

Certification device and method for providing a certificate of a gemstone

The invention relates to a certification device and to a corresponding method for providing a certificate of a gemstone.

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Gemstones are often used in jewelry and may have a high monetary value. In case a gemstone is sold or given away, for example for valuation or for incorporation into a piece of jewelry, it can be crucial for parties to secure the identity of a specific gemstone.

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It is thus an object of the present invention to provide for a certification device, and to provide for a corresponding method for providing a certificate of a gemstone.

This is achieved by a device and a method according to the respective main claims.

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Preferred embodiments can be derived from the dependent claims.

The invention relates to a certification device. The certification device comprises a measurement surface for positioning a gemstone. It comprises at least one light source emitting light on or through the measurement surface towards the gemstone.

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It comprises at least one camera for taking at least one picture of the gemstone while the at least one light source remains activated. It comprises preferably a control device for controlling the at least one light source and the at least one camera for generating a certificate of the gemstone.

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Using such a device may generate a certificate that contains unique characteristics of a gemstone. For example, characteristics as described further below can be extracted from pictures of the gemstone, can be printed on a certificate and can be used in order to uniquely identify the gemstone.

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With regard to the device, all statements given with regard to the method described further below may be applied accordingly. Also all statements given with regard to the device may be applied for the method described below. Especially, the method described below can fully or partly be performed using the described device.

The measurement surface may be a specific surface adapted for holding a gemstone. Especially, it may be a flat surface. This has the advantage that the gemstone lies on the surface with a defined orientation and without cavities towards the surface.

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Emitting light using the at least one light source will increase visibility of features like inclusions, facets or outlines in the gemstone. Thus, identification of such features may be simplified.

- 10 A camera can especially be a CCD camera or another optically sensing camera. Both video cameras being able to take a certain amount of pictures per second and one-shot cameras being able to take single pictures can be used.

- 15 According to a preferred implementation, the measurement surface is optically transparent. This allows illumination of the gemstone from below the measurement surface. Light emitted from below the measurement surface can directly shine into the gemstone after transmission through the measurement surface. Especially, an element forming the measurement surface can be optically transparent.

- 20 According to an implementation, at least one light source is an indirect light source being positioned and oriented for emitting light towards the gemstone through the measurement surface. Such an indirect light source typically does not shine directly on the gemstone, instead the light or at least most of the light has to be scattered, deflected, or reflected in order to reach the gemstone.

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- The at least one indirect light source can especially be positioned and oriented for emitting light below the measurement surface in an angle to the measurement surface such that the light does not impinge directly on the measurement surface. This leads to an indirect light that has proven to be best for at least some purposes with evaluation of a gemstone. The given positioning and orientation may be valid for
30 all indirect light sources.

According to an implementation, the at least one indirect light source is positioned and oriented for emitting light parallel to the measurement surface. This means that

the indirect light source at first emits light such that the light is parallel to a plane defined by the measurement surface. As the indirect light source is positioned below the measurement surface, this light does not directly reach the measurement surface. It will be scattered and/or reflected in order to reach the measurement surface.

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More generally, the at least one indirect light source may be positioned and oriented for emitting light in an angle of less than 10 degrees to the measurement surface, for example. This also prevents that most of the light impinges directly on the measurement surface.

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In principle, when an angle is given in this application, this can mean that the angle is fulfilled exactly with respect to measurement tolerances, or it can mean that a slight deviation from that angle can be applied, for example up to 10 degrees.

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According to an implementation, at least one light source may be a direct light source being positioned and oriented for emitting light towards the gemstone through the measurement surface. This allows direct illumination of the gemstone from below the measurement surface. Light emitted from a direct light source does not have to be scattered or deflected in order to reach the gemstone.

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If the at least one direct light source is positioned and oriented for emitting light below the measurement surface in an angle to the measurement surface such that the light impinges directly on the measurement surface, the gemstone can be illuminated with an undeflected straight beam

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Especially, the direct light source may be positioned and oriented for emitting light perpendicular to the measurement surface. However, also small angles of e.g. up to 10 degrees can be used between a direction perpendicular to the measurement surface and the direction of light emission.

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According to a possible implementation, the device further comprises a diffuser being positioned so that light emitted from the direct light source passes through the

diffuser before reaching the measurement surface. This can yield a smoother and/or less directed light beam for illumination of the gemstone.

5 The device may especially further comprise an adjustable aperture being positioned so that light emitted from an indirect light source and/or a direct light source passes through the adjustable aperture before reaching the measurement surface. This allows adjusting the size of a light beam so that it only illuminates the gemstone, not an area surrounding the gemstone. Disturbances in pictures due to artefacts from outside the gemstone can thus be prevented or reduced.

