(54) **Protective coating for printed securities**

The process provides the step of applying a protecting layer of parylene on securities, in particular banknotes. Preferably, the process is conducted continuously and implies steps of transporting a set of printed securities into a lock-chamber before transferring it to a deposition chamber, in which parylene is applied by way of a chemical vapour deposition process. The securities obtained by the process of the present invention are more resistant to soiling, wetting and mechanical damage than securities comprising traditional varnishes.
Description

Technical Field

[0001] The present invention generally relates to the field of printing, in particular to the field of printing securities, and is concerned with a process of producing printed securities and printed securities obtainable by the process.

Background of the Invention and Problems to be Solved

[0002] The entire process of producing stacks of numbered and bundled securities comprises many steps, which are generally conducted in different manufacturing units, such as different devices and/or machines, which may also be connected in series. The printing of sheets with securities is clearly one of the early steps in the production of printed securities. Generally, single sheets are continuously printed with a plurality of securities on it in specific printing machines, and piles of such sheets are created. Downstream the printing, a numbering process is conducted, the goal of which is of course to produce serial numbers, but in a way that at the end of the manufacturing process, individual securities present in a bundle of securities are preferably numbered in sequence. Depending on the setting of a particular printing process, and also on the handling of damaged or defective sheets, the numbering may be conducted on sheets comprising a plurality of securities or on individual securities. Further downstream the printing step, various other steps are performed, especially steps of providing a protective coating, such as a varnish, and steps of cutting sheets to obtain individual securities, and banding securities to obtain bundles. These steps are continuous, and high requirements of speed and efficiency are imposed on all steps of the overall process of producing printed securities.

[0003] The varnish that is provided following the printing step, and, generally, after the numbering step, has the overall purpose of increasing circulation lifetime of the securities, and, more particularly, of protecting printed securities against soiling, especially against moisture or needs further preparation of the surface. This is particularly the case with UV-cured varnishes which have the disadvantage that they offer very poor adhesion for the typographic inks which are typically used and applied during numbering. This is why numbering is preferably carried out prior to varnishing.

[0004] Two industrial processes of providing a varnish are employed today, namely water based varnishes and UV-cured varnishes. Both processes have disadvantages. With water-based varnishes, water, used as a solvent and which forms typically up to 60% of the varnish composition, needs to be evaporated following the application of the varnish on the printed material. This drying step may be conducted under the assistance of infra-red lamps, but in any case requires that the varnished printed material be allowed to rest for a certain period of time before being further processed so as to allow complete evaporation of the water content of the varnish, which is time-consuming. The other process comprises the application of a UV-polymerisable varnish (UV varnish). In this process, 100% of the applied varnish stays on the printed material and is polymerised, or cured, under the action of UV radiation. UV-curing is as such problematic as it imposes strict requirements and constraints on the equipment in order to protect the human operators from the UV radiation.

[0005] General information about the above-mentioned varnishing processes may be found in the Handbook of Print Media, H. Kipphan, Springer Verlag, 2001, ISBN 3-540-67326-1. Information about the varnishing of banknotes and the like securities may be found in US patent No. US 1,575,940, British patent No. GB 702,971, European patent applications Nos. EP 0 256 170 A1 and EP 0 860 286 A1, and International application WO 01/08899 A1. A varnishing machine for performing full-sheet varnishing of both sides of sheets of securities may be the flexographic printing machine sold by the Applicant under the trade name NotaProtector®.

[0006] Both prior art processes depicted above do not provide even, regular layers of constant thickness on the printed securities but rather flatten and smoothen the printed surface by filling the microscopic, irregular surface structure of the sheet or security with varnish. The quantity of varnish per surface area of the security is, as a consequence, relatively high, but shall not exceed a certain amount in particular in order not to degrade the characterizing tactile effect of intaglio-printed features. In the case of water-based varnishes, high quantities of "wet" varnish in particular have to be used as the major part of the varnish, namely water, is evaporated during the drying process, there typically remaining approximately 1.8 to 2.2 g/m² of dry varnish on the varnished substrate (which quantity amounts to a varnish thickness of approximately 1.8 to 2.2 microns). In the context of UV-cured varnishes, a quantity of applied varnish is typically of the order of 3 to 3.3 g/m², which quantity corresponds to 100% of the solid content of the applied UV-cured varnish (and amounts to a varnish thickness of approximately 3 to 3.3 microns).

