



(51) International Patent Classification:

G01N 21/21 (2006.01) G01N 21/41 (2006.01)
G01N 21/25 (2006.01) G02B 5/08 (2006.01)

(21) International Application Number:

PCT/KR2010/002461

(22) International Filing Date:

20 April 2010 (20.04.2010)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

10-2009-0053593 16 June 2009 (16.06.2009) KR

(71) Applicant (for all designated States except US): **KOREA RESEARCH INSTITUTE OF STANDARDS AND SCIENCE** [KR/KR]; 1, Doryong-dong, Yuseong-gu, Daejeon 305-340 (KR).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **CHO, Yong Jai** [KR/KR]; #506, I, The Poem Apt., 385-11, Doryong-dong, Yuseong-gu, Daejeon 305-340 (KR). **CHO, Hyun**

Mo [KR/KR]; #106-1306, Nuri Apt., Wolpyeong-dong, Seo-gu, Daejeon 302-791 (KR). **CHEGAL, Won** [KR/KR]; #319-802, Songgang Green Apt., Songgang-dong, Yuseong-gu, Daejeon 305-751 (KR).

(74) Agents: **KWON, Oh-Sig** et al.; 4F, Joeeunleaderstel, 921 Dunsan-dong, Seo-gu, Daejeon 302-120 (KR).

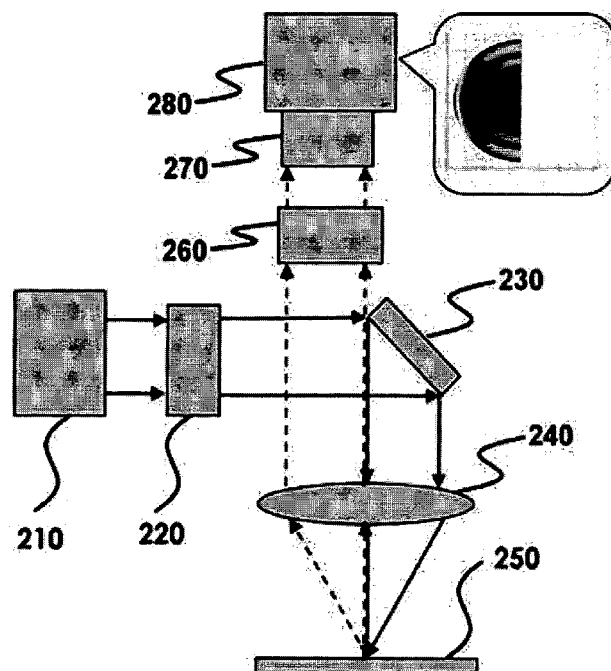
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE,

[Continued on next page]

(54) Title: ELLIPSOMETER USING HALF MIRROR

【Fig. 2】



(57) Abstract: The present invention relates to an ellipsometer using a half-mirror, and more particularly, to an ellipsometer using a half-mirror, in which, instead of using rectangular prism type or glass plate type beam splitter that transmits some of the light and reflects the rest of the light as in a conventional vertical incident type focused-beam ellipsometer, the light is reflected to half of the object lens by a half-mirror and the light reflected from the half of the focus of the object lens is not transmitted through the beam splitter but is detected directly by a photodetector, and thus light interference due to the beam splitter is prevented and the light intensity is increased to maximally four times to thereby allow more accurate and precise measurement and analysis of physical properties for a sample of nanofilm or nano-pattern.



ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, **Published:**

MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM,

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,

ML, MR, NE, SN, TD, TG).

— *without international search report and to be republished
upon receipt of that report (Rule 48.2(g))*

【DESCRIPTION】**【Invention Title】****ELLIPSOMETER USING HALF MIRROR****【Technical Field】**

[1] The present invention relates to an ellipsometer using a half-mirror, and more particularly, to an ellipsometer using a half-mirror, in which, instead of using rectangular prism type or glass plate type beam splitter that transmits some of the light and reflects the rest of the light as in a conventional normal incident type focused-beam ellipsometer, the light is reflected to half of the object lens by a high reflective half-mirror and the light reflected from the half of the focus of the object lens is not transmitted through the beam splitter but is detected directly by a photodetector, and thus light interference due to the beam splitter is prevented and the light intensity is increased to maximally four times to thereby allow more accurate and precise measurement and analysis of physical properties for a sample of nanofilm or nano-pattern.

[2]

【Background Art】

[3] The present invention relates to an ellipsometer, which is a measuring technology for finding out physical properties of a sample by measuring changes in polarization state of a

light after the light incident on a surface of the sample with a specific polarization state is reflected from the sample surface, and analyzing the measured value. Particularly, in semiconductor industries, a variety of nanofilm fabrication processes is used and an ellipsometer, which is a non-destructive and contactless real-time measurement equipment, is used as a process measurement device to evaluate physical properties of fabricated nanofilms.

[4] Various kinds of the ellipsometer are used not only in the semiconductor industries but also in various laboratories including university labs, and they can be divided into a type in which a parallel light is incident on a sample obliquely (U.S. Pat. No. 3,985,447), a type in which an oblique incident light is focused on a sample by an optics (U.S. Pat. Nos. 5,166,752 & 5,608,526) and a type in which a normal incident light is focused on a sample by an optics (U.S. Pat. Nos. 5,042,951 & 6,898,537) according to how the light used as a probe is incident on a sample

[5] In the type in which the parallel light is directed at an oblique angle of incidence to the sample surface, measuring accuracy is excellent since it is possible to accurately control an angle of incidence as all beams are irradiated to the sample at the same angle of incidence, whereas it is difficult to reduce a size of the beam irradiated on the sample to an order of mm or less since the effect of

diffraction becomes greater when the size of the incident beam is reduced by an iris.

[6] In semiconductor device fabrication industries, a measurement region with a limited area of tens μm x tens μm particularly provided on a wafer is used to measure and evaluate various film fabrication processes using the ellipsometer. In order to measure the thickness of the thin film using the ellipsometer within the measurement region limited to the order of micrometers, there is used a technology of focusing a parallel light incident in a tilted direction on a surface of a sample using an optics consisting of a lens (U.S. Pat. No. 3,985,447) or a reflective mirror (U.S. Pat. No. 5,608,526). However, in this case, since beams having a plurality of angles of incidence are incident simultaneously on the sample, it is difficult to ensure and maintain measurement accuracy as compared to the type in which the oblique parallel light is used .

