

# US Patent & Trademark Office

## Patent Public Search | Text View

United States Patent Application Publication

20250261849

Kind Code

A1

Publication Date

August 21, 2025

Inventor(s)

Sawada; Mio et al.

### EYEPIECE OPTICAL LENS, LIGHT MEASUREMENT SYSTEM, AND LIGHT MEASUREMENT METHOD

#### Abstract

An eyepiece optical lens includes: a base that has a plurality of faces; a concave portion that forms one face of the base, and is concave in a spherical shape; and a reflection portion that forms a face on an outer peripheral side of the concave portion of the base, the reflection portion reflecting, toward the concave portion, light that has been made incident on the base from a face that is included in the plurality of faces and is different from the concave portion. This provides an eyepiece optical lens that enables a non-invasive analysis of substances contained in aqueous humor of a subject eye.

<b>Inventors:</b>	Sawada; Mio (Bunkyo-ku, Tokyo, JP), Kinoshita; Taku (Bunkyo-ku, Tokyo, JP), Kubota; Shin (Saitama, JP), Kurihara; Toshihide (Shinjuku-ku, Tokyo, JP), Shinojima; Ari (Shinjuku-ku, Tokyo, JP), Furuya; Manabu (Minato-ku, Tokyo, JP)
<b>Applicant:</b>	SEED CO., LTD. (Bunkyo-ku, Tokyo, JP); KEIO UNIVERSITY (Minato-ku, Tokyo, JP); CENTURYARKS CO., LTD. (Minato-ku, Tokyo, JP)
<b>Family ID:</b>	1000008640639
<b>Assignee:</b>	SEED CO., LTD. (Bunkyo-ku, Tokyo, JP); KEIO UNIVERSITY (Minato-ku, Tokyo, JP); CENTURYARKS CO., LTD. (Minato-ku, Tokyo, JP)
<b>Appl. No.:</b>	18/573603
<b>Filed (or PCT Filed):</b>	July 11, 2022
<b>PCT No.:</b>	PCT/JP2022/027306

#### Foreign Application Priority Data

---

## Publication Classification

**Int. Cl.:**     **A61B3/117** (20060101); **A61B3/14** (20060101)

**U.S. Cl.:**

**CPC**           **A61B3/117** (20130101); **A61B3/14** (20130101);

---

## Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This is the U.S. National Phase application of PCT/JP2022/027306, filed Jul. 11, 2022, which claims priority to Japanese Patent Application No. 2021-116647 filed Jul. 14, 2021, the disclosures of these applications being incorporated herein by reference in their entireties for all purposes.

### FIELD OF THE INVENTION

[0002] The present invention relates to an eyepiece optical lens, a light measurement system, and a light measurement method.

### BACKGROUND OF THE INVENTION

[0003] There has been conventionally known a technique of analyzing substances contained in aqueous humor in a subject eye to assist in diagnosis of the subject eye. In this technique, it is necessary to perform paracentesis to extract aqueous humor below the cornea, and this has imposed a large burden on subjects.

[0004] Patent Literatures 1 to 4 disclose a technique for conducting a non-invasive examination on a subject eye. In these techniques, light is made transversely incident from a nose side or an ear side of the subject eye, and the light is transmitted in aqueous humor along a direction that is roughly orthogonal to a direction of an eye axis (a line connecting an apex of the cornea to the fovea centralis) of the subject eye. In this case, the light is transmitted through the anterior cornea, the aqueous humor, and the posterior cornea of the subject eye in this order. It has been proposed that this light path causes a reduction in the number of tissues to be transmitted, which are noise sources, and the concentration of a metabolite of the aqueous humor is measured. Furthermore, this light path prevents light from passing through the pupil, entering an inside of the eyeball, and damaging the retina.

[0005] Patent Literature [0006] Patent Literature 1: JP H6-503245 A [0007] Patent Literature 2: JP 2018-175760 A [0008] Patent Literature 3: JP 2018-175481 A [0009] Patent Literature 4: JP 2011-83342 A

### SUMMARY OF THE INVENTION

[0010] However, according to results of anatomical researches conducted by the present inventors on a shape of a corneal ring and a trial calculation based on data relating to the divergence of a light flux to be introduced or a movement of the eyeball, in order to achieve a light path that causes transverse transmission through aqueous humor in eyes of many subjects, it is necessary to control an angle of incidence of light on a subject eye with an error that is smaller than 1°, and it is considered difficult to achieve the light path.

