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(54) METHOD TO PRODUCE EMBOSSED DIGITALLY PRINTED WALLPAPER

VERFAHREN ZUR HERSTELLUNG VON GEPRÄGTER, DIGITAL BEDRUCKTER TAPETE
PROCÉDÉ POUR PRODUIRE UN PAPIER PEINT IMPRIMÉ NUMÉRIQUEMENT GAUFRÉ

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Description

TECHNICAL FIELD

[0001] The invention pertains to the technical field of methods to produce flexible wallpaper.

BACKGROUND

[0002] A wall covering, like wallpaper, is typically applied to the walls or ceiling of a room to improve the overall appearance of the room. Different types of wall coverings and methods to produce them are known in the art. These methods often consist in providing a substrate, which may be provided with or without an additional coating, and providing it with a desired coloured print pattern. Optionally a surface texture may also be provided to the wall covering. Wallpaper is typically positioned against a ceiling or wall in the form of strips of wall covering which are hung, often using an adhesive, side-by-side to form a coherent piece of decoration against the wall or ceiling.

[0003] EP2263884 discloses a method to produce a wallcovering which is a flexible wallpaper, which method comprises: providing a flexible substrate layer which is essentially endless along a longitudinal dimension; providing a coating on the top side of said substrate layer; providing said coating with an embossed pattern; and providing a print pattern directly on top of said embossed coating.

[0004] A problem with the known production methods for wall coverings is that when wall coverings with a similar colour print pattern are produced in different production batches, the colours of the print pattern of one batch can deviate from the colours of another batch, despite similar inks or pigments being used. In such a case, when hanging wall coverings with a similar colour print pattern but from different batches, the different strips will not form a nice coherent piece of decoration at the wall or ceiling, thereby significantly disturbing the look of the room. Furthermore, such colour deviations can even occur within the same production batch. Hence, when colour deviations occur, the production batches are often disposed of in large quantities, significantly decreasing the efficiency of the production process and increasing its overall cost.

[0005] These colour differences can occur, for example, due to the influence of the substrate or due to the influence of the surface texture, especially in the case when digital printing techniques are used to apply the print pattern to the substrate, as these print patterns tend to be much thinner than those applied using analogue printing techniques and hence are much more prone to colour deviations and influences from the substrate, the surface texture or other (external) influences. Therefore, additional print receiving layers are often applied to the substrate to reduce these influences. US 2002 0 118 267, for example, describes an ink jet printing medium for an embossed interior decorating member comprising a base

member having a face, a thermoplastic resin layer deposited on the face of the base member, and a non-aqueous and porous ink receiving layer, deposited on the thermoplastic resin layer, for receiving liquid pigment ink.

[0006] A problem with such additional print receiving layers is that they often increase the overall cost of the production process and, due to the increased amount of production steps required to apply them, also decrease the flexibility of the process and the amount of different types of wall coverings that can be obtained.

[0007] The present invention aims to resolve at least some of the problems mentioned above.

[0008] The invention thereto aims to provide a method to produce flexible wallpaper, which can be produced with high quality in a flexible and cost effective manner. The invention further allows colour deviations within the same production batch or between different batches of wallpapers comprising a similar colour print pattern to be reduced to a minimum.

SUMMARY OF THE INVENTION

[0009] The present invention provides a method to produce flexible wallpaper, as described in claim 1.

[0010] The method according to the present invention allows to produce flexible wallpaper with an embossed pattern in an efficient and cost effective manner with high quality and a high degree of flexibility in the different types of wallpapers that can be obtained. The method further allows that colour deviations, for example caused by the presence of the embossed pattern or due to the substrate, to be reduced to a minimum within the same or between different batches of wallpapers comprising a similar colour print pattern, without the necessity of applying additional print receiving layers to the wall covering.

DESCRIPTION OF FIGURES

[0011] Figure 1 provides a schematic side view of how a print pattern can be applied to an embossed coating according to an embodiment of the current invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The present invention concerns a method to produce (preferably flexible) wallpapers, more preferably wallpaper, and allows to produce wallpapers with an embossed pattern in an efficient and cost effective manner with high quality and a high degree of flexibility in the different types of wallpapers that can be obtained, and with a minimum of colour differences within a same production batch or between different batches of wallpapers comprising a similar colour print pattern.

[0013] Unless otherwise defined, all terms used in disclosing the invention, including technical and scientific terms, have the meaning as commonly understood by one of ordinary skill in the art to which this invention be-

longs. By means of further guidance, term definitions are included to better appreciate the teaching of the present invention.

[0014] As used herein, the following terms have the following meanings:

"A", "an", and "the" as used herein refers to both singular and plural referents unless the context clearly dictates otherwise. By way of example, "a print pattern" refers to one or more than one print pattern.

"Comprise," "comprising," and "comprises" and "comprised of" as used herein are synonymous with "include", "including", "includes" or "contain", "containing", "contains" and are inclusive or open-ended terms that specifies the presence of what follows e.g. component and do not exclude or preclude the presence of additional, non-recited components, features, element, members, steps, known in the art or disclosed therein.

[0015] The recitation of numerical ranges by endpoints includes all numbers and fractions subsumed within that range, as well as the recited endpoints.

[0016] The expression "weight percent", here and throughout the description unless otherwise defined, refers to the relative weight of the respective component based on the overall weight of the composition.

[0017] With the term "automated" as used herein, a method or process is meant that is partially or completely executed and guided by machinery, hereby limiting the input of humans. Preferably, the term "automated" also refers to a process or method that can be performed in a continuous or substantially continuous manner.

[0018] "m²" as used in the current invention corresponds to "square meter".

[0019] The term "polymer" as used herein generally includes, but is not limited to, homopolymers, copolymers, such as, for example, block, graft, random and alternating copolymers, terpolymers, etc. and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible geometrical configurations of the material. These configurations include, but are not limited to, isotactic, syndiotactic and random symmetries. Examples of polymers include, but are not limited to, polyolefins (such as polyethylene, polypropylene), polystyrene, polyurethanes, polyethylene terephthalate, polyvinyl chloride, etc.

[0020] The term "colour", as used in the present invention, may refer to any possible colour such as white, black, red, orange, yellow, green, blue, indigo, violet, brown, and/or any other colour or combination of colours.

[0021] The term "wall covering" as used herein refers to flexible wallpaper.

[0022] In a first aspect, the current invention provides an automated method to produce flexible wallpaper as defined in claim 1.

[0023] According to the current invention, the maximum depth of the embossed pattern provided in the coating comprises a value equal to or less than 1.0 mm. In a preferred embodiment, the maximum depth of the embossed pattern provided in the coating comprises a value equal to or less than about 0.9 mm, more preferably equal to or less than about 0.8 mm, most preferably equal to or less than about 0.7 mm.

[0024] The invention is specifically aimed at providing an improved, digitally printed wallpaper, the invention is however not restricted thereto. In a preferred embodiment, the method thus provides a method to product flexible wall coverings, more preferably wallpaper or the likes of such. The flexibility of the product adds different difficulties in the production of it as opposed to (semi-)rigid wall coverings, since extra actions need to be undertaken to ensure that the supplied substrate layer (and further intermediate products) is supplied in a taut fashion, which is unnecessary when dealing with (semi-)rigid substrate layers. Every deviation of a perfectly taut substrate layer will result in a distorted embossed pattern and/or a distorted print pattern, since these will be supplied at high speed past the digital printing device, which necessarily will need to work very fast and accurate, with no margin for errors as this would render a length of the produced wall covering useless. Furthermore, the flexible wall coverings are produced on an essentially endless substrate layer, as opposed to rigid wall coverings that are produced unit per unit. An endless production process can run at far greater speeds, bringing along very different technically difficulties (greater speed demands more accuracy in printing and embossment application for instance) to be tackled.

[0025] The coating preferably has a coating thickness. With the term "coating thickness" as used herein, the thickness of the coating is meant as measured along a direction which is substantially perpendicular to the plane of the substrate layer onto which the coating is applied. Due to the presence of the embossed pattern in the coating, the coating thickness will vary depending on the position on the coating, i.e. will be smaller due to e.g. local depressions, valleys, etc. created by the embossed pattern and will be larger e.g. where locally there is no embossed pattern provided in the coating. Preferably, the maximum depth of the embossed pattern is determined by the difference between the maximum coating thickness and the minimum coating thickness of the coating.

[0026] Studies have shown that by limiting the maximum depth of the embossed pattern to the values as provided herein, the visual appearance of the print pattern, which is directly applied on top of the embossed coating using a digital printing device, will not be influenced by the embossed pattern provided on the coating and hence, colour differences between different batches or within the same batch can be limited. If, on the other hand, the maximum depth of the embossed pattern were to exceed the values as provided herein, the print pattern provided in the "deeper" embossments, i.e. having a

depth exceeding the maximum value as provided herein, will have a significantly different appearance than the same print pattern provided in a less deep embossment and hence, would create visual colour differences, despite similar devices or inks being used to apply the print pattern. This way, a pre-embossed coating can be directly provided with a print pattern without the necessity of providing any additional ink receiving layers to the coating prior to applying the print pattern, as is now used in the prior art. This also significantly improves the flexibility of the method compared to prior art methods and allows wall coverings to be obtained that are more readily adaptable to the needs and wishes of a client.

