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- (71) Applicants (for all designated States except US): **UNIVERSITE DE MONS** [BE/BE]; Place du Parc 20, B-7000 Mons (BE). **UNIVERSITE CATHOLIQUE DE LOUVAIN** [BE/BE]; Place de l'Université 1, B-1348 Louvain-la-neuve (BE).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **DE CONINCK, Joël** [BE/BE]; Rue d'Hyon, 9, B-7022 Mesvin (BE). **RIOBOO, Romain** [FR/BE]; Rue des Canadiens 149, B-7022 Hyon (BE). **KOEUNE, François** [BE/BE]; Rue de la Gare 5/003, B-1348 Louvain-la-Neuve (BE). **STANDAERT, François-Xavier** [BE/BE]; Rue Philippe Baucq 103, B-1040 Bruxelles (BE). **SHARIATI, Seyedeh, Saloomeh** [IR/BE]; Avenue de l'Equerre 4/002, B-1348 Louvin-la-Neuve (BE).

- (74) Agents: **POWIS DE TENBOSSCHE, Roland** et al.; c/o Cabinet Bede S.A., Boulevard Général Wahis 15, B-1030 Bruxelles (BE).

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(54) Title: LABELLING SYSTEM

(57) Abstract: A security labelling system with a security tag comprising : - a security tag comprising solid material consisting of crystalline organic polymer material having a three dimensional structure, wherein the said solid polymer material defines at least a three dimensional pattern with a surface roughness, and - a device for receiving at least one or more signals of the security tag, said signal(s) being adapted for determining one or more identifiers.



Labelling system

The invention relates to a security labelling system comprising a security tag formed from crystalline or semi crystalline solid material, said crystalline or semi crystalline solid material being dispersed in or deposited on or covered by a layer of a polymer and/or copolymer material adapted for receiving at least one signal or image from the security tag.

WO 2007/002873 discloses a security labelling system comprising :

- a label formed from solid material comprising at least crystalline materials, said label having a unique pattern, and
- stored data comprising image data, imaging angle data's and label number, the data relating to the imaging angles being stored separately.

Crystalline material encompasses a large number of materials.

It has been observed that the label environment had an influence on the images taken of the label, or on the quality thereof. The security labelling system of WO 2007/002873 is a two dimensional security system, in which the image of the label is compared to image data within a data base.

As the authentication in WO 2007/002873 is based on a two dimensional analysis, copying risk exists, while due to the outside label environment, the image of a label could be considered as not being a correct or authenticated label, for example due to humidity, growth of micro organisms, etc..

The invention has for aim to solve at least said problem. It has been observed that by using a specific group of organic crystalline or semi-crystalline material, it was possible to have three dimensional tags, whereby rendering the copying very difficult, and whereby enabling correct authentication of the tag after an initial set-up phase using a randomness check followed by an extraction, whereby enabling correct authentication even if some portions of the tag are distorted.

The invention relates thus to a security labelling system comprising a security tag attached to a support, an object or label adapted to be associated or attached to a product or item to be secured.

The security labelling system of the invention comprises advantageously:

- a security tag comprising solid material consisting of crystalline or semi-crystalline organic polymer material having a three dimensional structure, said solid material of crystalline or semi-crystalline organic polymer material being dispersed within a layer of a polymer and/or copolymer material or being covered by a layer of a polymer and/or copolymer material, whereby said layer of polymer and/or copolymer material is adapted for enabling one or more signals, advantageously one or more images of the three dimensional structure of the said crystalline or semi-crystalline organic polymer material to be collected or taken from a face of said layer, wherein the said solid polymer material defines at least a three dimensional pattern with a face directed towards the face of the layer through which one or more images of the three dimensional pattern are taken, wherein said pattern defined by said solid material of crystalline or semi-crystalline organic polymer material defines a surface with a roughness, said surface roughness being visible optionally after removal of a protection element and having a portion with a surface roughness adapted for enabling an authentication of the security tag, wherein said surface roughness for said determined portion is adapted for being within a selected roughness range within roughness' of the group consisting of surface roughness' having:
 - (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1 μm and 100 μm , advantageously between 1.1 μm and 75 μm , preferably between 1.1 and 20 μm , most preferably between 5 μm and 16 μm , and/or

- (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor of 5, as well as at magnification factor 50, and

- 5 - a device for receiving at least one or more signals, advantageously for taking at least one or more images of the said determined portion of the security tag, said signal or signals, advantageously image or images being adapted for determining one or more identifiers, advantageously one unique identifier. Said identifier(s) is/are dependent at least from the surface roughness of said determined portion.
- 10 Said device is also advantageously adapted for enabling a tag signature verification, especially a tag signature verification.

The device has for example not to measure the surface roughness as such, but can for example compare two images of the tag so as to determine an average length

15 variation of the shade of various peaks of the tag, and to compare said average variation and possibly the variance thereof with data's relating to surfaces having different known roughness. Parameters or identifiers function of the surface roughness as well as of the uniqueness of the surface can thus be determined.

20 Crystalline or semi-crystalline material means material having a crystallinity of at least more than 2%, advantageously of more than 5%, preferably of more than 10%, most preferably greater than 25%, especially greater than 50%. The crystallinity of the polymer or copolymer is determined by DSC (differential scanning calorimetry). Said determination simply involves taking a small quantity

25 of the polymer (for example about 10 mg) and heating it at a rate of 20°C/minute through the melting region. The measured experimental heat of melting (ΔH_m) gives a curve, The area under the melting point is integrated and then compared to the heat of melting of the theoretical 100% crystalline polymer.

30 Details and characteristics of the invention are given in the attached claims.

The three dimensional tag has a first face directed towards the support, the object or the label and a second face opposite to said first face. Said faces are advantageously parallel the one to the other, but said faces can also be inclined the one with respect to the other. The three dimensional tag can take various shapes, for example the upper or second face of the tag can be a square, a rectangular, a circle, a star, etc.

Advantageously, said second face has at least one determined portion having a surface roughness which is visible optionally after removal of a protection element and which is adapted for enabling an authentication of the security tag, wherein said surface roughness for said determined portion is adapted for being within a selected roughness range within roughness' of the group consisting of surface roughness' having:

- (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1 μm and 100 μm , advantageously between 1.1 μm and 75 μm , preferably between 1.1 and 20 μm , most preferably between 5 μm and 16 μm , and/or
- (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor of 5, as well as at magnification factor 50, and
- a device for taking at least one image of the said determined portion of said second face of the security label, said image being adapted for determining one or more identifiers, advantageously one unique identifier.

According to a detail of an embodiment, said surface roughness for said determined portion of the security tag is adapted for being within a selected roughness range within roughness' of the group consisting of surface roughness' having:

- (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of

50, i.e. at a scale of approximately $220\text{ }\mu\text{m}$; comprised between $1\text{ }\mu\text{m}$ and $100\text{ }\mu\text{m}$, advantageously between $1.1\text{ }\mu\text{m}$ and $75\text{ }\mu\text{m}$, preferably between 1.1 and $20\text{ }\mu\text{m}$, most preferably between $5\text{ }\mu\text{m}$ and $16\text{ }\mu\text{m}$, as well as

- (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor 50.

According to another detail of an embodiment, the device for taking at least one image of the said determined portion comprises a image capture element adapted for taking at least one image of the said determined portion of the second face of the security tag along a view direction, and the device for taking at least one image of the said determined portion is provided with or associated to means for illuminating the said determined portion along a principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the view direction and/or for illuminating the said determined portion of the security tag from the first face of the security tag. The view direction can be perpendicular or not to the second face of the tag. When the view direction is perpendicular to the tag portion surface, the angle of the light direction is equal to the incident angle.

Preferably, the device for taking image of the said portion of the tag along a view direction is adapted for taking at least two images of said portion, a first image being taken with a first illumination with a first light illuminating the portion of the tag with a first incident angle, while a second image is taken with a second illumination with a second incidence angle (which can be equal or different from the first incidence angle), an angle comprised between 15° and 180° (advantageously between 45° and 175°) being formed between the first incidence angle and the second incidence angle. The device comprises then one or more illumination means and/or one or more control means for the one or more illumination means, for illuminating the tag portion at two different moments once with the first illumination, and once with the second illumination.

According to a preferred embodiment, in which the security tag has a first face directed towards the support, the object or the label and a second face opposite to said first face, said second face has :

- (i) a first determined portion having a first surface roughness adapted for
5 being within a first selected roughness range within roughness' of the group consisting of surface roughness' having:
- (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1.1 μm and 20 μm ,
10 advantageously between 5 μm and 16 μm , and/or
 - (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor of 5, as well as at magnification factor 50, and
- (ii) a second determined portion having a second surface roughness
15 adapted for being within a second selected roughness range not comprised within the first selected roughness range, wherein said second selected roughness range is advantageously selected within roughness' of the group consisting of surface roughness' having:
- (a) a root mean square surface roughness measured with a magnification factor of
20 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1.1 μm and 20 μm , advantageously between 5 μm and 16 μm , and/or
 - (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a
25 magnification factor of 5, as well as at magnification factor 50 ,
- wherein said second determined portion is advantageously adjacent to the said first determined portion.