[0007] Furthermore, due to the smoothened surface, a numbering step following the application is hampered or needs further preparation of the surface. This is particularly the case with UV-cured varnishes which have the disadvantage that they offer very poor adhesion for the typographic inks which are typically used and applied during numbering. This is why numbering is preferably carried out prior to varnishing.

[0008] Another disadvantage of the known varnishing processes resides in the fact that they exhibit a limitation in terms of deposition speed as the varnish is typically applied by means of rotating application rollers or cylinders, typically so-called anilox rollers/cylinders (as in the case of the above-mentioned NotaProtector® machine sold by the Applicant). Such anilox rollers/cylinders have a structured outer surface with a regular distribution of cells for taking up and carrying the varnish. The rotational speed of such rollers/cylinders is thus limited as too high
a rotational speed would imply that the varnish would be ejected out of the cells. In practice, varnishing is accordingly applied onto full sheets at a typical speed of 10'000 to 12'000 sheets per hour. Varnishing of individual securities can be varnished, e.g. 10'000 to 12'000 individuals securities per hour, which is by far too low as compared to the equivalent flow of individual securities produced in the form of sheets (i.e. 200'000 to 600'000 individual securities per hour considering a speed of 10'000 sheets per hour and between 20 to 60 individual securities per sheet).

It is accordingly an objective of the present invention to provide a more time-, material- and cost-efficient way of providing a protective layer on printed securities. The protective layer should be more evenly applied, to obtain a substantially constant thickness throughout the surface of the security. It is also an objective to provide a protective layer having the same or better properties than the usual varnishes, while retaining the possibility of subjecting the sheet to a subsequent numbering step.

It is a further objective to increase the lifetime of securities. In particular it is an objective to provide a higher protective quality, for example higher resistances to mechanical damage, moisture, dirt and to other destructive forces caused by environmental exposures, for example.

Besides the general problems associated with the step of providing a varnish to a printed security in a continuous production process, the present invention also addresses some more specific problems, intrinsic to the identification and removal of defective securities.

As indicated above, printed securities are generally produced by printing a plurality of securities on a sheet, one processed sheet thus encompassing a plurality of securities, which will finally be separated by cutting in a downstream step. In these processes, quality control devices are disposed at regular intervals throughout the production process, detecting, and advantageously marking, sheets comprising low printing quality, printing errors, physical damages and the like. Such defective sheets are generally removed from the continuous process of producing printed securities, analysed and, treated according to the extent and nature of the damage or defect. If the whole sheet is affected, the sheet comprising a plurality of securities is discarded. In many cases, however, there remain individual securities on the sheet that have a good printing quality. For the sake of production optimisation and cost efficiency, such partly defective sheets are preferably cut into individual securities and the good securities are retrieved by sorting them out from the defective securities and treated individually.

The individual securities obtained from partly defective sheets are typically processed on single-note sorting and/or numbering machines. On such machines, the individual securities are generally processed, i.e. typically numbered, at a flow of about 40'000 to 60'000 individual securities per hour. At this speed, typical varnishing processes entail the specific disadvantages in terms of deposition speed which were highlighted here-above.

Figure 3 summarizes a typical process of producing securities as discussed above. Step S1 in Figure 3 denotes the various printing phases which are typically carried out during the production of securities. These various printing phases include in particular an offset printing phase whereby sheets of securities are printed on one or both sides with an intaglio printing phase whereby the sheets are printed on one or both sides with intaglio features (i.e. embossed features which are readily recognizable by touch), a silk-screen printing phase whereby the sheets are printed on one or both sides with silk-screen features, such as features made of optically variable ink (OVI), and/or a foil/patch application phase whereby foils or patches, in particular so-called optically variable devices (OVD), holograms, or similar optically diffracting structures, are applied onto one or both sides of the sheets, etc. In Figure 3, step S1 encompasses all possible printing phases carried out during the production of securities, other than numbering and varnishing.