[0027] Preferably, the coating according to the current invention has a bottom surface, which bottom surface is in contact with the top side of the substrate layer, and a top surface, onto which top surface the embossed pattern is provided. When it is referred to that the print pattern is directly applied on top of the embossed coating, it is preferably meant that the print pattern is directly applied on the embossed top surface of the coating.

[0028] In a preferred embodiment, the print pattern is provided on top of the embossed coating by a wet-on-wet printing technique, preferably in a single pass, meaning that all the different inks are deposited on the coating in one single movement of the printheads. Providing the printing pattern in a single pass has the advantage that the printing process is more time efficient, especially when it's done wet-on-wet. A wet-on-wet printing process does not require drying time for the ink before the next ink can be deposited.

[0029] A wet-on wet printing technique has the advantage that the printheads can be placed close to each other because no drying or curing time is required between the depositions of different inks. This has the advantage that the overall printing array can be kept small and compact. During drying or curing of certain types of ink, gasses can be released from that ink. These gasses can get in contact with the print heads, disturbing the working of said printheads. The smaller the print array, the less contact between the gasses released by drying or curing and the array and the less problems that the gasses can cause.

[0030] In a preferred embodiment the gasses caused by drying or curing of ink are extracted during printing. Extracting the gasses causes the less interference of the gasses with the printing array and printheads.

[0031] In a preferred embodiment the print pattern is provided by colour inks and special effects inks. Preferably the colour inks comprise the, in the art standard colours for printing, namely cyan, magenta, yellow and black, also known as CMYK. Additionally other colour inks can be included. The special effect inks are inks that provide optical or mechanical properties to a substrate when printed that is not possible by colour inks alone.

[0032] The term "special effect" refers to glitter, metallic, magnetic, ceramic, polymeric, odour and flavour, glossy, matt, pearl, fluorescent, phosphorescent, elec-

troluminescent, electrical or thermal conductive, transparent, anti-static, adhesive, anti-bacterial, anti-corrosive, scratch resistant, anti-graffiti, anti-climb, or sound-absorbing effect.

[0033] In a preferred embodiment the ink is deposited on the coating in a thin layer, this layer has a maximum thickness when wet of 0.0 to 60.0 μm , more preferably 5.0 to 40.0 μm , even more preferably 10.0 to 20.0 μm . A thin wet ink layer results in a high resolution when dried or cured. Ink deposited by inkjet printing has a low viscosity, causing the ink to flow easily. Especially on an embossed surface, where parts of the surface are sloped, gravity will cause ink to flow. The thinner the layer of ink, the less the ink has the tendency to flow, resulting in a higher resolution after drying or curing.

[0034] The substrate layer according to the present invention may be any substrate layer known in the art for the production of wall coverings. Preferably, the substrate layer comprises paper, a non-woven, plastic, cellulose and/or cardboard. According to a preferred embodiment, the substrate layer comprises paper. According to another preferred embodiment, the substrate layer comprises a non-woven.

[0035] According to a preferred embodiment, the substrate layer has a weight between about 40 and about 200 g per m^2 of substrate layer, more preferably between about 50 and about 150 g per m^2 of substrate layer, most preferably between about 60 and about 130 g per m^2 of substrate layer. Such weights allow to produce a firm and robust wall covering without the wall covering being too heavy or too difficult to be applied to a wall, ceiling, etc. by a user or a craftsman.

[0036] The digital printing device may be any type of digital printing device known in the art such as a digital inkjet printing device, a digital laser printing device, etc. In a preferred embodiment, the digital printing device is a digital inkjet printing device.

[0037] In such inkjet printing devices, tiny drops of ink are typically projected directly onto an ink receptor surface, for example an embossed coating, without physical contact between the printing device and the receptor. Typically one or more printheads are used to deposit the droplets on the coating. The printing device typically stores the printing data electronically and controls a mechanism for ejecting the drops imagewise. Printing may be accomplished by moving e.g. a print head across the receptor or vice versa. Preferably, the provision of a print pattern on the embossed coating according to the present invention occurs by moving the substrate layer, comprising the embossed coating, relative to the printing device and not by moving the printing device, e.g. print head(s), relative to the substrate layer.

[0038] Inkjet printing devices generally are of two types which are known in the art: continuous stream and drop-on-demand. Preferably, the digital printing device is a digital drop-on demand inkjet printing device, preferably comprising at least one print head. Preferably, said one print head is piezo-electrically controlled. Early patents

on inkjet printers include US 3739393 (MEAD CORP), US 3805273 (MEAD CORP) and US 3891121 (MEAD CORP). Digital inkjet printing devices that may be used according to the present invention include, but are not limited to, printing devices disclosed in WO 2010/150012, WO 2010/125129, EP 2 055 490 or WO 2008/065411.

[0039] In a more preferred embodiment the printheads are recirculating printheads, more preferably recirculating piezo-drop-on-demand print heads. The recirculation keeps constantly ink flowing through the printhead, thereby preventing the printhead to dry out and getting blocked. An extra advantage is that shorter drying times can be achieved as solvents in the ink can be used with a higher vapour pressure without blocking the printhead due to evaporation.

[0040] Any type of ink known in the art may be used in the digital printing device of the current invention. Preferably, the ink according to the current invention is suitable for application in a digital inkjet printing device. Ink compositions for inkjet printing devices typically include following ingredients: dyes or pigments, water and/or organic solvents, humectants such as glycols, detergents, thickeners, polymeric binders, preservatives, etc. It will be readily understood that the optimal composition of such ink is dependent on the inkjet printing device used and on the nature of the ink-receiver to be printed. The ink compositions can be roughly divided in: water-based inks, the drying mechanism involving absorption, penetration and evaporation; oil-based inks, the drying involving absorption and penetration; solvent-based inks, the drying primarily involving evaporation; hot melt or phase change, in which the ink is liquid at the ejection temperature but solid at room temperature and wherein drying is replaced by solidification; UV-curable, in which drying is replaced by polymerization. Any of these ink-types may be used separately or combined in order to provide a print pattern according to the present invention. Preferably, the print pattern is provided on the embossed coating by applying between about 5 and about 20 g/m² of ink, more preferably between about 6 and about 18 g/m² of ink, even more preferably between about 7 and about 16 g/m² of ink, even more preferably between about 8 and about 14 g/m² of ink, even more preferably between about 9 and about 12 g/m² of ink, most preferably between about 10 and about 11 g/m² of ink.

[0041] In a preferred embodiment the printing device comprises colour ink printheads and special ink printheads. In a more preferred embodiment the printing device comprises 4 colour ink printheads, one for cyan ink, one for magenta ink, one for yellow ink and one for black ink.

[0042] In a preferred embodiment the special effect ink comprises particles. These particles provide the special effect. Preferably, the particles are rounded, with have a diameter between 2.00 and 100.00 μm , preferably 4.00 to 70.00 μm , more preferably 6.00 to 25.00 μm , even more preferably 7.50 to 15.00 μm and most preferably 10.00 to 12.50 μm . The larger the particle, the larger the

special effect but also the larger the tendency for the special effect ink to block the printhead. The use of a recirculating printhead prevents the blocking of the printhead, especially when a larger than standard nozzle is used, like a nozzle with a diameter of 15 to 150 μm , preferably 25 to 100 μm , more preferably 35 to 45 μm . The constant movement of the ink in the printhead prevents the particles to precipitate. When the particle size becomes too large, hence the upper limit, even the use of a recirculating printhead can't prevent the printhead from blocking. As previously stated, the larger the particles, the larger the special effect. This implies that a less concentrated ink can be used when using large particles to obtain the same special effect as when an ink is used with smaller particles. Eventually, larger particles will allow the ink to be deposited in a thinner layer than ink with smaller particles and still lead to the same special effect.

[0043] In a preferred embodiment the special effect ink comprises rounded but flattened shape, the particles have a diameter between 2.00 and 100.00 μm , preferably 4.00 to 70.00 μm , more preferably 6.00 to 25.00 μm , even more preferably 7.50 to 15.00 μm and most preferably 10.00 to 12.50 μm and a height of 0.01 to 1.20 μm , preferably 0.05 to 0.80 μm , more preferably 0.09 to 0.50 and most preferably 0.13 to 0.20 μm . When deposited, these particles will orient themselves in the still wet ink layer and form a less thick layer than when spherical particles are used.