According to a preferred detail of embodiments, the device for taking at least one
30 image of the said determined portion comprises an image capture element adapted for taking at least a first image of the said determined portion of the second face of the security tag along a first view direction, and an image capture element

adapted for taking at least a second image of the said determined portion of the second face of the security label along a second view direction different from the first view direction, and in which the device or the devices for taking at least said first and second images of the said determined portion is/are provided with or
5 associated to means for illuminating the said determined portion along a principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the first view direction and means for illuminating the said determined portion along a principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the
10 second view direction and/or for illuminating the said determined portion of the security tag from the first face of the security tag .

The angle between the first view direction and the second view direction is for example comprised between 15° and 180° , advantageously between 45° and 175° .

15 According to a further detail, the device for taking at least one image of the said determined portion comprises an image capture element adapted for taking at least two images of the said determined portion of the second face of the security tag along a first view direction, and in which the device for taking at least said two images of the said determined portion is/are provided with or associated to means
20 for illuminating the said determined portion along a first principal lighting direction and along a second principal lighting direction different from the first lighting direction, wherein said first and second principal lighting directions form each an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the first view direction and/or for illuminating the said determined portion of
25 the security tag from the first face of the security tag . The angle between the first principal lighting direction and the second lighting direction is for example comprised between 15° and 180° , advantageously between 45° and 175° .

The layer of a polymer and/or copolymer material is advantageously covered by a
30 transparent or semi transparent protection layer (transparent or semi transparent to the illumination or light used), said protection layer being advantageously resistant to solvent and to temperature of at least 100°C , advantageously at least 150°C .

The crystalline or semi-crystalline polymer material comprises preferably at least 50% by weight polypropylene, advantageously at least 75% by weight polypropylene, preferably at least 90% by weight polypropylene.

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The crystalline or semi-crystalline polymer material is advantageously prepared by depositing a solution of polypropylene in an appropriate solvent system and by drying said deposit at a temperature lower than 120°C.

- 10 However, the crystalline or semi-crystalline polymer material can also be prepared by depositing a solution of polypropylene in an appropriate solvent system on a support, by drying said deposit at a temperature lower than 120°C so as to form a layer having the appropriate roughness, by grinding the layer so as to form ground particles, and in which the ground particles are dispersed within a
- 15 layer of polymer and/or copolymer material and/or are deposited on a layer, advantageously a glue layer, before being covered by a layer of polymer and/or copolymer material.

- Preferably, the security tag has a first face adapted to be directed towards the
- 20 support, the object or the label to be attached or associated to the item or product to be secured, and a second face opposite to said first face. The tag can for example be applied or deposited directly within a recess of the item or product to be authenticated.

- 25 According to an advantageous detail of embodiments, the security tag is deposited on a face of the support having a roughness comprised between 1.1µm and 120µm.

- The system advantageously further comprises at least one means for digitizing at least a part of one or more images of the security tag or a combination of such
- 30 images, after physical extraction and/or fuzzy extraction of data's from said one or more images into binary data's or identifiers, and advantageously a means for

estimating the success rate of said binary data's or identifiers for the said part of one or more images.

The invention relates also to a method of ensuring the authenticity of an item ,
5 said method comprising at least the following steps :

- providing the item with or associating the item to a security labelling system as disclosed in anyone of the claims,
- receiving at least one or more signals, advantageously for taking at least one or more images of the said determined portion of said second face of the security tag ,
10 said signals or images being adapted for determining, possibly after treatment, one or more specific identifiers, advantageously one uniqueness identifier, said identifier(s) being at least function of the surface roughness of said determined portion, said roughness being within the said selected roughness range.

15 Advantageously, the method of ensuring the authenticity of an item comprises at least the following steps :

- providing the item with or associating the item to a security labelling system as disclosed in anyone of the attached claims,
- receiving at least one or more signals, advantageously for taking at least one or more images of the said determined portion of said second face of the security tag ,
20 said signals or images being adapted for determining, possibly after treatment, one or more identifiers or parameters whose values are randomly distributed among the tag portion,
- registering the parameter(s) or identifier(s), for example in a database or on a
25 support, and
- authenticating the tag by further determining one or more identifiers or parameters whose values are randomly distributed among the tag portion and comparing at least said parameter(s) or identifier(s) with the registered parameter(s) and/or identifier(s).

30 Advantageously, the method comprises at least the following steps:

- illuminating the said determined portion of the second face of the security tag as disclosed in claim 2 or 12 along a principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably comprised between 30° and 60° with the view direction and/or illuminating the said determined portion of the security tag from the first face of the security tag, and
- taking at least one image, advantageously a series of images of the said determined portion of the security tag, advantageously the second face of the security tag along the view direction.

10 Preferably, the method comprises at least the following distinct steps:

- taking at least one first image, when illuminating the said portion of the second face of the security tag along a first principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably comprised between 30° and 60° with the view direction, and
- 15 - taking at least one second image, when illuminating the said portion of the second face of the security tag along a second principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably comprised between 30° and 60° with the view direction, said second principal lighting direction forming an angle comprised between 15° and 180° with the first principal lighting direction.

20 The said first image(s) and the said second image(s) are then preferably treated or compared so as to determine one or more parameters or identifiers at least function of the roughness (for example determining an average length variation of the shade of various peak of the portion of the second face of the tag, as well as the variance of said average length variation). Said at least one or more parameters

25 and/or identifiers are suitable for authenticating the tag in a following step.

For items or products with one or more tags having two opposite faces, the method comprises advantageously the following steps:

- 30 - illuminating at a first moment the said determined portion of the second face of the security tag along a first principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the view

- direction and illuminating at a second moment the said determined portion of the security tag along a second principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the view direction, said second principal lighting direction being different from the first principal
- 5 lighting direction, or from the first face of the security label, said second principal lighting direction forming an angle comprised between 15° and 180° with the first principal lighting direction,
- taking a series of images of the said determined portion of the second face of the security tag at the said first moment along the view direction, and
 - 10 - taking a series of images of the said determined portion of the second face of the security tag at the said second moment along the said view direction.

According to detail of embodiment, the method comprises the steps of :

- illuminating at a first moment the said determined portion of the second face of
- 15 the security tag along a principal lighting direction or from the first face of the security tag,
- taking at least one image of the said determined portion of the second face of the security tag at a first moment along a first view direction forming an angle of at least 5° , advantageously at least 15° , preferably comprised between 30° and 60°
- 20 with the principal lighting direction, and
- taking at least one image of the said determined portion of the second face of the security tag at a second moment along a second view direction forming an angle of at least 5° , advantageously at least 15° , preferably comprised between 30° and 60° with the principal lighting direction, said second view direction being different
- 25 from the first view direction. The angle between the first view direction and the second view direction is advantageously comprised between 15° and 180° , preferably comprised between 45° and 175° .

According to another detail, the method comprises at least the following steps :

- 30 - providing the item with or associating the item to a security tag as disclosed in anyone of the attached claim 2 or 14,

- taking at least one image of a first determined portion of said second face of the security tag , said image(s) being adapted for determining one or more identifiers or parameters which is/are at least function of the surface roughness of said first determined portion, and
- 5 - taking at least one image of a second determined portion of said second face of the security tag , said image(s) being adapted for determining one or more identifiers or parameters which is/are at least function of the surface roughness of said second determined portion is within a second selected roughness range.
- 10 According to details of preferred embodiments, data's of at least a part of one or more images of the security tag are submitted to a physical extraction, advantageously to a fuzzy extraction and digitized in binary data's or identifiers, and advantageously a success rate of said binary data's or identifiers for the said part of one or more images is estimated.
- 15 According to another detail of preferred embodiments, several signals or images of the tag are treated with a randomness check, followed by a physical extraction, especially a fuzzy extraction.
- 20 Details and characteristics of preferred embodiments of the invention will appear from the following description in which reference is made to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

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In said drawings,

Figure 1 is a schematic flow sheet of methods for the production of preferred security label of the invention,

Figures 2 and 3 are perspective schematic view of supports provided with a security label;

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Figure 4 is a perspective view of an item provided with a security label of the invention;

Figure 5 is a schematic representation of a device for taking an image of the security label of the invention;

Figure 6 is a schematic flow sheet of a preferred authentication method of the invention,

5 Figures 7A and 7B is a further schematic view of a principle of authentication with two lighting means and one camera , and

Figure 8 is a schematic view of a Gabor Fuzzy extraction.

DESCRIPTION OF PREFERRED EMBODIMENTS

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Production of preferred security labels

A general flow sheet of a preferred method of production of a labelling system is schematic represented in Figure 1.

15

A. Selection of the support for the tag

The support for the tag is advantageously the item or product to be secured or authenticated. In this case the tag is advantageously directly applied on the item,
20 or in a recess of the item. Figure 4 shows a bottle, such as a perfume bottle 1 provided with a recess 2 for receiving the security label, said security label 3 being formed by depositing a liquid composition and by evaporating the solvent system or said security label is preformed away of the recess 2 and is applied or glued within the recess, as a solid or flexible layer, possibly attached on an intermediate
25 support. When the support is transparent it is quite easy to illuminate the tag or label from its first face.