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If the device further comprises at least one light source being positioned and oriented for emitting light towards the gemstone without passing the measurement surface, a direct illumination of the gemstone with light that has not passed the measurement surface is possible. This can be used in order to have illumination of the gemstone
15 with a specifically defined light beam.

The device may comprise at least one light source being positioned and oriented for emitting light from above the gemstone perpendicular to the measurement surface. This also allows direct and/or undeflected illumination. However, also an angle of e.g.
20 up to 10 degrees between a normal to the measurement surface and a direction of light emission can be used.

Especially, one, some or all cameras may be embodied as microscopes. A microscope may especially comprise one or a plurality of lenses in order to provide a
25 defined magnification before an image is taken, e.g. by a CCD camera or another light sensitive device.

The invention further relates to a method for providing a certificate of a gemstone, the method comprising the following steps:

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- positioning the gemstone on a measurement surface of a certification device,
 - activating at least one light source emitting light on or through the measurement surface towards the gemstone,
 - taking at least one picture of the gemstone while the at least one light source remains activated,

- identifying at least one characteristic of the gemstone based on the picture, and
- generating the certificate based on the characteristic.

5 A certificate may, for example, be a printed certificate or a digital certificate. It may, for example, be a document printed by a printing device and containing information about the certificate. It may also comprise additional security measures like signets. It may especially serve to compare it with a visual observation of the gemstone, so that it can be verified if the gemstone corresponds to the certificate.

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It should be noted that the method and further means described herein may not only be applied to a gemstone. They may equally be applied to objects like wine bottles, paintings, knives, antiques, artefacts, or collections. Also the certification device may be used for generating a certificate of such objects.

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Especially, a certification device as described herein can be used for performing the method. All described variants and embodiments can be applied. However, the method can also be performed with other devices and/or with additional components like a laboratory balance, as described below.

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The measurement surface may be a specific surface adapted for holding a gemstone. Especially, it may be a flat surface. This has the advantage that the gemstone lies on the surface with a defined orientation and without cavities towards the surface.

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Emitting light will increase visibility of features like inclusions in the gemstone. Thus, identification of such features may be simplified. Specific light sources have been shown to yield pictures suitable for specific analysis. Examples of preferably used light sources are given below.

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It is possible to take a picture separately. It is also possible to take it as part of a video. It is also possible to take several pictures for a certificate. For example, each picture can be analyzed separately, or several pictures can be analyzed in combination. This will be discussed further below.

According to an implementation, the measurement surface is optically transparent. This allows placing of one, some or all light sources below the measurement surface and to illuminate the gemstone through the measurement surface.

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Especially, at least one light source may be an indirect light source emitting light towards the gemstone through the measurement surface. An indirect light source is especially a light source not emitting directly towards the gemstone. Typically, only scattered light from an indirect light source reaches the gemstone.

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The indirect light source can especially emit light below the measurement surface in an angle to the measurement surface such that the light does not impinge directly on the measurement surface.

15 In an exemplary implementation, the indirect light source emits light parallel to the measurement surface. However, also other angles can be used.

It is possible that at least one light source is a direct light source emitting light towards the gemstone through the measurement surface. A direct light source may especially emit light such that the light can reach the gemstone without being scattered.

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Especially, the direct light source can emit light below the measurement surface in an angle to the measurement surface such that the light impinges directly on the measurement surface. For example, the direct light source may emit light perpendicular to the measurement surface.

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In an exemplary implementation, light emitted from the direct light source passes a diffuser before reaching the measurement surface. Such a diffuser may correct for possible structuring of the light beam, yielding a smoother beam. Such a smoother beam can give rise to better pictures for the purpose of pattern identification.

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According to a possible implementation, light emitted from an indirect light source or a direct light source passes through an adjustable aperture before reaching the

measurement surface. Such an aperture can especially be used in order to adjust the diameter of a light beam to the size of a gemstone. Thus, disturbances in a picture by artefacts arising from outside the gemstone can be omitted or suppressed.

- 5 According to an implementation, at least one light source emits light towards the gemstone without passing the measurement surface. This allows for an illumination of the gemstone from above the measurement surface. For example, such a light source may be integrated in a camera.
- 10 Especially, at least one light source can emit light from above the gemstone perpendicular to the measurement surface. This allows illumination exactly from above. However, also a small angle of e.g. up to 10 degrees may also be implemented instead.
- 15 According to an implementation of the method, at least one picture is taken with a camera positioned over the measurement surface viewing perpendicular to the measurement surface. This allows taking a picture perpendicular to the measurement surface and/or in vertical direction. However, also a small angle of e.g. up to 10 degrees may be implemented.
- 20 According to a further possible implementation of the method, at least one picture is taken with a camera positioned over or besides the measurement surface viewing sidewise to the measurement surface. This allows for a different perspective, for example to get a three-dimensional information.
- 25 It is possible to take at least one picture with a camera viewing parallel to the measurement surface. This can give a view of the gemstone exactly from besides it. However, also a small angle of e.g. up to 10 degrees may be implemented.
- 30 If several pictures are taken, one characteristic or more characteristics may be identified in each of several pictures. The certificate may be generated using characteristics identified in several pictures. This can increase accuracy and security. For example, pictures taken while different light sources have been activated and/or

pictures taken with different cameras can be used. Reliability of a generated certificate can thus be increased significantly.

