

(19)



SUOMI - FINLAND  
(FI)

PATENTTI- JA REKISTERIHALLITUS  
PATENT- OCH REGISTERSTYRELSEN  
FINNISH PATENT AND REGISTRATION OFFICE

(10)

**FI/EP3109056 T4**

(12)

**MUUTETUSSA MUODOSSA HYVÄKSYTYN EUROOPPAPATENTIN  
KÄÄNNÖS  
ÖVERSÄTTNING AV EUROPEISKT PATENT I ÄNDRAD FORM  
TRANSLATION OF AMENDED EUROPEAN PATENT  
SPECIFICATION**

(45)

Käännöksen kuulutuspäivä - Kungörelsedag av översättning -  
Translation available to the public

**08.02.2024**

(97)

Muutetussa muodossa hyväksytyn Eurooppapatentin  
myöntämispäivä - Meddelandedatum för det europeiska  
patentet i ändrad form - Date of grant of amended European  
patent

**29.11.2023**

(51)

Kansainvälinen patenttiluokitus - Internationell patentklassificering -  
International patent classification  
**B41M 5/00** ( 2006 . 01 )  
**B41M 3/00** ( 2006 . 01 )

(96)

Eurooppapatenttihakemus - Europeisk patentansökan -  
European patent application

**EP16171759.0**

(22)

Tekemispäivä - Ingivningsdag - Filing date

**27.05.2016**

(97)

Patenttihakemuksen julkiseksitulosopäivä - Patentansökans  
publiceringsdag - Patent application available to the public

**28.12.2016**

(30)

Etuoikeus - Prioritet - Priority  
25.06.2015 DE 102015110236

(73)

Haltija - Innehavare - Holder

**1• Hymmen GmbH Maschinen- und Anlagenbau**, Theodor-Hymmen-Straße 3, 33613 Bielefeld, (DE)

(72)

Keksijä - Uppfinnare - Inventor

(74)

Asiamies - Ombud - Agent

**Kolster Oy Ab**, Salmisaarenaukio 1, 00180 Helsinki, (FI)

(54)

Keksinnön nimitys - Uppfinningens benämning - Title of the invention

**Menetelmä ja laite rakenteen valmistamiseksi pinnalle**

**Förfarande och anordning för tillverkning av en struktur på en yta**

**METHOD AND DEVICE FOR PRODUCING A STRUCTURE ON A SURFACE**

(56)

Viitejulkaisut - Anförda publikationer - References cited

EP-A1- 1 902 849; WO-A1-2015/078449;

### **Method and Device for producing a structure on a surface**

The present invention relates to a method for producing a structure on the surface of a flat workpiece as well as a device for producing the structure.

A decorative coated plate of a wooden material is state-of-the-art and is applied in diverse cases of application, e.g. for producing furniture, laminate flooring and wall-, ceiling- or outside-panels. A typical example for a plate of a wooden material is a chip board, which is coated with a decoratively printed paper. Alternatively, there are also different kinds of fiber boards, e.g. MDF (medium-density fiberboard) or HDF (high-density fiberboard), like also cement fiberboards and cement bounded fiberboards, which are used in thicknesses of e.g. approx. 3 to 50 mm for different cases of application.

For most cases of application, it is desirable to obtain also a structure in the surface, alongside with a decorative coating, like e.g. an imitation of wood or an imitation of a slab for a stone-like appearing laminate flooring.

According to the state-of-the-art, this is produced by e.g. a method for melamine coating through an embossing die. Thereby, for example a paper imprinted with a wooden optic is impregnated with a melamine resin, dried and then pressed with an embossed sheet on a chip board in a heat press. The result is a chip board of a thickness of 12 mm, which is coated with an optic imitating beechwood. On the surface with the beechwood-imitating optic, structures with a depth of commonly 20 µm up to 150 µm or 200 µm are obtained by the embossed sheet.

Structures are produced to look similar to wood, independently from the real printed type of wood as so-called “all-over” structures. In accordingly more expensive methods with high quality appearing products, a so-called synchronous pore is also used, in which the embossed sheet has a structure, which is applied synchronously to the printed wooden optic. In this case, for example a printed knothole is actually tangibly deeper than the slightly higher rest of the printed wooden optic beside it.

Beside this method for pressing melamine, there are other methods for the coating of wooden composite boards. In another well-known method, for example a wooden composite board is lacquered, imprinted and provided with a transparent layer of a top-coat lacquer. Also in this case, to obtain a corresponding surface structure, there is the possibility to apply a structure with a structured roller for top coating lacquer. Such a method is described in the DE 10 2007 019 871 for instance.