The support on which the security tag will be deposited or attached can be a flexible thin support, such as a thin plate, a film or membrane or mat or tissue.
30 Said support is preferably not porous. This enables to prepare the security label away from the production plant of the item to be secured or authenticated.

The security label, as well as the support can have any possible shape.

The face on which the security label is deposited has advantageously a roughness comprised between 1.1 μ m and 120 μ m. It seems that such a roughness is
5 advantageous for inducing at least some roughness, so as to induce some roughness after coating.

The face can be pretreated for removing dust, for improving the adhesion of the label, or intermediate layer(s) or for controlling the roughness of the face(s).

For example, the face is brushed for creating some roughness.

10 The face can also be treated chemically (wet treatment) for increasing the adherence of hydrophobic material. Such chemical pretreatment is for example an acid treatment (weak or strong) for example with one or more mixtures disclosed in EP2028432A1. Such a chemical treatment can be made by dipping the support into a solution, by brushing or painting or pulverising or nebulising a solution onto
15 the face to support the security label.

In case of chemical wet treatment, the face of the support is advantageously washed (with water) and dried.

After said possible treatment, the roughness of the dried face is advantageously
20 controlled. For example one or more images of the face on which the security label has to be applied is/are taken.

The support (1) has advantageously a recess (2) adapted for receiving the security tag label (3) (see figure 2) and/or is advantageously provided with a slotted insert
25 (4) defining a central recess (2) adapted for receiving the security label (3) (see figure 3). The embodiment of Fig 3 enables the production of a continuous band provided with a central continuous tag part. The band 4 is advantageously provided with transversal precuts (5) , for enabling to separate easily a portion of the band. The precut (5) extends advantageously partly within the central tag part
30 The precut is thus preferably formed after deposit of the tag. By placing the security in a recess having a depth greater than the height of the security label, it is possible to ensure a protection for the security tag, for example by means of a

removable protection film 6. The film 6 is for example fixedly attached to an end of the support 1. The support 1 or the film 6 is provided with gluing means enabling the removal of a part of the film with respect to the support, while enabling the attachment back of the movable portion of the film onto the support.

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Said support has for example a thickness, measured between a first face on which the security label is deposited and a second face opposite to said first face, of less than 750 μ m, advantageously less than 500 μ m. Thicker support (for example thickness of 1mm up to 5mm) can be used, especially when provided with a

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recess.

The support can be transparent or translucent for enabling to illuminate the security label from the bottom face of the support and the security label.

15 The support can be provided with glass fibres (10) or other means for ensuring illumination of specific parts of the tag, for example ensuring lateral illumination of the tag

B. Optional treatment step of the face on which the security tag and/or optional
20 coating with one or more intermediate layers on the face on which the security tag
is applied

Such an optional treatment or deposit of one or more intermediate layers are for example layer(s) for increasing the adherence of the security label or for ensuring a
25 specific bottom roughness. Such layer(s) enter(s) advantageously within the porous structure of the support, when the support is porous.

The coating operation is preferably carried out after a drying step, so as to ensure that substantially no water is present in or on the support or face on which the label
30 has to be applied. The coating operation with such an intermediate layer is also preferably carried out in a dry atmosphere, such as with a relative humidity of less than 10%.

Such an optional coating is for example adapted for increasing the adherence of the security label or tag onto the support.

Said coating operation can be operated for applying on the support a glue layer
5 adapted for the adherence of particles with a specific size and/or shape (for example for giving a specific roughness of the support face on which the tag will be deposited, as well as for example for attaching solid tag particles.

10 C. Coating of the support, core layer thereof and/or optional intermediate layers with the security tag

The security tag has advantageously the form of a thin layer, and is advantageously made of a material selected with the hydrophobic coating material disclosed from paragraph 0027 to paragraph 0029 and from paragraph 0031 to
15 0050 of EP2028432A1, provided said material is a crystalline or semi-crystalline organic polymeric material and provided said material is adapted for ensuring a surface roughness, at least for a portion of the security label, for being within a selected roughness range within roughness' of the group consisting of surface roughness' having:

- 20 - (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1 μm and 100 μm , advantageously between 1.1 μm and 75 μm , preferably between 1.1 and 20 μm , most preferably between 5 μm and 16 μm , and/or
25 - (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor of 5, as well as at magnification factor 50.

The method for applying said coating layer is for example, one of the methods
30 disclosed in paragraph 0050 of EP2028432A1, but is preferably adapted for keeping at least partly the roughness of the core material. Such a method is advantageously a cast coating, a drop coating or a spray coating using

advantageously a dilute solution of the coating material, said solution comprising an appropriate solvent system.

Said coating operation is possibly repeated, if required.

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The coating operation is preferably carried out after a dry step, so as to ensure that substantially no water is present in the core layer.

Said coating layer forms the security tag and has advantageously a thickness of
10 less than 1000 μ m, preferably less than 500 μ m.

The security label comprises advantageously more than 50% by weight, preferably more than 75% by weight polypropylene. The security label material can comprise one or more additives, such as colorants, adjuvants, inert particles, non
15 crystalline or semi-crystalline polymer material, etc.

The coating operation can also be operated by using particles of crystalline or semi-crystalline polypropylene or other appropriate crystalline or semi-crystalline polymers. Said particles are for example by grinding or cutting a thin coating
20 layer having the roughness as disclosed in claim 1. The particles are rough particles and/or porous like particles and/or hollow (porous or not) beads. The thickness of the film to be cut or ground is advantageously less than 1000 μ m, preferably less than 500 μ m.

Said particles having for example a mean size (average in weight) comprised
25 between 60 μ m and 250 μ m, with substantially no particles with a size of less than 50 μ m. For example the particles used for the coating comprise less than 5% by weight particles with a size of less than 50 μ m.

The said particles can be deposited on the glue layer which was deposited in a
30 prior operation. The excess of particles can be removed by an air spray or by returning the support and by shaking so that the particles with no adherence or with a low adherence fall away from the support.

The said particles can also be mixed with a polymer material (transparent) before being deposited on the support. The crystalline or semi-crystalline particles are then dispersed within the polymer material. The polymer material is for example
5 a polyethylene, or a polymer having a melting point below the melting temperature of the crystalline or semi-crystalline particles. In this way the particles can be applied by fusing the polymer, said polymer acting as a hot melt glue.

D. Optional Coating of the security tag

10

The tag present on the support is advantageously coated with a polymer layer transparent at least to the light used with the device for determining one or more parameters function of the roughness. Said additional polymer layer is intended to form a protective cover layer. Said coating layer is advantageously made of a
15 polymer or polymer mixture resistant to solvents and water. Said covering layer is for example very thin and can be applied for example by spray coating. Such layer are for example thin silicon containing layer, fluoro polymer, etc.

Said protective cover layer is advantageously transparent to the illumination light.

20

E. Optional post treatment of the security tag, especially of its outer face with the desired roughness or of the protective cover layer

Said post treatment is for example a heat treatment, such as a heat calander pressing or heat roll pressing or a fusing of one or more portion of the security tag,
25 so as to form for example portions of the security tag having not a roughness within the selected range defined in claim 1. Such post treatment can also be carried out for ensuring a better curing of the protective cover layer.

F. Control of the surface properties of the security tag .

30

Said control of the surface of the security tag can be operated before and/or after the optional coating and/or post treatment of the security tag, but preferably after the optional coating and optional post treatment, if any. Advantageously a control is operated before the post treatment and after the post treatment.

5

By taking more images of the outer face of the security tag, with and without water drop deposit, with several different incident light rays directed to one or more specific areas of the tag, parameters function of the roughness of the tag are measured. The angle of incidence of the light rays is for example comprised between 30° and 60°. The angle formed between at least two light rays is

10

comprised between 15° and 180°, advantageously between 45° and 175°.

In case these properties are within the selected range of claim 1, the security label is used for the authentication and security of an item or product.

15 G. optional folding or shaping of the support or post treatment of the support

The support 1, 4 is for example provided with gluing means 8 on the face to be contacted with the product to be secured. Said gluing means, such as glue layer or dots, is advantageously protected before use with a removable film 9. In this way,

20

after removal of the film 9, the support with the security tag can be glued onto the item or product to be protected, for example within a recess of the item or product.

25 H. Optional Post treatment of the security label and/or of the support

Said optional post treatment is for example :

- applying a removable protective cover layer on the tag or on the support for ensuring a better stability.

30

- applying different marks on the support for enabling a better selection of the zone(s) or area(s) to be checked for the authentication process,
- etc.

The schematic principle of an authentication process of a tag according to the invention will be disclosed hereafter with reference to figures 7A and 7B.