[0011] Aspects of the present invention have been made in view of the above, and include an eyepiece optical lens, a light measurement system, and a light measurement method that enable a non-invasive analysis of substances contained in aqueous humor of a subject eye.

[0012] To solve the problem described above and to achieve the object, an eyepiece optical lens

according to aspects of the present invention includes: a base that has a plurality of faces; a concave portion configured to form one face of the base, the concave portion being concave in a spherical shape; and a reflection portion configured to form a face on an outer peripheral side of the concave portion of the base, the reflection portion reflecting, toward the concave portion, light that has been made incident on the base from a face that is included in the plurality of faces and is different from the concave portion.

[0013] In the eyepiece optical lens according to one aspect of the present invention, the reflection portion is configured to reflect the light that has been made incident on the base, in a direction that is roughly orthogonal to an incident direction.

[0014] In the eyepiece optical lens according to one aspect of the present invention, the reflection portion is configured to reflect the light that has been made incident on the base, in an axial direction that passes through an apex of the concave portion.

[0015] In the eyepiece optical lens according to one aspect of the present invention, the reflection portion has a critical angle that is determined according to a refractive index of a medium forming the eyepiece optical lens, the critical angle causing light made incident on the reflection portion to be totally reflected.

[0016] In the eyepiece optical lens according to one aspect of the present invention, the reflection portion is configured to form a face surrounding an outer periphery of the concave portion of the base.

[0017] In the eyepiece optical lens according to one aspect of the present invention, the reflection portion includes: a first reflection portion configured to form the face on the outer peripheral side of the concave portion of the base, the first reflection portion reflecting, toward the concave portion, the light that has been made incident on the base from the face that is included in the plurality of faces and is different from the concave portion; and a second reflection portion configured to form the face of the outer peripheral side of the concave portion of the base, the second reflection portion reflecting the light that has been reflected by the first reflection portion, toward the face that is included in the plurality of faces and is different from the concave portion.

[0018] A light measurement system according to one aspect of the present invention includes: the above-mentioned eyepiece optical lens; and a light measurement apparatus that includes a light source unit configured to irradiate the eyepiece optical lens with light, and a light receiver configured to receive the light from the eyepiece optical lens.

[0019] In the light measurement system according to one aspect of the present invention, the light receiver is configured to receive Raman scattered light in aqueous humor of a subject eye that has been brought into contact with the eyepiece optical lens.

[0020] A light measurement method according to one aspect of the present invention is a light measurement method that uses an eyepiece optical lens including: a base that has a plurality of faces; a concave portion configured to form one face of the base, the concave portion being concave in a spherical shape; and a reflection portion configured to form a face on an outer peripheral side of the concave portion of the base, the reflection portion reflecting, toward the concave portion, light that has been made incident on the base from a face that is included in the plurality of faces and is different from the concave portion, the light measurement method including: an adjustment step of irradiating a subject eye with examination light, and adjusting an incident position of the light to cause a position of a spot of the examination light to be formed in the reflection portion, the subject eye having been brought into contact with the eyepiece optical lens; and a measurement light irradiation step of irradiating the eyepiece optical lens with measurement light having a light intensity that is greater than a light intensity of the examination light; and a light reception step of receiving the measurement light.

[0021] The light measurement method according to one aspect of the present invention further includes, before the light reception step, a disposition step of disposing a light receiver configured to receive the measurement light, in a position that causes Raman scattered light in aqueous humor

of the subject eye to have a maximum light intensity.

[0022] Aspects of the present invention can achieve an eyepiece optical lens, a light measurement system, and a light measurement method that enable a non-invasive analysis of substances contained in aqueous humor of a subject eye.

---

## Description

### BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1 is a schematic diagram of a Raman scattered light spectroscopic measurement system according to an embodiment of the present invention.

[0024] FIG. 2 is an enlarged view of an eyepiece optical lens.

[0025] FIG. 3 is a partial enlarged view of a light source unit.

[0026] FIG. 4 is a flowchart illustrating a procedure of a Raman spectroscopic measurement method.

[0027] FIG. 5 is an enlarged view of an eyepiece optical lens of a first variation.

[0028] FIG. 6 is an enlarged view of a light source unit of a second variation.

[0029] FIG. 7 is an enlarged view of a light source unit of a third variation.

