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(54) Title: METHOD FOR PATTERNING A SURFACE

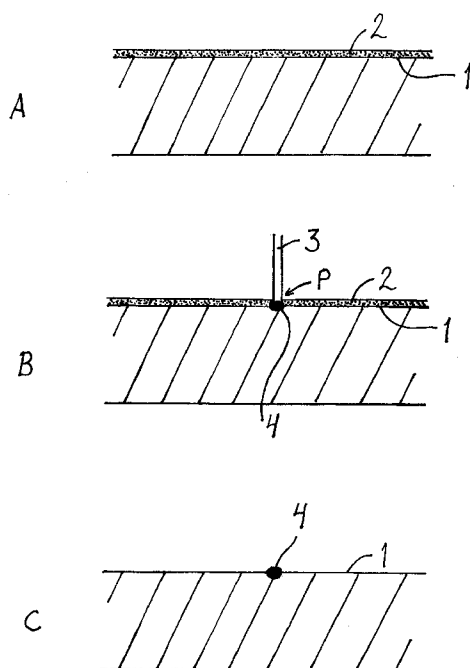


Fig. 1

(57) Abstract: A method for patterning a plastic surface (1), in which the surface is provided with an area different from the material of the surface by the following measures: - a coating (2) is formed onto a plastic surface (1) of thermoplastic polymer using thermoplastic polymer dissolved or dispersed in water, by applying the water solution or dispersion onto the plastic surface (1) and by evaporating the water, - an activating beam (3) is directed to the plastic surface (1), and the surface and the activating beam are moved in relation to each other so that at the point of action (P) of the beam, a component in the plastic surface or in the coating absorbs electromagnetic radiation of the beam (3), causing the heating and fusing and mixing of the thermoplastic polymers of the plastic surface (1) and the coating (2) at the interface of the coating and the plastic surface to each other so that a permanent bond (4) of the polymer of the plastic surface (1) and the polymer of the coating (2) is formed in the range of action of the beam, and - removing the coating (2) from the area left outside the range of action of the beam, by a treatment which leaves the coating (2) more firmly attached to the surface in the range of action of the beam, on the surface.



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METHOD FOR PATTERNING A SURFACE

The invention relates to a method for patterning a surface which is of the type according to the preamble of the appended claim 1. The invention also
5 relates to a patterned surface produced by the method.

For the patterning of surfaces of various materials, a plurality of methods are used depending on the material, the desired coating structure and precision, as well as the specific application. The known methods are generally based
10 on a pattern produced by impression; activation by light, in which case the pattern is formed by a special mask; chemical etching; or simple mechanical methods.

For the surface patterning of plastic and other materials, it is known to use a
15 laser to produce the desired pattern. The pattern can be formed, for example, by removing material by means of the laser, as is known from DE 4000372, US 3,786,224, DE 10254782, and DE 10254783. It is also known to use the laser for the curing of thermosetting plastic, as in JP 6113906. JP 2006128098 describes a method applying an organic solvent and agents dissolved in it that react by the effect of a laser beam, in the coating material of
20 a piece to be patterned.

In GB 1524717, an epoxy coating is engraved by a laser beam for patterning the surface of a printing cylinder.
25

GB 2098807 discloses the forming of conductive patterns on a glass substrate by scanning, with a laser beam, a coating that contains gold powder, glass powder and an organic adhesive, so that the coating on the areas passed by the beam fuses onto the substrate, after which the rest of the
30 coating is removed by a suitable solvent in ultrasonic washing. In EP 476320, a coating for ceramics or enamelled steel consists of a metal-containing paste, which is fired onto the substrate by a laser beam scanning across the coating.

35 The above-mentioned publications are based on the sintering or fusing of a pattern formed of a coating onto the substrate by a relatively effective thermal

treatment with a laser beam, which is not suitable for all coating materials and substrates.

Publication US 4,853,252 discloses a coating for a plastic substrate, comprising grainy carrier substance and possibly polymeric bonding agent which is a hot-melt adhesive. The surface of the carrier substance is provided with metal of the oxidation degree 0, which will later act as nuclei for metallization. In this approach, the grainy carrier material is used as a substrate for an actual fine-grained substance that provides functionality. The purpose of the laser treatment is to make the substrate of thermoplastic polymer fuse at its surface, to anchor the carrier material in the range of action of the laser beam as shown in Fig. 3 of the document. If bonding agent is used, the laser treatment makes it possible to glue the adhesive onto the plastic substrate in the areas scanned by the laser beam, and in a further treatment with heat after the washing, it is possible to make the bonding agent fuse into the plastic surface and to fix the grainy carrier more strongly (Figs. 6 and 7). The actual functional pattern (metallization) can thus be produced on the prefabricated pattern by successive chemical and galvanic treatments. Organic solvents are used for applying the coating.