- 5 In said figures 7A and 7B, the tag 3 to be authenticated is placed in a substantially horizontal plane H, while the camera 70 has a frame sensor 71 located preferably in a plane parallel to the horizontal plane H. The principal view direction V (vertical) is in this example perpendicular to the plane of the tag 3. The camera or the framing sensor thereof can be positioned in a plane forming an angle with the
- 10 plane of the tag or the principal view direction can form an angle with respect to the perpendicular to the plane of the tag. In case the tag is curved, the view direction can be for example substantially perpendicular to a plane tangent to the viewed tag portion to be analysed, or can form an angle with said plane tangent to the viewed tag portion.
- 15 Two illumination means 72,73 are used for illuminating the tag 3. The lighting direction of the illumination means 72,73 forms an angle of incidence γ comprised between 30° and 60° . The illumination means are intended to illuminate one area of the tag along two different directions, at two different moments. Between the lighting direction L72 of the illuminating means 72 and the lighting direction
- 20 L73 of the illuminating means 73, an angle comprised between 15° and 180° (advantageously from 45° to 175° , such as preferably from 90° to 150°) is formed. In this way, the framing sensor 71 of the camera can take a first series of images of the area of the tag 3 illuminated by the lamp 72 (the lamp 73 not illuminating the area of the tag 3), and a second series of images of the area of the tag 3 illuminated
- 25 by the lamp 73 (the lamp 72 not illuminating the area of the tag). Said first series of images and said second series of images can then be treated so as to determine parameters from the length or forms of the shades of the images, parameters which is function of the peak - valley distance, i.e. function of the rugosity or roughness. The number of information provided from said series of
- 30 images will thus be dependent of the amount, shape and size of the shades formed by the crystalline particles. According to embodiments, the images are not treated for determining the number of crystalline particles or the size of the particles as

such. By using the shade of the particles for determining a parameter function of the rugosity/roughness, the information are enlarged, enabling thus a more precise determination of parameters authenticating the tag.

- 5 A device for analysing one or more portions of a tag is disclosed here below as example only.

The device comprises four distinct units, namely an unit 100 for illuminating the tag or at least a portion thereof, an unit 101 for taking images of the tag, and a
10 control unit 102 for controlling the illumination and/or the angle of illumination and/or the type of illumination and/or the taking of images and/or the view angle and/or the timing, and a fourth unit 103 for treating the image signals. The device comprises also a table 105 for supporting the tag 90 to be analysed, said table being optionally movable so as to enable to position the tag 90 with respect to the
15 unit 100, as well to the unit 101. When using a movable table, it is possible to images of the tag while moving, for example when maintaining a same incident angle for the light. The units are part of one single apparatus, or can be distinct and separate units. The unit 102 is connected to the units 100 and 101 by means for sending signals and data's for controlling the said units 100 and 101.
20 Advantageously the control unit receives also some feedback information from said units 100 and 101.

The units 102 and 103 can form a single unit.

The unit 100 is for example provided with :

- 25 - means for directing electromagnetic radiation or illumination , UV radiation or illumination , white light, coloured lights, IR radiation or illumination ; etc. towards the tag 90 to be analysed;
- means for modifying the angle of illumination with respect to plane of the second face of the tag or the upper face of the tag, said means being suitable to vary the
30 angle the illumination (advantageously a substantially unidirectional radiation or illumination) from about 15° to about 60°, advantageously from about 30° to

about 60° with respect to the view direction of the tag (for example view direction perpendicular to the average plane in which the tag is located) ;

- means for modifying the relative position of the tag with respect to the illumination direction of the tag (so as to enable to take images with light having a same incident angle, but along two different illumination direction forming an angle therebetween with respect to the position of the tag comprised between 15° and 180°, advantageously between 45° and 175°)
- means for varying the intensity of the radiation or illumination (unidirectional), as well as the area to be illuminated;
- means for selecting the type of radiation or illumination .
- command elements (such as electric motor for modifying the position of the radiation or illumination head, electric motor for modifying the opening of a diaphragm, etc.) for modifying one or more parameters of the unit 100 in function of signals received from the control unit 102.

15

The unit 101 is for example provided with :

- means for receiving signals from the tag, such as images, said means comprising a camera, advantageously with one or more framing sensors, shutter and control means, such as lenses, objectives, filters, etc.
- means for varying the position of the camera with respect to the tag 90, or for varying the position of the framing sensor with respect to the tag 90,
- means for directing the view direction and for controlling the view angle of the camera,
- command elements for modifying one or more parameters of the camera
- means for transmitting signals to the treatment unit of the images,
- means for receiving signals from the control unit.

25

The unit 102 is adapted for controlling working parameters of the unit 100, as well as working parameters of the unit 101, and possibly even some parameters of the table 105. For example, the unit 102 can send signals to the radiation or illumination unit 100 and to the camera unit 101, so as to be able to take different images of the tag or from a portion of the tag.

30

For example the following commands will be possible:

- taking of several images of a portion of the tag while modifying the axial direction of the radiation or illumination ;
- taking several images of the tag while modifying the type of radiation or illumination and/or the intensity of the radiation or illumination ;
- taking several images of the tag along different view direction following a radiation or illumination in one or more specific radiation or illumination directions, or while modifying the radiation or illumination direction;
- taking images of several adjacent portions under a similar radiation or illumination ;
- etc.

The images of the Tag will be function of several parameters of the Tag as such, such as the crystalline or semi-crystalline polymer (density, molecular weight, tacticity, the solvent used for the crystallisation of the polymer, the size of the peaks, the size of the difference of height between the peak level and the valley level, the process parameters of the crystallization, the number of coating operation)

While all said parameters of the Tag influence the three dimensional images, the tag is quite unique and difficult to copy. The tag enables thus to authenticate a specific item, by comparing the parameter(s) with one or more registered parameters.

The unit 105 is advantageously provided with one or more motors suitable for modifying the position of the tag or the position of the item authenticated by the tag. For example, the table is a moving band enabling movement in the two opposite directions (forwards and backwards). The table 105 can possibly be inclined so as to vary the angle of view and/or the angle of radiation or illumination .

By varying the angle of radiation or illumination , as the crystalline or semi-crystalline polypropylene material forms a series of peaks and valleys, the shadow of the peaks will be modified, whereby the image of the tag or portion thereof will be different.

Various type of lights (radiation) can be used, When using fluorescent crystalline or semi-crystalline material in the tag, the signal emitted by the tag can be the fluorescence of the fluorescent material.

5

The unit 103 is adapted for treating signals of the images transmitted by the unit 101, as well signals relating to the parameters defining the radiation or illumination .

10 The unit 103 operates for example as follows :

- determining of the framed region of the tag to be analysed

for said analysis, several images of adjacent portions of the tag are taken and preprocessed to reduce misalignment. The camera head is for example moved so

15 as to find the mark to be analysed for authentication. For said determination, some marks can be present on the tag (for example for delimiting a zone of the tag for which images have to be taken) or the images can be processed to determine the relative distance between normalized images (i.e. intra-distances). For example, in case the spread of the intradistances measured from two images of two distinct
20 areas of the tag, advantageously adjacent areas, is too high or too large, the camera head is moved (for said movement, a signal is sent by the unit 103 towards the control unit 101) so as to take images of one or more other areas of the tag. The camera head is thus moved for taking images in a predetermined zone of the tag up to the moment that the spread of intradistances of two adjacent images is
25 sufficiently narrow and/or has a very marked unique peak.

- for the framed region, determination of a unique and robust identifier out of the random profile of tag framed region.

30 The images of the framed region are submitted to a "fuzzy extraction" for turning noisy physical information into a unique identifier. The fuzzy extraction comprises two procedures, namely an error correction for compensating the noise

existing in different measurements, and privacy amplification for mapping a non-uniform random string to a shorter, almost uniform, string. The fuzzy extraction is for example a Gabor based fuzzy extraction, which consists of a registration phase and a verification phase (see figure 8). In the registration phase, we first
5 filter the image data's through a 2Dimensional Gabor filter for the data's of the framed zone.

In "fuzzy extraction" process or method, the data's of the images are first digitized in binary string and for further treatment, such as for storage, comparison, etc.

10

Figure 6 is a schematic flow sheet of a preferred authentication method of the invention.

Items are produced or transformed in a production site. Before leaving the
15 production site, said items have to be provided with one or more authenticating tags. (Item Production)

Optional calibration step of the device

20 The device for registering and/or for authenticating tags applied on items has first to be calibrated, if required. The calibration step of the device can be operated at the production site or outside the production site, by using reference tags. The calibration step is advantageously carried out by experts independent from the production plant. The reference tags are tags having a roughness as disclosed in
25 one of the attached claims. (Reference calibrating tag - calibration step) In case, the device is precalibrated, the calibration step is not required.

For said calibration step, parameters relating to the illumination direction or directions and parameters relating to view direction of the apparatus taking several
30 images of the Reference calibrating tags are selected, for example in view of the shape of the item portion on which the tag is applied or intended to be applied.

For said calibration step, several images are taken from several portions of the reference calibrating tags. the images are first digitized in a binar string and then submitted to a fuzzy extraction for turning noisy physical information into a unique reference identifier. The fuzzy extraction comprises an error correction of the data for compensating noise existing during the different measures, and an amplification step for mapping a non uniform random string to a shorter reference string.

Parameters of the device are adapted so that the measured shorter reference string corresponds to the predetermined calibrating reference string. Possibly after modifying one or more parameters of the device (view angle, distance between the image taking system and the reference calibrating tag, illumination angle, etc.), a new shorter reference string of one or more reference calibrating tags are further measured, for controlling the accuracy of the parameter modification(s).