All these methods for structuring a surface have in common, that they are relatively inflexible and that the respective tool (the roller or the pressure plate) needs to be changed in case of a change of a structure.

To avoid these disadvantages, there is a method for a digital application of a structure, which is described in the DE 10 2009 044 802.

However, also this digital method has disadvantages: a big amount of radiation-hardened ink is used, which is very expensive. Furthermore, it is not always possible to realize a full coverage of the surface over the imprinted structure. Therefore, the imprinted ink is less resistant to scratching and less robust in comparison with other above-mentioned methods.

The EP 1 902 849 A1 discloses an ink jet printing method, at which the base layer is partly hardened and afterwards imprinted with ink, whereby ink droplets are introduced in the base layer.

The WO 2015/078449 A1 discloses a method for the ink jet or ink printing, whereby a liquid ink absorption layer is applied on a substrate, on which subsequently liquid print media is applied and the ink absorption layer then hardens.

Against this background, it is the aim of the method according to the invention and the device according to the invention to maintain the advantages of the flexibility of a digital structure and to exclude the above-mentioned disadvantages at the same time.

This is achieved by the method according to the invention as defined in claim 1. For this purpose, a workpiece to be coated, e.g. a wooden composite board, a cement fiberboard, or the like (flat workpiece), is coated with a liquid base layer on a surface of the workpiece. Then, in a second step, a structure in the yet liquid base layer is produced by means of sprayed liquid droplets, whereby indentations are formed by spraying the droplets on the previously applied liquid base layer. In a third step, this so formed structure is fixed by fixation of the liquid base layer. This happens, for example, by drying the liquid base layer together with the sprayed liquid droplets. The device according to the invention is defined in claim 13. Further advantageous embodiments of the present invention are disclosed in the dependent claims.

Before or after the fixation of the liquid base layer, the sprayed droplets can be evaporated.

In a variation of an embodiment, the sprayed droplets can be fixed together with the liquid base layer while fixing the latter.

The droplets can be sprayed according to a digital template by a digital printhead, or alternatively by a digital nozzle bar of a device for producing a structure on a surface of the workpiece. This device comprises a control unit or a control device. The control is carried out according to a digital template, which, for example, can be retrieved from a data storage belonging to the device. The control device can control the emission of droplets, like for example, the volume of the emission and the speed of the droplets impinging on the base layer, accordingly.

In a preferable embodiment, the liquid base layer and/or the sprayed droplets can consist of a radiation-hardening material.

The fixation can be realized by means of radiation hardening through UV-radiation or through electron radiation. Therefore, an applicable device includes corresponding UV-illuminants or electron radiation producing elements.

The sprayed droplets, which are sprayed according to a respectively the digital template, are coordinated with a decorative picture, which is printed on the surface beforehand or afterwards, in a manner that the resulting structure at least in partial areas of the surface is applied synchronously with the printed decorative pictures on the workpiece.

The sprayed droplets may consist of a material containing acrylate and are applied on the workpiece according to a digital template.

After the step of fixing the liquid base layer and the sprayed droplets, a further step can be performed, at which further droplets are sprayed on the fixed base layer and are hardened afterwards.

The plurality of droplets can consist of at least two different materials, such that droplets with one material can be applied on certain areas and droplets of a different material composition can be applied on other areas.

After and/or during the spraying of the plurality of droplets on the yet liquid base layer, a chemical reaction between the material of the sprayed droplets and the yet liquid base layer can take place, in a way that the reaction product between base layer and droplets changes the structure in this area optically and/or haptically.

In the following the invention is explained in detail according to the enclosed figures. They show:

- Fig. 1        Cross-sectional view of a workpiece before the application of the droplets;
- Fig. 2        Workpiece during the application of the droplets;
- Fig. 3        Workpiece after the application of the droplets and after the hardening;
- Fig. 4        Workpiece after the application of the droplets in the top view;
- Fig. 5        Device for producing a structure on the workpiece

Furthermore, figure 1 shows the workpiece 1 provided with a structure and the applied liquid base layer 2.

Furthermore, in Fig. 2, the sprayed droplets 3 can be seen, which are illustrated schematically as different groups of single droplets or as a plurality of droplets stringed together in a line.

