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(54) **WEARABLE VISION DEVICE**

TRAGBARE SICHTVORRICHTUNG

DISPOSITIF DE VISION EXTRACORPOREL

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Description

PRIOR STATE OF ART

[0001] Oral carcinoma has, in the world, an incidence of 8.2 cases out of 100000 male inhabitants per year and of 2.8 cases out of 100000 female inhabitants per year. However, in the world some areas are more affected; in the Indian Subcontinent the oral carcinoma exceeds 30% of all tumours. More than 90% of these tumours are classified as "squamocellular tumour" (Parkin DM, Bray F, Ferlay J, Pisani P. Global cancer statistics, 2002. CA Cancer J Clin 2005, 55:74-108).

[0002] The occurrence age is placed between the VI and the VII life decade; however, during the last decades, an increase in the cases of oral carcinoma in young age with prevailing lingual localization has been found.

[0003] Smokers have a risk of death due to oral cavity cancer 5 times higher than the remaining population. Even the excessive alcohol consumption promotes the oral cavity cancer and the association of alcohol and tobacco smoke has a synergic effect upon the increase in the risk of developing the tumour.

[0004] Some importance from the aetiological point of view seems to have also poor oral hygiene, incongruous prostheses, defective dental reconstructions, dental archs in wrong occlusion, sharp cusps. Frequently viral DNA (HPV, HCV) has been found in the oral cavity carcinoma. The identification of all lesions defined "precancerous", such as leukoplakia, eritroplakia and lichen planus, appear to be particularly important for the preventive purpose, as they constitute a specific risk factor. According to the literature data, Ie precancerous lesions can change into carcinoma in an amount variable between 5 and 18% of the cases.

[0005] Up to now no competent organism has ever proposed to establish screenings on wide populations. However, the study of the groups at risk could be useful for preventive purposes.

[0006] Currently the recommended screening tests are the clinical examination and the application of Toluidine blue on the suspected lesion, followed by definitive diagnosis with incisional or excisional biopsy.

[0007] Toluidine blue is the most used test; however id shows false negatives and the area wherein the dye is fixed seems not to always correspond to the real neoplasia extension; for this reason promising techniques of secondary prevention of the oral cavity cancer, based upon optical apparatuses are under development (W. H. Westra D. Sidransky "FluorescenceVisualization in Oral Neoplasia: Shedding Light on an Old Problem" Commentary on Poh et al. Clin Cancer Res 2006; 12(22) November 15, 2006; 6594-7; Poh CF, Zhang L, Anderson DW, et al. "Fluorescence visualization detection of field alterations in margins of oral cancer patient". Clin Cancer Res 2006;12:6716-22).

[0008] The diagnosis performed by using optical apparatuses is based on the evidence that some tissues emit fluorescence when lighted by visible light. This phenomenon is known as "autofluorescence". The tissues' autofluorescence provides diagnostically relevant data for preventing tumours in the lung, in the cervix uteri, in the skin and in the oral cavity.

[0009] The light interaction with the tissue reveals changes in the structure and in the metabolic activity in areas wherein there is clonal activity. More precisely, the loss in autofluorescence seems to reflect complex remodellings such as rupture of the tissue collagen, neoangiogenesis and decrease in the flavin adenine dinucleotide (FAD concentration) in the oxidized form thereof.

[0010] The healthy oral mucosa emits a small fluorescence with pale green colour (515nm) when lighted by blue-violet light (450nm).

[0011] In the dysplastic tissues the autofluorescence appears reduced basically due to alterations of the cellular metabolism (the FAD concentration decreases in the cells with active cellular metabolism) and scattering effect due to alterations of the cellular structure and disarranging of the extracellular matrix.

[0012] When the oral mucosa has suffered biochemical and/or structural alterations (squamous hyperplasia, dysplasia, carcinoma), an area of decreased autofluorescence can be seen.

[0013] A publication of the Journal of Biomedical Optics in 2006 showed a device able to highlight the decrease in fluorescence, indicating cancer degeneration in the area under examination (Lane PM, Gilhuly T, Whitehead P, Zeng H, Poh CF, Ng S, Williams PM, Zhang L, Rosin MP, MacAulay CE "Simple device for the direct visualization of oral-cavity tissue fluorescence"J Biomed Opt. 2006 Mar-Apr;11(2):024006, fig. 1). The device consisted in a light source connected by means of an optical fibre cable to the portion of the tool to hold. In the latter the light firstly crossed an excitation filter, after a converging lens, subsequently a dichroic mirror and at last it hit the oral mucosa. From the oral mucosa, the light subsequently travelled a backward route through the dichroic mirror. However, this time it was directed toward the examiner eye after having crossed two filters: the first emission filter, the second contrast filter.