Up to date, there has been no method for making, individually or in small series, durable coating patterns on the surfaces of various plastic objects quickly and with precision by a firm attachment of the pattern to the plastic substrate by a single scanning of a beam. The plastic object, whose surface is to be patterned, may be a film with a uniform thickness or a more complex three-dimensional structure, wherein the surface may be curved and comprise minor variations.

It is an aim of the invention to eliminate the above-mentioned drawbacks and to present a method, by which a variety of plastic surfaces consisting of different polymer materials can be patterned quickly and with high precision, to achieve durable patterns even in a very small scale. To achieve this aim, the method according to the invention is primarily characterized in what will be presented in the characterizing part of the appended claim 1.

According to the invention, the plastic surface to be patterned is first provided with a coating layer containing material intended for the desired surface pat-

tern and comprising at least one solid polymer. The polymer in the coating is thermoplastic polymer which is introduced by means of water acting as a carrier liquid for the coating substance, dispersed or preferably dissolved therein. The water is evaporated, and the polymer then acts as a "matrix polymer" or bonding agent of the coating which may, in turn, contain particles mixed therein to provide the functionality of the final pattern and/or to act as absorbents of radiation. The particles are thus included in the same coating substance, dispersed in the carrier liquid, as the polymer. The coated plastic surface consists of thermoplastic polymer which is insoluble in the carrier liquid (water) of the coating substance; in other words, it consists of thermoplastic polymer different from the polymer of the coating, for example of synthetic polymer which is generally used in injection moulding or extrusion techniques.

The coating is exposed to an activating beam of electromagnetic radiation, preferably a laser beam, which is moved along a path according to a predetermined pattern to cause, in its range of action, local mixing of the polymer of the coating and the material of the underlying plastic surface. From the area left outside the range of the beam, the coating material can be removed, so that the pattern "drawn" by the laser beam remains on the plastic surface, because the coating material – thanks to the polymer contained in it – remains firmly attached to the plastic surface in the areas scanned by the beam. The method is very fast, and it can be used to form patterns even in a very miniature size. The material of the coating may contain, for example, electrically conductive elements, wherein the method can be used to make electrically conductive patterns or circuits which can be placed in even very small areas and/or locations where it has been previously impossible to place them. It is also possible to form patterns of other types which have a certain functionality compared to the bare plastic surface, for example colour, catalytic properties, absorbency of substances, etc., depending on the use of the pattern.

A requirement is that the coating or the plastic surface comprises a component which is capable of absorbing electromagnetic radiation of the activating beam at the point of action of the beam, is heated, and causes the local fusing of the thermoplastic polymer of the coating and the thermoplastic polymer of the plastic surface and their permanent adhesion to each other at the

interface of the polymer phases after the polymers have been solidified. The component may be a thermoplastic polymer in the plastic surface or in the coating, or preferably a component separate from the polymer, wherein the polymer of the coating or the plastic surface can be selected more freely.

5 Preferably, this component consists of particles mixed in the coating, which may also have functionality for the properties of the pattern. Thus, it is also possible that the polymer of the coating is absorbent to radiation.

10 The plastic surface may also contain absorbent particles mixed in a corresponding thermoplastic polymer. Apart from the absorbing component, the components of the combination plastic-coating are thus transparent to radiation; that is, they do not interfere with the focusing of the beam to the particular component that absorbs radiation and is heated. This is particularly advantageous if the radiation is directed to the coating through the plastic

15 surface, that is, from the side of the plastic piece, where the path travelled by the beam is considerably longer than through the coating. The polymer of the piece forming the plastic surface is thus transparent to the radiation, and it must not contain any other radiation absorbing components either. If all the components of the coating on the plastic surface, including the particles

20 mixed therein, are transparent to the radiation, the plastic surface (either its thermoplastic polymer itself and/or another component, such as particles mixed therein) is absorbent to radiation.

25 The invention also provides the following advantages. The production of single pieces or small batches by printing techniques or transfer metallization is difficult and/or economically unprofitable; the treatment of three-dimensional surfaces is problematic as well. In the method, it is possible to make the pattern by programming a laser scanner to make the desired pattern. By modern methods, the pattern can also be made at a very high scanning speed.