### DETAILED DESCRIPTION

[0030] Hereinafter, details of an eyepiece optical lens, a light measurement system, and a light measurement method of the present invention will be described on the basis of embodiments, but these are not restrictive of the present invention.

#### Embodiment

##### [Configuration of Raman Scattered Light Spectroscopic Measurement System]

[0031] FIG. 1 is a schematic diagram of a Raman scattered light spectroscopic measurement system according to an embodiment of the present invention. A subject eye **10** includes a cornea **11** that takes light into the eyeball, aqueous humor **12** that is located inside the cornea **11**, and adjusts intraocular pressure, a sclera **13** that is located on an outer periphery of the cornea **11**, and a crystalline lens **14** that is located inside the aqueous humor **12**. The aqueous humor **12** contains a variety of metabolites, and it is considered that there is a correlation between these substances and eye diseases. Therefore, there is a request for a technique for identifying metabolites in the aqueous humor **12** and measuring the concentrations of the metabolites. A Raman scattered light spectroscopic measurement system **100** performs measurement for analyzing the metabolites contained in the aqueous humor **12** by using Raman spectroscopy. The Raman scattered light spectroscopic measurement system **100** includes an eyepiece optical lens **1** that is brought into contact with the subject eye **10**, and a Raman scattered light spectroscopic measurement apparatus **20** that irradiates the eyepiece optical lens **1** with pumping light, and performs spectroscopic measurement on Raman scattered light from the aqueous humor **12** of the subject eye **10**, as illustrated in FIG. 1. Note that in accordance with aspects of the present invention, “contact” refers to a state where the eyepiece optical lens **1** of an embodiment of the present invention comes into contact with the cornea **11**, and indicates a state that is similar to “wear”, “mount”, “attach”, “abut”, or the like.

##### [Configuration of Eyepiece Optical Lens]

[0032] FIG. 2 is an enlarged view of an eyepiece optical lens. FIG. 2 illustrates a cross section of the eyepiece optical lens **1**, and the eyepiece optical lens **1** includes a base **1a** that has a plurality of faces, a concave portion **1b** that forms one face of the base **1a**, a reflection portion **1c** that forms a face on an outer peripheral side of the concave portion **1b** of the base **1a**, and an incidence portion **1d** that forms a face on an opposite side of the concave portion **1b**. Note that herein, a face on a side of the incidence portion **1d** (on an upper side in FIG. 2) of the base **1a** is referred to as a front face, and a face on a side of the concave portion **1b** (on a lower side in FIG. 2) of the base **1a** is

referred to as a rear face.

[0033] It is preferable that a refractive index of the eyepiece optical lens **1** be greater than a refractive index (1.00) of the air, and be also greater than a refractive index (1.376) of the cornea **11**. Furthermore, it is preferable that the eyepiece optical lens **1** have such hardness that a radius of curvature of the base **1a** does not change in a case where the eyepiece optical lens **1** abuts onto the cornea **11**. As a material that satisfies these conditions, the eyepiece optical lens **1** is made of, for example, glass, poly methyl methacrylate (PMMA), or the like.

[0034] The concave portion **1b** is concave in a spherical shape, and has a radius of curvature that corresponds to the cornea **11** of the subject eye **10**. It is preferable that the radius of curvature of the concave portion **1b** be equal to a radius of curvature of the cornea **11**, or be greater than the radius of curvature of the cornea **11**. The concave portion **1b** is formed to have such a radius of curvature, and this can prevent a shape of the subject eye **10** from changing during measurement after the eyepiece optical lens **1** has been brought into contact with the subject eye **10**.

[0035] The reflection portion **1c** (a face on which a reflection portion **1c.sub.1** and a reflection portion **1c.sub.2** are continuously formed) is, for example, an interface between glass and the air, and has a critical angle that is determined according to a refractive index of a medium that forms the eyepiece optical lens **1**, and causes light made incident on the reflection portion **1c** to be totally reflected. However, it is sufficient if the reflection portion **1c** is a reflection portion having a sufficiently high reflectance, and the reflection portion **1c** is not limited to a total reflection type. Furthermore, the reflection portion **1c** may be formed by forming a thin film that is made of metal or the like on a surface of glass. The reflection portion **1c** is formed in an annular shape to surround an outer periphery of the concave portion **1b**. In other words, a cross section that passes through an apex of the concave portion **1b**, and includes a center axis C1 that passes through a center of a spherical surface formed by the concave portion **1b**, as illustrated in FIG. 2, has the same shape in any direction. Note that the apex of the concave portion **1b** means a point where the concave portion **1b** is most concave.

