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(54) Title: SURFACE CHARACTERIZATION SYSTEM

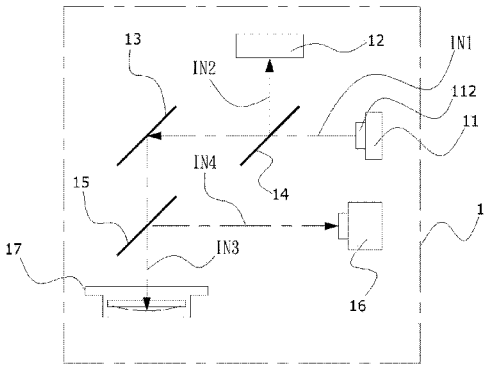

FIG. 1

(57) Abstract: The present invention discloses a surface characterization system. The surface characterization system mainly includes in its light path a first light-splitting unit and a second light-splitting unit, which respectively generate first reflected light and second reflected light from reflected light reflected from a surface of a measured object. A detection module receives the first reflected light via the first light-splitting unit and generates surface characteristic information of the measured object. Furthermore, an image capture module receives the second reflected light via the second light-splitting unit and generates image information.

SURFACE CHARACTERIZATION SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a surface characterization system, and more particularly to a surface characterization system through which surface characteristic information and surface characteristic image information of an object can be synchronously obtained during a measurement operation.

Related Art

With the development of nano technology, an optical measurement system with nano-level resolution becomes increasingly important currently. For example, an atomic force microscope uses a tip with a radius of several nanometers as a probe to measure surface characteristics of a measured object, such as smoothness, according to fluctuation and variation occurring due to interaction between the probe and a surface of the measured object. However, when the nano probe measures, people cannot directly read the currently measured position and the variation of the probe with naked eyes. Therefore, it is required to read or measure displacement information of the nano probe through another measurement system and then convert the displacement information into actual object surface fluctuation. At present, an optical system is generally used to directly measure or read the movement of the nano probe.

Therefore, in TW patent No. I264520 and entitled "System for Measurement of the Height, Angle and Their Variation of the Surface of an Object", an optical light path system with nano-level resolution is applied to the atomic force microscope. Disclosed is a four-quadrant photodetector. During measurement, a signal is converted into object surface characteristics such as the height and the displacement direction through the judging and reading of the four-quadrant photodetector, and then the variation of a light spot currently detected by the system is inferred. Through the implementation, although variation information of the detected light spot can be generated, the variation information is merely shown in numeric value information. Moreover, in the implementation of the single four-

quadrant photodetector, position misjudgment may still occur. Therefore, multiple four-quadrant photodetectors may also be used to generate several pieces of variation information at the same time, and then more precise variation information is generated after comparison. However, the application of the multiple four-quadrant photodetectors directly increases the system construction cost and complicates the light path design.

In addition, US patent No. US20110095210 discloses a light path mechanism, which is a combination of an astigmatic detection system and an optical image system. A collimating lens enables a beam emitted from a light source to become parallel beams, the parallel beams are focused on a surface of a measured object with an effect of two beam splitters through an objective lens, and reflected light of the measured object passes through the objective lens and one of the beam splitters and is split into an image beam and a measurement beam. The image beam passes through one of the beam splitters, and is focused and projected onto an image sensing unit of the optical image system through a sensing lens. The measurement beam is refracted by the beam splitter, then sequentially passes through the other beam splitter, a detecting lens and an astigmatic lens, and is projected onto the four-quadrant photodetector, so as to generate a surface measurement signal of the measured object. The algorithm for processing the surface measurement signal of the measured object is disclosed in US patent No. US7247827. The image sensing unit obtains the surface image information of the measured object in the measured area through the image beam projected onto the image sensing unit.