30 Providing the plastic with additives all over and the activation of the surface with the laser require a lot of additives. In this method, the unused additives, and also water if necessary, can be recycled. No additives are needed for removing the coating that was not welded to the substrate by an ultrasonic

35 washing machine.

In the following, the invention will be described in more detail with reference to the appended drawings, in which

5 Fig. 1 shows schematically the steps of the method, and

Fig. 2 shows one possible application of the invention for forming patterns in locations which are difficult to access.

10 Figure 1 shows the steps of the method in a simplified manner in a cross-section perpendicular to the plane of the surface. In the first step A, the plastic surface is coated with a coating layer 2 which forms a substantially uniform solid layer on the area to be patterned. The layer contains at least thermoplastic polymer applied onto the plastic surface by using water as a liquid carrier. The thermoplastic polymer has been dissolved or dispersed in this
15 carrier material, and the solid coating layer has been produced after the evaporation of the carrier substance. The adhesion of the coating layer to the plastic surface is poor, and it can be removed at this stage with the same carrier substance. For reasons of environmental safety, the substance applied onto the plastic surface is preferably an aqueous solution or aqueous dispersion of the polymer which forms the coating after it has dried. The use of
20 organic, inflammable solvents, as well as solvents which often cause problems of toxicity, can be avoided.

The coating may contain a material forming the functional portion of the pattern (so-called functional material) and mixed uniformly in it, wherein the thermoplastic polymer of the coating acts as a bonding agent. At the stage of applying the coating, this material may be uniformly mixed in the same coating substance, that is, the polymer solution or dispersion to be applied. The material may be, for example, electrically conductive, in which case it may
30 consist of electrically conductive particles, such as coal, or a metal. For this material, it is essential that is electrically conductive as such and does not require chemical changes or changes in the oxidation state to achieve the conductivity. The material may also be a material that provides another property different from the plastic surface, for example colour (colouring agent), a catalyst, an absorbent, an agent changing the surface energy, an agent providing optical properties, etc. Also these are active as such without any
35 chemical changes.

In the second step B, an activating beam 3 is directed to the coating in such a way that the point of action P of the beam and the plastic surface 1 and the coating 2 move in relation to each other. In practice, this is implemented preferably by moving the beam in relation to the surface along a predetermined path that corresponds to the pattern designed for the surface. This can be implemented, for example, by means of a manipulator, in which the movement of the beam 3 in the direction of the plastic surface can be programmed in advance. In the movement of the beam or, more precisely, in the movement of the point of action P of the beam on the surface, it is also possible to take into account the curvature (three-dimensional feature) of the plastic surface 1. In the range of action of the beam 3, the coating 2 adheres to the plastic surface 1 thanks to the fact that the beam has such an energy effect on either the polymer of the coating or the polymer of the underlying plastic surface that both the thermoplastic polymer of the plastic surface and the thermoplastic polymer of the coating layer fuse, and a local polymer blend 4 is formed, in which the polymers are blended within a certain depth in the direction perpendicular to the plane of the surface, possibly in the depth of only a few molecules at the interface of the polymer phases, but still in such a way that the phases adhere to each other permanently and with a greater adhesive force than in the areas left outside the range of action of the beam. The energy effect is produced by the absorbent, heatable component in the plastic surface or in the coating by the principle described above. The component shall absorb the radiation used for the activation at the radiation wavelength so that it is heated. If the component is separate from the polymer, it will thus transfer heat to the surrounding thermoplastic polymer as well. This local blend formed as a result of melt blending has a composition different from the adjacent compositions of the coating 2 and the plastic surface 1 left outside the range of action of the beam. The thermoplastic polymer of the plastic surface and the polymer of the coating must be compatible to make such a blend. If particles are mixed in the coating, an area is formed along the path passed, "drawn" by the point of action P of the beam 3, where the functional material, for example electrically conductive particles, are also permanently adhered to the plastic surface.

35

The formation of the pattern and its adherence to the plastic surface 1 are based on the physical phenomena induced by the beam (mixing of the

components of the coating, application onto the plastic surface, the fusing and blending of the thermoplastic polymers), and it does not require chemical changes, such as reactive hardening agents, or the like.