[0036] Returning to FIG. 2, the reflection portion **1c.sub.1** reflects light that has been made incident on the base **1a** from the incidence portion **1d**, toward the center axis C1 in a direction that is roughly orthogonal to an incident direction. However, it is sufficient if the reflection portion **1c.sub.1** reflects, toward the concave portion **1b**, the light that has been made incident on the base **1a** from the incidence portion **1d**, and it is sufficient if light reflected by the reflection portion **1c.sub.1** passes through a portion of the aqueous humor **12**. An angle  $\theta$  formed by the reflection portion **1c.sub.1** relative to a leftward/rightward direction of the subject eye **10** (a leftward/rightward direction in FIG. 2) is an angle at which light that has been made incident from the front is reflected at roughly right angles to the incident direction, and therefore the angle  $\theta$  is, for example,  $45^\circ$ . However, the angle  $\theta$  can be appropriately selected according to a direction in which light is made incident on the subject eye **10**. For example, in a case where light is made incident on the subject eye **10** to be inclined outward (to a right-hand side in FIG. 2) from the center axis C1 of the concave portion **1b**, the angle  $\theta$  formed by the reflection portion **1c.sub.1** may be set in such a way that reflected light goes straight to the center axis C1.

[0037] Furthermore, the reflection portion **1c.sub.2** reflects, toward the incidence portion **1d**, light that has been reflected by the reflection portion **1c.sub.1** and has passed through the aqueous humor **12**. An angle formed by the reflection portion **1c.sub.2** relative to the leftward/rightward direction of the subject eye **10** is an angle at which light from the concave portion **1b** is reflected forward, and therefore the angle is, for example,  $45^\circ$ . However, the angle can be appropriately selected according to a direction in which light is measured.

[0038] It is preferable that the incidence portion **1d** have a small reflectance with respect to light from the front, and for example, a flat plane that is orthogonal to the center axis C1 is formed.

[Configuration of Raman Scattered Light Spectroscopic Measurement Apparatus]

[0039] The Raman scattered light spectroscopic measurement apparatus **20** includes a light source

unit **21** that irradiates the eyepiece optical lens **1** with light, an objective **22**, a condenser lens **23**, a notch filter **24**, an optical fiber coupler **25**, an optical fiber **26**, a spectroscope **27** serving as a light receiver that receives light from the eyepiece optical lens **1**, and an absorber **28**, as illustrated in FIG. **1**.

[0040] The Raman scattered light spectroscopic measurement apparatus **20** measures Raman scattered light that has been scattered in a direction that is roughly orthogonal to light that the concave portion **1b** has introduced into the aqueous humor **12**, by using, as pumping light, incident light that has been applied from the light source unit **21**. This is because Raman scattered light has the same light intensity in any direction of measurement, while Rayleigh scattered light has the smallest light intensity in a direction that is roughly orthogonal to the pumping light, and this enables Raman scattered light to be efficiently measured.

[0041] FIG. **3** is a partial enlarged view of a light source unit. As illustrated in FIG. **3**, the light source unit **21** includes a light source **211** that irradiates the subject eye **10** with light, and a MEMS mirror **212** that can change in a reflection direction.

[0042] The light source **211** emits measurement light that is used as pumping light for performing spectroscopic measurement on Raman scattered light in the aqueous humor **12** of the subject eye **10**. Furthermore, the light source **211** emits examination light having a light intensity that is smaller than a light intensity of this measurement light. The examination light is used to examine whether the reflection portion **1c** has been irradiated with light from the light source **211** before measurement. Wavelengths of the measurement light and the examination light are, for example, 532 nm, but are not particularly limited. It is preferable that the examination light have the same wavelength as a wavelength of the measurement light. It is sufficient if the light source **211** is a light source that emits light of a predetermined wavelength, and an example is a laser diode (LD).

[0043] The objective **22** condenses scattered light from the aqueous humor **12**.

[0044] The condenser lens **23** couples light that has been condensed by the objective **22** to the optical fiber coupler **25**.