[0014] The same magazine in May 2008 published a work about a new device based on the same principle: improvements are provided by the transportability, by the binocular vision and by the association to video recording system (Rahman M, Chaturvedi P, Gillenwater AM, Richards-Kortum R "Low-cost, multimodal, portable screening system for early detection of oral cancer" J Biomed Opt. 2008 May-Jun;13(3):030502)

[0015] The device available in the state of art, as briefly described above, needs the use of a complex optical apparatus, constituted by several portions, which has to be held by the operator performing the analysis.

[0016] Such device allows visualizing the decrease in autofluorescence of diagnostic interest in the oral mucosa of the examined patients and it allows, with the last introduced changes published in 2008 (Rahman et al 2008, above) a binocular vision and the recording of the visualized images by means of an extremely complex device which has to be worn by the operator.

[0017] Further relevant documents are US 20030173525 and the article "Vision enhancement system for detection of oral cavity neoplasia based on autofluorescence " of E. Svistun et al., 2004

SUMMARY OF THE INVENTION

[0018] The present invention aims to simplify, and therefore to make more accessible to the operators, the early diagnosis of the precancerous lesions of the oral cavity by means of the autofluorescence examination. The complexity of the device shown in the publication of Rahman et al 2008 does not allow a use thereof on wide scale which could be useful for the mass prevention screening.

[0019] Although compared to the device published in 2006 the one of 2008 has allowed a binocular vision and a direct wearability of the same, that frees the operator's hands, the device appears clearly complex, expensive and not suitable for immediate use. Not lastly, the space requirement of such device and the need for spaces to place back the same further complicate the device versatility. Furthermore, such device has a not irrelevant weight for the operator which allows a limited wearability thereof and which limits the motion of the operator's head.

[0020] The whole system weighs about 1.5 kilograms and consists of a small helmet device, with integrated LED surgical light, surgical binoculars and an integrated CCD photo/video camera and an integrated power supply battery.

[0021] The technical principle linked to the device available in the state of art is to provide a highly selective lighting, in terms of wavelength, of the portion to be analysed so as to excite precisely the fluorophores of diagnostic interest. The device is equipped with lowpass filters to filter the emission.

[0022] The present invention wants to provide alternative means for the early diagnosis of the precancerous and cancerous lesions of the oral mucosa by the observation of the autofluorescence, easy to use, simple light and space-saving.

[0023] The present inventors have thought to make a device allowing also the use of means usually present in a dental laboratory, that is a photopolymerization lamp, hence a lamp emitting a light usually comprised in a wavelength range from about 400 to about 500 nm, by adapting the features of the diagnostic device to means usually used in odontology, by allowing at the same time the reduction of the costs for the users, the decreasing of the space requirement to store the device, a higher wearability of the same that enables the operator to move better and allowing nevertheless a binocular vision and, optionally, the possibility to record and/or photograph the images by means of additional devices.

[0024] The additional devices will be usual apparatuses for recording images, such as digital and non digital cameras and photo or video cameras on which a filter constituted by a lens having the same features as the one mounted on the eyeglasses of the present description can be mounted.

[0025] The invention hence provides an alternative solution to the known art solving also some negative features listed above, by providing a highly selective lens which can be used with simple photopolymerizing lamps, that are usually found in dental laboratories and consulting rooms.

[0026] The system according to the present invention enables to exploit a photopolymerizing lamp as light source for the analysis of the autofluorescence tissue response as described above, as it provides a wearable device as defined in claim 1.

[0027] The present invention further relates to a kit comprising a device according to the present description and one or more writing devices using an ink comprising a fluorescent or non fluorescent dye, which can be detected through said device; a kit comprising a device according to the present description and one or more optical filter systems according to the present description optionally mounted on adapters for video/photographic recording apparatuses.

[0028] A kit comprising a device according to the present description and one or more writing devices using an ink comprising fluorescent or non fluorescent dye, which can be detected through said device and one or more optical filter systems according to the present description optionally mounted on adapters for video/photographic recording apparatuses.

BRIEF DESCRIPTION OF THE FIGURES

[0029]

Figure 1 shows a schematization of the diagnostic principle based on the autofluorescence detection described above in the state of art.

Figure 2 shows an example of the detection obtained with the device of the present description, in the 2A the examined oral mucosa is lighted by normal light, box 2B shows the decrease in autofluorescence detected with the

device of the invention on the same oral mucosa lighted by photopolymerizing lamp, the arrow points the clear decrease in autofluorescence, associated to the risk of neoplasia.

Figure 3 is a graph showing the radiation spectrum of a halogen lamp emitting light for photopolymerization (in mW/cm^2 - nm); the values in abscissa are expressed in nanometers; 450 nm is the wavelength requested to excite the oxidized FAD; 515 nm is the wavelength emitted by the excited oxidized FAD.

Figure 4 is a graph representing the transmittance curve desired for a filter according to the present invention; the values in abscissa are expressed in nanometers; 450 nm is the wavelength requested to excite the oxidized FAD; 515 nm is the wavelength emitted by the excited oxidized FAD.

Figure 5 is a schematization of a filter according to example 2.