5 In the third step C, the coating 2 is removed from the top of the plastic surface 1 by a treatment that removes the coating from the area left outside the range of action of the beam 3. The treatment is of such a nature that it breaks the adhesion between the coating 2 and the plastic surface 1 which was formed during the application of the coating, but it is not capable of removing
10 the components of the coating from the plastic surface 1 at those points where it has adhered to the plastic surface by the effect of the beam. The coating can be removed by rinsing the surface 1 with the same liquid carrier by which its components were originally applied onto the surface, or with another liquid, for example with a suitable solvent. If the same carrier liquid as
15 was used for the application is used for removing the coating, the removed coating that is dissolved or dispersed in the carrier liquid can be re-used in step 1; in other words, there is no wastage. The effect of the rinsing can be boosted mechanically, for example by ultrasound (so-called ultrasonic washing).

20 It should be noted that the pattern scanned by the beam does not need to be continuous, but the pattern may comprise points of discontinuity. These are produced by switching the laser off during the movement. This can be implemented quickly by the on/off principle. Furthermore, it is possible to
25 draw a wider line by scanning the coating with the beam a short distance transversely back and forth and by shifting this beam gradually in a direction perpendicular to the direction of this movement, by moving the beam by the side of the area scanned the previous time, or in another way enabled by modern technology. In these ways, it is also possible to form other than mere
30 linear areas.

In the example of Fig. 1, the activating beam 3 is directed to the plastic surface from the direction of the coating 2. Figure 2 shows an example of the way how the activating beam is not necessarily directed from the side of the
35 coating 2 in all embodiments. If the coated plastic material is sufficiently transparent to the beam and it has a suitable thickness, the beam 3 can also be entered through the plastic material, wherein it acts on the interface be-

tween the plastic surface 1 and the coating 2 with the same effects as before. In this way it is possible, for example in the way shown in Fig. 2, to form patterns on the inner surfaces of tubular objects or other targets which are difficult to access, as long as these surfaces are first equipped with the coating 2. In the case of Fig. 2, the coating 2 is first formed on the inside of the tube, and after the pattern has been formed with the beam 3, the coating can be removed from the inside of the tube with the carrier liquid. In this case, the tube is made of plastic that is transparent to the beam at its wavelength. In principle, the steps of the method are the same as in Fig. 1. The same principle can also be applied for patterning plastic pieces of other shapes or merely plate-like shapes by directing the beam from the "reverse" side. Suitable transparent polymers include, *inter alia*, acrylic plastics, such as polymethyl metacrylate (PMMA) and polycarbonates (PC). On the basis of material data from the polymer manufacturers, these plastics are, at a thickness of 1 mm, transparent to more than 80% of radiation in the IR range, up to the wavelength of at least 1.1 μm (1100 nm). Most laser devices used in welding operate in said wavelength range.

As a rule of thumb, it can be stated that if the polymer is to be used as an absorbing component, radiation which is in the absorption range of the polymer in question or, alternatively, suitable absorbents are used. The absorbing wavelength will depend on the structure of the polymers. For radiation generally used in laser welding (typically in the range from 800 to 1100 nm), the absorbent may be a component mixed in the polymer. For example, only about 0.5 wt-% of carbon black in polymer that is otherwise transparent will normally be sufficient for absorption. There are also additives available which are very transparent to visible light and which can be mixed into plastic or applied as coatings and which absorb radiation at the wavelengths used in laser welding.

The activating beam 3 of electromagnetic radiation is preferably implemented by laser, so that the point of action P can be limited within a small range (a diameter of less than 0.1 mm) and to achieve good efficiency. Due to the efficiency, the scanning speed of the laser can be quite high, and it is thus possible to make patterns of fine lines with good resolution very fast, at linear speeds of at least more than 1 m/s, normally several metres per second. The method can be used for forming patterns requiring high precision in serial

production on plastic substrates. The laser wavelength can be selected on the basis of the chemical structures of the polymers in the coating and the plastic surface. The coating 2 is normally very thin, in the order of less than 100 micrometres, whereas the plastic material whose surface is to be patterned is considerably thicker. The plastic piece may be a piece made of thermoplastic polymer by means of, for example, injection moulding, compression moulding or extrusion techniques, or another melt processing technique.

10 The laser may be, for example, a diode, ND:YAG or fibre laser, or another corresponding laser whose beam can be focused on a small area in the coating 2.