Especially, several pictures can be taken for one certificate. These pictures can be
5 taken by different cameras and/or with illumination by different light sources.
Examples are described herein.

Especially, pictures may be taken using at least two or more different cameras. This
increases available information. The different cameras can especially be positioned
10 at different locations and/or can view the gemstone from different directions. More
information can be extracted from those pictures, increasing reliability of a generated
certificate.

Especially, several pictures may be taken while having different light sources
15 activated. This can increase visibility of inclusions. For example, different inclusions
can best be visible with different light sources. Especially, a different light source or a
different combination of light sources may be used for each picture. The different light
sources can especially be positioned at different locations and/or illuminate the
gemstone from different directions.

20 If at least one characteristic is a color code of the gemstone, the color can be used in
order to provide an identification of the gemstone. Such a color code may be
generated by predefined processes or algorithms from a picture.

25 Especially, it is possible to take a color image of the gemstone, and it is possible to
generate the color code based on the color image. For example, a specific algorithm
for extraction can be used.

If the color code is generated as a dominant color of the color image, the dominant
30 color can be used as a specific identification of the gemstone for the certificate.

Alternatively, also a combination of specific colors or colors with a specific minimum
percentage present in the picture can be used to generate the color code.

According to an embodiment, at least one characteristic is a pattern of inclusions in the gemstone. Such a pattern can be regarded as a very characteristic fingerprint of a gemstone. Each gemstone has inclusions, and features like positions, shapes, and types of these inclusions and/or distances between these inclusions can typically not
5 be found in any second gemstone, even if it has the same intended outer dimensions.

A pattern may comprise information about position, distances, and/or orientation of inclusions in a gemstone. Examples are given below. Such inclusions may serve as a
10 fingerprint of a specific gemstone and can be used to identify the gemstone.

The certificate may comprise information about the inclusions and/or the pattern. Thus, the certificate may be used to identify a specific gemstone. The certificate may also be identical with the pattern. Especially, a pattern may comprise locations of
15 inclusions and/or distances and/or orientations between them.

The at least one pattern of inclusions may in a preferred implementation be generated based on one or more pictures taken during sole activation of indirect light sources. Test have shown that such indirect light sources yield specifically good
20 picture quality for identifying inclusions. However, also direct light sources or other light sources can be used alternatively and/or additionally.

According to an implementation, one pattern or more patterns each comprise a plurality of distances between two respective inclusions. A distance may especially
25 be independent of an orientation, i.e., being a numerical value.

According to an alternative or additional implementation, one pattern or more patterns each comprise a plurality of orientations between two respective inclusions. An orientation may especially be given in three-dimensional space. It may be
30 combined with a respective distance.

It is possible that one pattern or more patterns each comprise a plurality of combinations of orientation and distance between two respective inclusions. This gives the highest level of information about two respective inclusions.

Especially, such distances and/or orientations may be determined for respective pairs of all inclusions found, or for only some of them.

- 5 According to an implementation, one pattern or more patterns each comprise a plurality of positions of inclusions inside the gemstone. Such positions may be given with reference to an external coordinate system, and/or with reference to one or more faces or facets of the gemstone.
- 10 It is further or alternatively possible that at least one characteristic comprises positions and/or orientations of outlines between facets of the gemstone.

Facets are typically made intentionally at a gemstone, for example by grinding. A facet is typically flat. It is especially an outer surface of the gemstone. A specific
15 combination of facets gives the gemstone a certain appearance.

Outlines are located between the facets. They are typically straight lines, but may also be bent lines. Even if it is usual to fabricate a plurality of gemstones in an identical manner, i.e. with the intention of identical facets, variations between outlines
20 of different such gemstones occur inadvertently. Such variations can be measured and can be used to identify a specific gemstone.

It is possible that at least one characteristic comprises positions of junction points between facets of the gemstone. Such junction points are typically points where two,
25 three, four or more outlines intersect. They are also subject to variations between gemstones that have been fabricated in an identical manner. Exact positions of the junction points can be measured and can be used as a specific fingerprint of a gemstone.

30 Accordingly, at least one characteristic may comprise distances between junction points between facets of the gemstone. As the positions are specific for a gemstone, the distances between the junction points are also specific for a gemstone. The distances may or may not include orientation.