[0044] In a preferred embodiment the particles are metallic particles. These metallic particles result in a metallic effect. The ink provides after drying or curing, a metal like appearance. The metal particles can also be used to print electrical conductor or even an electrical circuit. In a more preferred embodiment, the metallic particles are said special effect ink are aluminium filings. The advantage of aluminium is that when aluminium oxidises, on the surface a layer of aluminium oxide is formed and this layer stops the further oxidation of aluminium. Even with this aluminium oxide layer on the surface, the look of aluminium remains metallic. The aluminium filings provide a metallic silver appearance. The colour of the metallic effect can be changed by applying transparent colour ink on top of the metallic ink. In the art, metallic inks are available, but these have metallic particles with a diameter below 2 μm in an effort to stop blockage of a non-recirculating printhead.

[0045] In a preferred embodiment the particles are sparkling particles, glitter particles, pearl particles, glossy particles, matt particles, magnetic particles, ceramic particles, polymeric particles, particles with a high refractive index or zeolite particles. All these kind of particles can cause an effect that is not possible to achieve with colour inks, and hence these particles cause a special effect.

[0046] In a more preferred embodiment the particles are glitter particles, metallic particles or ceramic particles.

[0047] In a preferred embodiment, the print pattern is provided on the embossed coating using a solvent-based ink. Such solvent-based inks are usually more compati-

ble with the thermoplastic material of the coating, such as for example polyvinyl chloride, as compared to e.g. water-based inks and hence will result in a better print quality. Preferably, the ink is an anti-clogging ink.

[0048] In a preferred embodiment, the print pattern provided on the wall covering comprises a resolution of at least 250 dpi. Preferably the print pattern comprises a resolution of from about 250 dpi to about 650 dpi, most preferably of from about 300 dpi to about 600 dpi.

[0049] In a preferred embodiment is the resolution of the print pattern provided by colour inks different than the resolution of the print pattern provided by special effect inks. More preferably is the resolution of the print pattern provided by the colour inks higher than the resolution of the print pattern provided by special effect inks. This has the advantage that a larger nozzle can be used in the special effect printhead than in the colour printhead. The colour part will still provide a high resolution and therefore a high image quality. The use of a large nozzle allows inks to be used comprising larger particles, i.e. particles with a diameter between 2.00 and 100.00 μm , preferably 4.00 to 50.00 μm , more preferably 6.00 to 25.00 μm , even more preferably 7.50 to 15.00 μm and most preferably 10.00 and 12.50 μm .

[0050] After providing a print pattern directly on top of the embossed coating, the print pattern is preferably subjected to a post-treatment in order for it to properly adhere to the embossed coating. Such post-treatment may be for example a heat treatment, a UV-curing treatment, etc. In a preferred embodiment, the print pattern is subjected to a heat treatment. If a solvent-based ink is used to apply the print pattern on the embossed coating, such heat treatment will result in the evaporation of the solvent of the ink and hence in its adherence to the coating. Preferably, the wall covering (more specifically a section thereof) with the print pattern is subjected to such heat treatment as soon as possible after the application of the print pattern to remove solvents (which typically represent the bulk of the ink) before part of the solvents can settle and the ink dries and encapsulates part of these. Preferably, a temperature between about 110 and about 160 °C is used during the heat treatment, more preferably a temperature between about 120 and about 150 °C, most preferably between about 125 and about 145 °C. Preferably, said heat treatment comprises an infrared heat treatment. Such heat treatment can be directed to the top side of the wall covering after application of the print pattern, but a second heat treatment can also be directed to the back side of the wall covering. This can be achieved by moving the substrate layer with the print pattern applied through a heating system, such as an IR heating system, or similar. Optionally, the wall covering can be moved through such a heating system in a zigzag path, thus allowing the wall covering to remain exposed to the heat for a desired period of time, and ensuring that both sides of the wall covering are sufficiently exposed. Preferably, an airflow is induced in the heating system to further improve the adherence of the ink, for instance

by one or more ventilators or fans.

[0051] In a preferred embodiment, the post-treatment is performed in a different zone, a post-treatment zone, from the printing itself, in a printing zone. The zones are separated from each other in a way that gasses released during post treatment are not entering the printing zone. This has the advantage that the printheads are exposed to less gasses caused by drying or curing of the ink.

[0052] Even in a more preferred embodiment, the substrate and coating are preheated in a preheating zone, which is separated in a way that gasses released during the preheating are not entering the printing zone. This way gasses that are released from the coating or substrate do not interfere with the printheads.

[0053] In one embodiment, the print pattern comprises glitter particles, metallic particles and/or ceramic particles. Such particles may influence the optical appearance of the print pattern and camouflage any potential colour differences within the same production batch or between different batches of wall coverings comprising a similar colour print pattern. Preferably, the particles comprise a particle size between about 0.1 and about 100 μm , more preferably between about 0.5 and about 75 μm , most preferably between about 1 and about 50 μm . Particles of such size are more readily applicable on a coating using a digital printing device. Such particles may also provide additional surface texture to the coating, i.e. in addition to the embossed pattern.

[0054] As mentioned before, the provision of a print pattern on the embossed coating according to the present invention preferably occurs by moving the substrate layer, comprising the embossed coating, relative to the printing device and not by moving the printing device, e.g. print head(s), relative to the substrate layer. In a preferred embodiment, when the print pattern is directly provided on top of the embossed coating, the substrate layer is provided at a relative speed, as compared to the digital printing device, of between 15 and 60 meters of substrate layer per minute along the longitudinal dimension. More preferably, the substrate layer is provided at a relative speed, as compared to the digital printing device, of between about 18 and about 55 meters of substrate layer per minute, even more preferably between about 20 and about 50 meters of substrate layer per minute, most preferably between about 24 and about 48 meters of substrate layer per minute along the longitudinal dimension. The speed of the substrate layer is optimized in order to allow the substrate layer, with the embossed coating provided thereon, to be printed at a sufficient high rate, allowing an optimal production efficiency of the wall covering, while still maintaining a high print quality and print efficiency of the digital printing device on the embossed coating. It is crucial that the substrate layer, while moving, remains taut for the printing to be executed correctly.

[0055] Preferably, when the print pattern is directly provided on top of the embossed coating, the substrate layer is provided with a carrier means which is essentially end-

less along the longitudinal dimension of the substrate layer, whereby the carrier means has a contact surface, which contact surface is in contact with the back side of the substrate layer. Preferably, the relative speed between the contact surface of the carrier means and the substrate layer is essentially zero. Preferably, the contact surface of the carrier means has a relative speed, as compared to the digital printing device, of between about 15 and about 60 meters of contact surface per minute along the longitudinal dimension of the substrate layer. More preferably, the contact surface of the carrier means is provided at a relative speed, as compared to the digital printing device, of between about 18 and about 55 meters of contact surface per minute, even more preferably between about 20 and about 50 meters of contact surface per minute, most preferably between about 24 and about 48 meters of contact surface per minute along the longitudinal dimension of the substrate layer. In a preferred embodiment, a vacuum is applied to the back side of the substrate layer while the print pattern is provided to the embossed coating. In order to provide a high quality print pattern on the embossed coating, it is detrimental that the coating is positioned correctly compared to the digital printing device which is used to provide the print pattern on the embossed coating. For example, the relative distance between the substrate layer and the digital printing device, as measured along a direction which is substantially perpendicular to the plane of the substrate layer, may alter during application of the print pattern, for example due to displacement of the substrate layer, which will significantly influence the print quality. Moreover, this risk of displacement even increases when the substrate layer with the embossed pattern is provided at a certain relative speed as compared to the digital printing device along the longitudinal dimension of the substrate layer. By applying a vacuum to (a region or over a length of) the back side of the substrate layer, the positioning of the substrate layer as compared to the digital printing device and hence, simultaneously also of the embossed coating provided on the substrate layer, can be more readily controlled.

[0056] Preferably, the digital printing device is positioned near the top side of the substrate layer in a printing zone, whereby a vacuum is provided to the back side of the substrate layer near the printing zone to allow a correct positioning of the substrate layer compared to the digital printing device. Preferably, the vacuum applied to the back side of the substrate layer will significantly reduce the relative displacement of the substrate layer as compared to the printing device in at least one direction substantially perpendicular to a longitudinal direction, which longitudinal direction runs along the longitudinal dimension of the substrate layer. With the term "significantly reduce" it is preferably meant that the relative displacement of the substrate layer as compared to the printing device in at least one direction substantially perpendicular to the longitudinal direction is reduced by at least 10 % as compared to the situation where no vacuum is

applied to the back side of the substrate layer, more preferably at least 20 %, even more preferably at least 30 %, most preferably at least 50 %.