15 In the coating, it is possible to include several types of materials which provide a property different from the plastic surface when they are attached by the beam 3 onto the plastic surface. Examples to be mentioned include carbon in one or more forms, such as carbon black, fullers or carbon nanotubes, as well as metals and metal alloys, such as palladium, rhodium, gold, silver, copper, chromium, zinc, or tin. It is also possible to use mixtures of metals and non-metals and ceramics.

20 The coating 2 may contain two or more different functional materials. It may also contain auxiliary materials to facilitate processing, such as dispersing agents, stabilizers, and agents boosting the absorption of the beam 3.

25 The coating can be applied onto the plastic surface in a variety of ways, such as by dipping, brushing, spraying, or in any other way to provide a smooth uniform coating layer onto the plastic surface with such adhesion that its further processing is possible. The carrier liquid is removed by evaporating, possibly assisted by heating.

30 For reasons of environmental safety, water-soluble or water-dispersible thermoplastic polymer, such as polyvinyl alcohol or polyethylene glycol, is used as adhesive and water is used as the carrier liquid in the coating 2.

35 In addition to the thermoplastic polymer or a blend of them, the plastic material itself, forming the plastic surface 1 to be patterned, may contain additives

and auxiliary agents known from plastics technology, such as plasticizers, fillers, etc. The thermoplastic polymers of the plastic material are preferably insoluble in the carrier liquid used for forming and/or removing the coating, so that the method would change the original plastic surface as little as possible in the area outside the patterning.

The invention is not limited solely to the embodiments presented in this description, but it can be modified within the scope of the claims. For example, it is possible that the thermoplastic polymer of the coating 2 alone acts as such a functional material which, when mixed with the polymer of the plastic surface, provides the desired property, different from the properties of the bare plastic surface, in the area of the patterning. Similarly, the plastic surface 1 may be the surface of a piece made entirely of plastic, or the surface of a composite piece, or, for example, the surface of a plastic coating layer of pieces made of another material / other materials.

In the following, the invention will be illustrated with a few general examples of production and a detailed example of production.

Version 1

A water-soluble thermoplastic polymer doped with a functional additive is applied onto the surface of plastic. The additive may be, for example, electrically conductive, surface active molecules, catalysts, or nanoparticles that bind molecules. The coating is dried by evaporating the water off.

Scanning laser equipment is used to fuse the coating locally and to weld it onto the thermoplastic substrate. As a result of the fusing, the molecules of the substrate and the molecules of the surface are mixed, binding the coating to the substrate within a limited area. In addition to the physical mixing, it is possible to utilize the formation of covalent bonds between the molecules of the coating and the molecules of the substrate, for example by photoinitiators (grafting).

The unfused part which is weakly attached to the substrate, is washed off by an ultrasonic washing machine. The washing time is a few seconds. As a result, a functional patterned surface is obtained, which can be utilized either

as such or as a substrate for further processing. The dimensions of the patterning are substantially dependent on the intensity and the diameter of the laser beam as well as on the scanning precision of the beam.

- 5 Instead of water, it is, in principle, possible to use also other solvents and polymers, but particularly for reasons of environmental safety, water has been used in verifying the process.

Version 2

10

A coating layer of a material containing a thermoplastic water-soluble polymer dissolved in water is applied onto a plastic surface. A functional additive, for example electrically conductive carbon black or the like, is dispersed in the solution. After the water has been evaporated from the coating, part of it
15 is welded onto the substrate in a desired area, for example by means of a diode or fibre laser equipped with a scanner (patterning). After the patterning, the surface is subjected to ultrasonic washing for a few seconds, where the unfused areas are detached and the functionalized pattern is left.

20 Version 3

In the method, a liquid mixture that is applicable onto a surface, is prepared for coating, the mixture containing a solvent, a thermoplastic polymer soluble in it, an electrically conductive fine-grained additive, and possible additives to
25 improve dispersibility and/or to reduce foaming. The additive may be electrically conductive, surface active molecules, catalysts, or particles that bind molecules.

Said liquid is applied onto the surface of a piece, and the solvent is evaporated. The mixture of the polymer and the additive is fused locally with a fast
30 scanning laser beam. By programming the path and the power of the beam, it is possible to form desired patterns on the surface of the piece.

Example

35

In a test, the polymer material used for the coating was an injection moulded sample of water-soluble PVA based material from the firm PVAXX Research

& Development Ltd. In a method that was found feasible, thin polymer strips were dissolved in a ready-to-use carbon black dispersion, Degussa Russ-dispersion VAN EL 10/XE2, which contains the required auxiliary agents for dispersion.