[7] As a critical dimension patterned on a wafer is expected to be continuously reduced in the future semiconductor device fabrication process with continuous improvement of the semiconductor device fabrication technology, the area of the aforementioned limited measurement region should be correspondingly reduced. However, in the case of the aforementioned oblique focused-beam ellipsometer, it is actually difficult to reduce the size of the light beam any

more due to barrier such as aberration and structural limitation of the beam focusing optics despite many studies and efforts for minimizing the area of the light beam irradiated on the sample.

[8] The normal incident focused-beam ellipsometer allows the measurement within a fine patterned region having smaller area since it can make parallel light, which is normally incident, focused on the sample surface into a smaller size than an order of μm by using an objective lens.

[9] Fig. 1 shows a basic structure of the normal-incident focused-beam ellipsometer (U.S. Pat. No 5,042,951). The focused-beam ellipsometer is provided with a polarizer 130 for making a parallel light, emitted from a light source apparatus 110, linearly polarized, a beam splitter 140 for splitting some of the light transmitted through the polarizer 130, an objective lens 150 for refracting and focusing the light split by the beam splitter 140 on a sample 160, an analyzer 170 for filtering only the light of the specifically polarized state from the light transmitted through the objective lens 150 and the beam splitter 140 after reflected from the sample 160, and a photodetector 180 having pixels for detecting intensity of the light transmitted through the analyzer 170 as an electric signal such as voltage or current.

[10] The focused-beam ellipsometer is required to employ a high-power light source since there is great loss of light

intensity as only about half of the light incident on the beam splitter is reflected to be irradiated on the objective lens and also only about half of the light reflected from the sample, transmitted through the objective lens and then incident again on the beam splitter is transmitted through the beam splitter to be detected by the photodetector. In addition, some undesired beams can be incident on the photodetector due to multiple reflection in the beam splitter to thereby cause light interference, and this become the barrier to the accurate measurement.

[11]

[Disclosure]

[Technical Problem]

[12] An object of the present invention is to provide an ellipsometer using a half-mirror, in which a light is reflected to the half of an objective lens by the half-mirror that replaces the beam-splitter of a conventional ellipsometer and a light reflected from an area of a sample surface corresponding to the half of the focus of the objective lens is then detected, so that physical properties of the sample corresponding to the half of the focus of the objective lens is analyzed: more accurate analysis for the physical properties is allowed as light interference due to the beam splitter is prevented and a signal/noise ratio in the measurement is increased as light intensity is increased to

maximally four times.

[13]

【Technical Solution】

[14] To achieve the object of the present invention, the present invention provides an ellipsometer using a half-mirror, which includes a light source apparatus 210 for generating and emitting a parallel light; a polarizer 220 for converting the parallel light emitted from the light source apparatus 210 into a linear polarization state; a high-reflectance half-mirror 230 for completely reflecting the light transmitted through the polarizer 220; an object lens 240 for focusing the light reflected from the half-mirror 230 on a sample 250; an analyzer 260 for transmitting a light polarized in a specific direction alone among the light transmitted through the objective lens 240; and a photodetector 270 for detecting intensity of the light transmitted through the analyzer 260 as an electric signal, wherein the light transmitted through the polarizer 220 is reflected to half of the objective lens 240 by the half-mirror 230 and irradiated on the sample 250 with a size corresponding to half of focus of the objective lens 240 so that the light reflected from the sample 250 is transferred to the other half of the objective lens 240 and then detected by the photodetector 270.

[15] In another aspect of the present invention, an ellipsometer using a half-mirror includes, instead of the

polarizer 220 and the polarization detector 260, a single linear polarizer between the half-mirror 230 and the objective lens 240.

[16] Preferably, the ellipsometer further includes a processing device 280 for correcting the intensity of the light detected by the photodetector 270 into a value corresponding to a pixel of the photodetector 270 along a multiple incidence plane path of 180° with respect to respective incidence angles and processing the corrected value.

[17] Preferably, the half-mirror 230 is coated with a thin film that has a high reflectance in the range of wavelength of the light beam from the light source.

[18] Preferably, the ellipsometer further includes a half-mirror transportation device for transporting the half-mirror 230 so that the half-mirror 230 reflects the light to the half or the other half of the objective lens 240

[19] Preferably, the photodetector 270 employs a two-dimensional imaging device including a plurality of pixels.

[20] Preferably, the light source apparatus 210 employs a white light source selected from a tungsten-halogen lamp and a xenon discharge lamp or a monochromatic laser light source, and the light source apparatus 210 is, to make a parallel light, provided with an optics having any one selected from the group consisting of a lens, a mirror and a combination of the lens and the mirror.

[21] Preferably, the polarizer 220 and the analyzer 260 employ any one selected from the group consisting of a prism type linear polarizer and a plate type polarizer, respectively.

[22] Preferably, the objective lens 240 employs an optics having any one selected from the group consisting of a lens, a mirror and a combination of the lens and the mirror, so that the parallel light is focused on the sample 250.

[23]

[Advantageous Effects]

[24] As described above, the ellipsometer using a half-mirror in accordance with the present invention, as compared with a conventional focused-beam ellipsometer, allows more accurate measurement for the physical properties as interference by a beam splitter is prevented and allows enhanced measurement accuracy or use of a light source with less power as reduction in light intensity is minimized to maximally a quarter and thus a signal/noise ratio is increased.

[25] Also, the ellipsometer using a half-mirror in accordance with the present invention, as compared with the conventional focused-beam ellipsometer, has a simple structure as it employs a half-mirror, and is expected to have enhanced measurement accuracy as a measurement for a single incidence plane is expanded to measurement for multiple incidence plane and multiple angles of incidence. Therefore, use of the measurement device in accordance with the present invention

allows more accurate and precise measurement for information on physical properties of a sample, e.g. for a nanofilm, thickness, refractive index and so on of a thin film.

[26] In addition, the ellipsometer using a half-mirror in accordance with the present invention allows more accurate measurement for the optical properties of the sample by taking polarization components for the multiple planes of incidence of 180° with respect to multiple angles of incidence from 0 degree to the maximum angle of incidence in a static state in which there is no motor driving for the optical components, compared with conventional focused-beam ellipsometer which takes the polarization properties on a single plane of incidence.

[27]

[Description of Drawings]

[28] The above and other objects, features and advantages of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

[29] Fig. 1 shows a representative structure of a conventional focused-beam ellipsometer.