After said initial optional calibration step, in the production facility, items are provided with tags adapted to have a roughness within the claimed range. The device is then used for taking several images of tag portions with illumination once along the first illumination direction and then with the second illumination direction.

The chemical process enables the preparation of tags which are unique, whereby enabling thereafter to authenticate each tag as being one specific tag produced at a well determined time (day, hours and minutes).

For the calibration step, advantageously more than 10, preferably more than 20, such as 30, 40, 50, 70 or even more images are taken so as to determine the optimal parameters so as to ensure that an identical tag or different tags are well correctly recognised.

Registration step

After applying a tag on an item in the production facility of the item, the tag of the item or of items is/are advantageously submitted to a set-up step.

For said registration step, several images are taken from several portions of the tag of the various items. The images for each tag are first digitized in a binar string and then submitted to a fuzzy extraction for turning noisy physical information into a unique tag identifier for each item. The fuzzy extraction comprises an error correction of the data for compensating noise existing during the different measures for one tag, and an amplification step for mapping a non uniform random string to a shorter string for said tag.

The fuzzy extraction method is a method enabling to determine one specific identifier, for the conditions of illuminations and of taking images, said identifier being robust and secure. The identifier extracted by said method from one or more images will be robust so that two images of same tag or tag portion, a same identifier will be achieved although the images will not be identical. the said identifier will also be secure, so that for images of two different tags, the method will give different identifiers. Other methods can be used instead than the Fuzzy extraction, such as Gabor-based representation, multi resolution methods such as Wavelet-based representation, Curvelet-based representation and contour-based representation, linear methods such as random projection, or any combinations of said methods. Within the various possible image representation techniques, the fuzzy extraction process is preferred.

The tag of each item is then registered, for example in a data base and/or on a support, for example on a support attached to or placed into or on the box intended to contain the item authenticated by the tag.

This is advantageous so as to be able to identify one specific item in a series of item production, for example within items produced from a batch raw material, from a day production, etc.

While not being necessary for authenticating a tag, the tag of each item can also comprise one or more optional additional information readable or not by the device, for example readable by another device, such as bar code reader, for giving some other information, for example for determining whether an item has been produced from one batch or a series of batches, production month or day, etc. This is a secondary idea, but not essential for the invention. Said additional information are for example suitable for facilitating the control of the parameters or identifier of the tag of an item within a portion of a database. When the tag is prepared from a batch, it is possible for each batch material used for the production of the items to adapt the batch product of the tag for each batch material used for the production. For example for identifying whether items belong to the production of one specific year, specific period of one or more months period, specific period of one or more days, it is possible to add some particles with specific size, at a very low concentration, within the product batch used for the production of the tags dedicated for one day item production or for one batch item production. Said impurity or impurities or particles are then suitable for being detected as being a non random characteristic, whereby enabling to determine quickly whether an item belongs to a specific day or batch production.

In order to determine whether or not several items belongs to a same tag production batch, it is also possible to print some information or sign on a tag portion or on the item or on a support attached to the item.

Each item can also be associated to a readable reference, such as a bar code. In said case the database is in the form ensuring that to each bar code, only one unique identifier exists.

For safety purpose only, when the identifier of a tag is determined, the so determined identifier can be controlled with the preceding determined identifiers, before registering the identifier on a support or in the database.

Selling, distribution of the items

After the registration step being ended, the item is protected by a tag enabling authentication and can therefor be sent to distributors or shops for marketing purposes. The distributor(s) and/ or expert(s) (such as expert(s) dedicated to fight infringements of intellectual property rights) have the device adapted for
5 determining one or more parameters functions of the roughness of the tag present on items. Knowing the normal producer, the distributor(s) and/or the expert(s) will receive some parameters relating to method of capture of the images, such as numbers of images to be taken for determining the parameters whose values are randomly distributed among the tag considered, the parameters of the illumination,
10 such as colour, angle, etc. The expert(s) or distributor(s) will also receive data relating to validate authentication, for example an identifying reference for each tag and a string corresponding to the considered tag. Said data's can be given on every possible readable support (for example authenticating support attached to the item or the box of the item) or can be accessible via a security access (such as
15 password) to specific computer or server, for example via internet or telephone or other communicating system.

Authenticity of the reference data can for example be provided by cryptographic means ensuring the authenticity of the data stored on the specific computer or
20 server, or by providing an electronic signature of the data provided on the attached support, said signature being computed by the distributor(s) and/or expert(s).

After adapting optionally the verification device with the function parameters related to the manufacturer, the distributor or expert can optionally operate a prior control so as to control the correct working of the device by using a control
25 reference calibrating tag (for example furnished by the item manufacturer). After said optional further control, the expert or distributor can operate the verification step for the item(s), for example for authenticating items from the manufacturer and counterfeited items.

30 Verification step

For said verification step, several images are taken from several portions of the tag of one item to be examined for authentication. The images of the tag of the item considered for authentication are first digitized in a binar string and then submitted to a fuzzy extraction for turning noisy physical information into a
5 unique tag identifier for the item considered. The fuzzy extraction comprises an error correction of the data for compensating noise existing during the different measures for one tag, and an amplification step for mapping a non uniform random string to a shorter string for the tag of the considered item.

10 For the tag of the item considered, the device will compare the considered shorter string of the tag with the data's provided by the manufacturer. For facilitating the comparison, the device can advantageously be provided with an optional system for reading a identifying code, such as a bar code, so that the comparison function is quite automatic.

15 The robustness of the identifier associated to the analysed tag (during the optional calibration phase, the registration phase, as well as during the verification phase) is estimated by a success rate, which is the ratio between the correctly extracted identifier for the framed region of the tag and the total number of identifiers
20 determined for the framed region.

The False Acceptance rate is also advantageously evaluated (during the optional calibration phase, the registration phase, as well as during the verification phase), said false acceptance rate is computed as the ratio between the amount of similar
25 identifiers extracted from different tags to the number of identifiers.

The binary string extracted from several images of a tag, as well as the success rate and/or the false acceptance rate can form a unique signature for the tag considered.

30 After the required set-up phase, tests have shown that it was possible to reproduce the same identifier for one tag with a probability higher than 90% when more than 50 bit identifiers are determined for the tag or for the framed zone thereof, while

the probability of producing the same identifier for different tags was less than 5%. This result was achieved by using crystalline or semi-crystalline polymer material, especially crystalline or semi-crystalline polypropylene material (more particularly as a layer). This is important for the registration phase and for the verification phase of one specific tag, meaning to be able to determine with accuracy the authentication of the tag considered.

It is thus possible to have a well specified identifier for each tag, with a low probability to have the same identifier for different tags.

When determining 70 bit identifiers for the framed zone of a tag, we had still a 90% probability to reproduce the same identifier for the framed zone of the tag, while the risk to have the same identifier for different tags is about zero.

The identifier which is specific to a tag is in fact dependent of the roughness of the crystalline or semi-crystalline PP layer, but will random, whereby rendering impossible a copying.

The identifier will thus be unique, enabling a correct authentication or identification for the protected item.

As specific example of Gabor Fuzzy extraction, reference is made to figure 8.

In the registration phase occurring for example at the item production site, we first use the 2D Gabor Filter to the preprocessed framed region of the tag, in which the elemental Gabor function has the following formula :

$$\Gamma_{s,k,x_0}(x) = \frac{1}{s\sqrt{2\pi}} \sin(k \cdot (x - x_0)) \exp\left(\frac{-(x - x_0)^2}{4s^2}\right)$$

The basis function $\Gamma_{s,k,x_0}(x)$ is the product of a plane wave with wave vector $k \in \mathbb{R}^2$ and a Gaussian with variance $s \in \mathbb{R}$ centered on $x_0 \in \mathbb{R}^2$. $x_0 \in \mathbb{R}^2$ denotes a location in the tag image. Let $x_0 \in \mathbb{R}^N$ be an extracted tag image, Gabor coefficient g are then given by the convolution of the image with the family of the

5 basis functions:

$$g_{s,k}(x_0) = (\Gamma_{s,k,x_0} * x)$$

In the second step, a noise robust vector is selected as the M components i with the

10 largest absolute value $|g_i|$ and then binarized by quantizing to two quantization intervals (one bit per component) that leads to a M bits string $\bar{x}$ (fingerprint). The positions of robust components are stored in a first part of the helper data, w_1 . In parallel an identifier s of $K < M$ bits is generated by random Number Generator (RNG) and extended into a string $s_e \in B^M$ by an Error Correcting Code encoding

15 (ECC) of error -correction capability $T < K < M$. Finally, x is XORed with s_e to form $w_2 = s_e \oplus \bar{x} \in B^M$. The helper data of $M+M$ bits is composed of (w_1, w_2) . This data constitutes, together with the PUF (physical unclonable function) and the identifiers, the information required to authenticate the object.

20 During the verification stage, the tag is reobserved into a image $\bar{x}' \in \mathbb{R}^N$ undergoing the same preprocessing and extraction of Gabor robust components. From the helper data, w_1 is used to compute x' . After XORing this later with w_2 and sending the output to the ECC decoder (ECC), a final K -bits string s' is produced. Since $(u \oplus v) \oplus v = u$ for any two strings $u, v \in B^M$, if the ECC capability T is set

25 higher than the maximal hashing distortion of different observations of the same tag, and if we do observe the same object with same tag, then the system guarantees $s = s'$.