5

0.6 g of polymer, 1 g of carbon black dispersion and 3 g of pure water were weighed into a test tube. The dissolution was accelerated by keeping the test tube in an ultrasonic washing machine for about 10 min. The dissolution was applied with a brush onto the surface of plasma treated PMMA and PC
10 sheets, and the coating was allowed to dry. The dried coating was welded onto the substrate by a scanning laser, power 11 W, at the speed of 100 mm/s. The laser wavelength was about 940 nm. Lines and texts were made by the laser beam so that the number of scanning times in adjacent patterns varied from one to ten. Some of the patterns were made so that the
15 laser beam passed through the base sheet. After this, the sheets were placed in water in an ultrasonic washing machine, in which the unwelded part was detached from the surface of the sheet after a washing of about 2 seconds, and the sheets were finally rinsed lightly by dipping into water. After the surface had dried, the obtained lines having a width of about 1 mm
20 were tested for resistivity. Measured by a multi-function measuring instrument with the brand name Fluke, the resistivity of the line was about 20 k Ω /cm.

The invention has many applications, particularly in fields where patterns in a
25 small scale and with a high resolution are needed on plastic surfaces which may also be three-dimensional and not only planar. Another use is printed circuit boards, wherein the electrically conductive structure can be made on a plastic film or a corresponding plastic substrate quickly by scanning a plastic film or a corresponding substrate provided with a coating, with a laser. In this
30 way, it is possible to make, for example, RFID circuits. If the functional additive of the coating has catalytic properties, the method can be used for the manufacture of various microreactor structures. If the desired property of the pattern compared with a bare plastic surface is a visual difference, the method can be used for implementing small markings, which are invisible to
35 the eye, on various plastic substrates.

Claims

1. A method for patterning a plastic surface (1), in which the surface is provided with an area different from the material of the surface by the following measures:

- forming a coating (2) by means of a carrier liquid onto the plastic surface (1),
- focusing an activating beam (3) onto the surface, and moving the surface and the activating beam in relation to each other so that the point of action (P) of the beam (3) attaches the coating (2) onto the surface when it moves in relation to the surface, and
- removing the coating (2) from the area left outside the range of action of the beam produced by the movement of the point of action (P) of the beam, by a treatment which leaves the coating (2) more firmly attached to the surface in the range of action of the beam, on the surface,

characterized in that

- the plastic surface (1) comprises thermoplastic polymer,
- the coating (2) is formed by means of thermoplastic polymer dissolved or dispersed in water, by applying an aqueous solution or dispersion containing the polymer onto the plastic surface (1) and by evaporating the water, and
- an activating beam (3) is directed to the plastic surface (1) so that at the point of action (P) of the beam, a component of the plastic surface or the coating absorbs electromagnetic radiation of the beam (3), causing the heating and fusing and mixing of the thermoplastic polymers of the plastic surface (1) and the coating (2) at the interface of the coating and the plastic surface to each other so that a permanent bond (4) of the polymer of the plastic surface (1) and the polymer of the coating (2) is formed in the range of action of the beam, corresponding to the pattern.

2. The method according to claim 1, **characterized** in that particles are mixed into the coating (2) or the plastic surface, which act as a component absorbing the electromagnetic radiation of the beam (3).

3. The method according to claim 2, **characterized** in that the particles of the coating (2) are functional material which provides the pattern with a property which is different from the properties of the plastic surface (1), wherein the

thermoplastic polymer of the coating acts as a bonding agent for the particles.

5 4. The method according to claim 3, **characterized** in that the functional material is an electrically conductive material, and in the method, a pattern is formed which has better electrical conductivity compared with the plastic surface (1).

10 5. The method according to claim 3 or 4, **characterized** in that the functional material has, before the action of the beam (3), inherently the properties which provide the desired property of the finished pattern, and the finished pattern comprising said desired properties is formed in a single step by moving the point of action (P) of the beam and the surface in relation to each other.

15 6. The method according to any of the preceding claims, **characterized** in that the activating beam (3) is a laser beam.

20 7. The method according to any of the preceding claims, **characterized** in that the coating (2) is removed from the area left outside the range of action of the beam (3) by means of a carrier liquid, possibly with mechanical, such as ultrasonic, assistance.

25 8. The method according to claim 7, **characterized** in that the coating (2) is removed with the same carrier liquid, water, that was used for forming it onto the plastic surface (1), and that the material/materials of the coating is/are re-used by forming a coating (2) of them by means of water onto a new plastic surface (1) to be patterned by the method.