If the positions of inclusions comprised in the at least one pattern are given relative to outlines and/or junction points, these outlines or junction points can be used as a reference frame of the gemstone. The positions of the inclusions can be measured and given in that reference frame.

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At least one characteristic may comprise geometries of inclusions in the gemstone. Such geometries may relate to the respective inclusion itself. For example, a shape of an inclusion can be used as a geometry. Such shapes or geometries can be classified into several classes.

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The geometries can especially be generated based on one or more pictures taken during sole activation of a direct light source shining light from above the measurement surface on the gemstone. It was found that pictures taken with such a light are especially suitable for extracting geometries. However, also other light sources can be used alternatively and/or additionally.

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If during application of a light source an adjustable aperture being positioned between the light source and the gemstone is closed so that a light beam only shines through the gemstone, artefacts from features outside the gemstone can be omitted and extraction of information from a generated picture can be made more reliable.

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At least one characteristic may be one or more dimensions of the gemstone. These may especially be outer dimensions like length, widths, height, diameter, etc. The dimensions can especially be measured with sufficient accuracy so that they can be used to differentiate different gemstones from each other, even if it was intended to fabricate them identically. Dimensions can be extracted from one or more pictures, or may also be measured with specific devices.

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At least one characteristic may be a pattern of polishing lines on at least one facet of the gemstone. Such a pattern is characteristic for each specific gemstone, even if it was intended to grind and polish a specific facet in a predefined way that should be identical for all gemstones. Polishing lines occur when polishing facets. They are typically parallel lines with different widths.

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When the pattern of polishing lines is generated based on a monochrome picture of the facet, the polishing lines have shown to be best visible in most cases.

The pattern of polishing lines may be a barcode or may be regarded as a barcode.

- 5 The pattern of polishing lines may also be a trace of numbers or may be regarded as a trace of numbers. A barcode may typically represent such a trace of numbers.

- For example, barcode reading devices or barcode-related algorithms can be used for identification of the patterns of polishing lines. Such barcodes or representations of
10 barcodes can be printed on the certificate.

- Especially, one characteristic or pattern or more characteristics or patterns can be generated using artificial intelligence. For example, an artificial neural network may be used. Especially, any means performing artificial intelligence, for example an
15 artificial neural network, may be trained using training data with different characteristics, for example different positions of inclusions. However, also other means of computation may be used.

- The method may further comprise measuring a weight of the gemstone, and may
20 further comprise including a measured weight into the certificate. This gives additional information about the gemstone. The weight may especially be measured using a separate device to the certification device. For example, a laboratory balance may be used.

- 25 One, some or all cameras may especially be embodied as microscopes. Such a microscope may especially provide for magnification before a picture is taken. A microscope may especially comprise a plurality of lenses that provide for a specific magnification and/or optical quality before a picture is recorded, for example by a CCD sensor or another means of optical detection device being part of the
30 microscope.

The method may further comprise identifying a shape and/or a size and/or dimensions of the gemstone, and may further comprise including an identified shape

and/or an identified size and/or identified dimensions into the certificate. This also yields additional information that can be used to identify the gemstone.

5 The method may further comprise detecting if the gemstone is artificial and/or made by CVD or high-pressure synthesis, and may further comprise including a result of such detection into the certificate. This allows identification of fake or artificial gemstones that may have less value. For example, ultraviolet light can be used for such detection.

10 In addition, the method may further comprise at least one metallurgical analysis and/or an analysis regarding gold content with the gemstone, and may further comprise including a result of such analysis into the certificate. Thus, additional information regarding metallurgical composition can be put into the certificate, giving additional possibilities to securely identify a specific gemstone.

15 Especially, the gemstone may be positioned with a predefined face on the measurement surface. This allows for a specific reference orientation. For example, a central face of one side of the gemstone may be used, e.g. a central facet of a diamond.

20 Especially, the inclusions may be one or more of solid, liquid or gas inclusions, zones of crystal growth, striation, healed fractures, hollow growth tubes, needle-shaped crystals, twin-planes, internal fissures, cleavages, stress cracks, doubling effect, bubbles, cleavage fault, curved striae, dark ball like inclusions, feather, fingerprint, 25 flash effect, halo inclusions, internal growth patterns, liquid filled or healing feathers, needle or feather inclusions, rain inclusions, swirl marks, three-phase inclusions, tube inclusions, twinning planes, color zone, and two-phase inclusions.

The certificate can especially be generated as a printed certificate. For example, a 30 printer can be used to generate the certificate on a piece of paper.

In an alternative, an electronic certificate can be generated. For example, such an electronic certificate can be a file stored on a storage device of a computer.