[0057] Preferably, the vacuum applied to the back side of the substrate layer is provided through aid of a substrate layer supporting element which supporting element has an upper surface and a lower surface, which supporting element supports the substrate layer whereby the upper surface of the supporting element is in contact with the back side of the substrate layer. The supporting element hereby preferably allows air to penetrate from its upper surface to its lower surface, and vice versa, which allows a vacuum to be applied to the back side of the substrate layer through the supporting element, for example by positioning a vacuum chamber near the lower surface of the supporting element. The supporting element may allow the penetration of air through means of, for example, the presence of one or more perforations in the supporting element, or because the supporting element comprises a material which allows such air penetration. In a preferred embodiment, the supporting element comprises one or more perforations to allow the penetration of air from its upper surface to its lower surface, and vice versa. By applying a vacuum at the back side of the substrate layer through means of the above described substrate layer supporting element, the substrate layer is sucked against the upper surface of the supporting element by means of the vacuum and thus is kept in the correct position while a print pattern is provided to the embossed coating at the top side of the substrate layer. The relative speed between the supporting element and the digital printing device along the longitudinal dimension of the substrate layer may be essentially zero or may be larger than zero. In a preferred embodiment, the relative speed between the supporting element and the digital printing device is essentially zero along the longitudinal dimension of the substrate layer. It is also plausible that the supporting element corresponds to a carrier means for the substrate layer, for example a carrier means as described above, whereby the carrier means comprises e.g. a material which allows air penetration or which comprises one or more perforations in order to be able to provide a vacuum to the back side of the substrate layer. In such a case, the relative speed between the supporting element and the digital printing device along the longitudinal dimension of the substrate layer is preferably higher than zero.

[0058] Preferably, the pressure used to apply a vacuum to the back side of the substrate layer is optimized in order to allow a correct positioning of the substrate layer compared to the digital printing device, while still allowing a relative movement of the substrate layer, as compared to the digital printing device, along the longitudinal dimension of the substrate layer. Preferably, the vacuum is applied at a pressure between about 0.02 MPa and about 0.09 MPa, and more preferably at a pressure between about 0.05 MPa and about 0.08 MPa.

[0059] A possibility to ensure the tautness of the sub-

strate layer is applying longitudinal strain or tensile force over at least the part of the substrate layer that is to be printed. Preferably this is applied over a lateral cross-section of the substrate layer. In a more preferred embodiment, the substrate layer supporting element is at least partially (smoothly) concave (or convex) along a longitudinal axis and preferably levelled laterally (with respect to the substrate layer). This allows the substrate layer to be provided tautly by exerting limited strain, while the curve of the supporting element makes it easier for the substrate layer to adhere to the top side of the supporting element (furthermore without possibly damaging the substrate layer as could be the case in straight supporting elements to optimally ensure the tautness). The substrate layer supporting element can be in a possible embodiment be seen as a curved bed over which the substrate layer is moved. Optionally, this curved bed as a supporting element can furthermore be provided with the aforementioned option of applying a vacuum to the back side of the substrate layer. It stands to reason that the printing device can be adapted to deal with a curved substrate layer supporting element.

Note that several of the aforementioned measures can be combined.

[0060] In a preferred embodiment, the maximum tensile force applied to the substrate layer comprises a value equal to or less than about 5 Newton, more preferably equal to or less than about 4 Newton, most preferably equal to or less than about 3 Newton. The term "tensile force" is a term known in the art and herein refers to a stretching force (tension) pulling the substrate layer both along and against the longitudinal dimension. Studies have shown that if a tensile force higher than the values provided herein is applied to the substrate layer, the microscopic structure of both the substrate layer and of the coating provided on the substrate layer gets significantly modified and will affect the visual appearance of the print pattern provided on top of the coating and hence, will result in diverging results between different batches or within the same production batch. Moreover, a too high tensile force also increases the risk that the substrate layer might rupture at certain points, which reduces the overall quality of the final wall covering.

[0061] The surface of the embossed coating, onto which the print pattern is to be applied, may be modified prior to and/or during the provision of a print pattern thereon. For example, the surface energy of the embossed coating may be modified in such a manner that the surface energy difference between the surface energy of the embossed coating and the surface energy of the ink which is e.g. used to provide the print pattern to the embossed coating, may be altered and controlled. By altering this surface energy difference, the tendency of the ink to spread over the surface of the embossed coating when applied thereon can be tuned, and hence, the print quality and resolution of the print pattern can be controlled. Surface treatments that may be used according to the present invention include a flame treatment, a corona

treatment, a plasma treatment, and/or a liquid treatment. In a preferred embodiment, the embossed coating is subjected to a corona treatment and/or a humidification treatment before and/or during the application of the print pattern, preferably to alter the surface energy of the embossed coating. Further, the above described surface treatments may also be used in order to allow a stronger adherence of the print pattern to the coating.

[0062] It should be noted that when used herein, surface tension and surface energy refer to equivalent parameters. The surface tension of a liquid is defined as the force acting on a unit length of the surface and is expressed in mN/m, whereas surface energy of a solid is the energy needed to create a unit area of interface and is expressed in mJ/m². These dimensions are equivalent: mN/m x m/m = mJ/m². For consistency in disclosing the present invention, the term surface energy of an ink will be used instead of the term surface tension of an ink.

[0063] The embossed pattern may be provided to the coating using any type of embossing technique known in the art such as mechanical embossing techniques or chemical embossing techniques. Preferably, the embossing pattern is provided to the coating using a mechanical embossing technique. In such mechanical embossing technique, an embossed pattern is preferably applied in the coating by means of an embossing element which is pressed into the coating, optionally using heat to aid the pressure process. The embossing element typically comprises a pattern which is the negative/positive of the embossing pattern that is to be applied to the coating.

[0064] The thermoplastic material of the coating can be any thermoplastic polymer material known in the art that can be used as coating material in wall coverings and includes, but is not limited to, vinyl containing thermoplastics such as polyvinyl chloride, polyvinyl acetate, polyvinyl alcohol, and other vinyl and vinylidene resins and copolymers thereof; polyolefins such as polyethylenes and encompassing low density polyethylenes and high density polyethylenes, and polypropylenes, and copolymers thereof (which are environmentally friendly, cheap and have a high potential for mechanical recycling, and furthermore the elastic modulus of these materials can be changed to suit a particular desire by using plasticizers); styrenes such as ABS, SAN, and polystyrenes and copolymers thereof; saturated and unsaturated polyesters; acrylics; polyamides such as nylon containing types; engineering plastics such as acetyl, polycarbonate, polyimide, polysulfone, and polyphenylene oxide and sulfide resins and the like; polyurethanes. In a preferred embodiment, the thermoplastic materials comprises polyvinyl chloride. The term "polyvinyl chloride" as used in the present invention does not only refer to the polymer polyvinyl chloride, but also to derivatives of polyvinyl chloride, such as polyvinylidene chloride, polyvinyl acetate, polyacrylate, polymethacrylate and/or combinations thereof. Preferably, the term "polyvinyl chloride" refers to the polymer polyvinyl chloride.

[0065] According to the invention, the coating is applied to the substrate layer by providing between 50 and 400 g of a coating composition per m² substrate layer to the top side of the substrate layer, more preferably between about 100 and about 300 g of a coating composition per m² substrate layer, even more preferably between about 125 and about 275 g of a coating composition per m² substrate layer, most preferably between about 150 and about 250 g of a coating composition per m² substrate layer. Preferably, the coating composition is applied in a substantially uniform manner to the substrate layer, meaning that the coating composition is applied to substantially the entire top side surface of the substrate layer.

[0066] Preferably, the coating composition comprises polyvinyl chloride, a blowing agent, a plasticizer, a dispersing agent, a diluent, a filler and/or a stabilizer.

[0067] Alternatively, the ink comprises at least one blowing agent, as defined above. The coating can thus be provided (in an embossed pattern), the ink however causes the foaming itself upon application on the coating and creates the actual embossments. In this case, preferably the coating comprises a polyolefin material.

In a preferred embodiment, the coating composition comprises polyvinyl chloride. Preferably, the coating composition comprises between about 20 to about 80 weight percent of polyvinyl chloride. In a more preferred embodiment, the coating composition comprises between about 20 to about 75 weight percent of polyvinyl chloride, even more preferably between about 20 and about 70 weight percent polyvinyl chloride, most preferably between about 25 and about 65 weight percent of polyvinyl chloride. Polyvinyl chloride is preferably used in the coating composition because it offers many advantages such as for example its easy processability and applicability as a coating material to a substrate layer. Further it is known for its isolating properties, both for heat and sound, and because it makes the final wall covering more readily washable compared to other polymer materials.

[0068] The coating composition preferably comprises a blowing agent, more preferably comprises between about 0 to about 5 weight percent of a blowing agent. As used herein, the term "blowing agent", also sometimes referred to as "foaming agent", refers to a compound that is capable of forming a cellular structure in a wide variety of materials, such as a coating, through a foaming process. The formation of such cellular structure typically results in an expansion of the material, thereby decreasing the density of the material. The blowing agent used in the present invention may include at least one selected from a chemical blowing agent, a physical blowing agent, or a mixture thereof.