30 9. The method according to any of the preceding claims, **characterized** in that the absorbent component is in the coating (2), and the activating beam (3) is directed to the surface from the side of the coating (2).

35 10. The method according to any of the preceding claims 1 to 8, **characterized** in that the absorbent component is in the plastic surface (1), and the activating beam (3) is directed to the surface from the side of the coating (2) that is transparent to radiation.

11. The method according to any of the preceding claims 1 to 8, **characterized** in that the absorbent component is in the coating (2), and the activating beam (3) is directed to the surface from the side of a plastic piece forming the plastic surface (1) and being transparent to the radiation, particularly for the patterning of three-dimensional surfaces and/or surfaces which are difficult to access.

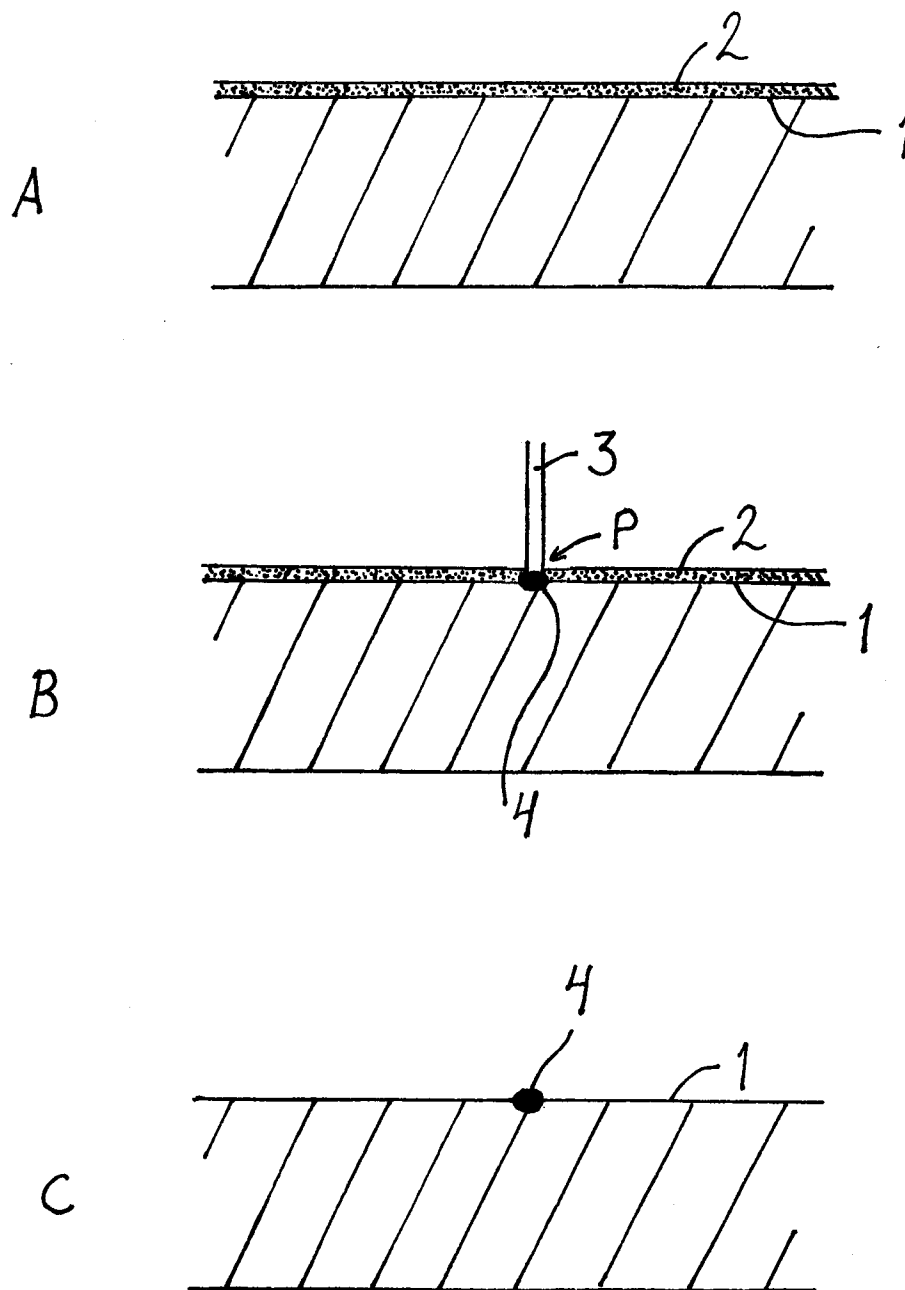


Fig. 1

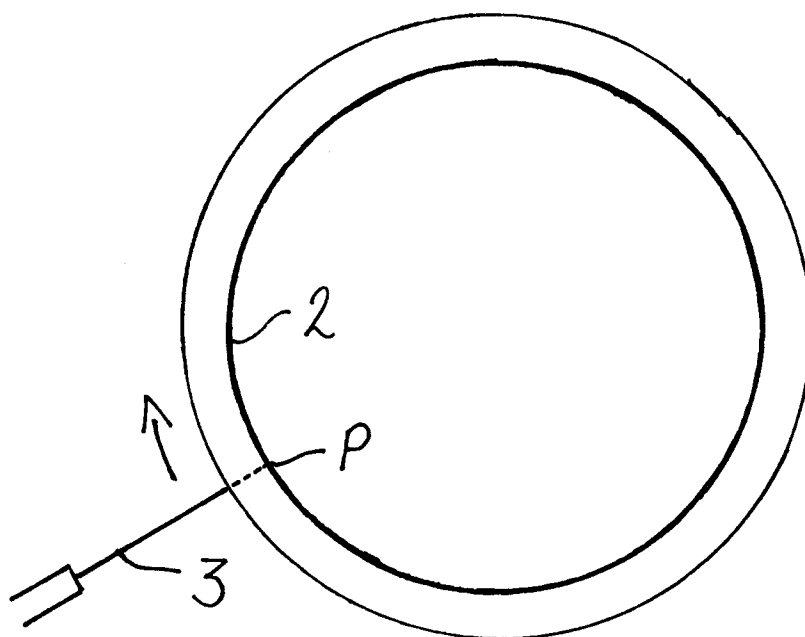


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2008/050370

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8: C08J, B41M, B29C, D06P, C09D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6592949 B1 (POLKE REINHARD et al.) 15 July 2003 (15.07.2003) column 1, lines 60-65, column 2, line 53, column 4, lines 12-20, claims 1-8	1-7, 9
Y		1-10
X	US 6238847 B1 (AXTELL III ENOS AYRES et al.) 29 May 2001 (29.05.2001) column 1, line 65, column 7, lines 36-40, column 8, lines 5-8, column 9, line 28, example 9	1, 2, 6, 9, 11
Y		1, 2, 9, 10
Y	US 6210472 B1 (KWAN WING SUM VINCENT et al.) 03 April 2001 (03.04.2001), column 3, lines 9-16, column 5, line 42	1, 2, 9, 10