Robustness is estimated through the success rate (SR) that is simply computed as

30 the ratio between the amount of correctly extracted identifiers (s) for the same tags and the total amount of measures. False acceptance rate (FAR) is evaluated for

showing the likelihood that different tags build the same identifier. FAR is computed as the ratio between the amounts of similar identifiers extracted from different tags to the total of identifiers.

- 5 In the description hereabove reference is made to fuzzy extraction process using a Gabor Filter. This extraction process is given as example only. Other fuzzy extraction processes of crystal process are suitable for the invention, assuming the use of an efficient image representation technique adapted to reduce the dimension of the image while preserving the main information thereof. This can be achieved
- 10 using Gabor-based representation, multiresolution methods such as Wavelet-based representation, Curvelet-based representation and contour-based representation, linear methods such as random projection, or any combinations of said methods. Within the various possible image representation techniques, the fuzzy extraction process is preferred.

What we claim is :

1. A security labelling system comprising a security tag attached to a support or
5 an object or label adapted to be associated or attached to a product or item to be
secured, said security labelling system comprising :
- a security tag comprising solid material consisting of crystalline or semi-
crystalline organic polymer material having a three dimensional structure, said
10 solid material of crystalline or semi-crystalline organic polymer material being
dispersed within a layer of a polymer and/or copolymer material or being covered
by a layer of a polymer and/or copolymer material, whereby said layer of polymer
and/or copolymer material is adapted for enabling one or more signal,
advantageously one or more images of the three dimensional structure of the said
15 crystalline or semi-crystalline organic polymer material to be collected or taken
from a face of said layer, wherein the said solid polymer material defines at least a
three dimensional pattern with a face directed towards the face of the layer through
which one or more images of the three dimensional pattern are taken .
wherein said pattern defined by said solid material of crystalline or semi-
20 crystalline organic polymer material defines a surface with a roughness, said
surface roughness being visible optionally after removal of a protection element
and having a portion with a surface roughness adapted for enabling an
authentication of the security tag, wherein said surface roughness for said
determined portion is adapted for being within a selected roughness range within
25 roughness' of the group consisting of surface roughness' having:
 - (a) a root mean square surface roughness measured with a magnification factor of
5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of
50, i.e. at a scale of approximately 220 μm ; comprised between 1 μm and 100 μm ,
advantageously between 1.1 μm and 75 μm , preferably between 1.1 and 20 μm ,
30 most preferably between 5 μm and 16 μm , and/or
 - (b) a Wenzel roughness factor (defined as the ratio between the real surface area
and the apparent surface area) above 1.2, advantageously above 2 at a
magnification factor of 5, as well as at magnification factor 50,

and

- a device for receiving at least one or more signals, advantageously for taking at least one or more images of the said determined portion of the security tag, said signal or signals, advantageously image or images being adapted for determining one or more identifiers, advantageously one unique identifier, said identifier(s) being dependent at least from the surface roughness of said determined portion of the security tag.

2. The security labelling system of claim 1, wherein the three dimensional tag has a first face directed towards the support, the object or the label and a second face opposite to said first face,

wherein said second face has at least one determined portion having a surface roughness which is visible optionally after removal of a protection element and which is adapted for enabling an authentication of the security tag, wherein said surface roughness for said determined portion is adapted for being within a selected roughness range within roughness' of the group consisting of surface roughness' having:

- (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1 μm and 100 μm , advantageously between 1.1 μm and 75 μm , preferably between 1.1 and 20 μm , most preferably between 5 μm and 16 μm , and/or

- (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor of 5, as well as at magnification factor 50,

and

- a device for taking at least one image of the said determined portion of said second face of the security label, said image(s) being adapted for determining one or more identifiers, advantageously one unique identifier, said identifier(s) being dependent at least from the surface roughness of said determined portion of the security tag.

3. The security labelling system of claim 1 or 2, in which said surface roughness for said determined portion of the security tag is adapted for being within a selected roughness range within roughness' of the group consisting of surface roughness' having:

- 5 - (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1 μm and 100 μm , advantageously between 1.1 μm and 75 μm , preferably between 1.1 and 20 μm , most preferably between 5 μm and 16 μm , as well as
- 10 - (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor 50.

4. The security labelling system of any one of the preceding claims, in which the
15 device for taking at least one image of the said determined portion comprises a image capture element adapted for taking at least one image of the said determined portion of the second face of the security tag along a view direction, and in which the device for taking at least one image of the said determined portion is provided with or associated to means for illuminating the said determined portion along a
20 principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the view direction and/or for illuminating the said determined portion of the security tag from the first face of the security tag, wherein the device for taking images is adapted for taking one or more first images in the view direction with a first illumination light and for taking one or more
25 second images in the view direction with a second illumination light, wherein an angle comprised between 15° and 180° is formed between the directions of the first and second lights .

5. The security labelling system of anyone of the preceding claims, in which the
30 security tag has a first face directed towards the support, the object or the label and a second face opposite to said first face, said second face having :

(i) a first determined portion having a first surface roughness adapted for being within a first selected roughness range within roughness' of the group consisting of surface roughness' having:

- (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1.1 μm and 20 μm , advantageously between 5 μm and 16 μm , and/or
- (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor of 5, as well as at magnification factor 50, and

(ii) a second determined portion having a second surface roughness adapted for being within a second selected roughness range not comprised within the first selected roughness range, wherein said second selected roughness range is advantageously selected within roughness' of the group consisting of surface roughness' having:

- (a) a root mean square surface roughness measured with a magnification factor of 5, i.e. at a scale of approximately 2.2 mm, as well as with a magnification factor of 50, i.e. at a scale of approximately 220 μm ; comprised between 1.1 μm and 20 μm , advantageously between 5 μm and 16 μm , and/or
- (b) a Wenzel roughness factor (defined as the ratio between the real surface area and the apparent surface area) above 1.2, advantageously above 2 at a magnification factor of 5, as well as at magnification factor 50 ,

wherein said second determined portion is advantageously adjacent to the said first determined portion.

6. The system of any one of the preceding claims, in which the device for taking at least one image of the said determined portion comprises an image capture element adapted for taking at least a first image of the said determined portion of the second face of the security tag along a first view direction, and an image capture element adapted for taking at least a second image of the said determined portion of the second face of the security label along a second view direction different from the first view direction, and in which the device or one or the

devices for taking at least said first and second images of the said determined portion is/are provided with or associated to means for illuminating the said determined portion along a principal lighting direction forming an angle of at least 5°, advantageously at least 15°, preferably from 30° to 60° with the first and
5 second view direction and/or for illuminating the said determined portion of the security tag from the first face of the security tag.

7. The system of any one of the preceding claims, in which the device for taking at least one image of the said determined portion comprises an image capture
10 element adapted for taking at least a two images of the said determined portion of the second face of the security tag along a first view direction, and in which the device for taking at least said two images of the said determined portion is/are provided with or associated to means for illuminating the said determined portion along a first principal lighting direction and along a second principal lighting
15 direction different from the first lighting direction, wherein said first and second principal lighting directions form each an angle comprised between 30° and 60° with the first and second view direction and/or for illuminating the said determined portion of the security tag from the first face of the security tag .

20 8. The system of anyone of the preceding claims, in which the layer of a polymer and/or copolymer material is covered by a transparent or semi transparent protection layer, said protection layer being advantageously resistant to solvent and to temperature of at least 100°C, advantageously at least 150°C.

25 9. The system of anyone of the preceding claims, in which the crystalline or semi-crystalline polymer material comprises at least 50% by weight polypropylene, advantageously at least 75% by weight polypropylene, preferably at least 90% by weight polypropylene.

30 10. The system of the preceding claim, in which the crystalline or semi-crystalline polymer material is prepared by depositing a solution of polypropylene in an

appropriate solvent system and by drying said deposit at a temperature lower than 120°C.

11. The system of claim 9, in which the crystalline or semi-crystalline polymer material is prepared by depositing a solution of polypropylene in an appropriate solvent system on a support, by drying said deposit at a temperature lower than 120°C so as to form a layer having the appropriate roughness, by grinding the layer so as to form ground particles, and in which the ground particles are dispersed within a layer of polymer and/or copolymer material and/or are deposited on a layer, advantageously a glue layer, before being covered by a layer of polymer and/or copolymer material.

12. The system of claim 11, in which the security tag has a first face adapted to be directed towards the support, the object or the label to be attached or associated to the item or product to be secured, and a second face opposite to said first face.

13. The system of anyone of the preceding claims, in which the security tag is deposited on a face of the support having a roughness comprised between 1.1 µm and 120 µm.

14. The system of any one of the preceding claims, which further comprises at least one means for digitizing at least a part of one or more images of the security tag or a combination of such images, after physical extraction and/or fuzzy extraction of data's from said one or more images into binary data's or identifiers, and advantageously a means for estimating the success rate of said binary data's or identifiers for the said part of one or more images.