As a result of the various printing phases of step S1, successive sheets 100 are produced. While quality control checks are usually performed at various stages during the production of the securities, a final quality check is typically carried out on the full sheets after these have completely been printed. This full-sheet quality inspection is schematised by step S2 in Figure 3. Three categories of sheets in terms of quality requirements are generated as a result of this full-sheet quality inspection, namely (i) good sheets (i.e. sheets carrying securities which are all regarded to be satisfactory from the point of view of the quality requirements), (ii) partly defective sheets (i.e. sheets carrying both securities which are satisfactory from the point of view of the quality requirements and securities which are unacceptable, which defective securities are typically provided with a distinct cancellation mark), and (iii) entirely defective sheets carrying no acceptable security. From this point onward, the three categories of sheets follow distinct routes. More precisely, the entirely defective sheets are destroyed at step S10, while the good sheets are processed at steps S3 to S5 and the partly defective sheets are processed at steps S20 to S23.

Referring to steps S3 to S5, the good sheets are typically numbered at step S3, then optionally varnished at step S4 and finally cut and subjected to an ultimate finishing process at step S5, i.e. stacks of sheets are cut into individual bundles of securities 200, which bundles 200 are banderoled (i.e. surrounded with a securing band) and then stacked to form packs of bundles 210. While the sheets 100 are processed in succession at steps S3 and S4, step S5 is usually carried out on
stacks of hundred sheets each, thereby producing successive bundles 200 of hundred securities each, which bundles 200 are stacked to form, e.g., packs 210 of ten bundles each.

[0017] Referring to steps S20 to S23, the partly defective sheets are firstly cut into individual securities at step S20 and the resulting securities are then sorted out at step S21 (based on the presence or absence of the cancellation mark previously applied at step S2 on the defective securities), the defective securities being destroyed at step S10, while the good securities are further processed at steps S22 and S23. At step S22, the individual securities are numbered in succession and subsequently subjected to a finishing process at step S23 which is similar to that carried out at step S5, i.e. bundles of securities 200 are formed, which bundles 200 are banded and then stacked to form packs of bundles 210.

[0018] While Figure 3 is discussed in the context of the production of securities on individual sheets, it shall be understood that the same principle is applicable to the production of securities on a continuous web. In that context, steps S1, S2, S3 and S4 could each be carried by processing a continuous web of printed material, which continuous web is ultimately cut into sheet portions and then into individual securities.

[0019] As regards the varnishing operation, Figure 3 shows that such varnishing is typically carried out on full sheets at step S4 after full-sheet numbering at step S3. While this varnishing step is preferred, it is not as such required. Varnishing may furthermore be carried out at a different stage of the production as explained below.

[0020] In case keeping the numbering sequence throughout the securities of successive bundles 200 is not required and one wishes to produce varnished securities, the partly defective sheets could follow a somewhat similar route as the good sheets, i.e. be subjected to a full-sheet numbering step (thereby numbering both the good and defective securities), then to full-sheet varnishing, before being cut into individual securities, sorted out to extract and destroy the defective securities, and then subjected to an ultimate finishing process to form bundles and packs of bundles (in this case single-note numbering would not be required).

[0021] In case one wishes to produce varnished securities while keeping the numbering sequence throughout the securities of successive bundles, only two solutions are possible, namely (a) varnishing the individual securities between steps S22 and S23 (in parallel to step S4), or (b) performing full-sheet varnishing of both the good sheets and defective sheets directly after full-sheet inspection at step S2 (or even before full-sheet inspection), i.e. before numbering at step S3 and before cutting at step S20 (which other solution would imply that numbering is carried out after varnishing). All other solutions would lead to securities exhibiting different characteristics depending on the processing route of the securities, i.e. whether the securities were processed in sheets or in individual securities, which is not desired. As already mentioned, solution (a) is not as such satisfactory or even possible in practice due to the inherent limitations of the known varnishing processes in terms of speed of deposition, while solution (b) is not preferred as the serial numbers and other typographic features applied during the numbering step are applied on top of the varnish layer, thus giving rise to potentially problematic issues in terms of physical resistance, in particular as regards the adhesion of the typographic inks on the varnish layer.

