the reinforcing element, the reinforcing element is transferred to the substrate and attached thereto.

3. Method according to claims 1 and 2, characterised in that, after application to the auxiliary substrate, the application of powder is provided with a textile blank which has an open structure.
4. Method according to claims 1 to 3, characterised in that the three-dimensional reinforcing element is of multi-layered construction.
5. Method according to one of claims 1 to 4, characterised in that the template used is a template having a wedge-shaped cross section.
6. Method according to claims 1 to 5, characterised in that separating paper is used as the auxiliary substrate.
7. Method according to claims 1 to 5, characterised in that the auxiliary substrate used consists in its entirety or on its surface of aluminium, polyester or polyethylene-terephthalate.
8. Method according to claims 1 to 7, characterised in that the auxiliary substrate used for the application of powder consists in its entirety or on its surface of silicone rubber.
9. Apparatus for carrying out the method according to claim 1,



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- 2 or 3, comprising an application unit (1), an auxiliary substrate and means for applying pressure and heat, wherein the application unit is able to apply powder to the auxiliary substrate via a template (2), characterised in that the means for applying pressure and heat consists of a pressing device having a heatable pressing die (8).
10. Apparatus according to claim 9, characterised in that the auxiliary substrate is provided with a depression.
 11. Apparatus according to claims 9 and 10, characterised in that the pressing die is provided with a surface coating of polytetrafluoroethylene.
 12. Apparatus according to claim 11, characterised in that a heat source is arranged between the application unit and the pressing device.