However, US patent No. US20110095210 discloses a light path system, in which an image sensing unit is assembled on a perpendicular optical axis formed through the beam splitter and the measured object, and an optical signal received by the image sensing unit is obtained through the effect of the objective lens and the beam splitter after being reflected from the measured object. More attention needs to be paid on the light path calibration during assembly for the design of the perpendicular coaxial light path; otherwise deflections or errors are easily occur in the surface image information.

The disclosure of the aforementioned documents are incorporated herein by reference, and are construed as one part of the specification.

SUMMARY OF THE INVENTION

In view of the foregoing problems, a main objective of the present invention is to provide a surface characterization system through which object surface characteristic information and surface image information of a measured object can be synchronously obtained during the implementation, so that a user can know the measurement conditions in time during the measurement.

To achieve the foregoing objective, the surface characterization system of the present invention includes, in a light path of the system, a light-emitting module, a first light-splitting unit, a refraction unit, a second light-splitting unit, a lens set, a detection module and an image capture module. The light-emitting module includes a primary light source, where a primary projection optical axis is formed according to a light path of the primary light source. The first light-splitting unit is located on a light path of the primary projection optical axis, and a light-splitting axis is formed from the first light-splitting unit. The refraction unit is located behind the first light-splitting unit, where the primary projection optical axis is refracted by the refraction unit and then a refracted optical axis is formed from the refraction unit. The second light-splitting unit is located on a light path of the refracted optical axis formed from the refraction unit, and another light-splitting axis is formed from the second light-splitting unit. The lens set is located on a light path of the refracted optical axis formed from the second light-splitting unit. The detection module is located on a light path of the light-splitting axis formed from the first light-splitting unit, and is used to convert received reflected light into surface characteristic information. The image capture module is located on a light path of the another light-splitting axis formed from the second light-splitting unit, and is used to convert another received reflected light into image information. The image information may be further displayed on a display device. In this way, during measurement, through the surface characteristic information and the surface image information synchronously generated, the user can rapidly access the current state of the measurement operation of the system.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic composition view of the present invention.

Fig. 2 is a schematic view of a light path of the present invention.

Fig.3 illustrates another preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 1, a schematic composition view of the present invention is shown. As shown in Fig. 1, a surface characterization system 1 of the present invention mainly includes a light-emitting module 11, a detection module 12, a refraction unit 13, a first light-splitting unit 14, a second light-splitting unit 15, an image capture module 16 and a lens set 17. Based on a primary projection optical axis IN_1 formed according to the light path of the primary light source 112 of the light-emitting module 11, the elements are arranged as follows:

(1) The first light-splitting unit 14 is located on a light path of the primary projection optical axis IN_1, and a light-splitting axis IN_2 formed from the first light-splitting unit 14.

(2) The refraction unit 13 is located on a light path of a projection light path IN_1 formed from the first light-splitting unit 14, and the primary projection optical axis IN_1 is refracted by the refraction unit 13 and then a refracted optical axis IN_3 is formed from the refraction unit 13.

(3) The second light-splitting unit 15 is located on a light path of the refracted optical axis IN_3 formed from the refraction unit 13, and another light-splitting axis IN_4 is formed from the second light splitting unit 15.

(4) The lens set 17 is located on a light path of the refracted optical axis IN_3 formed from the second light-splitting unit 15.

(5) The detection module 12 is located on a light path of the light-splitting axis IN_2 formed from the first light-splitting unit 14. The detection module 12 is preferably a four-quadrant photodetector, and is used to convert a received light into surface characteristic information. The surface characteristic information is, for example, information of a surface shape of the measured object;

(6) The image capture module 16 is located on a light path of the light-splitting axis

IN_4 formed from the second light-splitting unit 15. The image capture module 16 can be, for example, a Charge-Coupled Device (CCD), and is used to convert received light into image information.