[0022] For the sake of completeness, one may refer to International applications Nos. WO 01/85457 A1, WO 01/85586 A1, WO 2005/008605 A1, WO 2005/008606 A1, and WO 2005/104045 A2 for an overview of possible full-sheet quality inspection machines to carry out step S2 in Figure 3. Of particular interest are the machines disclosed in International applications WO 01/85457 A1, WO 01/85586 A1, WO 2005/008605 A1 and WO 2005/008606 A1 which combine the functions of full-sheet quality inspection and full-sheet numbering (which machines can thus perform the operations of steps S2 and S3 in one pass). A full-sheet inspection machine is sold by the Applicant under the trade name Note Check, while a combined full-sheet inspection and numbering machine is sold by the Applicant under the trade name Super Check Numerota®.

[0023] The interested reader may furthermore refer to US patents Nos. US 3,939,621, US 4,045,944, US 4,453,707, US 4,558,557, to European patent applications Nos. EP 0 656 309, EP 1 607 355, and to International application No. WO 01/49464 A1, all in the name of the present Applicant, for a discussion of various cutting and finishing machines suitable for carrying out step S5 of Figure 3. Such machines are for instance sold by the Applicant under the trade name CutPak®.

[0024] As regards the more specific issue of full-sheet numbering, European patent application No. EP 0 598 679 A1 and International application No. WO 2004/016433 A1 are of interest. The numbering and finishing principle disclosed in WO 2004/016433 A1 is of particular interest in this context as it provides for the numbering of sheets in a manner such that bundles of securities are produced in a consecutive and uninterrupted numbering sequence at the end of the finishing process without this requiring any complex bundle collating system. Numbering machines for carrying out full-sheet numbering are for instance sold by the Applicant under the trade name SuperNumerota®, as well as under the above-mentioned Super Check Numerota® trade name.

[0025] In the context of single-note sorting and numbering as provided under steps S21 and S22 of Figure 3, one may refer to US patents Nos. US 3,412,993, US 4,299,325, US 4,915,371. A machine combining the functions of single-note sorting and numbering is for instance sold by the Applicant under the trade name NotaNumber®.

[0026] It is a further objective of the present invention to alleviate the problems depicted above. In particular, it is an objective of the present invention to provide a meth-
Summary of the Invention

In a first aspect, the present invention provides a process of producing printed securities, the process comprising the step of providing a coating or layer of parylene on said securities.

In an other aspect, the present invention provides printed securities obtainable by the processes of the present invention. The present invention thus provides printed securities comprising a coating or layer of parylene. More preferably, the securities are obtainable by the process of the present invention.

Other important features of the present invention are described in the dependent claims.

Remarkably, the problems addressed are resolved by applying a protective layer of parylene to printed securities, the process by way of a chemical vapour deposition process. Securities obtained by the process disclosed herein have been subjected to various tests of durability, mechanical resistance, resistance to soiling and so forth. In these tests, generally designed for predicting circulating life time of securities, the securities obtained by the present invention performed at least as good but generally much better than traditionally varnished securities.

In a further aspect, the present invention provides a method of producing printed securities, the method comprising the step of subjecting said securities to a chemical vapour deposition process, wherein, during the step of chemical vapour deposition, a set of securities placed in a deposition chamber is subjected to vibrating.

Brief Description of the Drawings

Figure 1 schematically illustrates the process of the present invention in a continuous setting, in which piles of securities are successively transported into a vapour deposition chamber, where a parylene coating is applied in a chemical vapour deposition process.

Figure 2 schematically illustrates an embodiment of the present invention, in which a set of securities is placed in a retaining device and subjected to vibrating during the chemical vapour deposition process.

Figure 3 schematically illustrates a typical process of producing securities according to the state of the art, in particular for the production of banknotes.

Detailed Description of the Invention and its Preferred Embodiments

Securities, for the purpose of present invention, comprise any documents incorporating a material value, for example banknotes, tickets in general, including lottery tickets, cheques, but also travel documents such as passports, and the like. Preferably, the security is a banknote. The verb "comprise", for the purpose of the present invention means "includes amongst others". It is not intended to mean "consists only of".

The process of the present invention comprises the step of providing a coating or layer of parylene on the printed securities. The terms "coating" and "layer" are used herein as synonyms.