15. A method of ensuring the authenticity of an item, said method comprising at least the following steps :
- providing the item with or associating the item to a security labelling system as disclosed in anyone of the preceding claims,

- receiving at least one or more signals, advantageously for taking at least one or more images of the said determined portion of said second face of the security tag , said signals or images being adapted for determining, possibly after treatment, especially from the shade of the peaks of the tag, one or more parameters or/and one or more identifiers, advantageously one unique identifier, said parameter(s) or/and identifier(s) being dependent at least from the surface roughness of said determined portion of the security tag.

16. The method of claim 15, said method comprising at least the following steps:

- illuminating the said determined portion of the second face of the security tag as disclosed in claim 2 or 12 along a principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the view direction and/or illuminating the said determined portion of the security tag from the first face of the security tag , and
- taking at least one image, advantageously a series of images of the said determined portion of the security tag, advantageously the second face of the security tag along the view direction.

17. The method of claim 15 with a tag according to claim 2 or 12, said method comprising the steps:

- illuminating at a first moment the said determined portion of the second face of the security tag along a first principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the view direction and illuminating at a second moment the said determined portion of the security tag along a second principal lighting direction forming an angle of at least 5° , advantageously at least 15° , preferably from 30° to 60° with the view direction, said second principal lighting direction being different from the first principal lighting direction, or from the first face of the security label, said second lighting direction forming an angle comprised between 15° and 180° with the first lighting direction,

- taking at least one image, advantageously a series of images of the said determined portion of the second face of the security tag at the said first moment along the view direction, and
- taking at least one image, advantageously a series of images of the said
- 5 determined portion of the second face of the security tag at the said second moment along the said view direction.

18. The method of claim 16 or 17, said method comprising the steps :

- illuminating at a first moment the said determined portion of the second face of
- 10 the security tag along a principal lighting direction or from the first face of the security tag,
- taking at least one image of the said determined portion of the second face of the security tag at a first moment along a first view direction forming an angle of at least 5°, advantageously at least 15°, preferably from 30° to 60° with the principal
- 15 lighting direction, and
- taking at least one image of the said determined portion of the second face of the security tag at a second moment along a second view direction forming an angle of at least 5°, advantageously at least 15°, preferably from 30° to 60° with the principal lighting direction, said second view direction being different from the
- 20 first view direction.

19. The method of anyone of the claims 15 to 18, said method comprising at least the following steps :

- providing the item with or associating the item to a security tag as disclosed in
- 25 anyone of the claims 2 or 12,
- taking at least one image of a first determined portion of said second face of the security tag , said image(s) being adapted for determining from the shade of the peaks of the tag one or more identifiers, advantageously one unique identifier, said identifier(s) being dependent at least from the surface roughness of said first
- 30 determined portion of the security tag,
- and

- taking at least one image of a second determined portion of said second face of the security tag , said image(s) being adapted for determining from the shade of the peaks of the tag one or more identifiers, advantageously one unique identifier, said identifier(s) being dependent at least from the surface roughness of said
- 5 determined portion of the security tag.

20. The method of any one of the claims 15 to 19, in which data's of at least a part of one or more images of the security tag are submitted to a physical extraction, advantageously to a fuzzy extraction and digitized in binary data's or identifiers,

10 and in which advantageously a success rate of said binary data's or identifiers for the said part of one or more images is estimated.

21. The method of any one of the claims 15 to 20, in which several signals or images of the tag are treated with a randomness check, followed by a physical

15 extraction, especially a fuzzy extraction.

Selection of the support for the security tag



Optional coating with intermediate layer(s)