Referring to Fig. 2, a schematic view of a light path of the present invention is shown. As shown in Fig. 2, in implementation of the present invention, the primary light source 112 of the light-emitting module 11 emits projection light L1 (shown in heavy line). The projection light L1 goes forward along the primary projection optical axis IN_1, passes through the first light-splitting unit 14, reaches the refraction unit 13. Then the projection light L1 is refracted, goes forward along the refracted optical axis IN_3, passes through the second light-splitting unit 15, reaches and passes through the lens set 17, and then is projected onto a surface B1 of a measured object B, so as to measure the surface B1. In addition, after the projection light L1 reaches the surface B1 of the measured object B, reflected light RL1 is then reflected by the measured object B. The reflected light RL1 first passes through the second light-splitting unit 15 when going forward along the refracted optical axis IN_3. The reflected light RL1 is partially split by the second light-splitting unit 15, and the split light RL12 is projected onto the image capture module 16. Moreover, the reflected light RL1 continuously goes forward, and reaches the refraction unit 13. Then the reflected light RL1 is refracted to continuously goforward along the primary projection optical axis IN_1 and passes through the first light-splitting unit 14. At last the reflected light RL1 is then again partially split by the first light-splitting unit 14 and the the split light RL14 is projected onto the detection module 12. Accordingly, the split light RL12 generated due to the light-splitting effect is captured by the image capture module 16, and then is converted into image information. Therefore, a surface image of the measured object B can be accordingly generated and then optionally displayed on a display device 2. In addition, after the split light RL14 generated due to the light-splitting effect is captured by the detection module 12, surface characteristic information of the surface B1 of the measured object B can be accordingly generated. Therefore, the operator can synchronously obtain the surface characteristic information and the image information of the surface B1 of the measured object B during the measurement operation.

Referring to Fig. 3, another preferred embodiment of the present invention is shown. In order to improve the precision of the whole measurement of the present invention, relevant components can be installed in the system according to the requirements. As shown in Fig. 3, a cylindrical lens 30 is installed between the first light-splitting unit 14 and the detection module 12, so that after the split light RL14 passes through the cylindrical lens 30, an astigmatic effect occurs and then the split light RL14 is projected onto the detection module 12. In this way, through the astigmatic effect, the split light RL14 received by the detection module 12 can be converted through an algorithm into the surface characteristic information of the surface B1 of the measured object B. In addition, a collimating lens 40 is installed between the first light-splitting unit 14 and the refraction unit 13, so as to collimate projection light L1 emitted from the primary light source 112. Therefore and light scattering is prevented in the projection path, and the projection light L1 can be collimated into parallel light when passing through the collimating lens 40. Moreover, a third light-splitting unit 18, in cooperation with an auxiliary optical module 50, is installed between the refraction unit 13 and the second light-splitting unit 15. The auxiliary optical module 50 can generate auxiliary light 501 as an auxiliary light source, so as to be complementary to the case of an insufficient light during the measurement process. Therefore the whole measurement result is clearer. That is, the auxiliary light 501 generated by the auxiliary optical module 50 is deflected by the third light-splitting unit 18 located on the light path of the refracted optical axis IN_3, then goes forward along the refracted optical axis IN_3, passes through the second light-splitting unit 15 and the lens set 17, and finally illuminates the surface B1 of the measured object B and the adjacent area thereof. The auxiliary light 501 is reflected and then is partially split by the second light-splitting unit 15 onto the light-splitting axis IN_4, and is projected onto the image capture module 16, thereby complementing the light required in the operation of the image capture module 16. Continuously referring to Fig. 3, in order to improve the definition of the image captured by the image capture module 16, a filter 60 is installed between the image capture module 16 and the second light-splitting unit 15, so as to filter parasitic light and further improve the definition of the captured image. Moreover, the lens set 17 is adjustable, so that the operator can adjust the lens set 17 upward or downward (the shown

dashed arrow) according to the requirements during the measurement operation, so as to adjust the focus. In this way, the operator can select a proper focus for measurement by adjusting the position of the lens set 17 during the measurement.