The result of the spraying is illustrated in Fig. 3, at which the droplets 3 have introduced corresponding immersions into the previously applied liquid base layer 2 and deposited on the ends of the immersions. Depending on the used parameters (material, speed of droplets, volume of droplets, etc.), also elevations can be formed by the displaced lacquer of the liquid base layer alongside with the resulting immersions by the droplet.

In Fig. 4, the workpiece 1 can be seen from above with the thereupon applied liquid base layer 2. Here, the respective structures that are caused by the sprayed droplets 3 are sketchily insinuated.

#### Embodiment 1:

Firstly, a chip board with a thickness of 12 mm is supplied to the device according to the invention. The device serves for producing a structure on a surface of the workpiece with a transport device for the supply and/or removal of a workpiece provided with a liquid base layer in a transport direction with one or a plurality of print heads and/or a or a plurality of nozzle bars for the emission of droplets onto and/or into the liquid base layer and with a fixation device, which is arranged

subsequently to the print head or heads in transport direction and which radiates heat and/or light onto the base layer of the workpiece, whereby the device comprises a control device. In this context, light is not only to be understood as light in a visible range of wave lengths, but particularly also UV light and infrared light.

The device includes in the specific embodiment of Fig. 5 digital print heads 4, a drying device 5, constituted by UV-LEDs and a continuous transport 6, constituted by a belt transport in this case. An emission device for applying the base layer 2 can also be provided. The chip board can be provided with a white grounding beforehand. In an alternative embodiment, it is also possible, that a decorative picture, e.g. an imitation of wood, an imitation of a slab or a photorealistic picture, has already been printed on the grounded chip board beforehand. Afterwards the so pretreated 12 mm chip board is coated with a liquid base layer in the form of an acrylate lacquer, whereby the thickness lies between 5  $\mu\text{m}$  and 200  $\mu\text{m}$ , preferably between 10  $\mu\text{m}$  and 60  $\mu\text{m}$ . In this embodiment, the acrylate lacquer ("liquid base layer") is a formulation with 30 wt% of a bi-acrylate HDDA, 40 wt% of a bi-acrylate DPGDA, 10 wt% of a crosslinker TM PTA, 3 wt% of an industry standard photoinitiator as well as 17 wt% of other components. The acrylate lacquer has a viscosity of 80 - 500 mPas, preferably 150 - 400 mPas, measured at 25 °C and normal pressure with a rheometer (e.g. the model Kinexus of company Malvern).

Afterwards, the so pre-coated board is supplied to a digital print unit, at which also ink containing acrylate is sprayed into the still liquid acrylate-containing base layer 2 by digital print heads 4. The acrylate-containing ink contains 65 wt% of a methacrylate CTFA, 15 wt% of a N-vinyl caprolactam NFC, 8 wt% of a photoinitiator as well as 12 wt% of other components. The viscosity of the ink amounts to 8 - 30 mPas at a processing temperature of 20 - 45°C (measured with the rheometer Kinexus of the company Malvern) and normal pressure. The surface tension lies at 22 - 38 mN/m, measured in the tensiometer, model K100 of the company Krüss at 20°C and normal pressure. In this embodiment, the droplets have a volume of 3 - 100 pl, especially preferred 6 - 60 pl. the droplets are applied according to the digital print template, such that the digital print device can print a corresponding "picture" as variation of the layer thickness into the still liquid base

layer. The droplets are sprayed with a distance of 0.5 mm to 10 mm to the liquid base layer, especially preferred is a distance of 0.5 mm to 4 mm. While impinging on the e.g. 50  $\mu\text{m}$  thick base layer, the droplets displace the liquid material at this location. According to the size and the speed of the droplets during the spraying, the material of the droplets can penetrate the liquid base layer, such that an immersion of e.g. 50% of the base layer is formed. Here, in the present embodiment, accordingly 25  $\mu\text{m}$  of penetration depth. Alternatively, with an appropriate change of the size and speed of the droplets, the droplet can also penetrate less deeply and/or accumulate displaced material on the side of the droplet, such that both, an immersion and adjacent elevations in the liquid base layer are created. After the printing of the droplets, the liquid base layer and the printed droplets are hardened. In an especially preferred embodiment, this hardening is performed within less than 5 seconds after the printing with the aid of UV-LEDs, which pre-harden the acrylate material, which also contains corresponding UV-photoinitiators, that the surface congeals and no more dissolving of the liquid is possible.

In a further step the final hardening is performed by more intensive UV-exposure.

In an alternative embodiment of the method according to the invention, a second round can be made, at which a further liquid base layer is applied and also droplets are sprayed, after the first application of the liquid base layer and the application of the droplets and the first hardening.