[30] Figs. 2 and 3 show an ellipsometer using a horizontal incident type half-mirror in accordance with an embodiment of the present invention, respectively.

[31] Fig. 4 shows a filter wheel.

[32] Figs. 5 and 6 show an ellipsometer using a vertical incident type half-mirror in accordance with an embodiment of the present invention, respectively.

[33] Figs. 7 and 8 show an ellipsometer using a horizontal incident type half-mirror in accordance with another embodiment of the present invention, respectively.

[34] Fig. 9 shows a two-dimensional image illustrating distribution of the light intensity signal measured by the photodetector.

[35]

[36] [Detailed Description of Main Elements]

[37] 210: light source apparatus 220: polarizer

[38] 230: half-mirror 240: objective lens

[39] 250: sample 260: analyzer

[40] 270: photodetector 280: processing device

[41] 290: linear polarizer

[42]

[Best Mode]

[43] Hereinafter, the embodiments of the present invention will be described in detail with reference to accompanying drawings.

[44] Figs. 2, 3, 5 and 6 show the structure of an ellipsometer using a half-mirror in according to the present invention.

[45] As shown, an ellipsometer using a half-mirror for measurement of physical properties of a sample such as a

thickness and refractive index of a thin film in accordance with an embodiment of the present invention includes a light source apparatus 210 for emitting a parallel light; a polarizer 220 for converting the parallel light emitted from the light source apparatus 210 into a linear polarization state; a high reflective half-mirror 230 for completely reflecting the light transmitted through the polarizer 220; an object lens 240 for focusedly irradiating the light reflected from the half-mirror 230 on a sample 250; a analyzer 260 for transmitting a light polarized in a specific direction alone among the light transmitted through the objective lens 240; and a photodetector 270 for detecting intensity of the light transmitted through the analyzer 260 as an electric signal.

[46] The light source apparatus 210 may employ a white light source selected from a tungsten-halogen lamp and a xenon discharge lamp or may employ the a monochromatic light source of a laser, and is provided with an optics having any one selected from the group consisting of a lens, a mirror and a combination of the lens and the mirror which converts the light into a parallel light.

[47] When the light source is a white light source, the ellipsometer preferably further includes a band-pass filter (see Fig. 4) for transmitting light with a specific range of wavelength in back of the light source apparatus 210 or in front of the photodetector 270. As shown in Fig. 4, the band-

pass filter 211 is radially arranged and a rotatable filter wheel 212 is preferably provided so that the light can selectively pass through the band-pass filter 211. The filter wheel 212 is rotated by a motor 213. The motor 213 is preferably a stepping motor.

[48] The polarizer 220 employs a linear polarizer and converts the parallel light emitted from the light source apparatus 210 into a linear polarization state.

[49] The linearly polarized light transmitted through the polarizer 220 is transferred to the high reflective half-mirror 230.

[50] The half-mirror 230 completely reflects the light transmitted through the polarizer 220. The light transferred to the half-mirror 230 is reflected to the objective lens 240 placed below the half-mirror 230 and having a large numerical aperture.

[51] At this time, the light reflected by the half-mirror 230 is transferred to half of the objective lens 240 and the light transferred to half of the objective lens 240 is vertically irradiated on the surface of the sample 250 with a half size of the focus of the objective lens 240.

[52] The half-mirror 230 is preferably a thin film-coated mirror so as to show a high reflectivity in the wave length range of the used light source.

[53] Preferably, the ellipsometer further includes a half-

mirror transportation device (not shown) for transporting the half-mirror 230 so that the half-mirror 230 reflects the light to the half or the other half of the objective lens 240. With this half-mirror transportation device, it is possible to measure physical properties of the sample corresponding to the entire focus of the objective lens 240 by reflecting the light to half of the objective lens 240 by the half-mirror to measure the physical properties of the sample corresponding to the half of the focus of the objective lens 240, and then reflecting the light to the other half of the objective lens 240 by the half-mirror 230, after transportation of the half-mirror 230 by the half-mirror transportation device, to measure the physical properties of the sample corresponding to the other half of the focus of the objective lens 240.

[54] The objective lens 240 functions to vertically focus the light reflected from the half-mirror 230 on the surface of the sample 250. Further, the objective lens 240 employs an optics having any one selected from the group consisting of a lens, a mirror and a combination of the lens and the mirror.

[55] A sample support (not shown) is provided below the sample 250, and the sample support is preferably transported by a transportation device (not shown) rotatable and movable in forward and rearward direction and left and right direction.

[56] After the half-mirror is transported by the half-mirror transportation device and optical physical properties of the

sample corresponding to entire focus of the objective lens 240 is measured, the sample can be transported by the sample transportation device for transporting the sample support to move the focus of the objective lens 240, so that it is possible to measure the measure the physical properties of entire sample.

[57] The analyzer 260 transmits the light of a linear polarization state in a specific direction alone among the light transmitted through the objective lens 240 so that the light is incident on the photodetector 270. Here, the photodetector 270 has a plurality of pixels, and an example of the photodetector 270 is a charge-coupled device (CCD) that is able to measure two-dimensional distribution of light intensity.

[58] Information obtained from the respective pixels of the photodetector 270 is transmitted to the processing device 280 and stored as a digital signal.

[59] Also, an optics (not shown) having a relay lens is preferably further provided so as to enhance the measurement performance of the photodetector 270.

[60] Preferably, the ellipsometer further includes a processing device 280 for correcting the intensity of the light detected by the photodetector 270. The processing device 280 corrects an electric signal for the intensity of the light detected by the photodetector 270 into a value corresponding

to a pixel of the photodetector 270 along a multiple incidence plane path of 180° with respect to respective incidence angles and processes the corrected value.

[61] By analyzing a waveform from the electric signal such as voltage or current detected by the photodetector 270 through the processing device 280 or a computer, the physical properties of the sample or, when the sample is a thin film, thickness and optical constant of the thin film.

[62] Figs. 2 and 3 show an ellipsometer using a horizontal incident type half-mirror, where Fig. 2 shows the case of measuring physical properties for the portion of the sample 250 corresponding to half (right half) of the focus of the objective lens 240 and Fig. 3 shows the case of measuring physical properties for the portion of the sample 250 corresponding to half (left half) of the focus of the objective lens 240. For the special case of thin film sample with uniform thickness, the two measurements give the same result.