[0069] Examples of physical blowing agents include carbon dioxide, nitrogen, argon, water, air, helium, or the like, and/or an organic blowing agent such as aliphatic hydrocarbons containing 1 to 9 carbon atoms, such as methane, ethane, propane, n-butane, isobutene, n-pentane, isopentane, neopentane, etc.; aliphatic alcohols

containing 1 to 3 carbon atoms, such as methanol, ethanol, n-propanol, isopropanol, etc.; and halogenated aliphatic hydrocarbons containing 1 to 4 carbon atoms, such as methyl fluoride, perfluoromethane, ethyl fluoride, 1,1-difluoroethane, pentafluoroethane, difluoromethane, perfluoroethane, 2,2-difluoropropane, 1,1,1-trifluoropropane, perfluoropropane, dichloropropane, difluoropropane, perfluorobutane, perfluorocyclobutane, methyl chloride, methylene chloride, ethyl chloride, etc., and/or combinations and/or derivatives thereof.

[0070] Preferably, the blowing agent comprises a chemical blowing agent. As the chemical blowing agent, any compound is not particularly limited as long as the compound may be decomposed at a specific temperature or more to generate gas and thus form a cellular structure, and an example thereof may include azodicarbonamide, azodi-isobutyro-nitrile, benzenesulfonhydrazide, 4,4-oxybenzene sulfonyl-semicarbazide, p-toluene sulfonyl semicarbazide, barium azodicarboxylate, N,N'-dimethyl-N,N'-dinitrosoterephthalamide, trihydrazino triazine, sodium bicarbonate, potassium bicarbonate, ammonium bicarbonate, sodium carbonate, ammonium carbonate, and/or combinations and/or derivatives thereof.

[0071] The blowing agent preferably becomes "active", i.e. starts forming a cellular structure in the coating, when it is exposed to heating. Depending on the amount and type of blowing agent in the coating composition, the density of the resulting coating will be larger or smaller, which will also influence the colour appearance of the print pattern on the coating. The amount and type of blowing agent in the coating composition may so indirectly influence the appearance of the print pattern. The amount of residual non-reacted blowing agent can, depending on the type of blowing agent, also influence the final colour. In a preferred embodiment, the coating composition comprises between about 0.1 and about 4.5 weight percent of blowing agent, more preferably between about 0.2 and about 4 weight percent of blowing agent, even more preferably between about 0.5 and about 3 weight percent of blowing agent, most preferably between about 1 and about 2 weight percent of blowing agent.

[0072] Alternatively, the chemical blowing agent becomes "active" by contact with a catalyst that initiates the foaming process. Preferably, the ink (or at least, the ink applied at certain regions) functions as such a catalyst (or comprises such a catalyst), ensuring that the foamed embossments are provided at the correct position on the wall covering.

[0073] The coating composition preferably comprises a plasticizer, more preferably comprises between about 5 to about 40 weight percent of a plasticizer. The term "plasticizer" as used herein refers to a compound that will increase the plasticity or fluidity of a material, typically a polymer. This will cause the coating composition to be more readily applicable to a substrate layer. The plasticizer can be any conventional plasticizer known in the art and comprises, but is not limited to, phthalate-based

plasticizers, trimellitate-based plasticizers, adipate-based plasticizers, sebacate-based plasticizers, maleate-based plasticizers, benzoate-based plasticizers, dibenzoate-based plasticizers, terephthalate-based plasticizers, hydrogenated derivatives of the previous and/or any combination of the previous.

[0074] In preferred embodiment, the composition comprises between about 8 and about 38 weight percent of a plasticizer, more preferably between about 15 and about 35 weight percent of a plasticizer, most preferably between about 20 and about 30 weight percent of a plasticizer.

[0075] The coating composition preferably comprises a dispersing agent, more preferably comprises between about 0.01 to about 5 weight percent of a dispersing agent. The term "dispersing agent" as used herein refers to a component that improves the dispersion of solids in a composition. Preferably, the dispersing agent will improve the dispersion of polyvinyl chloride, and of pigments and the filler in the composition, when present. A better dispersion and stabilization will increase the covering properties of the coating on the substrate layer and thus will reduce the influence of the substrate layer on the colour appearance of the print pattern. Dispersing agents are typically surfactants and comprise, but are not limited to alcohol ethoxylates, oxo-alcohol ethoxylates, alcohol ethoxysulphates, alkylphenol-ethoxylates, amine- and -amide-ethoxylates, alkyl polyglucosides and/or combinations thereof. In a preferred embodiment, the coating composition comprises between about 0.05 and about 4 weight percent of a dispersing agent, more preferably between about 0.1 and about 3 weight percent of a dispersing agent, most preferably between about 0.2 and about 2 weight percent of a dispersing agent.

[0076] The coating composition may comprise at least one diluent, more preferably may comprise between about 0 to about 5 weight percent of at least one diluent. With the term "diluent" as used herein, a component is meant which reduces the viscosity of a composition. This further contributes to a better applicability of the composition to the substrate layer in order to form a coating. Non-limiting examples of diluents include water, alkanes, toluene, xylene, methyl isobutyl ketone, isopropyl alcohol, acetone, isobutyl alcohol, butanone, turpentine, fatty acid esters and/or derivatives and/or combinations thereof. In a preferred embodiment, the coating composition comprises between about 0 and about 4 weight percent of a diluent, more preferably between about 0 and about 3 weight percent of a diluent, most preferably between about 0 and about 2 weight percent of a diluent.

[0077] The coating composition preferably comprises a filler, more preferably comprises between about 0.01 to about 40 weight percent of a filler. The term "filler" as used herein refers to a component that can improve the properties of the composition by improving the structure or texture of the composition and/or by reducing the overall cost of the composition. Fillers may thus reduce the overall cost to produce the coating and/or enhance the

covering properties of the coating. Examples of suitable fillers include calcium/magnesium carbonate, talc, kaolin, silica, alumina, magnesium hydroxide, clay and/or combinations thereof. In a preferred embodiment, the coating composition comprises between about 0.02 and about 38 weight percent of a filler, more preferably between about 0.05 and about 35 weight percent of a filler, most preferably between about 0.1 and about 30 weight percent of a filler.

[0078] The coating composition preferably comprises a stabilizer, more preferably comprises between about 0.1 to about 5 weight percent of a stabilizer. The term "stabilizer" as used herein refers to a component that can increase the stability of a thermoplastic material, preferably of polyvinyl chloride, and/or that can increase the activity of the blowing agent, when present. The stabilizer can for example inhibit that HCl is liberated from polyvinyl chloride and form polyenes, which will influence the colour of the coating and thus, indirectly, also will influence the colour of the print pattern. Further, it can result in an increased foaming activity of the blowing agent, when present, and thus simultaneously influence the density of the coating. A suitable stabilizer includes, but is not limited to, Ca-Zn based compounds, K-Zn based compounds, Ba-Zn based compounds, organic Tin based compounds, metallic soap based compounds, phenolic compounds, phosphoric acid ester based compounds, and phosphorous acid ester based compounds. Specific examples of a stabilizer that may be used in the present invention include Ca-Zn based compounds; K-Zn based compounds; the Ba-Zn based compounds; organic Tin based compounds such as mercaptide based compounds, maleic acid based compound, or carboxylic acid based compound; the metallic soap based compounds such as Mg-stearate, Ca-stearate, Pb-stearate, Cd-stearate, or Bastearate, and the like; the phenolic compounds; the phosphoric acid ester based compounds; the phosphorous acid ester based compounds, and the like, and these stabilizers may be selectively contained according to the using purposes. In a preferred embodiment, the coating composition comprises between about 0.2 and about 4 weight percent of a stabilizer, more preferably between about 0.3 and about 3 weight percent of a stabilizer, most preferably between about 0.5 and about 2 weight percent of a stabilizer.

[0079] In a preferred embodiment, the coating composition according to the present invention, used to provide a coating to the substrate layer, preferably comprises the following components:

- 20-80 weight percent of polyvinyl chloride;
- 0-5 weight percent of a blowing agent;
- 5-40 weight percent of a plasticizer;
- 0.01-5 weight percent of a dispersing agent;
- 0-5 weight percent of a diluent;
- 0.01-40 weight percent of a filler; and
- 0.1-5 weight percent of stabilizer,

whereby the total sum of all components in the coating composition comprises 100 weight percent.

[0080] The combination of the different components in the coating composition allow it to sufficiently cover the substrate layer in order to prevent possible interactions between the substrate layer and the print pattern that may cause colour differences.

[0081] According to a more preferred embodiment, the coating composition comprises the following components:

- 20-75 weight percent of polyvinyl chloride;
- 0.2-4 weight percent of a blowing agent;
- 8-38 weight percent of a plasticizer;
- 0.05-4 weight percent of a dispersing agent;
- 0-4 weight percent of a diluent;
- 0.02-38 weight percent of a filler; and
- 0.2-4 weight percent of stabilizer,

whereby the total sum of all components in the coating composition comprises 100 weight percent.