In a further alternative embodiment, after producing a three-dimensional structure according to the invention with a depth of 2  $\mu\text{m}$  - 100  $\mu\text{m}$ , especially preferred 3  $\mu\text{m}$  - 50  $\mu\text{m}$ , a decorative picture is printed onto this structured surface. The process of printing is performed in a preferred embodiment also with the aid of an ink jet printer. In doing so, the decorative picture is adjusted in such a way to this three-dimensional structure, that the decorative elements of the picture at least in some parts are synchronous with the previous generated three-dimensional structure. Here, synchronous means that the decorative imaging of a lengthwise deviation of the three-dimensional structure lying underneath accomplishes less than 5 mm, especially preferred less than 1 mm. Here, deviations are measured between parts



of the picture, e.g. a decorative printed knothole and the corresponding associated structure, e.g. a round immersion of the same dimensions as the printed knothole.

In an alternative embodiment, the decorative picture is printed primarily on the workpiece, e.g. the wooden composite board, before the structure of the surface is generated. In doing so, before printing the picture, the surface of the material has a suitable layer as coating for receiving pressure, which consists of a white lacquering in an embodiment. On this layer, the decorative picture is printed preferably also with an ink jet method. Afterwards, in the method according to the invention, the coating with the liquid base layer is performed, which in this case is transparent to allow perceiving the decoratively printed picture underneath. After the application of the liquid base layer by the spraying of the droplets, the structure according to the invention is then generated, which subsequently is fixed by the following hardening of the liquid layer and the droplets. Also in this embodiment, a synchronous structure between the picture underneath and the applied structure is generated. This synchronous structure is generated by the comparison of electronic image data, which is used for both, the printing of the decorative picture underneath and also for the spraying of the droplets into the liquid base layer.

#### Embodiment 2:

A cement fiber board with a thickness of 10 mm is transported to a roller coating device, at which a watery acrylate lacquer, which is colored white with titanium dioxide, is applied on the cement fiber board with a layer thickness of 14  $\mu\text{m}$  by roller coating. The watery acrylate lacquer has a viscosity of 300 to 600 mPas. Afterwards, the cement fiber board, provided in this manner with the liquid base layer, is supplied to a digital printer, at which a watery ink is sprayed through droplets with a volume of 10 - 40 pL. Subsequently, the thus generated structure is pre-hardened in an IR-radiator and afterwards completely hardened in a channel of nozzles to fix the so generated surface structure.

In an alternative embodiment, the base layer applied in a liquid form can consist of a watery lacquer system or a solvent-based lacquer system. It is then dried e.g. in a jet dryer after the spraying of the droplets and thus receives the structure.

In an alternative embodiment, a solvent-based ink is primarily printed digitally onto a flat workpiece, whereby the ink reacts with the watery acrylate lacquer applied liquidly in a second step in such a way that the ink printed in the first step displaces the lacquer at the corresponding locations. By this displacement a structure is generated at this location, which is pre-dried and fixed by the pre-drying of the watery acrylate lacquer in the subsequent step.

In general, a random combination of the different method steps, i.e. printing a decorative picture, application of a liquid basic player, spraying of droplets into the liquid base layer, fixation and hardening of the base layer, p.r.n. printing a decorative picture on an existing previously generated structure and printing a structure according to the above-mentioned state-of-the-art according to the document DE 10 2009 044802, is possible. This combination of the method steps is dependent on which structure depths and which structure edge definitions are to be generated. In every case, the composition of the liquid base layer is dependent on the chosen combination of method steps. Thus, in one embodiment of the method according to the invention, the liquid base layer is made out of a transparent material, preferably acrylate, which contains photoinitiators and hardens through UV-radiation. In an alternative embodiment of the method according to the invention a liquid base layer is colored in white, in order to print the optical picture on the generated structure. Other colors are also possible, depending on the case of application for the liquid base layer.