Coating solid objects with a layer of parylene has been described previously, namely for the purpose of depositing insulating layers on surfaces of semiconductor wafers, as is disclosed, for example, in US 5,538,758. According to the Applicant's knowledge, use of parylene as replacement to the traditional varnishing processes applied during the course of the production of securities has not yet been envisaged.

In general, parylene is deposited as a coating in a chemical vapour deposition (CVD) polymerisation process, which takes place at sub-atmospheric pressure, generally in a vacuum. The process starts from a dimeric monomer-precursor, namely di-p-xylene, which, at room temperature, is present in the form of a white powder. The di-p-xylene powder is vaporized by heating to temperatures around 150°C. Thereafter, the vaporized dimer is subjected to a pyrolysis step at around 650°C, which generally takes place in a specific pyrolysis chamber, in which the dimer undergoes a chemical transformation to form reactive monomers. The reactive monomers are guided to a low-pressure deposition chamber, in which they come in contact with the surface of the substrate to be coated. When condensing on the preferably cool surface of the substrate, monomers spontaneously polymerise, thus forming a poly-p-xylene coating on the entire surface of the substrate.

The most commonly used forms of parylene dimers include parylene N, in which the benzene unit of p-xylene is unsubstituted; parylene C, in which each benzene unit is substituted with a single chlorine atom; and parylene D, in which each benzene unit is dichlorinated. Many other forms of parylene have been produced and tested meanwhile. In general, they are characterized by the presence or absence of various substituents, generally halogens, on the benzene and/or the methylene groups of the dimer. While variants of these may be used for the purpose of the present invention, parylene C is particularly preferred. For the purpose of the present invention, the term "parylene", without indication of a specific type, refers to any parylene or parylene derivative, including any of the types mentioned above. It also includes compositions comprising different types of parylene.
The present invention provides the possibilities of providing a parylene layer on individual securities, on an entire pile of securities, on an individual sheet having a plurality of securities printed on it, or on a stack of such sheets.

For coating individual securities and also piles of securities, apparatuses for effecting parylene coatings on ferrites, magnets, elastomers, screws and other objects, which are commercially available, could be used. Examples are apparatuses sold by company Comelec SA, La Chaud-de-Fonds, Switzerland (www.comelec.ch), or by company Specialty Coating Systems, Indianapolis, USA (www.scscoatings.com).

In a first, batch-wise mode of working the present invention, parylene was applied using a Comelec-C-50-S© apparatus, from company Comelec SA mentioned above. Individual banknotes were placed in a static deposition chamber, and parameters were adjusted to obtain a thin, even parylene layer of a thickness of e.g. 0.4 to 0.5 microns, which was obtained after a processing time of about 4 minutes in the deposition chamber.

Individual banknotes were recovered from the deposition chamber after completion of the process. The applied coating was completely transparent and none of the securities was damaged in the process. The banknotes were subjected to quality and resistance checks as described further below.

According to an embodiment of the process of the present invention, the application of a coating of parylene on printed securities is performed continuously. It comprises the steps of:

- transporting printed securities into a first lock chamber;
- creating a sub-atmospheric pressure in said first lock chamber;
- transporting said printed securities into a chemical vapour deposition chamber;
- exposing the securities to a chemical vapour deposition process providing a coating of parylene on said securities;
- transporting said printed securities to a second lock chamber;
- increasing pressure in said second lock chamber; and
- transporting said printed securities out of said second lock chamber.

The steps of this embodiment are illustrated by way of example with reference to Figure 1, in which a pile of individual securities is processed.

Figure 1 schematically shows an apparatus 1 for applying a parylene coating on successively transported piles of securities 7, wherein arrows indicate the direction of transportation. The central unit of the apparatus is deposition chamber 2. This chamber is held at sub-atmospheric pressure, preferably a vacuum. A vaporizer 3 is supplied with parylene powder. When heated, parylene vaporizes and is brought to pyrolysis chamber 4, where the reactive monomer is created at temperatures around 650°. By adjusting the temperature in the vaporizer, monomer partial pressure may be adjusted, eventually adjusting polymerisation rate.