The invention will now be further described with respect to the accompanying drawings, wherein

Fig. 1 shows a certification device,

fig. 2 shows a light source,

5 fig. 3 shows a gemstone,

fig. 4 shows a certificate, and

fig. 5 shows a pattern of polishing lines.

Fig. 1 shows a certification device 100 according to an embodiment used for
10 providing a certificate for a gemstone 105.

The certification device 100 comprises a fixed base 110, on which a rotating element 120 is mounted. With this rotating element 120, elements above the rotating element 120 can be rotated, if needed.

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The certification device 100 comprises a first direct light source 210, emitting a light beam 216 directly upwards towards the gemstone 105. Immediately above the first direct light source 210, there is a diffuser 310 diffusing emitted light and thus smoothening it. The diffuser 310 is movable so that it can be moved away if no
20 diffusing is needed.

The certification device 100 comprises a first indirect light source 220 and a second indirect light source 225, emitting light beams 222 ,227 in a horizontal direction. Thus, mostly scattered light from these indirect light sources 220, 225 reaches the
25 gemstone 105. It was found that these indirect light sources 220, 225 are especially beneficial for determining distances between inclusions.

The certification device 100 comprises an adjustable aperture 320 above the indirect light sources 220, 225. The aperture 320 is made of a black material. The size of a
30 hole provided in the aperture 320 can be adjusted in order to define how much light will be let towards the gemstone 105. The aperture 320 also defines the size of a light beam 216, 222, 227 propagating towards the gemstone 105.

The certification device 100 also comprises a measurement surface 330, which is made of a transparent material. For example, glass can be used as transparent material. The measurement surface 330 holds the gemstone 105, i.e., the gemstone 105 is positioned on the measurement surface 330 with a specific facet 107 of the
5 gemstone 105. Two other facets 108, 109 are shown as examples of a plurality of facets.

The certification device 100 comprises a first camera 410 being positioned immediately above the measurement surface 330 and viewing the gemstone 105
10 directly from above. The certification device 100 further comprises a second camera 420 being positioned besides the measurement surface 330 and viewing the gemstone 105 in a horizontal direction.

The certification device 100 comprises a second direct light source 230, which is
15 embodied as a ring around the first camera 410 and emitting a light beam 232 directly downwards on the gemstone 105.

The certification device 100 further comprises a control device 500 being configured to perform a method as described herein. Especially, the control device 500 may
20 activate and deactivate the light sources 210, 220, 225, 230 and take pictures with the cameras 410, 420 while a specific light source 210, 220, 225, 230 is activated, or several specific light sources 210, 220, 225, 230 are activated. In these pictures, it may identify inclusions and may calculate positions of these inclusions inside the gemstone 105. Especially, any inclusion may be identified in two, three or more
25 pictures taken by different cameras 410, 420. As the position and orientation of each camera are known, the exact position of an inclusion inside the gemstone can be calculated. Especially, such positions can be determined with respect to junction points and/or outlines between facets of the gemstone. It may also calculate distances and orientations between each two such inclusions. Also other
30 characteristic like a color code can be calculated. This calculated data may form, at least partly, a pattern of the gemstone 105 and may be used to create a certificate. For example, the certificate may comprise indications about the positions, orientations and/or distances.

The light sources 210, 220, 225 and/or 230 may, for example, emit white light with a color temperature of 5,500 K, or in a range between 5,000 K and 6,000 K. They may also emit yellow light with a color temperature of 2,000 K to 2,500 K.

- 5 A possible implementation of the first direct light source 210 is shown in fig. 2, which is a top view.

The shown first direct light source 210 comprises a central white LED 212, which may emit a white light and may be used to illuminate the gemstone 105 while taking
10 pictures. It also comprises a plurality of surrounding UV LEDs 214, which may emit ultraviolet light with a wavelength of e.g. 450 nm. This light can be used in order to detect artificial gemstones, for example made by Chemical Vapor Deposition (CVD) or high-pressure synthesis. Such artificial gemstones have a different fluorescent behavior when illuminated with ultraviolet light compared with natural gemstones.

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Control of the light sources 210, 212, 214 may especially be performed by the control device 500. The control device 500 may switch each light source 210, 212, 214 on and off separately and may use cameras 410, 420 in a coordinated manner in order to perform certain measurements with the best illumination.

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Fig. 3 shows a gemstone 105 in a separate view.

The facets 107, 108, 109 have already been described with respect to fig. 1. It should be noted that the gemstone 105, which basically has the shape of a diamond, has
25 more facets than those denoted with reference signs.

Between the facets 107, 108, 109 there are outlines O. More specifically, each two adjacent facets 107, 108, 109 adjoin each other at a respective outline O.

30 The outlines O adjoin each other at junction points J.

The positions and orientations of the outlines O are specific for each gemstone 105. Also the positions of the junction points J are specific for each gemstone 105. Thus, information about such positions and orientations can be used to uniquely identify a

specific gemstone 105. This is also true for cases in which a plurality of gemstones was fabricated with the intention to fabricate them identically.