Figure 6 is a graph representing the transmittance curve of a filter implemented according to the present invention, in a range of wavelengths comprised between 200 and 1100 nm.

GLOSSARY

[0030] **Canada balsam** (or *Canada turpentine,* or *balsam of fir*) is a turpentine obtained from the resin of the balsamic fir (*Abies balsamea*). The resin, dissolved in essential oils, is a colourless, viscous and adhesive liquid which dries up in a transparent mass. Due to its refraction index (n = 1.55) similar to that of the Crown glass, the purified and filtered Canada balsam has had a traditional use as wholly transparent adhesive (once dried up) for glasses, lenses and optical components.

[0031] **Optical glass** is the material used to produce quality objectives for its transparency and for its refractive properties. The addition of elements like barium, boron, phosphorous, lanthanum allows obtaining glasses with low or high refraction and high or low dispersion. The optical glass is produced by making the raw material to melt and then to slowly cool down.

[0032] **Photopolymerizing lamp** photopolymerisator or "curing light" consists in a light source, such as a halogen lamp or LED, used by the odontologists to make the resins, commonly used to fill up cavities or dental roots, to solidify. The light emitted by the photopolymerizing lamps is generally comprised in an emission spectrum of 380-500 nm.

[0033] The term **"Dysplastic/anaplastic lesions of the oral cavity"** means the mucosa areas of the oral cavity, characterized by the presence of the alterations of the normal cellular composition or of the normal cellular proliferation which affect the tissue structure and which can lead to a cancerous disease (in case of dysplasia) or they are themselves the anatomo-pathological sign of the presence of a tumour (in case of anaplasia).

[0034] With **"Animal biological tissue"** it is meant a complex and dynamic material of animal origin constituted by cells that, together with their basic substances (extracellular matrix), act together in a coordinated way to carry out a particular function in reply to specific stimuli, where the meaning of animal is of complex (pluricellular) organisms belonging to the animal kingdom, in particular mammals including humans.

[0035] With **"Frame for glasses"** it is meant any structure suitable to mount lenses, apt to be worn so that the lenses are positioned in front of the user's eyes.

DETAILED DESCRIPTION OF THE INVENTION

[0036] Figure 1 schematizes the autofluorescence principle underlying the present invention.

[0037] In particular, it can be noted that the healthy oral mucosa emits a light fluorescence with pale green colour (515nm) when lighted by blue - violet light (450nm).

[0038] In the dysplastic tissues the autofluorescence appears reduced substantially due to alterations of the cellular metabolism (the FAD concentration decreases in the cells with active cellular metabolism) and scattering effect due to alterations of the cellular structure and disarranging of the extracellular matrix.

[0039] If the oral mucosa has undergone biochemical and/or structural alterations (squamous hyperplasia, dysplasia, carcinoma), an area of decreased autofluorescence is noted, as highlighted in the following figures 2A and 2B.

[0040] A wearable device according to the present invention allows the detection of the autofluorescence of an animal biological tissue emitting a fluorescent component having a wavelength of about 515 nm when lighted by a light source at a wavelength comprised between 200 and 1.100 nm, provided that it comprises at least a component between 400 and 500 nm, preferably 450 nm.

[0041] Such animal biological tissue could be selected among the tissues commonly known to the person skilled in the art showing a decrease in autofluorescence at about 515 nm when lighted by a light source as described above, in presence of dysplastic/anaplastic lesions, such as for example, the pulmonary tissue, the cervix uteri and the oral cavity mucosa.

[0042] For example, the person skilled in the is aware that the fluorophore flavin adenine dinucleotide (FAD), in its oxidized form responds to a light of 450nm (blue-violet) by emitting a fluorescence having a wavelength of 515nm (green).

[0043] In the tumour tissue, the fluorescence of the oxidized FAD irradiated by blue-violet light decreases. The cause

of this phenomenon is not known with certainty: probably it has to be searched for in a combination of several phenomena. The tumours are generally associated to angiogenesis which could lead to an increase in the absorption of the exciting light (the haemoglobin strongly absorbs the light at 420nm). Even the consequent disarranging of the extracellular matrix and the epithelial thickening caused by the tumour seem to decrease the signal intensity. The cross-links bounds of the collagen matrix seem to be subjected to the same phenomenon of absorption, excitation and emission of a luminous signal.

[0044] Consequently, any tissue showing these features could be investigated with the device of the present invention.

[0045] The device according to the present invention isolates the light around 515nm (the one emitted by the oxidized FAD).

[0046] The light source which can be advantageously used can be a photopolymerizing lamp of the type commonly used by the odontologists, emitting a light having a peak generally comprised between 440 and 480 nm, the absorption curve of the composites used by the odontologists being between 360 and 520 nm with a peak at 465 nm. In particular, it is essential that the light source emits also at wavelengths near to the one at which the oxidized FAD excites (450 nm). Consequently, the light emitted by the photopolymerizing lamp is suitable to produce autofluorescence of the animal biological tissue under examination.