[63] Figs. 5 and 6 show an ellipsometer using a vertical incident type half-mirror, where Fig. 5 shows the case of measuring physical properties for the portion of the sample 250 corresponding to half (right half) of the focus of the objective lens 240 and Fig. 6 shows the case of measuring physical properties for the portion of the sample 250 corresponding to half (left half) of the focus of the

objective lens 240.

[64] Figs. 7 and 8 show an ellipsometer using a half-mirror in accordance with another embodiment of the present invention, which includes, instead of the polarizer 220 and the analyzer 260, a single linear polarizer 290 between the half-mirror 230 and the objective lens 240.

[65] A compensator may be provided between the linear polarizer 290 and the objective lens 240. The compensator is for compensating the polarization in front of the objective lens 240 and arbitrarily controls the polarization state of the light incident on the sample 250.

[66] The compensator has a characteristic that when the linearly polarized light is vertically incident on the surface of the compensator, the polarization direction has the value of phase difference between the light transmitted when the polarization direction is parallel to the light axis of the compensator and the light transmitted when the polarization direction is vertical to the light axis of the compensator.

[67] Instead of the compensator, an electrical polarization modulator capable of controlling phase difference of the polarized light with electricity may be provided in front of the objective lens 240.

[68] The ellipsometer using a half-mirror in accordance with the present invention having the above described structure measures the optical physical properties of the sample such as

thickness and refractive index of the thin film by the following manner.

[69] The parallel light emitted from the light source apparatus 210 is converted into a linear polarized light by the polarizer 220, and the polarized light is transferred to and reflected by the half-mirror 230. The polarized beam reflected by the half-mirror 230 is transferred to the objective lens 240 placed below the half-mirror 230. At this time, the polarized beam reflected by the half-mirror 230 is transferred to half of the objective lens 240 and the polarized beam transferred to half of the objective lens 240 is vertically irradiated on the surface of the sample 250 with a half size of the focus of the objective lens 240. The light vertically incident on the surface of the sample 250 with a half size of the focus of the objective lens 240 is reflected to the other half of the objective lens 240. The transferred light is transmitted through the other half of the objective lens 240 and the light of the linear polarization state in a specific direction alone is filtered by the analyzer 260, so that an electric signal for the light intensity is detected by the pixels of the photodetector 270. The electric signal detected by the photodetector 270 is corrected into a value corresponding to the pixel of the photodetector 270 along a multiple incidence plane path of 180° with respect to respective incidence angles and processing on the corrected

value is performed.

[70] In accordance with the present invention, with employment of a high reflective half-mirror, it is possible to easily detect the light by the photodetector 270 even when the power of the light source is reduced to a quarter or less as compared to that of the conventional one. It is also possible to accurately and precisely measure the physical properties of finer nanofilm and nano-patterned sample since the detection is carried out without the light interference due to the multiple reflection generated by the conventional beam splitter.

[71] Hereinafter, the principle of the ellipsometer using a half-mirror in accordance with the present invention will be described in detail with reference to Fig. 9.

[72] An angle θ of incidence of the light incident on the center 420C of the objective lens 240 is 0, and all the lights incident on the circumference with the same radius r have the same angle θ of incidence and the plane of incidence is rotated according to a value of azimuth ϕ .

[73] When the parallel light of a specific polarization state which is reflected by the half-mirror 230, is incident on 420A of the objective lens 240, the light is refracted by the objective lens 230 to a point 430 on the surface of the sample 250 with the angle θ of incidence, then reflected with the angle θ of reflection to be arrived at a position 420B

symmetrical with respect to the center 420C of the objective lens 240, and then the intensity of the corresponding light is detected as an electric signal such as voltage or current by the pixel of the photodetector 270.

[74] The parallel light incident on the objective lens 240 is incident on the surface of the sample 250 with being refracted by the numerical aperture of the objective lens 240, and the maximum angle $\theta_{\max}$ of incidence of the light incident on the surface of the sample 250 is determined as follows by the numerical aperture (NA) of the objective lens 240:

[75] $\theta_{\max} = \sin^{-1}(NA)$

[76] An electric signal for the intensity of the light detected by the photodetector 270 is corrected into a value corresponding to the respective unit cells of the photodetector 270 [for example, if the photodetector is a CCD, the unit cell is a pixel] along multiple incidence plane path of 180° generated on a circumference with fixed radius of r from the center of the photodetector 270 and then processed to be shown by a graph. Though simple calculation, the intensity signal of the light detected by the photodetector 270 is generally expressed by the following equation:

[77]
$$I(\varphi) = I_0 [1 + \alpha_2 \sin(2\varphi) + \alpha_4 \sin(4\varphi) + \beta_2 \cos(2\varphi) + \beta_4 \cos(4\varphi)]$$

[78] where, I_0 is a mean value of the intensity of the light detected on the circumference with fixed radius of r , and α_2 ,

α_4 , β_2 and β_4 are Fourier coefficients.

[79] Therefore, the values of α_2 , α_4 , β_2 and β_4 are obtained by Fourier transformation of data on one semi-circle of the various concentric semi-circles to the central axis 420C of the objective lens 2430 in the two-dimensional data measured for the light intensity. In general, only two of these Fourier coefficients have non-zero value.

[80] The optical properties of the sample is found out by obtaining Fourier coefficients determined by the multiple incidence plane measurement with respect to the respective angles of incidence from the center axis 420C to the maximum angle $\theta_{\max}$ of incidence of the objective lens 240, i.e. with respect to multiple angles of incidence and analyzing the constants. Since the measurement with respect to the multiple planes of incidence can obtain similar effect to the conventional rotating analyzer type ellipsometer or the rotating polarizer type ellipsometer, the multiple incidence plane measurement with respect to the multiple angles of incidence is expected to raise the measurement accuracy compared to the conventional focused-beam ellipsometer using a single plane of incidence.

[81] The present application contains subject matter related to Korean Patent Application No. 2009-0053593, filed in the Korean Intellectual Property Office on June 16, 2009, the entire contents of which is incorporated herein by reference.

[82] While the present invention has been described with respect to the specific embodiments, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the following claims.