#### Reference list:

- 1 workpiece
- 2 base layer
- 3 droplet
- 4 digital print heads
- 5 UV-radiator
- 6 belt transport

## Patenttivaatimukset

1. Menetelmä rakenteen valmistamiseksi tasaisen työkappaleen (1) pinnalle, jossa menetelmässä on seuraavat vaiheet:

(A) nestemäisen peruspinnoitteen (2) levittäminen työkappaleen (1) pinnalle;

(B) lukuisien pikkupisaroiden (3) ruiskuttaminen vielä nestemäiseen peruspinnoitteeseen (2) siten, että peruspinnoitteen (2) kerrospaksuus muuttuu niissä kohdissa, joihin pikkupisaroita (3) ruiskutetaan, jolloin pikkupisaroiden (3) ruiskuttamisen avulla muodostetaan painaumia aikaisemmin levitettyyn, nestemäiseen peruspinnoitteeseen (2), jolloin ruiskutetut pikkupisarot (3) ruiskutetaan digitaalisen mallin mukaan, joka malli on sovitettu jonkin pinnalle ennen tai jälkeen painetun koristekuvan kanssa siten, että syntynyt rakenne on ainakin pinnan osa-alueilla synkroninen painettuun koristekuvaan nähden;

(C) nestemäisen peruspinnoitteen (2) kiinnittäminen.

2. Patenttivaatimuksen 1 mukainen menetelmä, t u n n e t t u siitä, että ruiskutetut pikkupisarot (3) haihdutetaan ennen tai jälkeen nestemäisen peruspinnoitteen (2) kiinnittämistä.

3. Patenttivaatimuksen 1 mukainen menetelmä, t u n n e t t u siitä, että kun nestemäistä peruspinnoitetta (2) kiinnitetään, kiinnittyvät myös ruiskutetut pikkupisarot (3).

4. Jonkin edellä olevan patenttivaatimuksen mukainen menetelmä, t u n n e t t u siitä, että ruiskuttamalla pikkupisaroita (3) aikaisemmin levitettyyn, nestemäiseen peruspinnoitteeseen (2), muodostetaan kolmiulotteinen rakenne, jonka syvyys on 2 µm - 100 µm, edullisesti 3 µm - 50 µm.

5. Jonkin edellä olevan patenttivaatimuksen mukainen menetelmä, t u n n e t t u siitä, että pikkupisarot (3) ruiskutetaan digitaalisen mallin mukaan laitteen digitaalisesta tulostuspäästä ja/tai digitaalisesta suutinpalkista rakenteen tuottamiseksi pinnalle.

6. Jonkin edellä olevan patenttivaatimuksen mukainen menetelmä, t u n n e t t u siitä, että nestemäinen peruspinnoite (2) ja/tai ruiskutetut pikkupisarot (3) koostuvat säteilykovettuvasta materiaalista.

7. Edellä olevan patenttivaatimuksen mukainen menetelmä, t u n n e t t u siitä, että vaiheen (C) kiinnittäminen tapahtuu säteilykovetuksen muodossa UV-säteilyn tai elektronisäteilyn avulla.

8. Jonkin edellä olevan patenttivaatimuksen mukainen menetelmä, t  
u n n e t t u siitä, että digitaalisen mallin mukaan ruiskutetut pikkupisarat (3)  
koostuvat akrylaattia sisältävästä materiaalista.

5 u n n e t t u siitä, että vaiheen (C), nestemäisen peruspinnoitteen (2) kiinnittä-  
misen jälkeen, suoritetaan vielä menetelmävaihe (D), jossa kiinnitetylle perus-  
pinnoitteelle (2) ruiskutetaan lisää pikkupisaroita (3) ja kovetetaan lopuksi.

10 10. Jonkin edellä olevan patenttivaatimuksen mukainen menetelmä,  
t u n n e t t u siitä, että vaiheen (B) aikana lukuisat pikkupisarat (3) koostuvat  
ainakin kahdesta eri materiaalista, niin että tiettyihin kohtiin levitetään yhdestä  
materiaalista olevia pikkupisaroita ja tiettyihin kohtiin levitetään pikkupisaroita,  
joissa on toinen materiaali-koostumus.

15 11. Jonkin edellä olevan patenttivaatimuksen mukainen menetelmä,  
t u n n e t t u siitä, että sen jälkeen, kun lukuisia pikkupisaroita (3) on ruisku-  
tettu vielä nestemäiseen peruspinnoitteeseen (2), muodostuu ruiskutettujen  
pikkupisaroiden (3) materiaalin ja vielä nestemäisen peruspinnoitteen (2) välille  
kemiallinen reaktio siten, että peruspinnoitteen (2) ja pikkupisaroiden (3) väli-  
nen reaktiotuote muuttaa kohdan rakennetta optisesti ja/tai haptisesti.

20 12. Jonkin edellä olevan patenttivaatimuksen mukainen menetelmä,  
t u n n e t t u siitä, että pikkupisaroiden (3) tilavuutta ruiskutuksen aikana vaih-  
dellaan digitaalisen mallin mukaan.