To sum up, in the surface characterization system of the present invention, two light splitters are installed on the light path formed according to the system, so that the reflected light generated during the measurement operation of the system is received by the detection module and the image capture module separately. In this way, during the measurement, the surface characteristic information and the image information of the measured object can be synchronously obtained, thereby improving the convenience during the measurement operation and achieving the efficacy of precise operation. Therefore, after the implementation of the present invention, through the surface characterization system of the present invention, the object surface characteristic information and the surface image information of the measured object can be synchronously obtained during the implementation, so that a user can know the measurement conditions in time during the measurement.

The above descriptions are merely preferred embodiments of the present invention, but are not intended to limit the present invention. Any equivalent variation and modification made by persons skilled in the art without departing from the spirit and scope of the present invention shall fall within the appended claims of the present invention.

CLAIMS

What is claimed is:

1. A surface characterization system, for measuring surface characteristics of a measured object, so as to synchronously obtain surface characteristic information and image information of a surface of the measured object, comprising:

a light-emitting module, comprising a primary light source, wherein a primary projection optical axis is formed according to a light path of the primary light source;

a first light-splitting unit, located on a light path of the primary projection optical axis, and a light-splitting axis being formed therefrom;

a refraction unit, located behind the first light-splitting unit, wherein the primary projection optical axis is refracted by the refraction unit and then a refracted optical axis is formed therefrom;

a second light-splitting unit, located on a light path of the refracted optical axis formed from the refraction unit, and another light-splitting axis is formed therefrom;

a lens set, located on a light path of the refracted optical axis formed from the second light-splitting unit;

a detection module, located on a light path of the light-splitting axis formed from the first light-splitting unit, and used to convert received reflected light into the surface characteristic information; and

an image capture module, located on a light path of said another light-splitting axis formed from the second light-splitting unit, and used to convert another received reflected light into the image information.

2. The surface characterization system according to claim 1, wherein a cylindrical lens is installed between the first light-splitting unit and the detection module.

3. The surface characterization system according to claim 1, wherein a collimating lens is installed between the first light-splitting unit and the refraction unit.

4. The surface characterization system according to claim 1, wherein a third light-

splitting unit, in cooperation with an auxiliary optical module, is installed between the refraction unit and the second light-splitting unit, and the auxiliary optical module is capable of generating auxiliary light to be projected onto the third light-splitting unit.

5. The surface characterization system according to claim 1, wherein a filter is installed between the image capture module and the second light-splitting unit.

6. The surface characterization system according to claim 1, wherein the lens set is adjustable, and an upper or a lower position thereof is adjusted according to requirements during a measurement operation.

7. The surface characterization system according to claim 1, wherein the detection module is a four-quadrant photodetector.

8. The surface characterization system according to claim 1, wherein the image capture module is a Charge-Coupled Device (CCD).