[0047] A not limitative list of light sources suitable to the operation with the present invention is shown in Table 1 of the EXAMPLES.

[0048] Figure 3 is a graph showing the radiation spectrum of a halogen lamp emitting light for photopolymerization (in mW/cm^2 - nm); the values in abscissa are expressed in nanometres; 450 nm is the wavelength requested to excite the oxidized FAD; 515 nm is the wavelength emitted by the excited oxidized FAD.

[0049] According to the invention, the device according to the present invention comprises a system of optical filter of bandpass type, so as to isolate the fluorescent component (515 nm) and substantially excluding other light components in the visible and in the UV.

[0050] The optical filter system according to the present invention hence guarantees a specificity for the fluorescence of the oxidized FAD excluding the blue light, the red light and the UV rays and having a transparency peak of about 515nm (corresponding to the light emitted by the oxidized FAD).

[0051] Figure 4 is a graph representing the transmittance curve wished for a filter according to the present invention; the values in abscissa are expressed in nanometres; 450 nm is the wavelength requested to excite the oxidized FAD; 515 nm is the wavelength emitted by the excited oxidized FAD.

[0052] The optical filter system according to the present invention can be carried out by coupling several superimposed nanometre-controlled lenses. In particular the system comprises three lenses in optical glass having the following features.

1) bandpass filter having a transmittance curve as a Schott BG39 showing a peak at about 500 nm and a bandwidth comprised between about 300 and 700 nm;
2) highpass filter having a transmittance curve as a Schott GG495 showing a plateau beyond about 540 nm;
3) bandpass filter having a transmittance curve as a Schott BG23 showing a peak at about 465 nm and a bandwidth comprised between about 300 and 600 nm.

[0053] Preferably, the filters are worked in a plane-parallel way, optically polished on the two surfaces and glued to each other with a suitable gluing agent, for example the synthetic Canada balsam or any other gluing agent having similar technical features, known to the person skilled in the art.

[0054] Of course, it is to be meant that the order according to which the lenses are superimposed and coupled will not modify the final result.

[0055] Table 2 reported in the chapter EXAMPLES shows the technical features of an optical filter system according to a preferred embodiment of the present invention.

[0056] The optical filter system, in particular the lenses by which it is constituted, can be advantageously modelled and housed inside any frame for glasses or visor.

[0057] The glasses' frame can comprise any wearing system (pince-nez, laces, small rods, etc.) preferably adjustable for a good adhesion to the operator's face.

[0058] The frame can further comprise shielding members, for example side small tabs or around the lenses in order to allow the insulation with respect to the environmental light.

[0059] Advantageously, the device according to the present invention could be made even in the form of additional lenses (clip-on type) apt to be applied for example to a pair of glasses for sight correction.

[0060] The device may further comprise video recording means, arranged so as to capture images filtered by the optical filter system.

[0061] For example such recording means could comprise a micro camera to record the same images which the operator sees through the filter lenses.

[0062] According to the present invention, it is also possible to provide a diagnostic kit comprising a device as herein

described and a writing device using an ink comprising a fluorescent or a non fluorescent dye, which can be detected through said device.

[0063] The writing device will preferably be a dermatological pen which may be provided in sterile packagings, advantageously of disposable type. Obviously the ink and the selected dye will be of the type suitable to surgery in general. The pen could be sterilized for example by gamma rays. Obviously, the ink will be not toxic and resistant to the pre-surgical treatment, of the type known to the person skilled in the art and it will include, besides a conventional dye, visible to the naked eye, a fluorescent dye which emits fluorescence at a wavelength comprised between about 500 nm and about 550 nm.

[0064] This will allow the operator to define the areas of interest during the visualization with the device of the invention and to be able to visualize the delimitation carried out even under environmental lighting conditions, with naked eye.

[0065] In a preferred embodiment, such dye will emit the desired fluorescence when lighted by light containing components between about 400 and about 500 nm. The person skilled in the art will easily be able to select the suitable dye by evaluating the dyes known in literature.

[0066] A not limiting example of known commercial dyes which emit at the wished wavelength when excited by a light containing components between about 400nm and about 500nm is reported in table 3 below.