A set of securities 7 is transported on a conveyor 10 in the form of a pile (or other suitable arrangement) by conventional transporting means towards locking chamber 5, adjacent to deposition chamber 2, and into which it is guided by suitable pushers and/or belt conveyors (not illustrated). Once the pile of securities 7 is placed in locking chamber 5, the latter is locked by closing a first automated door 15, so that the first locking chamber 5 is hermetically separated from the outside and from deposition chamber 2 and a vacuum or quasi-vacuum is created in the first locking chamber 5.

Thereafter, access is provided between locking chamber 5 and deposition chamber 2, by means of a second automated door 16, provided at one entry of chamber 2. The pile of securities is transported into the deposition chamber 2, and the second automated door 16 is closed. In deposition chamber 2 a parylene type C (mono-Cl-substituted p-xylene) coating of e.g. 0.4 to 0.5 micrometers is formed on the surface of the securities, which is completed after a processing time of about 4 minutes. Then, a third automated door 17, provided at the output side of chamber 2, is opened giving access to a second locking chamber 6. The pile of coated securities 8 is transported to locking chamber 6, after which the third automated door 17 is closed and ambient pressure is established in locking chamber 6. The second locking chamber 6 is provided with a fourth automated door 18 giving access to the outside and the pile is transported by pushers out of device 1.

In the illustration of Figure 1, it shall be understood that automated doors 15 and 16 are not opened at the same time, but in a consecutive manner such that a new series of securities is transported in the first locking chamber 5 which is brought to the same pressure, following closure of the first automated door 15, as that of the deposition chamber 2 before opening the second automated door 16 and bringing the securities into the deposition chamber 2. Similarly, automated doors 17 and 18 are not opened at the same time, but again in a consecutive manner such that a freshly coated series of securities is transported out of the deposition chamber 2 into the second locking chamber 6, the pressure of which is increased, following closure of the third automated door 17, up to ambient pressure before opening the fourth automated door 18.

The banknotes obtained with the continuous process of Figure 1 have the same coating thickness and transparency as those obtained by the batch-wise process depicted further above. As with the batch-wise process, the continuously coated banknotes are not damaged.

After exiting the parylene-coating device, the
Pile of securities may be subjected to usual checks and be further processed, for example bundled and stacked together with respective subsequent and preceding bundles as discussed hereinafter.

As the process depicted above with reference to Figure 1 is designed as a continuous process, successive piles of securities may continuously and simultaneously be entering and exiting the first locking chamber 5, the deposition chamber 2 and the second locking chamber 6. Of course, these steps take place at a predetermined frequency, which is adjusted so that a parylene layer of a predetermined thickness is obtained in the deposition chamber 2.

The processing time in the deposition chamber 2 may, of course, vary from the specific value of 4 minutes indicated depending on the desired thickness of the parylene layer to be applied on the securities. Preferably, the processing time is in the range of 2 to 7, more preferably 3 to 5 minutes.

It will be appreciated that, as compared to the traditional varnishing processes which exhibit an inherent limitation in terms of speed of deposition, the coating process according to the invention can simultaneously be performed on a plurality of individual securities or sheets. As mentioned hereinafter, a typical varnishing speed using the conventional techniques is of the order of 10,000 substrates per hour, i.e. approximately 170 substrates per minute. Using the above-described batch or continuous coating process, several hundreds or even thousands substrates per minute could be treated.

As illustrated in more detail with reference to Figure 2, a set of individual securities may be juxtaposed by being placed on top of each other, in a retainer device 20. Before exposure to a chemical vapour deposition process in deposition chamber 2, the retainer device 20 is rotated so that the securities lies substantially vertically in the retainer device 20. In deposition chamber 2, the retainer device 20 comprising the set of individual securities 26 is submitted to a vibrating unit 25, causing the individual securities to be in constant motion during the deposition step. Once the deposition is completed and the retainer device 20 transported out of the deposition chamber 2, the retainer is rotated back, the coated individual securities are removed from the retaining device, and a pile of securities is again formed. In a further downstream step, the pile of securities is banded and bundles 27 of securities are thus created.