Y	US 2004086674 A1 (HOLMAN THOMAS J) 06 May 2004 (06.05.2004), paragraph [0053]	1, 2, 9, 10

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

07 October 2008 (07.10.2008)

Date of mailing of the international search report

17 October 2008 (17.10.2008)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2008/050370

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0922589 A1 (TEKMAX INC) 16 June 1999 (16.06.1999), paragraph [0006]	1-9
Y	US 2007080146 A1 (STOCKUM WERNER et al.) 12 April 2007 (12.04.2007), claims 1-7	1-7, 9-10
Y	US 4853252 A (FRAENKEL JUERGEN et al.) 01 August 1989 (01.08.1989), cited in the application	1-7, 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2008/050370

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.

C08J 3/28 (2006.01)

B41M 5/26 (2006.01)

B29C 71/04 (2006.01)

D06P 5/20 (2006.01)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2008/050370

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 6592949 B1	15/07/2003	EP 1099565 A2 DE 19954366 A1	16/05/2001 17/05/2001
US 6238847 B1	29/05/2001	None	
US 6210472 B1	03/04/2001	WO 0061377 A1 AU 3978800 A	19/10/2000 14/11/2000
US 2004086674 A1	06/05/2004	WO 2004041344 A1 AU 2003276861 A1	21/05/2004 07/06/2004
EP 0922589 A1	16/06/1999	None	
US 2007080146 A1	12/04/2007	RU 2006120080 A JP 2007510547T T BR PI0416383 A KR 20060122870 A CN 1894108 A EP 1682356 A1 DE 102004053376 A1 WO 2005047010 A1	27/12/2007 26/04/2007 21/02/2007 30/11/2006 10/01/2007 26/07/2006 09/06/2005 26/05/2005
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