Table 3

→ DiO	487 nm	501 nm
→ LysoSensor Green pH 5.0	447 nm	502 nm
→ Cy 2	489 nm	503 nm
→ LysoSensor Green	447 nm	504 nm
→ Fura-2, high Ca	336 nm	504 nm
→ Fura-2 Ca2+	336 nm	505 nm
→ SYTO 13-DNA	488 nm	506 nm
→ YO-PRO-1-DNA	491 nm	507 nm
→ YOYO-1-DNA	491 nm	509 nm
→ eGFP (Enhanced Green Fluorescent Protein)	488 nm	509 nm
→ LysoTracker Green	503 nm	509 nm
→ GFP (S65T)	489 nm	509 nm
→ BODIPY FL, MeOH	502 nm	511 nm
→ Sapphire	396 nm	511 nm
→ BODIPY FL conjugate	503 nm	512 nm
→ MitoTracker Green	490 nm	512 nm
→ MitoTracker Green FM, MeOH	490 nm	512 nm
→ Fluorescein 0.1 M NaOH	493 nm	513 nm
→ Calcein pH 9.0	494 nm	514 nm
→ Fluorescein pH 9.0	490 nm	514 nm
→ Calcein	493 nm	514 nm
→ Fura-2, no Ca	367 nm	515 nm
→ Fluo-4	494 nm 516 nm	
→ FDA	495 nm	517 nm
→ DTAF	495 nm	517 nm
→ Fluorescein	495 nm	517 nm
→ Fluorescein antibody conjugate pH 8.0	493 nm	517 nm
→ CFDA	495 nm	517 nm

(continued)

→ FITC	495 nm	517 nm
→ Alexa Fluor 488 hydrazide-water	493 nm	518 nm
→ DyLight 488	493 nm	518 nm
→ 5-FAM pH 9.0	492 nm	518 nm
→ FITC antibody conjugate pH 8.0	495 nm	519 nm
→ Alexa 488	493 nm	520 nm
→ Rhodamine 110	497 nm	520 nm
→ Rhodamine 110 pH 7.0	497 nm	520 nm
→ Alexa Fluor 488 antibody conjugate pH 8.0	499 nm	520 nm
→ BCECF pH 5.5	485 nm	521 nm
→ PicoGreen dsDNA quantitation reagent	502 nm	522 nm
→ SYBR Green I	498 nm	522 nm
→ Rhodaminen Green pH 7.0	497 nm	523 nm
→ CyQUANT GR-DNA	502 nm	523 nm
→ NeuroTrace 500/525, green fluorescent Nissl stain-RNA	497 nm	524 nm
→ Dansyl Cadaverine	335 nm	524 nm
→ Rhodol Green antibody conjugate pH 8.0	499 nm	524 nm
→ Fluoro-Emerald	495 nm	1524 nm
→ Nissl	497 nm	524 nm
→ Fluorescein dextran pH 8.0	501 nm	524 nm
→ Rhodamine Green	497 nm	524 nm
→ 5-(and-6)-Carboxy-2', 7'-dichlorofluorescein pH 9.0	504 nm	525 nm
→ Dansyl Cadaverine, MeOH	335 nm	526 nm
→ eYFP (Enhanced Yellow Fluorescent Protein)	514 nm	526 nm
→ Oregon Green 488	498 nm	526 nm
→ Oregon Green 488 antibody conjugate pH 8.0	498 nm	526 nm
→ Fluo-3	506 nm	527 nm
→ BCECF pH 9.0	501 nm	527 nm
→ SBFI-Na+	336 nm	527 nm
→ Fluo-3 Ca2+	506 nm	527 nm
→ Rhodamine 123, MeOH	507 nm	529 nm
→ FIAsH	509 nm	529 nm
→ Calcium Green-1 Ca2+	506 nm	529 nm
→ Magnesium Green	507 nm	530 nm
→ DM-NERF pH 4.0	493 nm	530 nm
→ Calcium Green	506 nm	530 nm
→ Citrine	515 nm	530 nm
→ LysoSensor Yellow pH 9.0	335 nm	530 nm
→ TO-PRO-1-DNA	515 nm	531 nm

(continued)

→ Magnesium Green Mg2+	507 nm	531 nm
→ Sodium Green Na+	507 nm	531 nm
→ TOTO-1-DNA	514 nm	531 nm
→ Oregon Green 514	512 nm	532 nm
→ Oregon Green 514 antibody conjugate pH 8.0	513 nm	533 nm
→ NBD-X	466 nm	534 nm

[0067] The advantage conferred by the writing device of the herein described kit is given by the fact of allowing the operator to circumscribe the areas with reduced autofluorescence and therefore potentially dysplastic/neoplastic areas, in order to allow the removal of the same, by keeping on the detection device and thus by visualizing in a precise way the above-mentioned areas.

[0068] The used normal pre-surgical writing devices are generally constituted by dyes, the visualization of which is not quite easy, if not impossible, with the invention device. The dermatological pen herein described, hence, adds a practical advantage for the operator in the diagnosis for autofluorescence described above.

[0069] Alternatively, or in addition, the kit of the present invention, could contain, apart from the device, an optical filter system of the invention, which the operator could model according to the needs thereof to adapt, for example, to the wished image recording systems. The operator, then, may model the herein described optical filter system for its own image recording devices (photographic apparatuses or video cameras, for example).

[0070] Alternatively, the kit may comprise one or more optical filter systems already mounted on a support adaptable to image recording systems.

[0071] The kit as described above could comprise even one or more light sources at a wavelength comprised between 200 and 1.100 nm, in a particular embodiment, said light source could be a photopolymerizing lamp.