Preferably, the retainer 20 does not contain large surfaces that come in contact with the securities. Preferably, it is made of meshes or of few retaining structures, sufficient for retaining the securities when placed vertically therein. A set of securities, be it in the form of a pile or juxtaposed securities in a retainer device, preferably comprises from about 10 to about a couple thousands, preferably 50 to about 200 individual securities.

The step of vibrating has the purpose of providing free surfaces on the securities that are juxtaposed or piled, so that the coating of the protective layer is applied evenly over the entire surface of the securities. It may be conducted as is shown by the double-sided arrow in Figure 2, on a set of vertically-oriented individual securities juxtaposed in a suitable retainer device, which is simply subjected to alternate movements in opposite directions. The step of vibrating may be performed by exerting other cyclic movements, for example, circular, up- and down movements, or more complex, combined movements.

The above described process of submitting the securities to vibrating can of course be applied as such to any chemical vapour deposition process to be applied to securities.

Whereas in Figure 2, only a single bundle is shown to be processed, of course a plurality of bundles are preferably simultaneously and continuously processed in chamber 2, depending on the number of securities to be processed per hour, the size of the chamber being chosen accordingly.

While the process of the present invention has been described so far for processing subsequent individual bundles of securities, it may of course easily be adapted for the processing of a plurality of bundles produced as a result of cutting of a pile of sheets with each sheet comprising rows and columns of securities printed on it, said pile being generally cut lengthwise and widthwise, so that subsequent rows of piles of individual securities are obtained, one row of piles being transported and processed simultaneously, on conveyors having the according number of lanes. The present invention thus also foresees several deposition chambers as shown in Figure 1 being situated next to each other, or, alternatively, an upscaled, single deposition chamber, suitable to receive and coat a plurality of individual securities in parallel.

It is, of course, also possible to subject entire sheets having a plurality of securities printed on them to a similar treatment, which can be done by adapting the equipment accordingly, including a larger-sized deposition chamber. Accordingly, in an embodiment of the process of the present invention, the step of providing a coating of parylene on said securities comprises the steps of providing a sheet having a plurality of securities printed on it, and subjecting said sheet to a chemical vapour deposition process.

According to this embodiment it is also possible to transport sheets by a suspension system, in which each sheet is fixed at a non-printed border portion. In the deposition chamber, sheets may remain in the suspended situation, so that even application of a coating is warranted.

A sheet comprising a plurality of securities printed on it can accordingly be subjected as a whole to the parylene coating process before the step of cutting the sheets to obtain individual securities. This full-sheet coating process could advantageously replace the traditional full-sheet varnishing of printed sheets discussed in reference to Figure 3.

Whether sheets or sets of individual securities are subjected to the parylene chemical vapour deposition
step, the process of the present invention preferably is a continuous process. Within the scope of the present invention, "continuous process" shall mean an automatic or semi-automatic process according to which a continuous or quasi continuous flow of substrates is subjected to the coating procedure, in contrast to batch-wise processing where human interactions are typically required between each processed batch.

According to an embodiment of the present invention, the thickness of the parylene layer on the printed securities has an average thickness in the range of 0.25 - 10 micrometers. Preferably, the thickness is in the range of 0.3 - 5 micrometers, more preferably 0.35 - 1 and most preferably 0.4 - 0.7 micrometer. It is an important advantage of the present invention that much less material is required for obtaining a substantial protective effect and for increasing circulation lifetime than with traditional varnishes. According to the process of the present invention, the step of providing a layer of parylene can therefore advantageously replace the traditional step of providing a lacquer or varnish to printed securities.

It is an advantage of the parylene coating according to the present invention that the surface of the security retains its nano- and/or microscale profile, because of the very regular and even application of the coating on the entire surface. This optimises the amount of coating substance that is applied, in contrast to traditional varnish processes, where the thickness of the varnish layer differs with the layer being thicker in the cavities and thin layers on the tops of the nano- and microstructures of the surface of the printed security. In the context of intaglio printing which is characterized by embossed patterns which are readily recognizable by touch, parylene coating is accordingly particularly advantageous as it does not degrade the characterizing effect of intaglio printing, whereas traditional varnishing has a tendency to smoothen the relief created by intaglio printing.