5 Inclusions I are positioned inside the gemstone 105. As an example, two such inclusions I are shown in fig. 3. A distance d1 between these inclusions I is also shown. Such a distance d1 is very characteristic for a specific gemstone 105, as each gemstone has specific inclusions I. The distance d1 may be implemented as a one-dimensional distance, giving only a length without orientation, or as a three-dimensional distance, giving a length and orientation in three dimensional space.

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Furthermore, a distance d2 of each of the inclusions I to a junction point J can be used as a characteristic of the gemstone 105. Also such a distance d2 may be regarded as a one-dimensional distance, giving only a length without orientation, or as a three-dimensional distance, giving a length and orientation in three dimensional space.

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Fig. 4 shows an example of a certificate. The certificate is for a specific gemstone 105. For example, it could be for the gemstone 105 shown in fig. 3.

20 It comprises, just as an example of a certificate, the number of the certificate, a date when the certificate was printed, and a weight of the gemstone as basis information.

In addition, a plurality of distances between specific junction points are given in micrometers. These distances have been extracted from pictures of the gemstone for which the certificate has been made. These distances are very specific for this gemstone. Even if there exist several gemstones that have apparently the same shape, these distances typically differ between different gemstones and thus can be used to identify a specific gemstone.

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30 If a specific gemstone should be checked if it is the gemstone covered by the specific certificate, it can be analyzed, for example with the device shown in fig. 1. Before, it can be checked manually and/or visually. Pictures can be taken, and distances can be measured between specific junctions. If these distances correspond to those given on the certificate, it can be expected that the gemstone is actually the

gemstone for which the certificate has issued. Otherwise it can be expected that it is another gemstone.

Fig. 5 shows a pattern of polishing lines in an exemplary example. Such polishing
5 lines are generated inadvertently during polishing of a facet. It can be seen that they look like a barcode. They are specific for a gemstone and can be used for differentiation gemstones.

Especially, the following order of steps can be used for generating information for a
10 certificate:

step 1: weight check

step 2: generating color code

step 3: identifying facets, outlines and junction points

step 4: identifying locations of inclusions and distances from junction points

15 step 5: identifying distances between inclusions

step 6: identifying geometries of inclusions

step 7: measuring polishing lines

However, also orders can be used. It is also possible to omit certain steps and/or to
20 perform further steps.

Reference Signs:

	100	certification device
	105	gemstone
	107	facet
5	108	facet
	109	facet
	110	fixed base
	120	rotating element
	210	first direct light source
10	212	central white LED
	214	UV LEDs
	216	light beam
	220	first indirect light source
	222	light beam
15	225	second indirect light source
	227	light beam
	230	second direct light source
	232	light beam
	310	diffuser
20	320	aperture
	330	measurement surface
	410	first camera
	420	second camera
	500	control device
25	J	junction points
	O	outlines
	I	inclusions
	d	distance

Patent Claims:

1. Certification device (100), comprising
 - a measurement surface (330) for positioning a gemstone (105),
 - 5 - at least one light source (210, 220, 225, 230) emitting light on or through the measurement surface (330) towards the gemstone (105),
 - at least one camera (410, 420) for taking at least one picture of the gemstone (105) while the at least one light source (210, 220, 225, 230) remains activated, and
 - 10 - a control device (500) for controlling the at least one light source (210, 220, 225, 230) and the at least one camera (410, 420) for generating a certificate of the gemstone (105).
2. Certification device (100) according to claim 1,
 - 15 - wherein the measurement surface (330) is optically transparent.
3. Certification device (100) according to one of the preceding claims,
 - wherein at least one light source (210, 220, 225, 230) is an indirect light source (220, 225) being positioned and oriented for emitting light towards the
 - 20 gemstone (105) through the measurement surface (330).
4. Certification device (100) according to claim 3,
 - wherein the at least one indirect light source (220, 225) is positioned and oriented for emitting light below the measurement surface (330) in an angle to
 - 25 the measurement surface (330) such that the light does not impinge directly on the measurement surface (330).
5. Certification device (100) according to one of claims 3 or 4,
 - wherein the at least one indirect light source (220, 225) is positioned and
 - 30 oriented for emitting light parallel to the measurement surface (330) or in an angle of less than 10 degrees to the measurement surface (330).