EXAMPLES

Example 1

[0072] Assay for the determination of light sources compatible with the wearable device of the invention.

[0073] Oral mucosae of patients have been analysed by using the wearable device of the invention by lighting the mouth area to be examined with different light sources. In particular different photopolymerizing lamps available on the market, commonly utilized in dental surgery, have been used.

[0074] In table 1, reported below, it is highlighted how almost all lamps known to the inventors have revealed to be suitable to the desired use.

Table 1

LAMP	PRODUCER	COMPATIBILITY
Allegro	Den-Mat	OK
Bluelight s	Mectron	OK
Bluephase	Ivodar-Vivadent srl	OK
B-Max	Tecno-Gaz industries	OK
Coltolux 3	3M	OK
Cybird	DXM	OK
Degulux soft star	Dentsply Degusta	OK
Deltalight	Elettronica Trasimeno	X
Demetron A.1	KerrHawe	OK

(continued)

LAMP	PRODUCER	COMPATIBILITY
Demetron A.2	KerrHawe	OK
Demetron LC	KerrHawe	OK
Demi	KerrHawe	OK
Eliolux DLX	3M	OK
Elipar 2500	3M	OK
Led demetron 1	KerrHawe	OK
Mini led	SATELEC Acteongroup	OK
Optilux 501	KerrHawe	OK
PenCure	Morita	OK
Poliled	Faro spa	OK
Poliled compact	Faro spa	OK
Radii	Southern Dental Industries Ltd.	OK
Smartlite IQ	Dentsply Caulk	OK
Smartlite PS	Dentsply DeTrey	OK
Spectrum	3M	OK
Spectrum 800	Dentsply Caulk	OK
Starlight p	Mectron	OK
Starlight pro	Mectron	OK
Starlight s	Mectron	OK
Swiss Master Light	EMS SA	X
T LED	ELCA Technologies	OK
Translux power blue	Heraeus Kulzer	OK
U.V.LUX F.A.6 D	Nuova Alba srl	X
Ultra +	Orion	OK
VIP	Carbon Denit spa	OK
XL3000	3M	OK
OK: Compatible; X: Not compatible.		

Example 2

[0075] Measurement Of The Transmittance Curve And Verification Of the

Technical Features Of The Optical Filter System Made According To The Description

[0076] Systems of optical filters according to the above description have been made, comprising three nanometre-controlled lens in optical glass superimposed one to another and joined by gluing with synthetic Canada balsam, the used optical glasses were commercial filters, in particular, the filters in optical glass Schott BG39, GG495 and BG23.

[0077] Figure 5 schematizes the realisation of the optical filter system according to the example.

[0078] The detection of the data reported below has been performed with a Shimadzu instrument model UV1601.

[0079] The transmittance curve of a filter realised according to the present invention, in a range of wavelength comprised between 200 and 1100 nm is shown in figure 6.

[0080] Table 2, below, reports the raw data sampled between 200 and 1100 nm at ranges of 5 nm.

Table 2

Wavelength nm.	Raw Data ...	Wavelength nm.	Raw Data ...	Wavelength nm.	Raw Data ...
200.00	0.000	370.00	0.000	540.00	52.588
205.00	0.000	375.00	0.000	545.00	47.888
210.00	0.000	380.00	0.000	550.00	42.834
215.00	0.000	385.00	0.000	555.00	37.549
220.00	0.000	390.00	0.000	560.00	32.227
225.00	0.000	395.00	0.000	565.00	27.063
230.00	0.000	400.00	0.000	570.00	22.266
235.00	0.000	405.00	0.000	575.00	17.834
240.00	0.000	410.00	0.000	580.00	13.892
245.00	0.000	415.00	0.000	585.00	10.461
250.00	0.000	420.00	0.000	590.00	7.617
255.00	0.000	425.00	0.000	595.00	5.347
260.00	0.000	430.00	0.012	600.00	3.650
265.00	0.000	435.00	0.000	605.00	2.417
270.00	0.000	440.00	0.000	610.00	1.526
275.00	0.000	445.00	0.000	615.00	0.928
280.00	0.000	450.00	0.000	620.00	0.537
285.00	0.000	455.00	0.012	625.00	0.305
290.00	0.000	460.00	0.037	630.00	0.159
295.00	0.000	465.00	0.085	635.00	0.073
300.00	0.000	470.00	0.171	640.00	0.037
305.00	0.000	475.00	0.403	645.00	0.012
310.00	0.000	480.00	1.465	650.00	0.000
315.00	0.000	485.00	6.104	655.00	0.000
320.00	0.000	490.00	18.567	660.00	0.000
325.00	0.012	495.00	36.243	665.00	0.000
330.00	0.000	500.00	51.794	670.00	0.000
335.00	0.000	505.00	60.791	675.00	0.000
340.00	0.012	510.00	65.112	680.00	0.000
345.00	0.000	515.00	66.333	685.00	0.000
350.00	0.000	520.00	65.637	690.00	0.000
355.00	0.000	525.00	63.623	695.00	0.000
360.00	0.000	530.00	60.718	700.00	0.000
365.00	0.000	535.00	56.970	705.00	0.000