It was indicated above that processes of producing printed securities generally involve a numbering step. According to a preferred embodiment, the process of the present invention comprises the step of numbering said printed securities before or after the step of providing a coating of parylene on the printed securities. Both steps are generally accomplished in different units, the step of cutting sheets comprising a plurality of securities generally being part of the finishing process. For the step of printing sheets with a plurality of securities, reference may again be made to the above discussion of Figure 3, as well as regards the steps of cutting sheets comprising a plurality of individual securities.

Soiling Tests

Banknotes obtained by the process of the present invention as described above, were subjected to several tests in which resistance to different types of soil ing and to mechanical constraints and stresses was tested. Various parameters may be tested, depending on the specific setting of an individual test, as detailed, for example, in the presentation of Timothy T. Crane "Predicting Banknote Longevity®", held at the Currency Conference in Rome, Italy in May 2004, which presentation is accessible on www.crane.se. Among the usual tests performed are in particular the so-called "dry soiling test" whereby dry soiling material is rubbed against the surface of the security documents and the so-called "washing machine test" whereby the security documents are subjected to a washing treatment under the action of a washing agent.

In all tests performed, the banknotes having a 0.4 to 0.5 micron thick coating of parylene applied in a chemical vapour deposition process performed at least as well, but in many cases significantly better than traditionally varnished banknotes, having a traditional varnish coating of an average thickness of approximately 2 to 3 microns, corresponding to 2 to 3 g/m² of varnish on the banknote surface. It may therefore be pointed out that a substantially lower quantity of coating material, namely of parylene, is required within the scope of the present invention as compared to the usual varnishing processes.
defined by the annexed claims. For instance, while spe-
cific quantities or thickness of parylene layers have been
mentioned, these shall not be considered as being limit-
ing, other quantities and thickness being possible.

Claims

1. A process of producing printed securities, the proc-
process comprising the step of providing a coating or
layer of parylene on said securities.

2. The process of claim 1, comprising the step of num-
bering said printed securities before or after the step
of providing the coating or layer of parylene.

3. The process of claim 1, comprising the steps of print-
ing sheets comprising a plurality of securities and
cutting the sheets to provide individual printed secu-
rities, before providing a coating of parylene on said
securities.

4. The process of any of claims 1 to 3, wherein the step
of providing a coating of parylene on said securities
comprises the steps of providing a set of juxtaposed
or piled individual printed securities, and subjecting
said set of individual securities to a chemical vapour
deposition process thus providing a coating of
parylene on said securities.

5. The process of any of claims 1 or 2, wherein the step
of providing a coating of parylene on said securities
comprises the steps of providing a sheet having a
plurality of securities printed on it, and subjecting
said sheet to a chemical vapour deposition process
thus providing a coating of parylene on said securities.

6. The process of claim 5, comprising the step of cutting
the sheets to obtain individual securities after apply-
ing a coating of parylene on said sheets.

7. The process of any of the preceding claims, in which
the step of providing a coating or layer of parylene
on said securities is performed continuously.

8. The process of any of the preceding step, wherein
the step of applying a coating of parylene on printed
securities comprises the steps of:

   - transporting printed securities into a first lock
     chamber;
   - creating a sub-atmospheric pressure in said
     first lock chamber;
   - transporting said printed securities into a chem-
     ical vapour deposition chamber;
   - exposing the securities to a chemical vapour
     deposition process providing a coating of

9. The process of any of the preceding claims, wherein
the parylene coating or layer has an average thick-
ness in the range of 0.3 - 10 microns.

10. The process of claim 8, wherein, during the step of
exposing the securities to said chemical vapour dep-
osition process, the securities are subjected to vi-
brating.

11. Use of parylene for providing a protective layer on
printed securities.

12. Printed securities comprising a coating or layer of
parylene, preferably obtainable by the process ac-
cording to any of claims 1 to 10.
### DOCUMENTS CONSIDERED TO BE RELEVANT

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**TECHNICAL FIELDS SEARCHED (IPC)**

B41M
B42D

The present search report has been drawn up for all claims

**Place of search**
The Hague

**Date of completion of the search**
16 April 2007

**Examiner**
Martins Lopes, Luis
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16-04-2007

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