[0082] According to an even more preferred embodiment, the coating composition comprises the following components:

- 20-70 weight percent of polyvinyl chloride;
- 0.5-3 weight percent of a blowing agent;
- 15-35 weight percent of a plasticizer;
- 0.1-3 weight percent of a dispersing agent;
- 0-3 weight percent of a diluent;
- 0.05-35 weight percent of a filler; and
- 0.3-3 weight percent of stabilizer,

whereby the total sum of all components in the coating composition comprises 100 weight percent.

[0083] According to a most preferred embodiment, the coating composition comprises the following components:

- 25-65 weight percent of polyvinyl chloride;
- 1-2 weight percent of a blowing agent;
- 20-30 weight percent of a plasticizer;
- 0.2-2 weight percent of a dispersing agent;
- 0-2 weight percent of a diluent;
- 0.1-30 weight percent of a filler; and
- 0.5-2 weight percent of stabilizer,

whereby the total sum of all components in the coating composition comprises 100 weight percent.

[0084] It is possible that the top side of the substrate layer may be provided with one or more additional layers prior to providing the coating to the top side of the substrate layer, the one or more layers thus being positioned between the substrate layer and the coating. Such additional layers may, for example, improve the adherence between the coating and the substrate layer, provide better isolating properties to the final wall covering, etc.

[0085] The coating according to the present invention

may also comprise components or additives other than the ones described above. For example, the coating may comprise one or more pigments. With the term "pigment", as used in the current invention, a compound is meant that can change the colour of reflected or transmitted light as the result of wavelength-selective absorption. This way, the coating can be provided with a certain colour, depending on the desired wall covering. This also influences the colour perception of the print pattern provided on the coating and thus will influence potential colour differences that may arise within a production batch or between different production batches of wall coverings comprising a similar colour print pattern. The pigment may comprise any type of pigment known in the art and may comprise inorganic pigments, metal-based pigments and/or organic pigments. In a preferred embodiment, the coating composition comprises titanium dioxide as pigment. This component provides the coating with a substantially white colour and improves the opacity of the coating, i.e. it will cause the coating to be less transparent, which influences the colour perception of the print pattern. Further, the coating composition may comprise fire retarding agents such as, but not limited to antimony(III)oxide, aluminium trihydrate, magnesium hydroxide, etc. and/or combinations thereof. Such fire retardant agents provide the eventual wall covering with fire retardant properties and thus also the room, i.e. wall, ceilings, etc. where the wall covering is provided.

[0086] After providing a coating on the top side of the substrate layer, the substrate layer with coating can be used as such to provide it with an embossed pattern, or the substrate layer with coating can optionally undergo additional steps prior to providing an embossed pattern to the coating. The coating can for example be gelled after application of the coating, for example at a temperature between about 100 and about 200 °C, whereby the coating is typically brought from a viscous, semiliquid condition into a solid, non-sticky condition under the influence of heat which enables plasticizer absorption of polyvinyl chloride. Further, preferably when the coating composition used to apply the coating to the substrate layer comprises a blowing agent, the coating can undergo a foaming step, whereby the blowing agent is activated under the influence of heat to form a cellular structure in the coating. Typically, the coating will hereby expand and increase in thickness. This foaming step is preferably performed at a temperature between about 150 and about 250 °C. In one embodiment, after application of the coating composition, the substrate layer with the coating will be gelled and/or will undergo a foaming step prior to applying an embossed pattern to the coating.

[0087] After providing a print pattern directly on top of the embossed coating, the substrate layer with embossed coating and print pattern is preferably cut into the desired dimensions and further processed as is known in the art for conventional wall covering processing techniques, e.g. rolled, packaged, etc.

[0088] The current invention provides a flexible wall-

paper, produced by a method as described above. The wall covering hereby preferably comprises a length according to an x-axis, a width according to a y-axis, which y-axis is substantially perpendicular to the x-axis, and a thickness according to a z-axis, which z-axis is substantially perpendicular to the x-axis and the y-axis. The length of the wall covering is preferably significantly larger than the width of the wall covering, which width is preferably significantly larger than the thickness of the wall covering. In a preferred embodiment, the wall covering comprises a length, which length ranges between about 3 and about 20 m; a width, which width ranges between about 40 and about 150 cm. According to the invention, the thickness of the wallpaper ranges between about 0.1 and about 2.5 mm. More preferably, the length of the wall covering comprises a value between about 3 and about 20 m, more preferably between about 5 and about 15 m, even more preferably between about 9 and about 11 m, most preferably between about 9.90 and about 10.20 m. More preferably, the width of the wall covering comprises a value between about 50 and about 120 cm, most preferably between about 53 and 106 cm.

[0089] The thickness of the wall covering is preferably obtained by combining at least the thickness of the substrate layer, coating and print pattern, and optionally the thickness of any additional layers that may be present in the wall covering. Due to the embossed pattern provided on the coating, the thickness of the wall covering will preferably also vary depending on the position on the wall covering, i.e. will be smaller due to e.g. local depressions, valleys, etc. created by the embossed pattern in the coating and will be larger e.g. where locally there is no embossed pattern provided in the coating. In a preferred embodiment, the maximum wall covering thickness, i.e. the maximum thickness of the wall covering, will comprise a value of between 0.1 and 2.5 mm, even more preferably of between about 0.2 and about 1.5 mm, even more preferably of between about 0.3 and about 1.0 mm, even more preferably of between about 0.3 and about 0.9 mm, even more preferably of between about 0.35 and about 0.8 mm, most preferably of between about 0.33 and about 0.55 mm.

[0090] The present invention will be now described in more detail referring to examples and with reference to the figures.

[0091] Example 1: automated method to produce wallpaper according to an embodiment of the current invention.

[0092] A non-woven substrate layer (100 g/m²) was provided, which substrate layer was essentially endless along a longitudinal dimension and which substrate layer had a top side and a back side. A coating was provided on top of the substrate layer by applying 180 g of a coating composition per m² of substrate layer to the top side of the substrate layer. The coating composition hereby comprised the following components:

- 40 weight percent of polyvinyl chloride;

- 1.5 weight percent of a blowing agent;
- 25 weight percent of a plasticizer;
- 1 weight percent of a dispersing agent;
- 1 weight percent of a diluent;
- 15 weight percent of a filler;
- 1 weight percent of a stabilizer;
- 5.5 weight percent of titanium dioxide.

[0093] After applying the coating composition to the top side of the substrate layer, it was allowed to undergo a foaming step by subjecting it to a temperature of 180 °C during 15 seconds in order to activate the blowing agent in the coating composition and form a foamed coating on the top side of the substrate layer. After the foaming step, an embossed pattern was provided in the foamed coating using a mechanical embossing technique. The maximum depth of the embossed pattern provided in the coating comprised a value equal to about 0.6 µm. After providing the coating with an embossed pattern, a print pattern was provided to the embossed coating using a digital inkjet printing device, whereby 11 g/m² of solvent-based ink was applied to the embossed coating.

[0094] Figure 1 provides a schematic side view of how the print pattern was applied to the embossed coating according to example 1. It should be noted that the dimensions of the various devices and layers are exaggerated and enlarged for better understanding and are not in proportion.

[0095] Figure 1 displays a side view of the substrate layer (1) with a top side (2) and a back side (3) whereby a foamed coating (4) is provided on the top side of the substrate layer. The foamed coating is provided with an embossed pattern (6) and the coating has a coating thickness, measured along a direction (Z) which is substantially perpendicular to the plane of the top side of the substrate layer onto which the coating is provided, which varies depending on the position on the coating. The coating has a maximum coating thickness ($Z_{4,MAX}$) and a minimum coating thickness ($Z_{4,MIN}$) whereby the maximum depth of the embossed pattern ($Z_{6,MAX}$) was determined by the difference between the maximum coating thickness and the minimum coating thickness and comprised a value of about 0.6 µm. A digital inkjet printing device (7) provided a print pattern (5) on the embossed coating (schematically represented by the arrows underneath (7)). Though the print pattern is represented here as a significant continuous print pattern, i.e. covering substantially the entire embossed coating, this is not necessarily always the case and the print pattern may also be provided on only selected areas of the embossed coating (not shown). The substrate layer, with the foamed embossed coating provided thereon was provided at a relative speed, as compared to the digital printing device (7), of about 30 meters of substrate layer per minute along the longitudinal dimension (L) of the substrate layer.