Wavelength nm.	Raw Data ...
710.00	0.000
715.00	0.000
720.00	0.000
725.00	0.000
730.00	0.000
735.00	0.000
740.00	0.000
745.00	0.000
750.00	0.000
755.00	0.000
760.00	0.000
765.00	0.000
770.00	0.000
775.00	0.000
780.00	0.000
785.00	0.000
790.00	0.000
795.00	0.000
800.00	0.000
805.00	0.000
810.00	0.000
815.00	0.000
820.00	0.000
825.00	0.000
830.00	0.000
835.00	0.000
840.00	0.000
845.00	0.000
850.00	0.000
855.00	0.000
860.00	0.000
865.00	0.000
870.00	0.000
875.00	0.000

Wavelength nm.	Raw Data ...
880.00	0.000
885.00	0.000
890.00	0.000
895.00	0.000
900.00	0.000
905.00	0.000
910.00	0.000
915.00	0.000
920.00	0.000
925.00	0.000
930.00	0.000
935.00	0.000
940.00	0.000
945.00	0.000
950.00	0.000
955.00	0.000
960.00	0.000
965.00	0.000
970.00	0.000
975.00	0.000
980.00	0.000
985.00	0.000
990.00	0.000
995.00	0.000
1,000.00	0.000
1,005.00	0.000
1,010.00	0.000
1,015.00	0.000
1,020.00	0.000
1,025.00	0.000
1,030.00	0.000
1,035.00	0.000
1,040.00	0.000
1,045.00	0.000

Wavelength nm.	Raw Data ...
1,050.00	0.000
1,055.00	0.000
1,060.00	0.000
1,065.00	0.000
1,070.00	0.000
1,075.00	0.000
1,080.00	0.000
1,085.00	0.000
1,090.00	0.000
1,095.00	0.000
1,100.00	0.000

[0081] As it is evident from the table, the optical filter system made is highly selective for wavelengths around 515nm.

Example 3

Realisation of the Kit of the invention

[0082] In order to verify the suitability of the optical filter system of the invention to the image recording, such system

has been mounted on a support for Nikon filter and photographic shots have been performed (ex. Figure 2B) with a photographic apparatus Nikon D70 equipped with lens Nikkor AF Micro 60mm. As it is clear from the photograph in 2B (numerous photographic data are not reported herein), the optical filter system according to the present description is suitable to the use on apparatuses for the image recording and it allows the operator to record and store the observed data.

Claims

1. Wearable device for the detection of auto fluorescence of an animal biological tissue emitting a fluorescent component at a wavelength of about 515 nm when lighted by a light source at a wavelength comprised between 200-1100 nm, comprising at least a component at about 450 nm, said device comprising an optical filter system of the bandpass kind, such that it isolates the light around said fluorescent component and it excludes components in the visible and in the UV said optical filter system being positioned in a frame for glasses or in a visor and comprising three superimposed nanometer-controlled lenses in optical glass having the following features:

   - bandpass filter having a transmittance curve as a Schott® BG39, showing a peak at about 500 nm and a bandwidth comprised between about 300 and 700 nm;
   - highpass filter having a transmittance curve as a Schott® GG495, showing a plateau beyond about 540 nm and substantially no transmittance below about 480 nm;
   - bandpass filter having a transmittance curve as a Schott® BG23, showing a peak at about 465 nm and a bandwidth comprised between about 300 and 600 nm.

2. Wearable device according to claim 1 wherein said nanometer-controlled lenses are joined by gluing.

3. Device according to claim 1 or 2, comprising screening elements with respect to the ambient light.

4. Device according to any one of claims 1 to 3, **characterised in that** it is suitable for applicability on glasses for sight correction.

5. Device according to any one of the preceding claims, further comprising means for video taping, positioned so to capture filtered images.

6. Diagnostic kit comprising a device according to any one of claims from 1 to 5 and one or more writing device using an ink comprising a fluorescent or a non fluorescent dye detectable through said device.

7. Diagnostic kit comprising a device according to claim 6 further comprising a light source at a wavelength of 200 and 1.100 nm, comprising at least a component at about 450 nm.