【CLAIMS】**【Claim 1】**

An ellipsometer using a half-mirror, comprising: a light source apparatus (210); a polarizer (220) for converting parallel light emitted from the light source apparatus (210) into a linear polarization state; a half-mirror (230) for reflecting the light transmitted through the polarizer (220); an objective lens (240) for focusing the light reflected from the half-mirror (230) on a sample (250); an analyzer (260) for transmitting a light polarized in a specific direction alone among the light transmitted through the objective lens (240); and a photodetector (270) having pixels for detecting intensity distribution of the light transmitted through the polarization detector (260).

【Claim 2】

An ellipsometer using a half-mirror, comprising: a light source apparatus (210); a polarizer (220) for converting parallel light emitted from the light source apparatus (210) into a linear polarization state; an objective lens (240) for focusing the light transmitted through the polarizer (220) on a sample (250); a half-mirror (230) for reflecting the light reflected from the sample (250) and transmitted through the objective lens (240); an analyzer (260) for transmitting a light polarized in a specific direction alone among the light reflected by the half-mirror (230); and a photodetector (270)

having pixels for detecting intensity distribution of the light transmitted through the polarization detector (260).

【Claim 3】

An ellipsometer using a half-mirror, comprising: a light source apparatus (210); a half-mirror (230) for reflecting the parallel light emitted from the light source apparatus (210); a linear polarizer (290) for transmitting a light polarized in a specific direction alone among the light reflected by the half-mirror (230); an objective lens (240) for focusing the light transmitted through the linear polarizer (290) on a sample (250); and a photodetector (270) having pixels for detecting intensity distribution of the light reflected from the sample (250) and transmitted through the linear polarizer (290).

【Claim 4】

An ellipsometer using a half-mirror, comprising a light source apparatus (210), a linear polarizer (290), an objective lens (240), a half-mirror (230) and a photodetector (270), wherein the linear polarizer (290) converts parallel light emitted from the light source apparatus (210) into a linear polarization state, the objective lens (240) focuses the light transmitted through the linear polarizer (290) on a sample (250), the linear polarizer (290) transmits a light polarized in a specific direction alone among the light reflected from the sample (250) and transmitted through the objective lens (240), the half-mirror (230) reflects the light transmitted

through the linear polarizer (290); and a photodetector (270) having pixels detects intensity distribution of the light reflected by the half-mirror (230).

【Claim 5】

The ellipsometer of any one of claims 1 to 4, wherein the half-mirror (230) reflects the light to half or the other half of the object lens (240) or reflects the light transmitted through the half or the other half of the object lens (240).

【Claim 6】

The ellipsometer of claim 5, further comprising: a processing device (280) for correcting the intensity distribution of the light detected by the photodetector (270) into values corresponding to pixels of the photodetector (270) along a multiple incidence plane path of 180° with respect to respective incidence angles and processing the corrected value.

【Claim 7】

The ellipsometer of claim 6, further comprising: a half-mirror transportation device for transporting the half-mirror (230) so that the half-mirror (230) reflects the light to half or the other half of the object lens (240) or reflects the light transmitted through the half or the other half of the object lens (240).

【Claim 8】

The ellipsometer of claim 6, wherein the light source apparatus (210) employs a white light source selected from a tungsten-halogen lamp and a xenon discharge lamp or a

monochromatic laser light source.

【Claim 9】

The ellipsometer of claim 6 further comprising: a band-pass filter for transmitting light with a specific range of wavelength and placed in back of the light source apparatus (210) or in front of the photodetector (270) when the light source apparatus (210) employs the white light source.

【Claim 10】

The ellipsometer of claim 1 or 2, further comprising: a compensator placed between the half-mirror (230) and the objective lens (240) to compensate the polarized beam.

【Claim 11】

The ellipsometer of claim 3 or 4, further comprising: a compensator placed between the linear polarizer (290) and the objective lens (240) to compensate the polarized beam.

【Claim 12】

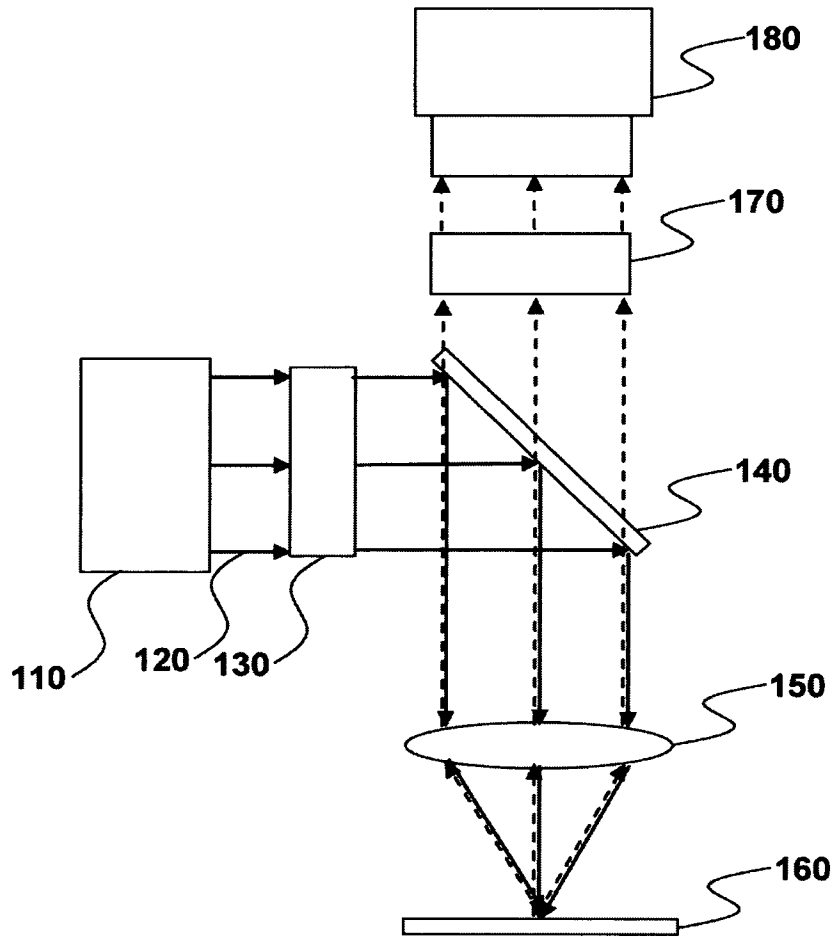
The ellipsometer of claim 1 or 2, further comprising: an electrical polarization modulator placed between the half-mirror (230) and the objective lens (240) to control phase difference of the polarized beam with electricity.