[0045] The notch filter **24** is a band-stop filter that selectively shields Rayleigh scattered light included in the scattered light from the aqueous humor **12**. Accordingly, the notch filter **24** shields Rayleigh scattered light included in the scattered light from the aqueous humor **12**, and transmits Raman scattered light. However, it is sufficient if the notch filter **24** is a filter that selectively shields light of the same wavelength as a wavelength of the Rayleigh scattered light included in the scattered light from the aqueous humor **12**, and transmits Raman scattered light included in the scattered light from the aqueous humor **12**. For example, in a case where Stokes Raman scattering is measured, a filter that transmits light of a wavelength that is longer than a wavelength of pumping light applied by the light source unit **21** may be used. Furthermore, in a case where anti-Stokes Raman scattering is measured, a filter that transmits light of a wavelength that is shorter than the wavelength of the pumping light applied by the light source unit **21** may be used. Moreover, in a case where Raman scattered light of a known wavelength is measured, a bandpass filter that selectively transmits Raman scattered light may be used.

[0046] The optical fiber coupler **25** couples light that has been condensed by the condenser lens **23** to the optical fiber **26**.

[0047] The optical fiber **26** introduces scattered light from the aqueous humor **12** into the spectroscope **27**.

[0048] The spectroscope **27** performs spectroscopic measurement on light that has been transmitted through the notch filter **24**. Note that light that has been condensed by the condenser lens **23** may be made directly incident on the spectroscope. In this case, the optical fiber coupler **25** and the optical fiber **26** are omitted.

[0049] The absorber **28** absorbs light that has been applied by the light source unit **21**.

[Raman Scattered Light Spectroscopic Measurement Method Performed by Raman Scattered Light Spectroscopic Measurement System]

[0050] Next, a Raman scattered light spectroscopic measurement method, which is a light measurement method performed by the Raman scattered light spectroscopic measurement system **100**, is described. FIG. **4** is a flowchart illustrating a procedure of the Raman spectroscopic measurement method. As illustrated in FIG. **4**, the eyepiece optical lens **1** is brought into contact with the subject eye **10** (Step S1).

[0051] Next, the subject eye **10** that has come into contact with the eyepiece optical lens **1** is irradiated with examination light from the light source unit **21**. Then, an incident position of light is adjusted in such a way that a spot position of the examination light is formed in the reflection portion **1c.sub.1** (Step S2: adjustment step). Note that if an incident direction and the spot position of light are confirmed and a refractive index of each substance that light passes through is used, a light path can be estimated according to the Snell's law. Stated another way, an incident position of light is adjusted while a position of a spot is confirmed, and this enables a light path to be adjusted in such a way that incident light transversely passes through the aqueous humor **12** of the subject eye **10**.

[0052] Moreover, the optical fiber coupler **25** that introduces light into the spectroscope **27** serving as a light receiver is disposed in a position that causes Raman scattered light in the aqueous humor **12** of the subject eye **10** to have a maximum light intensity (Step S3: disposition step).

[0053] Then, the eyepiece optical lens **1** is irradiated from the light source unit **21** with measurement light having a light intensity that is greater than a light intensity of the examination light (Step S4: measurement light irradiation step).

[0054] Then, the measurement light is introduced from the optical fiber coupler **25** into the spectroscope **27**, and spectroscopic measurement is performed by the spectroscope **27** (Step S5: light reception step).

[0055] According to the Raman scattered light spectroscopic measurement method described above, by using the eyepiece optical lens **1** including the concave portion **1b**, light can be made incident on the subject eye **10** from the front, and substances contained in the aqueous humor **12** can be analyzed.

#### [Variations of Eyepiece Optical Lens]

##### (First Variation)

[0056] FIG. **5** is an enlarged view of an eyepiece optical lens of a first variation. FIG. **5** illustrates a cross section of an eyepiece optical lens **1A** of the first variation, and the eyepiece optical lens **1A** includes a base **1Aa** that has a plurality of faces, a concave portion **1Ab** that forms one face of the base **1Aa**, a reflection portion **1Ac** (a face on which a reflection portion **1Ac.sub.1** and a reflection portion **1Ac.sub.2** are continuously formed) that forms a face on an outer peripheral side of the concave portion **1Ab** of the base **1Aa**, a third reflection portion **1Ad** (a face on which a third reflection portion **1Ad.sub.1** and a third reflection portion **1Ad.sub.2** are continuously formed) that forms a face that faces the reflection portion **1Ac** of the base **1Aa**, and an incidence portion **1Ae** that forms a side face of the base **1Aa**. The reflection portion **1Ac** and the third reflection portion **1Ad** are formed in an annular shape to surround an outer periphery of the concave portion **1Ab**. In other words, a cross section that passes through an apex of the concave portion **1Ab**, and includes a center axis **C2** that passes through a center of a spherical surface formed by the concave portion **1Ab**, as illustrated in FIG. **5**, has the same shape in any direction. The reflection portion **1Ac.sub.1** reflects light that has been made incident from the incidence portion **1Ae** and has been reflected by the third reflection portion **1Ad.sub.1**, toward the center axis **C2** in a direction that is roughly orthogonal to an incident direction. Furthermore, the reflection portion **1Ac.sub.2** reflects light that has been reflected by the reflection portion **1Ac.sub.1**, toward the third reflection portion **1Ad.sub.2**.