[0096] While a print pattern was provided on the embossed coating, a vacuum was applied to the back side (3) of the substrate layer (1) through aid of a substrate

layer supporting element (8), which has an upper surface (9) and a lower surface (10), which upper surface was in contact with the back side of the substrate layer and thus supported the substrate layer. The relative speed of the substrate layer as compared to the supporting element was about 30 meters of substrate layer per minute along the longitudinal direction (L), i.e. similar as the relative speed compared to the digital inkjet printing device. The relative speed between the supporting element and the digital inkjet printing device thus was essentially zero along the longitudinal direction of the substrate layer. The supporting element comprised perforations (11) which allowed air to pass from the upper surface to the lower surface and vice versa. A vacuum chamber (12, indicated by the arrows) was connected to the lower surface of the supporting element, whereby a vacuum was applied to the back side of the substrate layer through means of the perforations provided in the supporting element. A pressure of about 0.07 MPa was thus provided to the back side of the substrate layer allowing to keep the substrate layer, with the foamed embossed coating provided thereon, in the correct position as compared to the digital inkjet printing device. The presence of the vacuum thus prevented that the distance between the substrate layer and the digital printing device, as measured along a direction which is essentially perpendicular to the plane of the substrate layer (Z) substantially did not vary, while still allowing the substrate layer to move at a relative speed of about 30 meters of substrate layer along its longitudinal dimension. The vacuum according to this embodiment also significantly reduced the relative movement of the substrate layer as compared to the digital inkjet printing device along a transverse direction (not shown) in the plane of the substrate layer essentially perpendicular to the longitudinal direction (L).

[0097] After providing the print pattern to the embossed coating, the print pattern was dried and adhered to the coating by subjecting it to an infrared heat treatment at 135 °C, making the print pattern 'touch-dry'. The substrate layer, with coating and print pattern, was then cut in the right dimensions to obtain pieces of wallpaper having a length of about 10.05 m, a width of about 53 cm and a thickness of about 0.9 mm. Next, the piece of wallpaper was rolled up along its length to obtain a roll of wallpaper having a width of 53 cm.

[0098] Using this method, a piece of wallpaper was obtained with a print pattern having a resolution of between about 300x600 dpi. After the production of the rolls of wallpaper, samples of wallpaper of the same production batch and from different production batches of wall coverings comprising a similar colour print pattern were compared and examined for potential colour differences. Colour can be determined in an objective manner, for example through aid of a spectrophotometer or a tristimulus colorimeter, whereby light is directed at a sample and the reflected light is detected and analyzed for its intensity. Using a spectrophotometer, the light which is directed at the sample usually originates from a polychro-

matic light source whereby the reflected light is measured at a range of wavelengths at a distance of 5, 10 or 20 nm throughout the whole visible spectrum (380-730 nm or 400-700 nm). A Tungsten light bulb of a Xenon lamp may be used as a light source. To evaluate the colour differences, the samples are preferably measured using various light sources, both in the presence of daylight as well as in the presence of e.g. the light of a fluorescent lamp.

[0099] Colour differences within the same production batch and between different batches of wall coverings comprising a similar colour print pattern were measured through aid of a spectrophotometer whereby the values obtained for each sample were compared to each other. When measuring colour differences, a threshold value should be taken into account, under which value the measured values should fall so as to not be distinguished by the human eye: $dE_{CMC} \leq 0.8$ according to the CIE-LAB colour space.

[0100] The wallpaper which was produced according to the method as described in example 1 displayed a dE_{CMC} value below 0.4 for the samples from the same production batch comprising a same colour print pattern and below 0.7 for the samples obtained from different production batches of wall coverings comprising a same colour print pattern, and thus were below the threshold value.

[0101] It is supposed that the present invention is not restricted to any form of realization described previously and that some modifications can be added to the presented example of fabrication as long as such embodiment fall under the scope of the appended claims.

35 Claims

1. Automated method to produce flexible wallpaper, which method comprises the following steps:

- a. providing a flexible substrate layer which is essentially endless along a longitudinal dimension and which substrate layer has a top side and a back side;
- b. providing a coating on the top side of said substrate layer, which coating comprises a thermoplastic material;
- c. providing said coating with an embossed pattern;
- d. providing a print pattern directly on top of the embossed coating using a digital printing device;

wherein the maximum depth of the embossed pattern provided in the coating comprises a value equal to or less than 1.0 mm, whereby the coating has a minimum thickness, whereby the thickness of the wallpaper is comprised between 0.1 mm and 2.5 mm, and whereby the coating is provided on the sub-

strate layer in an amount comprised between 50 g/m² and 400 g/m².

2. Automated method according to claim 1, whereby the coating comprises a thermoplastic polymer material. 5
3. Automated method according to claim 1 or 2, whereby when the print pattern is directly provided on top of the embossed coating, the substrate layer is provided at a relative speed, as compared to the digital printing device, of between 15 and 60 meters of substrate layer per minute along the longitudinal dimension. 10
4. Automated method according to claim 1, 2 or 3, whereby a vacuum is applied to the back side of the substrate layer while the print pattern is provided to the embossed coating. 15
5. Automated method according to claim 4, whereby the vacuum is applied at a pressure between 0.02 MPa and 0.09 MPa. 20
6. Automated method according to any of the previous claims, whereby the maximum tensile force applied to the substrate layer comprises a value equal to or less than 5 Newton. 25
7. Automated method according to any of the previous claims, whereby said digital printing device is a digital inkjet printing device. 30
8. Automated method according to any of the previous claims, whereby said digital printing device is a digital inkjet printing device comprising recirculating print-heads. 35
9. Automated method according to any of the previous claims, whereby the embossed coating is subjected to a corona treatment and/or a humidification treatment before and/or during the application of the print pattern. 40
10. Automated method according to any of the previous claims, whereby the print pattern is provided on the embossed coating by applying between 5 and 20 g/m² of ink. 45
11. Automated method according to any of the previous claims, whereby at least part of the print pattern is provided by ink comprising particles, with a particle size between 0.1 and 100 µm. 50
12. Automated method according to claim 11, whereby the particles are metallic particles, glitter particles or ceramic particles. 55

13. Automated method according to any of the previous claims, whereby the embossed pattern is provided to the coating using a mechanical embossing technique.

14. Automated method according to any of the previous claims, whereby the thermoplastic material of the coating comprises polyvinyl chloride, and the coating composition comprises optionally a blowing agent, a plasticizer, a dispersing agent, a diluent, a filler and/or a stabilizer.

15. Automated method according to any of the previous claims, whereby the substrate layer comprises paper, a non-woven, plastic, cellulose and/or cardboard.

Patentansprüche

1. Automatisiertes Verfahren zur Herstellung flexibler Tapete, wobei das Verfahren die folgenden Schritte umfasst:

- a. Bereitstellen einer flexiblen Substratschicht, die entlang einer Längsabmessung im Wesentlichen endlos ist und wobei die Substratschicht eine Oberseite und eine Rückseite aufweist,
- b. Bereitstellen einer Beschichtung auf der Oberseite der Substratschicht, wobei die Beschichtung ein Thermoplastmaterial umfasst,
- c. Versehen der Beschichtung mit einem geprägten Muster,
- d. Bereitstellen eines Druckmusters direkt auf der Oberseite der geprägten Beschichtung mit Hilfe einer Digitaldruckvorrichtung,

wobei die maximale Tiefe des geprägten Musters, das in der Beschichtung bereitgestellt wird, einen Wert umfasst, der gleich oder kleiner 1,0 mm ist, wobei die Beschichtung eine minimale Dicke aufweist, wobei die Dicke der Tapete zwischen 0,1 und 2,5 mm beträgt und wobei die Beschichtung auf der Substratschicht in einer Menge zwischen 50 g/m² und 400 g/m² bereitgestellt wird.

2. Automatisiertes Verfahren nach Anspruch 1, wobei die Beschichtung ein thermoplastisches Polymermaterial umfasst.

3. Automatisiertes Verfahren nach Anspruch 1 oder 2, wobei die Substratschicht, wenn das Druckmuster direkt auf der Oberseite der geprägten Beschichtung bereitgestellt wird, mit einer relativen Geschwindigkeit im Vergleich zur Digitaldruckvorrichtung von zwischen 15 und 60 Metern Substratschicht pro Minute entlang der Längsabmessung bereitgestellt wird.

4. Automatisiertes Verfahren nach Anspruch 1, 2 oder 3, wobei an die Rückseite der Substratschicht ein Unterdruck angelegt wird, während das Druckmuster auf der geprägten Beschichtung bereitgestellt wird.
5. Automatisiertes Verfahren nach Anspruch 4, wobei der Unterdruck mit einem Druck zwischen 0,02 MPa und 0,09 MPa angelegt wird.
6. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei die an die Substratschicht angelegte maximale Zugkraft einen Wert gleich oder kleiner 5 Newton umfasst.
7. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei die Digitaldruckvorrichtung eine Tintenstrahl-Digitaldruckvorrichtung ist.
8. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei die Digitaldruckvorrichtung eine Tintenstrahl-Digitaldruckvorrichtung ist, die umlaufende Druckköpfe umfasst.
9. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei die geprägte Beschichtung vor dem und/oder während des Aufbringens des Druckmusters einer Koronabehandlung und/oder einer Befeuchtungsbehandlung unterzogen wird.
10. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei das Druckmuster auf der geprägten Beschichtung durch Aufbringen von zwischen 5 und 20 g/m² Drucktinte bereitgestellt wird.
11. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei mindestens ein Teil des Druckmusters durch Druckertinte bereitgestellt wird, die Partikel mit einer Partikelgröße zwischen 0,1 und 100 µm umfasst.
12. Automatisiertes Verfahren nach Anspruch 11, wobei die Partikel Metallpartikel, Glitterpartikel oder Keramikpartikel sind.
13. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei das geprägte Muster in der Beschichtung mit Hilfe einer Technik des mechanischen Prägens bereitgestellt wird.
14. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei das Thermoplastmaterial der Beschichtung Polyvinylchlorid umfasst und die Beschichtungszusammensetzung optional ein Treibmittel, einen Weichmacher, ein Dispergiermit-

tel, einen Verdünner, einen Füllstoff und/oder ein Stabilisierungsmittel umfasst.