6. Certification device (100) according to one of the preceding claims,
- wherein at least one light source (210, 220, 225, 230) is a direct light source (210) being positioned and oriented for emitting light towards the gemstone (105) through the measurement surface (330).
- 5
7. Certification device (100) according to claim 6,
- wherein the direct light source (210) is positioned and oriented for emitting light below the measurement surface (330) in an angle to the measurement surface (330) such that the light impinges directly on the measurement surface (330).
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8. Certification device (100) according to one of claims 6 or 7,
- wherein the direct light source (210) is positioned and oriented for emitting light perpendicular to the measurement surface (330).
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9. Certification device (100) according to one of the preceding claims,
- further comprising a diffuser (310) being positioned so that light emitted from the direct light source (210) passes through the diffuser (310) before reaching the measurement surface (330).
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10. Certification device (100) according to one of the preceding claims,
- further comprising an adjustable aperture (320) being positioned so that light emitted from an indirect light source (220, 225) or a direct light source (210) passes through the adjustable aperture (320) before reaching the measurement surface (330).
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11. Certification device (100) according to one of the preceding claims,
- comprising at least one light source (230) being positioned and oriented for emitting light towards the gemstone (105) without passing the measurement surface (330).
- 30

12. Certification device (100) according to one of the preceding claims,
- comprising at least one light source (230) being positioned and oriented for emitting light from above the gemstone (105) perpendicular to the measurement surface (330).
- 5
13. Certification device (100) according to one of the preceding claims,
- wherein one, some or all cameras (410, 420) are embodied as microscopes.
14. Certification device (100), comprising
- 10 - a measurement surface (330) for positioning a gemstone (105),
- at least two light sources (210, 220, 225, 230) emitting light on or through the measurement surface (330) towards the gemstone (105),
- at least one camera (410, 420) for taking at least one picture of the gemstone (105) while the at least one light source (210, 220, 225, 230) remains
15 activated, and
- a control device (500) for controlling the at least one light source (210, 220, 225, 230) and the at least one camera (410, 420) for generating a certificate of the gemstone (105),
- wherein at least one light source (210, 220, 225, 230) is an indirect light
20 source (220, 225) being positioned and oriented for emitting light towards the gemstone (105) through the measurement surface (330), and
- wherein at least one light source (210, 220, 225, 230) is a direct light source (210) being positioned and oriented for emitting light towards the gemstone (105) through the measurement surface (330).
- 25
15. A method for providing a certificate of a gemstone (105), the method comprising the following steps:
- positioning the gemstone (105) on a measurement surface (330) of a certification device (100),
- 30 - activating at least one light source (210, 220, 225, 230) emitting light on or through the measurement surface (330) towards the gemstone (105),
- taking at least one picture of the gemstone (105) while the light source (210, 220, 225, 230) remains activated,

- identifying at least one characteristic of the gemstone (105) based on the picture, and
 - generating the certificate based on the pattern.
- 5 16. Method according to claim 15,
- which is performed using a certification device according to one of claims 1 to 14.
17. Method according to one of claims 15 or 16,
- 10 - wherein at least one picture is taken with a camera (410) positioned over the measurement surface (330) viewing perpendicular to the measurement surface (330).
18. Method according to one of claims 15 to 17,
- 15 - wherein at least one picture is taken with a camera (420) positioned over or besides the measurement surface (330) viewing sidewise to the measurement surface (330).
19. Method according to one of claims 15 to 18,
- 20 - wherein at least one picture is taken with a camera (420) viewing parallel to the measurement surface (330).
20. Method according to one of claims 15 to 19,
- wherein several pictures are taken,
- 25 - wherein one characteristic or more characteristics are identified in each of several pictures, and
- wherein the certificate is generated using characteristics identified in several pictures.
- 30 21. Method according to claim 20,
- wherein pictures are taken using at least two or more different cameras (410, 420).

22. Method according to claim 21,
- wherein the different cameras (410, 420) are positioned at different locations and/or view the gemstone (105) from different directions.
- 5 23. Method according to one of claims 20 to 22,
- wherein several pictures are taken while having different light sources (210, 220, 225, 230) activated.
- 10 24. Method according to claim 23,
- wherein the different light sources (210, 220, 225, 230) are positioned at different locations and/or illuminate the gemstone (105) from different directions.
- 15 25. Method according to one of claims 15 to 24,
- wherein at least one characteristic is a color code of the gemstone (105).
- 20 26. Method according to claim 25,
- wherein a color image of the gemstone (105) is taken, and
- wherein the color code is generated based on the color image.
- 25 27. Method according to claim 26,
- wherein the color code is generated as a dominant color of the color image.
28. Method according to one of claims 15 to 27,
- wherein at least one characteristic is a pattern of inclusions (I) in the gemstone (105).
- 30 29. Method according to claim 28,
- wherein the at least one pattern of inclusions (I) is generated based on one or more pictures taken during sole activation of indirect light sources (220, 225)
30. Method according to one of claims 28 or 29,
- wherein one pattern or more patterns each comprise a plurality of distances (d1) between two respective inclusions (I).