【Claim 13】

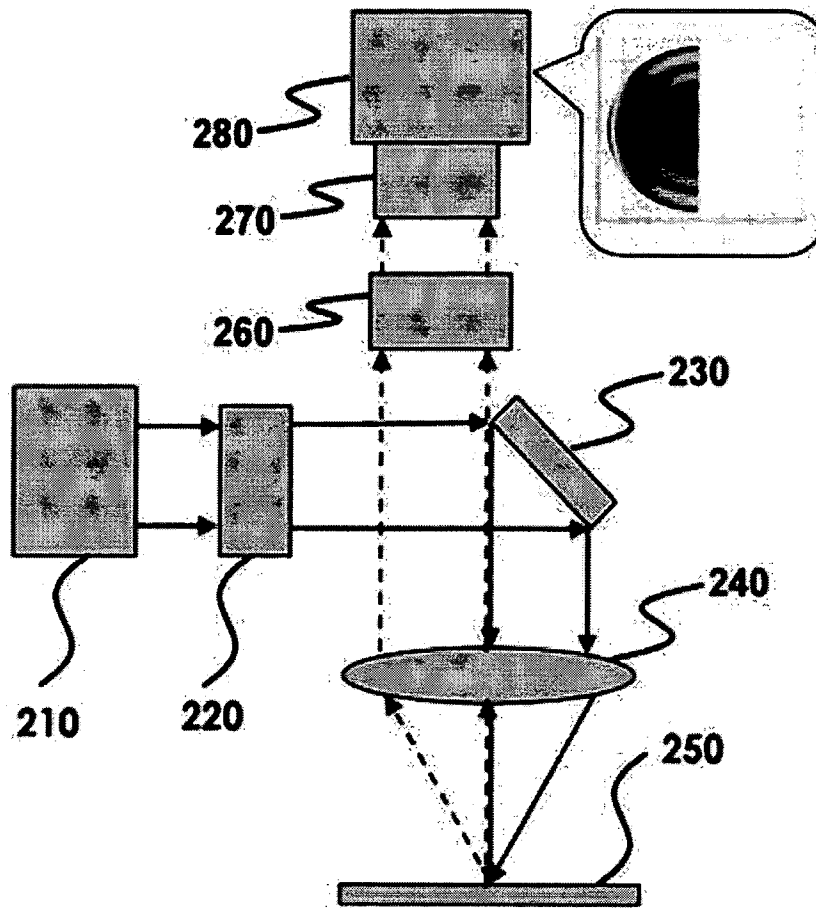
The ellipsometer of claim 3 or 4, further comprising: an electrical polarization modulator placed between the linear polarizer (290) and the objective lens (240) to control phase difference of the polarized beam with electricity.