Coating with the security tag



Optional coating



Optional post treatment



Control



Optional folding / shaping



Optional post treatment

Fig. 1

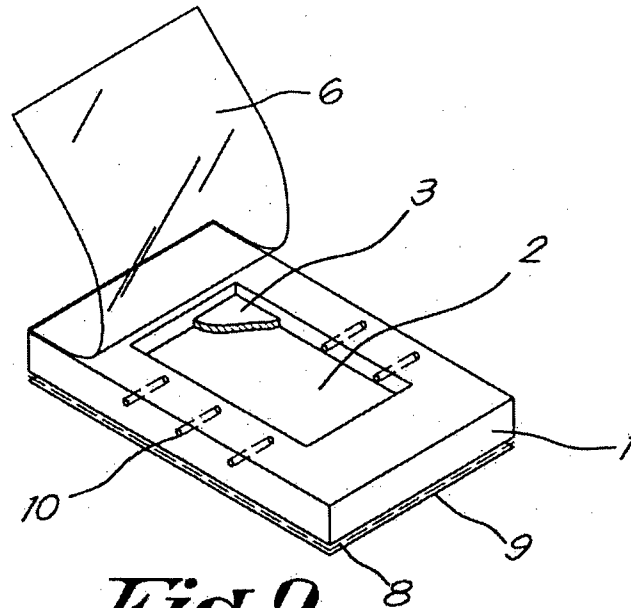


Fig. 2

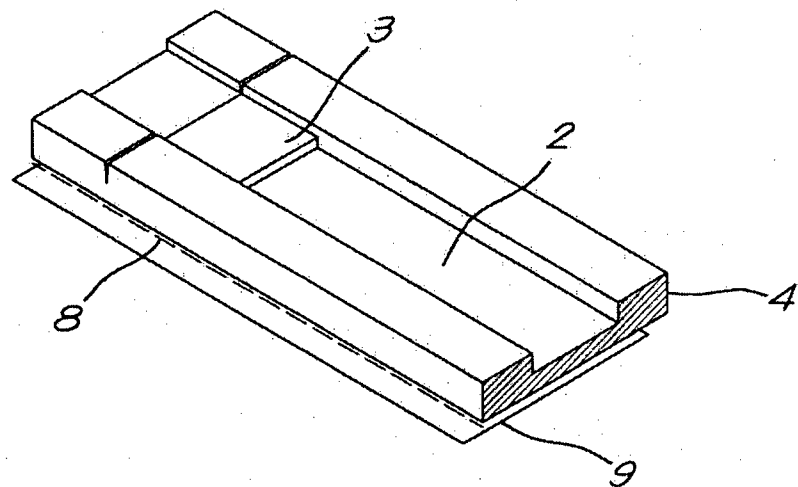


Fig. 3

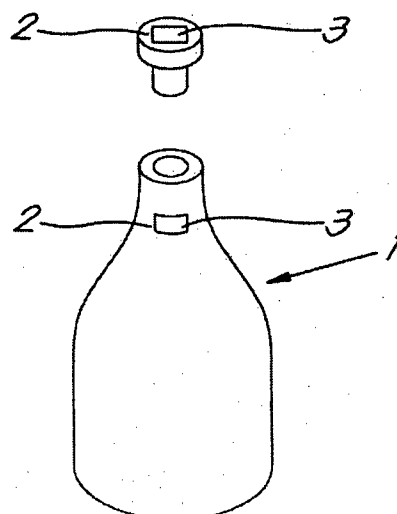
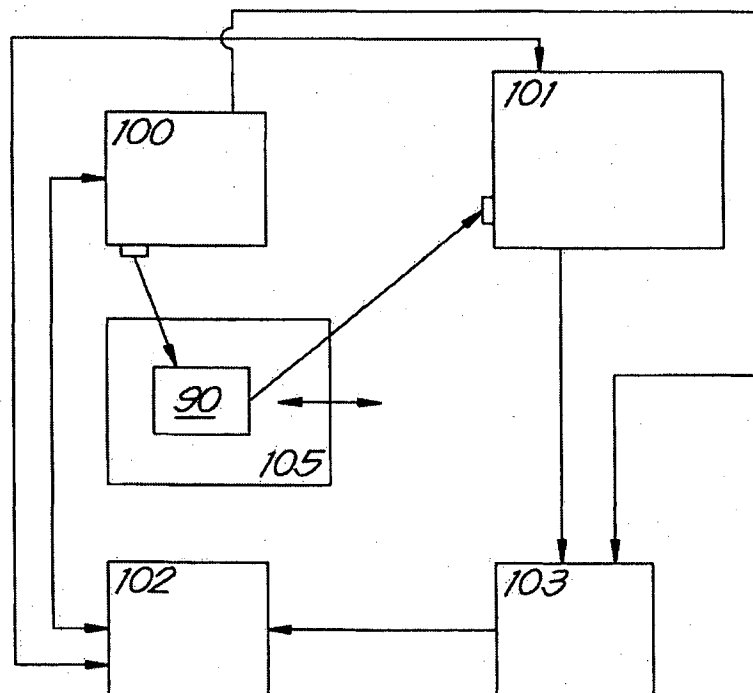
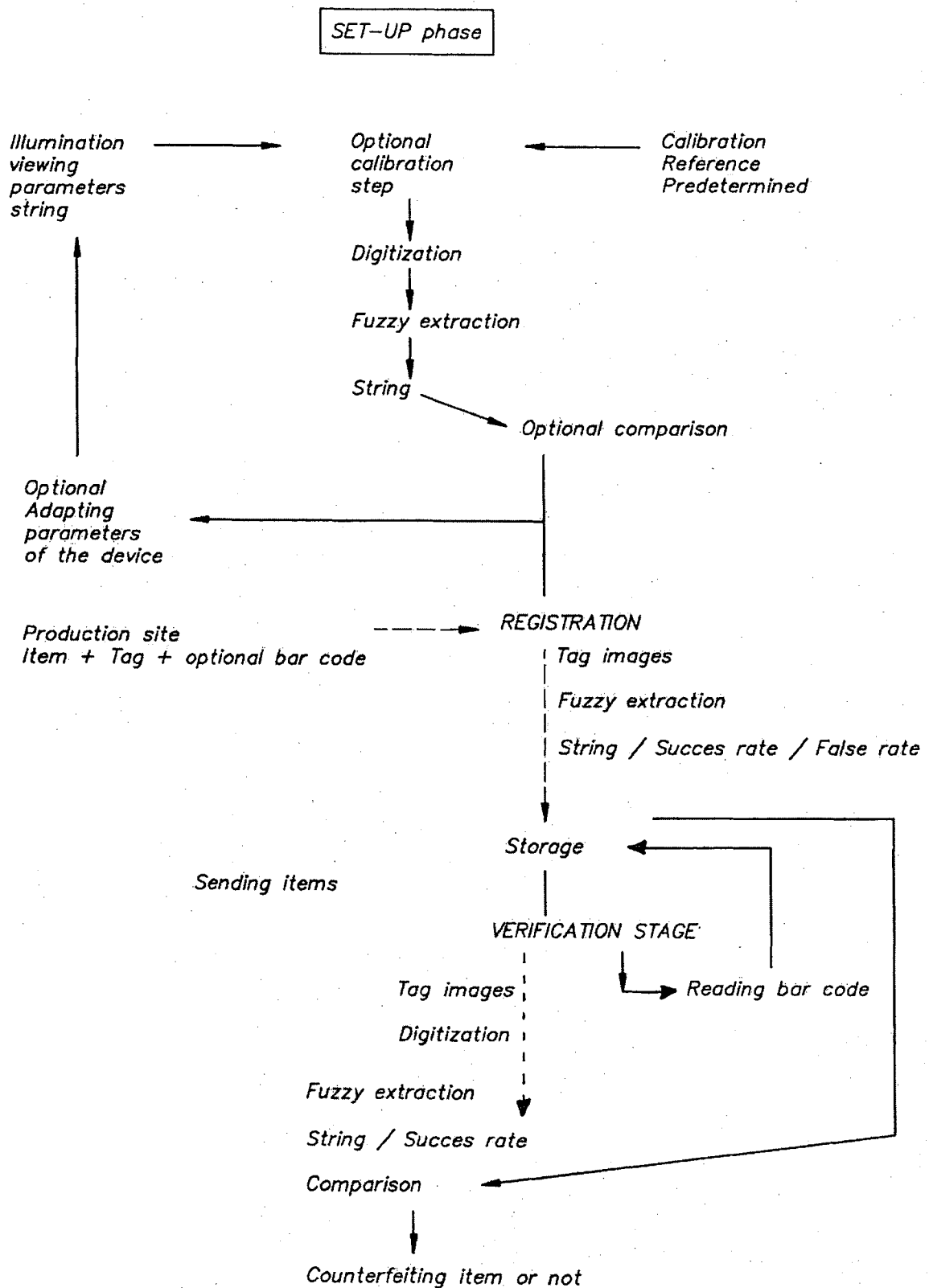


Fig. 4

*Fig.5*

*Fig. 6*

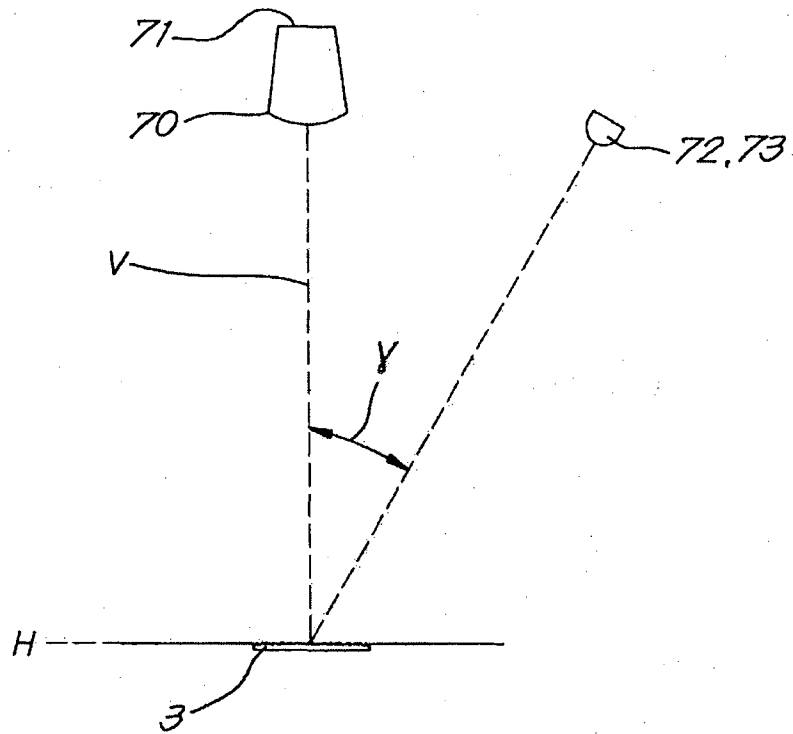


Fig. 7A

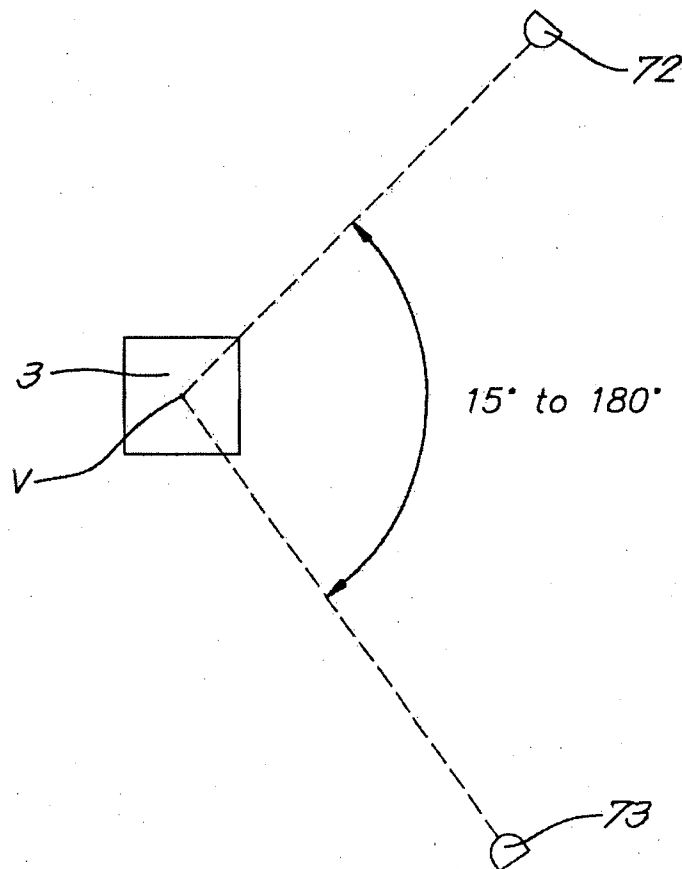
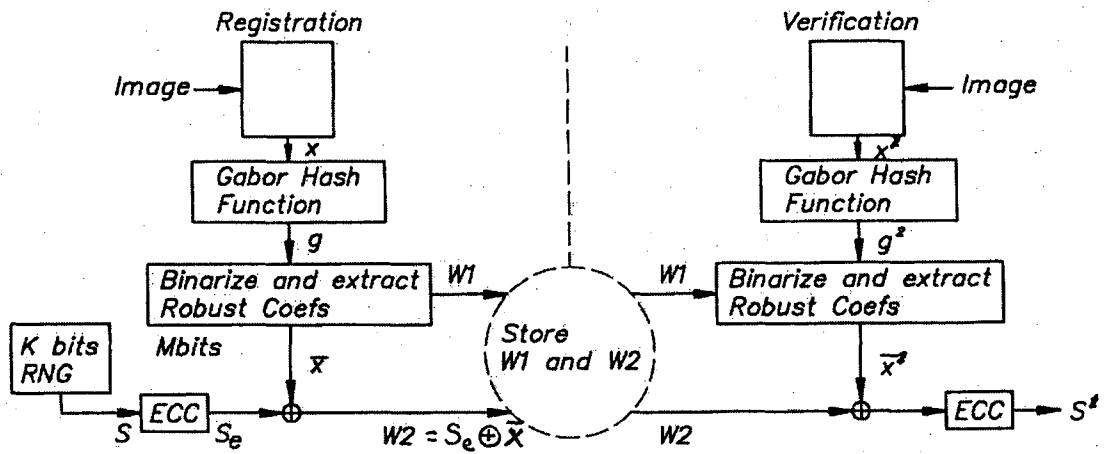


Fig. 7B

*Fig.8*