31. Method according to one of claims 28 to 30,
- wherein one pattern or more patterns each comprise a plurality of orientations between two respective inclusions (I).
- 5
32. Method according to one of claims 28 to 31,
- wherein one pattern or more patterns each comprise a plurality of combinations of orientation and distance (d1) between two respective inclusions (I).
- 10
33. Method according to one of claims 28 to 32,
- wherein one pattern or more patterns each comprise a plurality of positions of inclusions (I) inside the gemstone (105).
- 15
34. Method according to one of claims 15 to 33,
- wherein at least one characteristic comprises positions and/or orientations of outlines (O) between facets (107, 108, 109) of the gemstone (105).
- 20
35. Method according to one of claims 15 to 34,
- wherein at least one characteristic comprises positions of junction points (J) between facets (107, 108, 109) of the gemstone (105).
- 25
36. Method according to one of claims 15 to 35,
- wherein at least one characteristic comprises distances between junction points (J) between facets (107, 108, 109) of the gemstone (105).
- 30
37. Method according to one of claims 28 to 33 and according to one of claims 34 to 36,
- wherein positions of inclusions (I) comprised in the at least one pattern are given relative to the outlines (O) and/or junction points (J).
38. Method according to one of claims 15 to 37,
- wherein at least one characteristics comprises geometries of inclusions (I) in the gemstone (105).

39. Method according to claim 38,
- wherein the geometries are generated based on one or more pictures taken during sole activation of a direct light source (230) shining light from above the measurement surface (330) on the gemstone (105).
5
40. Method according to one of claims 15 to 39,
- wherein, during application of a light source (210, 220, 225) an adjustable aperture (320) being positioned between the light source (210, 220, 225) and the gemstone (105) is closed so that a light beam (216, 222, 227) only shines through the gemstone (105).
10
41. Method according to one of claims 15 to 40,
- wherein at least one characteristic is one or more dimensions of the gemstone (105).
15
42. Method according to one of claims 15 to 41,
- wherein at least one characteristic is a pattern of polishing lines on at least one facet (107, 108, 109) of the gemstone (105).
20
43. Method according to claim 42,
- wherein the pattern of polishing lines is generated based on a monochrome picture of the facet (107, 108, 109).
- 25 44. Method according to one of claims 42 or 43,
- wherein the pattern of polishing lines is a barcode and/or a trace of numbers.
45. Method according to one of claims 15 to 44,
- wherein one characteristic or more characteristics are generated using artificial intelligence.
30
46. Method according to one of claims 15 to 45,
- further comprising measuring a weight of the gemstone (105), and
- including a measured weight into the certificate.

47. Method according to one of claims 15 to 46,
- further comprising identifying a shape and/or a size and/or dimensions of the gemstone (105), and
5 - including an identified shape and/or an identified size and/or identified dimensions into the certificate.
48. Method according to one of claims 15 to 47,
- further comprising detecting if the gemstone (105) is artificial and/or made by
10 CVD or high-pressure synthesis, and
- including a result of such detection into the certificate.
49. Method according to one of claims 15 to 48,
- further comprising at least one metallurgical analysis and/or an analysis
15 regarding gold content with the gemstone (105), and
- including a result of such analysis into the certificate.
50. Method according to one of claims 15 to 49,
- wherein the gemstone (105) is positioned with a predefined facet (107) on the
20 measurement surface (330).
51. Method according to claim 28 or a claim dependent on claim 28,
- wherein the inclusions are one or more of solid, liquid or gas inclusions, zones
25 of crystal growth, striation, healed fractures, hollow growth tubes, needle-shaped crystals, twin-planes, internal fissures, cleavages, stress cracks, doubling effect, bubbles, cleavage fault, curved striae, dark ball like inclusions, feather, fingerprint, flash effect, halo inclusions, internal growth patterns, liquid filled or healing feathers, needle or feather inclusions, rain inclusions, swirl marks, three-phase inclusions, tube inclusions, twinning planes, color zone,
30 and two-phase inclusions.
52. Method according to one of claims 15 to 51,
- wherein the certificate is generated as a printed certificate.

53. A method for providing a certificate of a gemstone (105), the method comprising the following steps:
- measuring a weight of the gemstone (105),
 - positioning the gemstone (105) on a measurement surface (330) of a certification device (100),
 - activating at least one light source (210, 220, 225, 230) emitting light on or through the measurement surface (330) towards the gemstone (105),
 - taking at least one picture of the gemstone (105) while the light source (210, 220, 225, 230) remains activated,
 - identifying at least one characteristic of the gemstone (105) based on the picture,
 - wherein at least one characteristic is a pattern of inclusions of the gemstone (105) and at least one characteristic comprises distances between junction points of the gemstone (105), and
 - generating the certificate based on the weight and the characteristics.