[0057] The third reflection portion **1Ad.sub.1** reflects light that has been made incident on the incidence portion **1Ae** from a side (a nose side or an ear side) of the subject eye **10**, in a direction that is roughly parallel to the center axis **C2**. Furthermore, the third reflection portion **1Ad.sub.2**

reflects light that has been reflected by the reflection portion **1Ac.sub.2**, in a direction that is roughly orthogonal to the center axis **C2**.

[0058] As described above in the first variation, a configuration that introduces incident light from a side of the subject eye **10** may be employed. In this case, angles, positions, sizes, or the like of the reflection portion **1Ac** (the face on which the reflection portion **1Ac.sub.1** and the reflection portion **1Ac.sub.2** are continuously formed) and the third reflection portion **1Ad** (the face on which the third reflection portion **1Ad.sub.1** and the third reflection portion **1Ad.sub.2** are continuously formed) are appropriately set, and this enables light to be easily made incident on the aqueous humor **12** in comparison with a case where incident light is directly introduced into the aqueous humor **12** from the side.

(Second Variation)

[0059] FIG. **6** is an enlarged view of a light source unit of a second variation. As illustrated in FIG. **6**, a light source unit **21B** includes a light source **211B** that irradiates the subject eye **10** with light, a driving unit **212B** that drives the light source **211B**, and a mirror **213B** that reflects light from the light source **211B** toward the subject eye **10**.

[0060] The driving unit **212B** includes a rail that extends in a direction that is orthogonal to a direction in which the light source **211B** applies light, and a motor that drives the light source **211B**, and drives the motor to move the light source **211B** that is movably held on the rail. According to a movement of the light source **211B** on the rail, a position of irradiation of the eyepiece optical lens **1** with light can be adjusted.

(Third Variation)

[0061] FIG. **7** is an enlarged view of a light source unit of a third variation. As illustrated in FIG. **7**, a light source unit **21C** includes a light source **211C** that irradiates the subject eye **10** with light, a lens **212C**, and a driving unit **213C** that rotates the lens **212C** to change a traveling direction of light that has been transmitted through the lens **212C**.

[0062] Note that, in the embodiment, an example where the reflection portion **1c** surrounds the concave portion **1b** in an annular shape has been described, but this is not restrictive. The reflection portion **1c** may include a first reflection portion that forms a face on an outer peripheral side of the concave portion **1b** of the base **1a**, and reflects light that has been made incident from the incidence portion **1d**, toward the concave portion **1b**, and a second reflection portion that forms a face on the outer peripheral side of the concave portion **1b** of the base **1a**, and reflects light that has been reflected by the first reflection portion, toward the incidence portion **1d**. In other words, the reflection portion **1c** may include a plurality of reflection portions that is provided to be spaced apart from each other. In this case, it is preferable that the eyepiece optical lens **1** be held to not rotate relative to the subject eye **10**. Furthermore, the reflection portion **1c** may only include a reflection portion that forms a face on the outer peripheral side of the concave portion **1b** of the base **1a**, and reflects light that has been made incident from the incidence portion **1d**, toward the concave portion **1b**. The formation of the reflection portion **1c**, as described above, enables light made incident on the subject eye **10** from the front to be transversely introduced into the aqueous humor **12**. In this case, light that has been transmitted through the aqueous humor **12** is emitted to a side (the nose side or the ear side) of the subject eye **10**, and therefore the absorber **28** may be disposed on the side of the subject eye **10**.