【DRAWINGS】

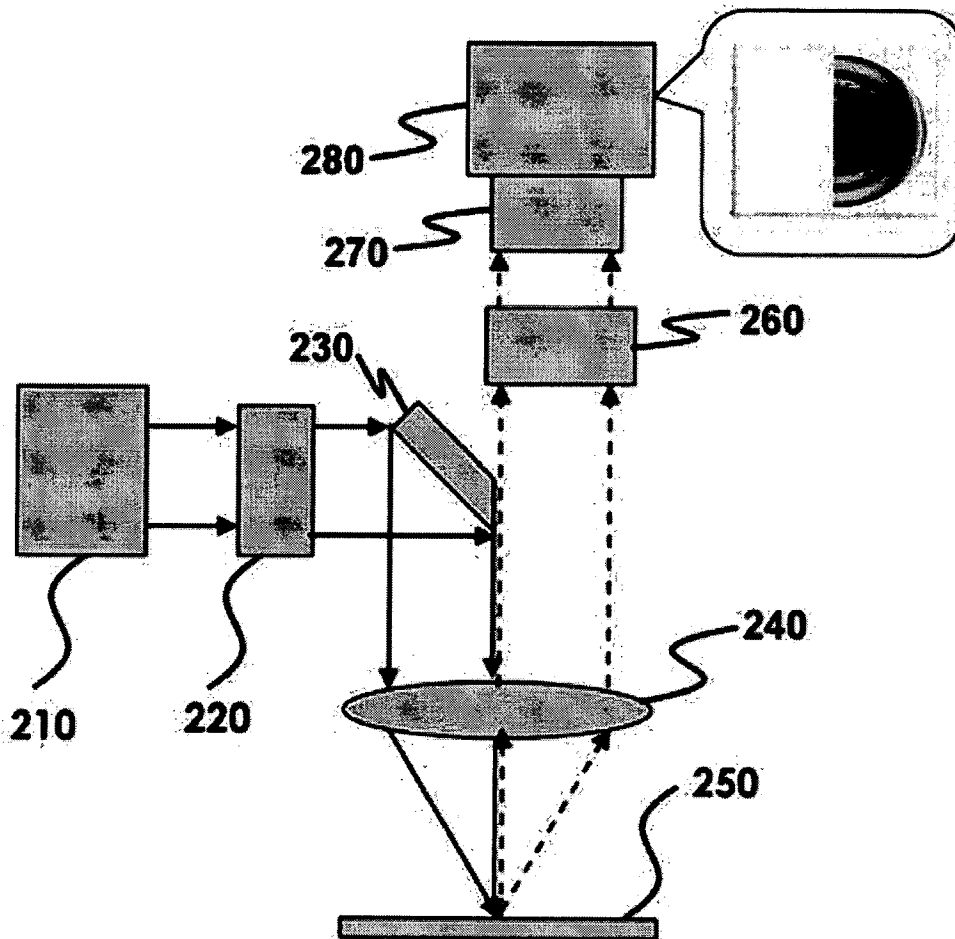
【Fig. 1】



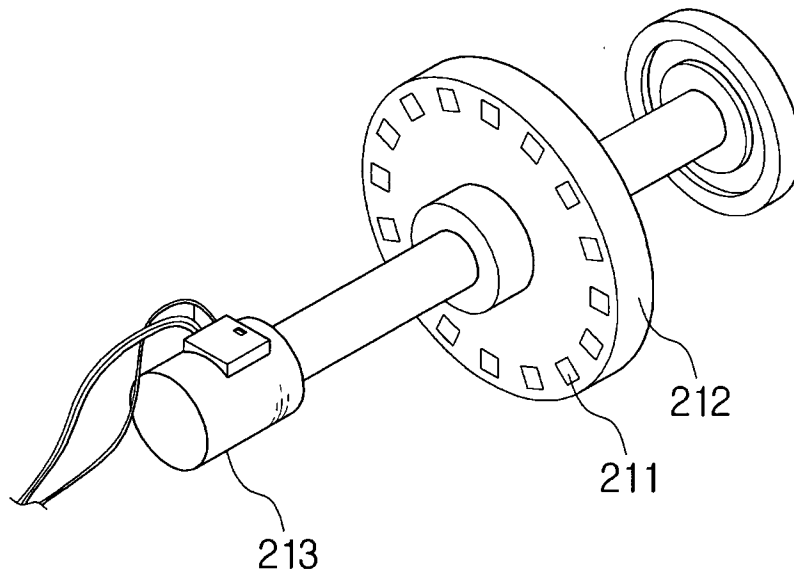
【Fig. 2】



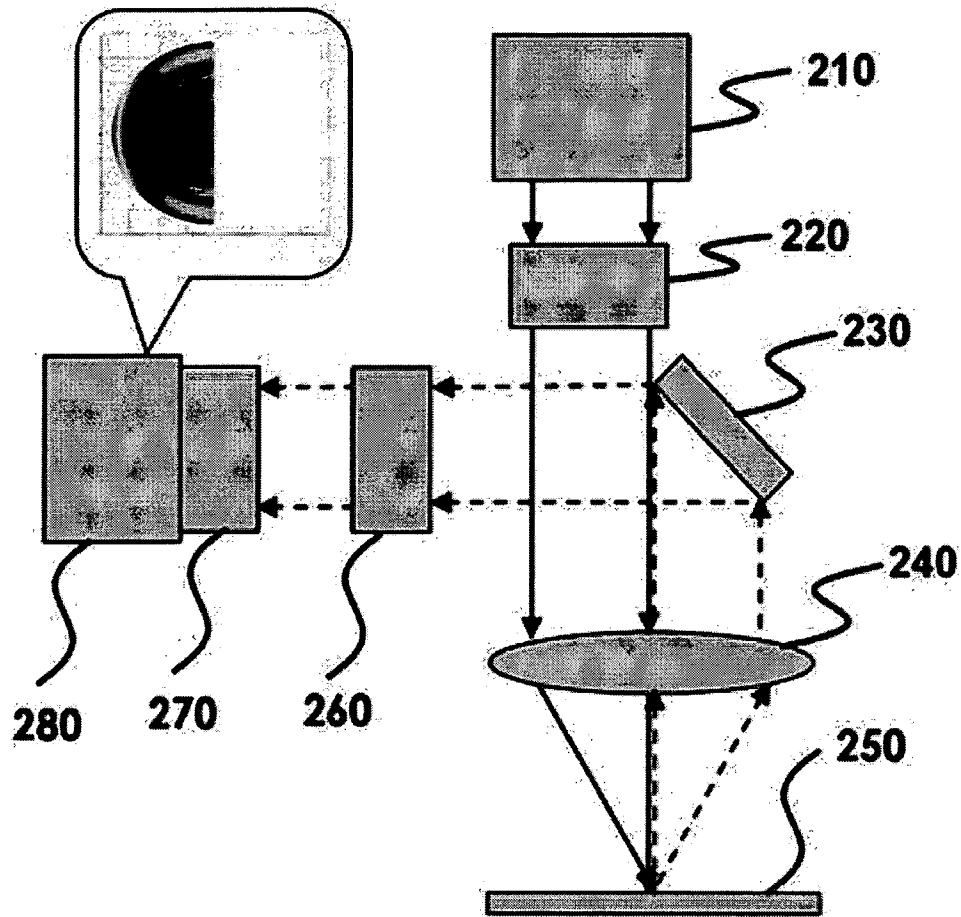
【Fig. 3】