15. Automatisiertes Verfahren nach einem der vorhergehenden Ansprüche, wobei die Substratschicht Papier, ein Vlies, Kunststoff, Cellulose und/oder Karton umfasst.

10 Revendications

1. Procédé automatisé de production de papier peint souple, lequel procédé comprend les étapes suivantes :

- a. fournir une couche de substrat souple qui est essentiellement sans fin le long d'une dimension longitudinale et laquelle couche de substrat a un côté supérieur et un côté arrière ;
- b. fournir un revêtement sur le côté supérieur de ladite couche de substrat, lequel revêtement comprend un matériau thermoplastique ;
- c. munir ledit revêtement d'un motif gaufré ;
- d. fournir un motif d'impression directement sur le revêtement gaufré en utilisant un dispositif d'impression numérique ;

dans lequel la profondeur maximale du motif gaufré fourni dans le revêtement comprend une valeur égale ou inférieure à 1,0 mm, dans lequel le revêtement a une épaisseur minimale, l'épaisseur du papier peint étant comprise entre 0,1 mm et 2,5 mm, et dans lequel le revêtement est prévu sur la couche de substrat en une quantité comprise entre 50 g/m² et 400 g/m².

2. Procédé automatisé selon la revendication 1, dans lequel le revêtement comprend un matériau thermoplastique polymère.
3. Procédé automatisé selon la revendication 1 ou 2, dans lequel, lorsque le motif d'impression est directement appliqué sur le revêtement gaufré, la couche de substrat est fournie à une vitesse relative, par rapport au dispositif d'impression numérique, comprise entre 15 et 60 mètres de couche de substrat par minute le long de la dimension longitudinale.
4. Procédé automatisé selon la revendication 1, 2 ou 3, dans lequel un vide est appliqué sur le côté arrière de la couche de substrat pendant que le motif d'impression est appliqué sur le revêtement gaufré.
5. Procédé automatisé selon la revendication 4, dans lequel le vide est appliqué à une pression comprise entre 0,02 MPa et 0,09 MPa.
6. Procédé automatisé selon l'une quelconque des re-

vendications précédentes, dans lequel la force de traction maximale appliquée à la couche de substrat comprend une valeur égale ou inférieure à 5 Newton.

7. Procédé automatisé selon l'une quelconque des revendications précédentes, dans lequel ledit dispositif d'impression numérique est un dispositif d'impression à jet d'encre numérique. 5
8. Procédé automatisé selon l'une quelconque des revendications précédentes, dans lequel ledit dispositif d'impression numérique est un dispositif d'impression à jet d'encre numérique comprenant des têtes d'impression à recirculation. 10
9. Procédé automatisé selon l'une quelconque des revendications précédentes, dans lequel le revêtement gaufré est soumis à un traitement Corona et/ou à un traitement d'humidification avant et/ou pendant l'application du motif d'impression. 15 20
10. Procédé automatisé selon l'une quelconque des revendications précédentes, dans lequel le motif d'impression est fourni sur le revêtement gaufré en appliquant entre 5 et 20 g/m² d'encre. 25
11. Procédé automatisé selon l'une quelconque des revendications précédentes, dans lequel au moins une partie du motif d'impression est fournie par de l'encre comprenant des particules, avec une taille de particule comprise entre 0,1 et 100 µm. 30
12. Procédé automatisé selon la revendication 11, dans lequel les particules sont des particules métalliques, des particules brillantes ou des particules céramiques. 35
13. Procédé automatisé selon l'une quelconque des revendications précédentes, dans lequel le motif gaufré est appliqué sur le revêtement en utilisant une technique de gaufrage mécanique. 40
14. Procédé automatisé selon l'une quelconque des revendications précédentes, dans lequel le matériau thermoplastique du revêtement comprend du polychlorure de vinyle et la composition de revêtement comprend éventuellement un agent gonflant, un plastifiant, un agent dispersant, un diluant, une charge et/ou un stabilisant. 45 50
15. Procédé automatisé selon l'une quelconque des revendications précédentes, dans lequel la couche de substrat comprend du papier, un non-tissé, du plastique, de la cellulose et/ou du carton. 55

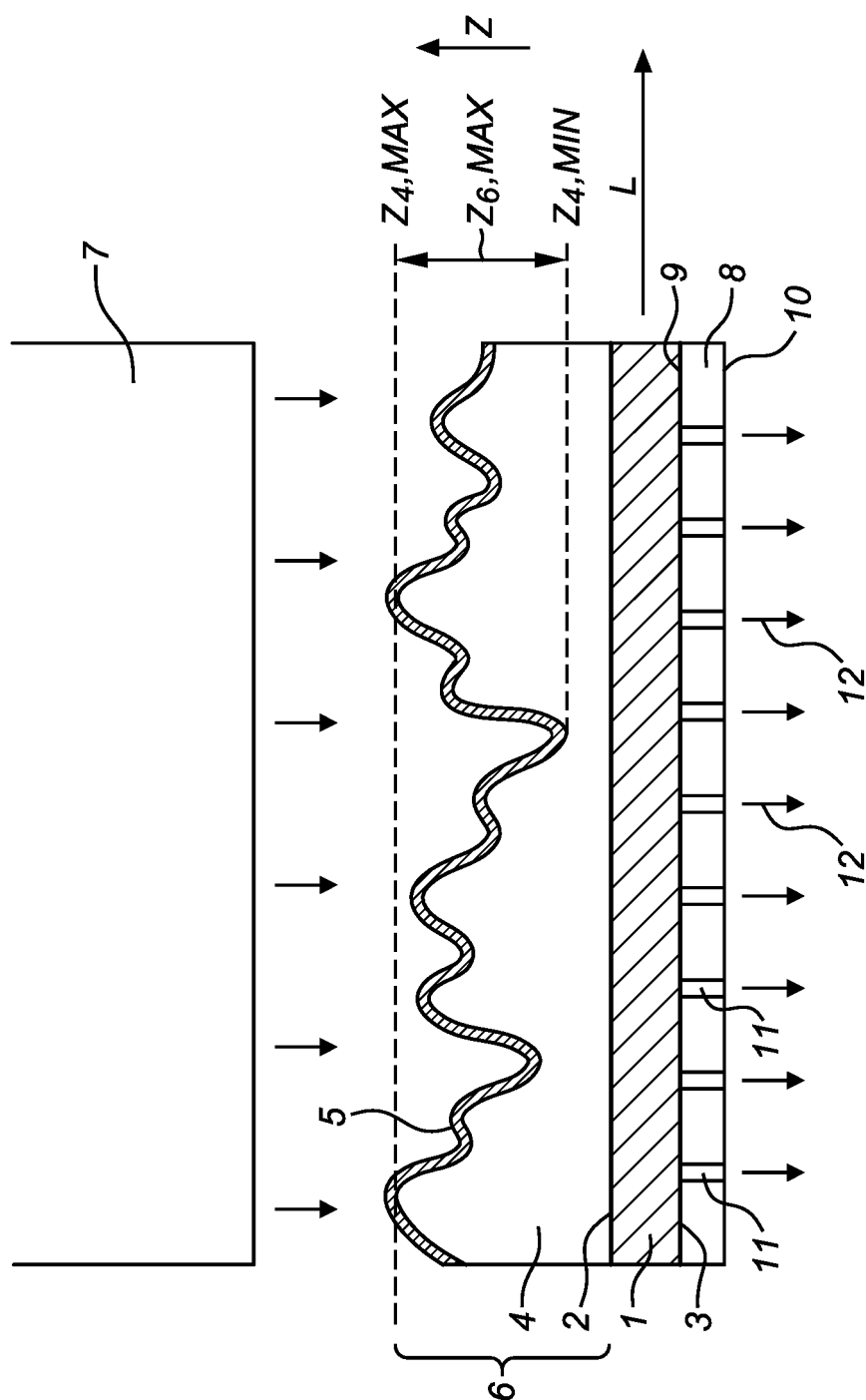


Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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