REFERENCE SIGNS LIST

[0063] **1**, **1A** EYEPIECE OPTICAL LENS [0064] **1a**, **1Aa** BASE [0065] **1b**, **1Ab** CONCAVE PORTION [0066] **1c**, **1Ac** REFLECTION PORTION [0067] **1d**, **1Ae** INCIDENCE PORTION [0068] **1Ad** THIRD REFLECTION PORTION [0069] **10** SUBJECT EYE [0070] **11** CORNEA [0071] **12** AQUEOUS HUMOR [0072] **13** SCLERA [0073] **14** CRYSTALLINE LENS [0074] **20** RAMAN SCATTERED LIGHT SPECTROSCOPIC MEASUREMENT APPARATUS [0075] **21**, **21B**, **21C** LIGHT SOURCE UNIT [0076] **22** OBJECTIVE [0077] **23** CONDENSER LENS [0078] **24** NOTCH FILTER [0079] **25** OPTICAL FIBER COUPLER [0080] **26** OPTICAL FIBER [0081]



**27** SPECTROSCOPE [0082] **28** ABSORBER [0083] **100** RAMAN SCATTERED LIGHT  
SPECTROSCOPIC MEASUREMENT SYSTEM [0084] **211**, **211B**, **211C** LIGHT SOURCE  
[0085] **212** MEMS MIRROR [0086] **212B**, **213C** DRIVING UNIT [0087] **213B** MIRROR [0088]  
**212C** LENS

## Claims

1. An eyepiece optical lens comprising: a base that has a plurality of faces; a concave portion configured to form one face of the base, the concave portion being concave in a spherical shape; and a reflection portion configured to form a face on an outer peripheral side of the concave portion of the base, the reflection portion reflecting, toward the concave portion, light that has been made incident on the base from a face that is included in the plurality of faces and is different from the concave portion.
2. The eyepiece optical lens according to claim 1, wherein the reflection portion is configured to reflect the light that has been made incident on the base, in a direction that is roughly orthogonal to an incident direction.
3. The eyepiece optical lens according to claim 1, wherein the reflection portion is configured to reflect the light that has been made incident on the base, in an axial direction that passes through an apex of the concave portion.
4. The eyepiece optical lens according to claim 1, wherein the reflection portion has a critical angle that is determined according to a refractive index of a medium forming the eyepiece optical lens, the critical angle causing light made incident on the reflection portion to be totally reflected.
5. The eyepiece optical lens according to claim 1, wherein the reflection portion is configured to form a face surrounding an outer periphery of the concave portion of the base.
6. The eyepiece optical lens according to claim 1, wherein the reflection portion includes: a first reflection portion configured to form the face on the outer peripheral side of the concave portion of the base, the first reflection portion reflecting, toward the concave portion, the light that has been made incident on the base from the face that is included in the plurality of faces and is different from the concave portion; and a second reflection portion configured to form the face of the outer peripheral side of the concave portion of the base, the second reflection portion reflecting the light that has been reflected by the first reflection portion, toward the face that is included in the plurality of faces and is different from the concave portion.
7. A light measurement system comprising: the eyepiece optical lens according to claim 1; and a light measurement apparatus that includes a light source unit configured to irradiate the eyepiece optical lens with light, and a light receiver configured to receive the light from the eyepiece optical lens.
8. The light measurement system according to claim 7, wherein the light receiver is configured to receive Raman scattered light in aqueous humor of a subject eye that has been brought into contact with the eyepiece optical lens.
9. A light measurement method that uses an eyepiece optical lens including: a base that has a plurality of faces; a concave portion configured to form one face of the base, the concave portion being concave in a spherical shape; and a reflection portion configured to form a face on an outer peripheral side of the concave portion of the base, the reflection portion reflecting, toward the concave portion, light that has been made incident on the base from a face that is included in the plurality of faces and is different from the concave portion, the light measurement method comprising: an adjustment step of irradiating a subject eye with examination light, and adjusting an incident position of the light to cause a position of a spot of the examination light to be formed in the reflection portion, the subject eye having been brought into contact with the eyepiece optical lens; and a measurement light irradiation step of irradiating the eyepiece optical lens with measurement light having a light intensity that is greater than a light intensity of the examination

light; and a light reception step of receiving the measurement light.

**10.** The light measurement method according to claim 9, further comprising, before the light reception step, a disposition step of disposing a light receiver configured to receive the measurement light, in a position that causes Raman scattered light in aqueous humor of the subject eye to have a maximum light intensity.

---