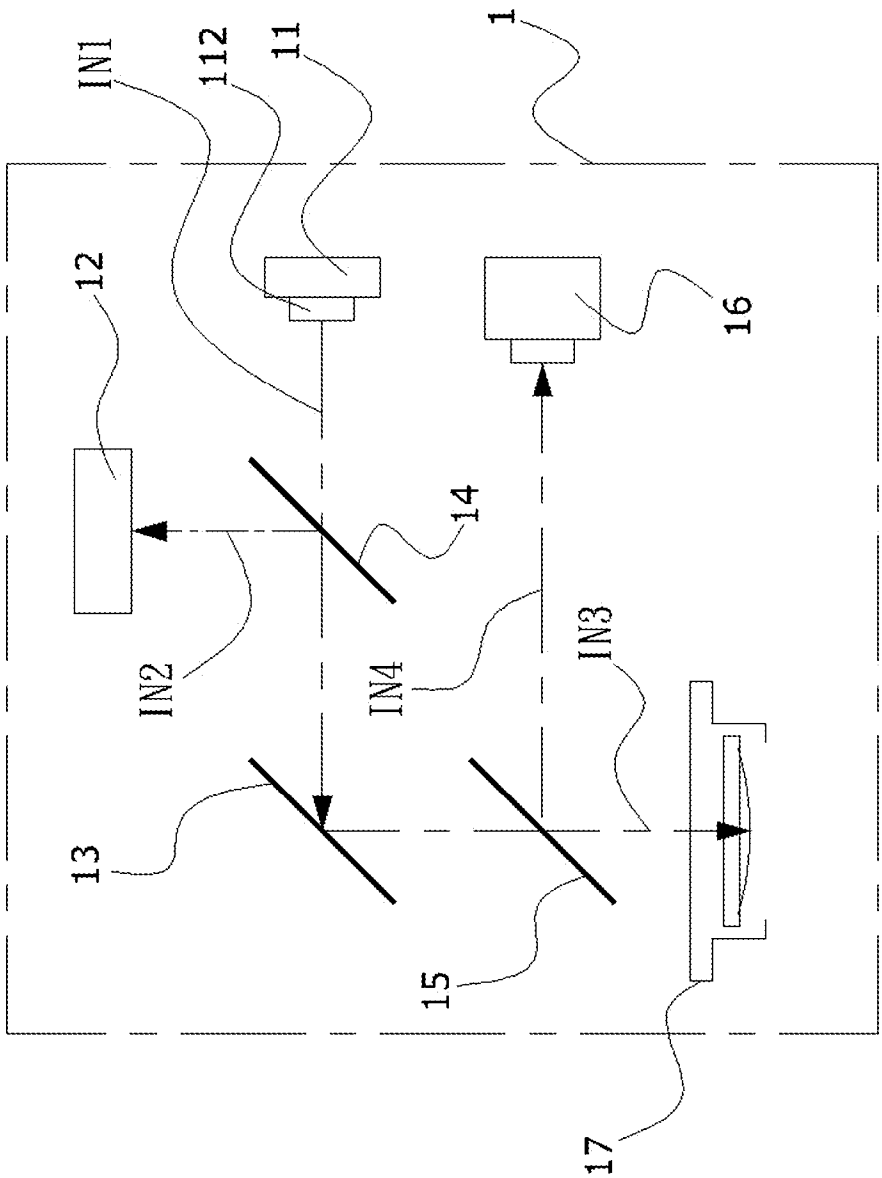

FIG. 1

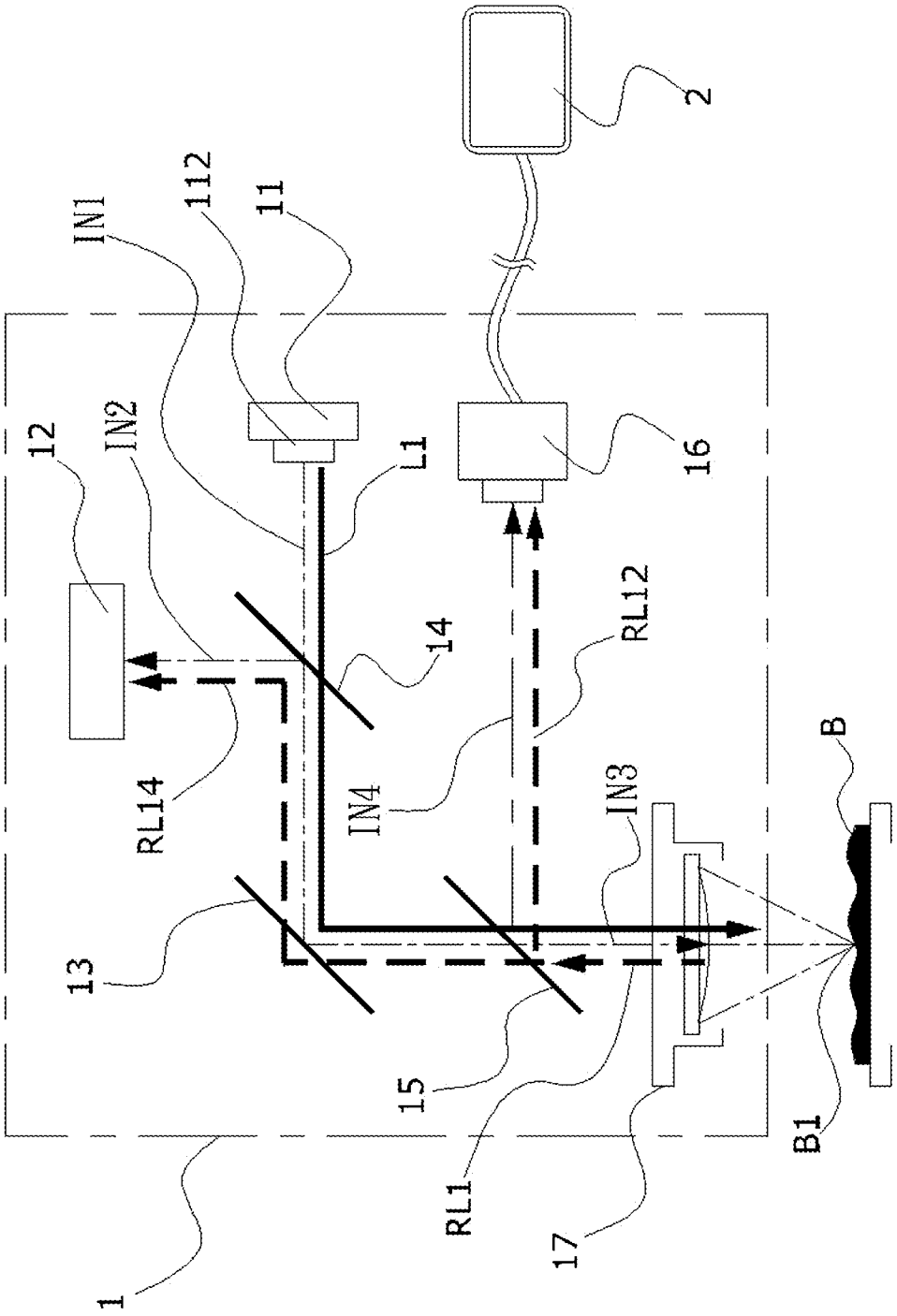

FIG. 2

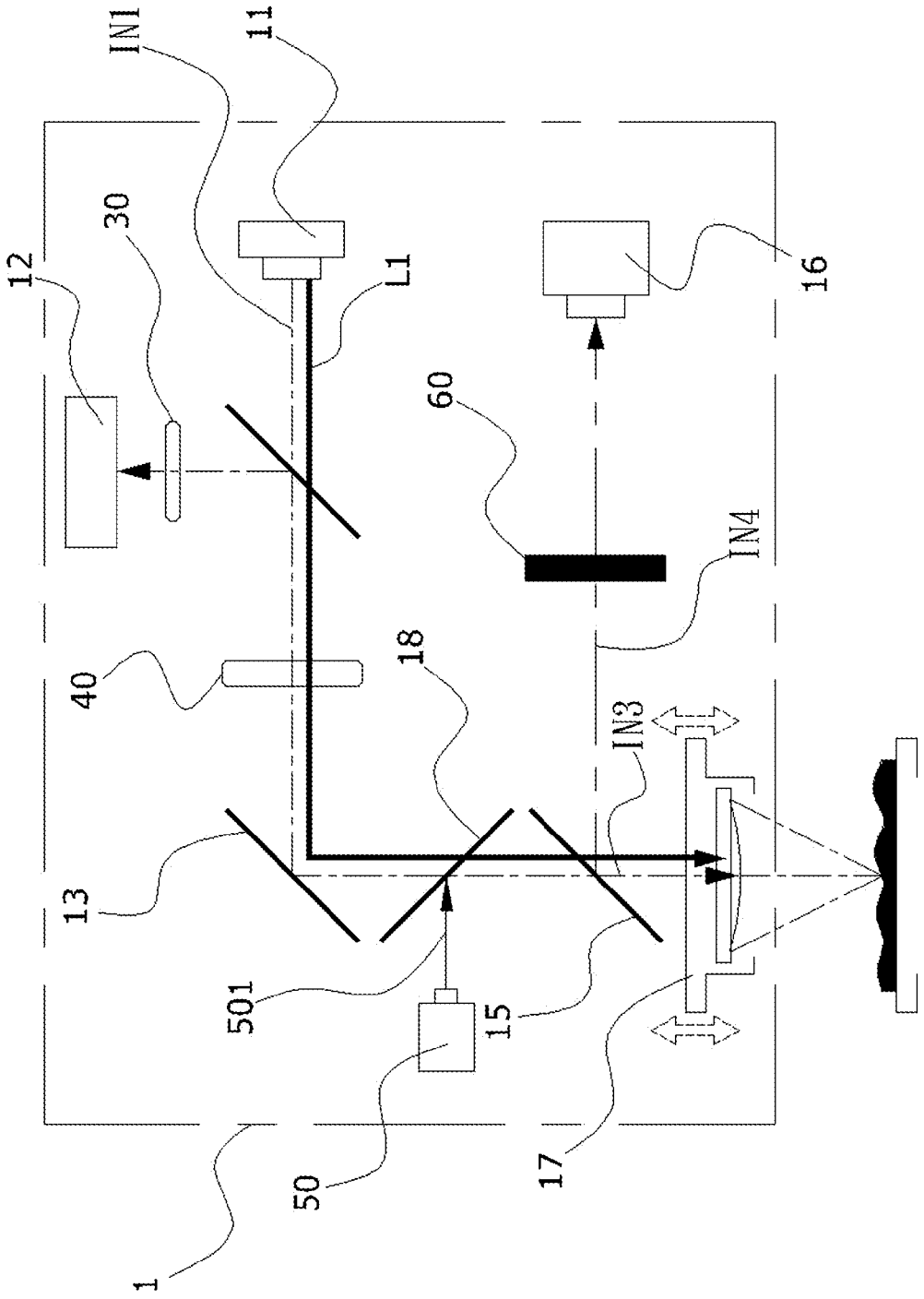

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 12/43110

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G01B 11/30 (2012.01)
USPC - 356/603
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC: 356/603

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 356/601, 603, 432; 702/1.33 (keyword limited - see search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (PGPB, USPT, USOC, EPAB, JPAB); GOOGLE; Google Scholar, Thomson Innovation
Terms: surface, sample, measure, characterize, inspect, smoothness, fluctuation, flatness, defects, light, source, emit, optical, refract, axis, direction, filter, lens, cylindrical, detector, diode, ccd, supplemental, auxiliary.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2011/0095210 A1 (Hwang et al.) 28 April 2011 (28.04.2011), entire document, especially abstract, Fig. 1B, para [0008], [0011], [0020], [0021], [0022], [0023], [0024], [0030], [0039].	1-3, 7-8 --- 4-6
Y	US 2008/0094616 A1 (Tanaka) 24 April 2008 (24.04.2008), entire document, especially abstract, Fig. 16, para [0005], [0006], [0013], [0205], [0258], [0312].	4-6
A	US 2007/0024998 A1 (Bills et al.) 01 February 2007 (01.02.2007), entire document, especially abstract, para [0037], [0040], [0048], [0232], [0234].	1-8
A	US 2007/0030493 A1 (Zettler et al.) 08 February 2007 (08.02.2007), entire document, especially abstract, para [0006], [0011], [0016], [0028], [0038].	1-8

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 August 2012 (15.08.2012)	06 SEP 2012
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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