25 13. Laite rakenteen tuottamiseksi pinnalle, jossa laitteessa on kulje-  
tuslaite (6) nestemäisellä peruspinnoitteella (2) varustetun työkappaleen tuo-  
miseksi tai pois kuljettamiseksi kuljetussuunnassa, jossa on yksi tai useampi  
tulostuspää (4) ja/tai yksi tai useampi digitaalinen suutinpalkki pikkupisaroiden  
luovuttamiseksi nestemäisen peruspinnoitteen päälle ja/tai nestemäiseen pe-  
ruspinnoitteeseen (2), ja jossa on kiinnityslaite (5), joka on järjestetty kuljetus-  
suunnassa tulostuspäiden (2) ja/tai suutinpalkkien jälkeen, ja joka säteilee läm-  
pöä ja/tai valoa työkappaleen peruspinnoitteelle kiinnittämistä varten, jolloin  
30 laite käsittää ohjauslaitteen, joka on konfiguroitu yhden patenttivaatimuksista  
1–12 mukaisen menetelmän suorittamiseksi.

Fig. 1

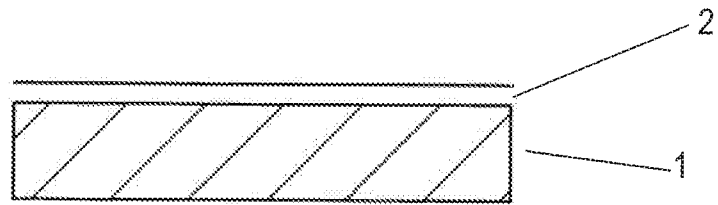


Fig. 2

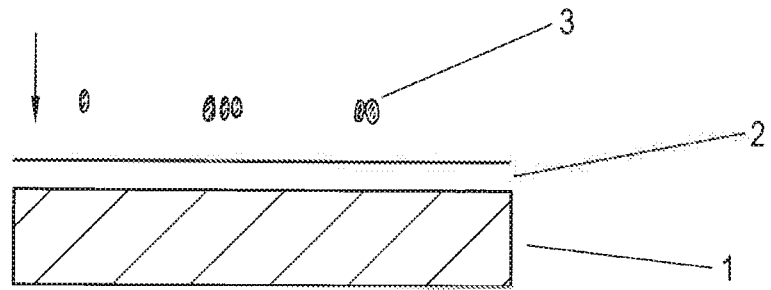


Fig. 3

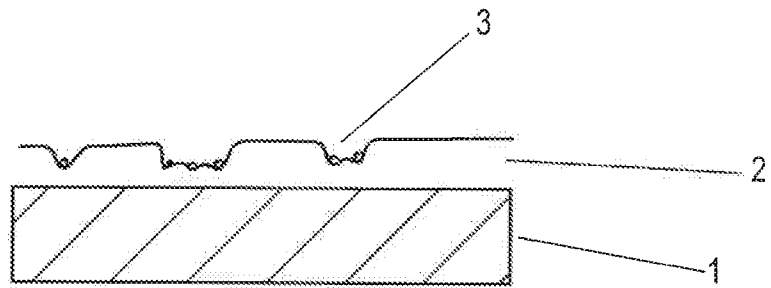


Fig. 4

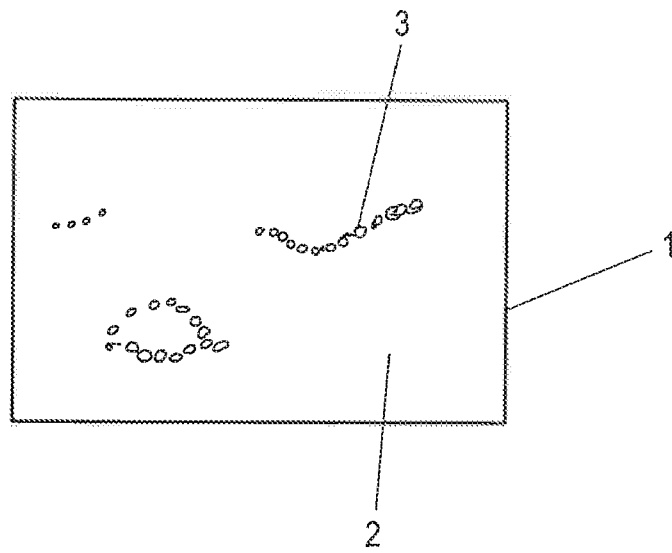


Fig. 5