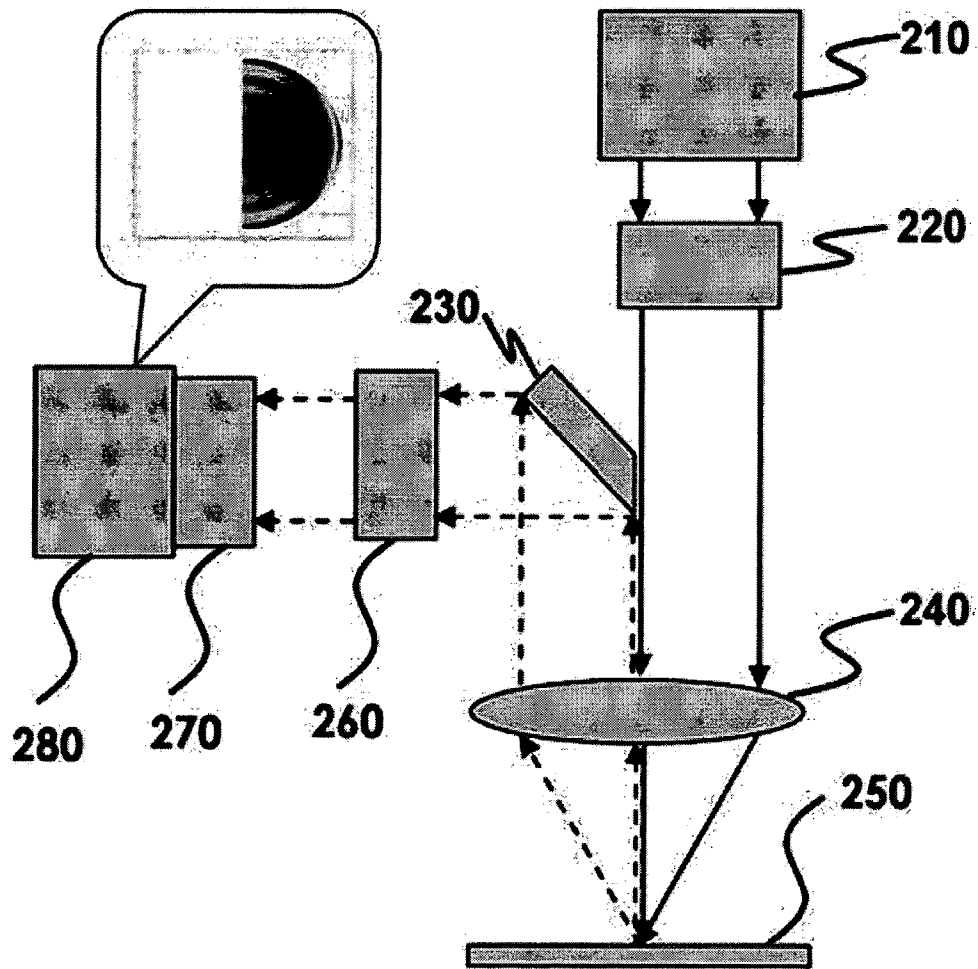
【Fig. 4】



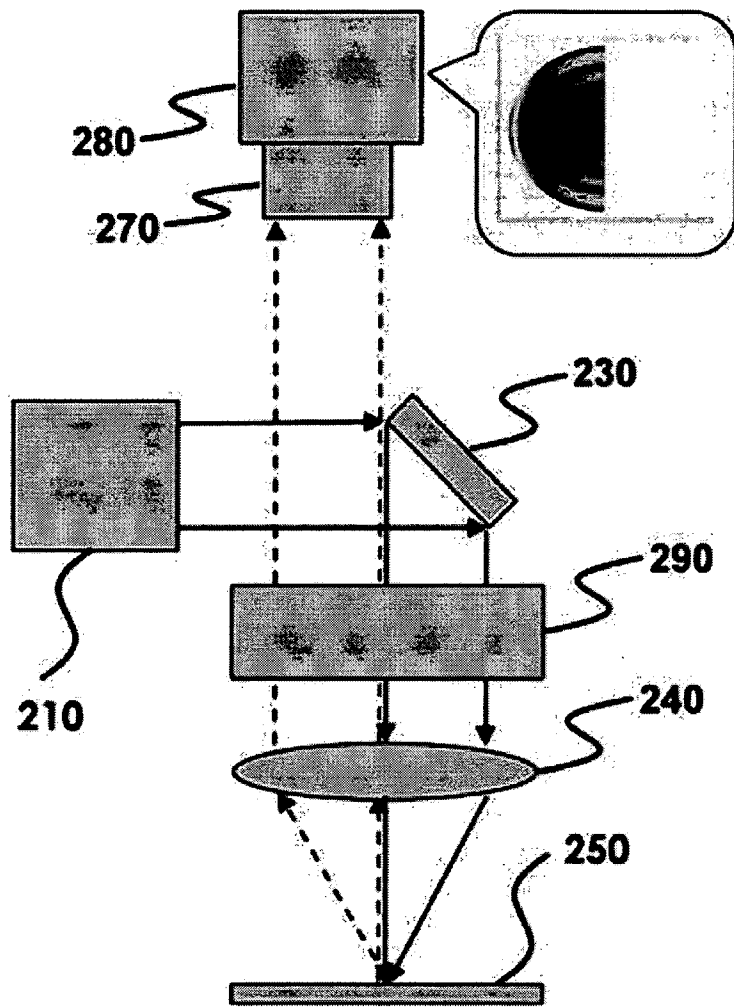
【Fig. 5】



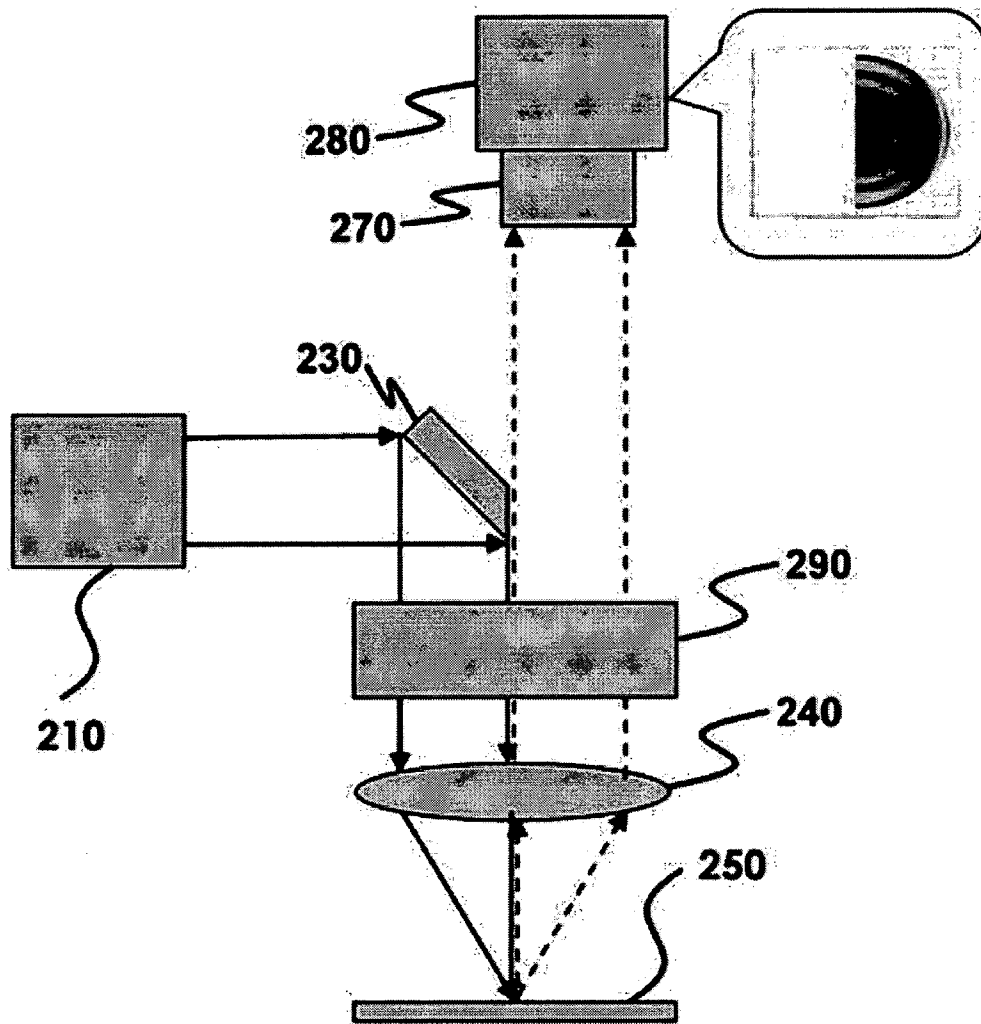
【Fig. 6】



【Fig. 7】



【Fig. 8】



【Fig. 9】