8. Diagnostic kit according to claim 7, wherein said light source is a photopolymerising lamp.

Patentansprüche

1. Tragbare Vorrichtung zur Detektion von Eigenfluoreszenz eines tierischen biologischen Gewebes, das eine fluoreszierende Komponente bei einer Wellenlänge von ungefähr 515 nm emittiert, wenn es durch eine Lichtquelle bei einer Wellenlänge von zwischen 200 - 1100 nm beleuchtet wird, die mindestens eine Komponente bei ungefähr 450 nm umfasst, wobei die Vorrichtung ein optisches Filtersystem von der Bandpass-Sorte umfasst, so dass es das Licht um die fluoreszierende Komponente isoliert und Komponenten im sichtbaren Bereich und im UV-Bereich ausschließt, wobei das optische Filtersystem in einem Rahmen für Gläser oder in einer Blende angeordnet ist und drei überlagerte im Nanometerbereich gesteuerte Linsen aus optischem Glas umfasst, die über die folgenden Features verfügen:

   - Bandpassfilter, das über eine Transmissionskurve wie ein Schott® BG39 verfügt, das eine Spitze bei ungefähr 500 nm und eine Bandbreite von zwischen ungefähr 300 und 700 nm zeigt;
   - Hochpassfilter, das über eine Transmissionskurve wie ein Schott® GG495 verfügt, das ein Plateau jenseits von 540 nm und im Wesentlichen keine Transmission unterhalb von ungefähr 480 nm zeigt;
   - Bandpassfilter, das über eine Transmissionskurve wie ein Schott® BG23 verfügt, das eine Spitze bei ungefähr 465 nm und eine Bandbreite von zwischen ungefähr 300 und 600 nm zeigt.

2. Tragbare Vorrichtung gemäß Anspruch 1, wobei die im Nanometerbereich gesteuerten Linsen durch Leimen miteinander verbunden sind.

3. Vorrichtung gemäß Anspruch 1 oder 2, die Screening-Elemente bezüglich des Umgebungslichts umfasst.

4. Vorrichtung gemäß einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** sie zur Anwendung auf Gläser zur Sichtkorrektur geeignet ist.

5. Vorrichtung gemäß einem der vorangehenden Ansprüche, die weiterhin ein Mittel für Videoaufnahmen umfasst, das so angeordnet ist, dass es gefilterte Bilder erfasst.

6. Diagnose-Kit, das umfasst: eine Vorrichtung gemäß einem der Ansprüche 1 bis 5 und eine oder mehrere Schreibvorrichtungen, die eine Tinte verwenden, die einen fluoreszierenden oder einen nicht fluoreszierenden Farbstoff, die durch die Vorrichtung detektiert werden können, umfasst.

7. Diagnose-Kit, das eine Vorrichtung gemäß Anspruch 6 umfasst, die weiterhin eine Lichtquelle bei einer Wellenlänge von 200 und 1100 nm, die mindestens eine Komponente bei ungefähr 450 nm umfasst, umfasst.

8. Diagnose-Kit gemäß Anspruch 7, wobei die Lichtquelle eine Photopolymerisationslampe ist.

Revendications

1. Dispositif portable pour la détection de l'auto fluorescence d'un tissu biologique animal émettant une composante fluorescente à une longueur d'onde d'environ 515 nm lorsqu'il est éclairé par une source de lumière à une longueur d'onde comprise entre 200 et 1 100 nm, comprenant au moins une composante à environ 450 nm, ledit dispositif comprenant un système de filtre optique du type passe-bande, de sorte qu'il isole la lumière autour de ladite composante fluorescente et qu'il exclut les composantes dans le visible et dans les UV, ledit système de filtre optique étant positionné dans une monture pour des lunettes ou dans un viseur et comprenant trois lentilles commandées dans les nanomètres superposées en verre optique présentant les caractéristiques suivantes :

   - un filtre passe-bande ayant une courbe de transmittance tel qu'un BG39 de Schott®, présentant un pic à environ 500 nm et une bande passante comprise entre environ 300 et 700 nm ;
   - un filtre passe-haut ayant une courbe de transmittance tel qu'un GG495 de Schott®, présentant un plateau au-delà d'environ 540 nm et sensiblement aucune transmittance au-dessous d'environ 480 nm ;
   - un filtre passe-bande ayant une courbe de transmittance tel qu'un BG23 de Schott®, présentant un pic à environ 465 nm et une bande passante comprise entre environ 300 et 600 nm.

2. Dispositif portable selon la revendication 1, dans lequel lesdites lentilles commandées dans les nanomètres sont jointes par collage.

3. Dispositif selon la revendication 1 ou 2, comprenant des éléments de filtrage par rapport à la lumière ambiante.

4. Dispositif selon l'une quelconque des revendications 1 à 3, **caractérisé en ce qu'**il est approprié pour une applicabilité à des lunettes pour une correction de la vision.

5. Dispositif selon l'une quelconque des revendications précédentes, comprenant en outre des moyens d'enregistrement vidéo, positionnés de manière à capturer des images filtrées.

6. Kit de diagnostic comprenant un dispositif selon l'une quelconque des revendications 1 à 5 et un ou plusieurs dispositif d'écriture utilisant une encre comprenant un colorant fluorescent ou un colorant non fluorescent détectable par l'intermédiaire dudit dispositif.

7. Kit de diagnostic comprenant un dispositif selon la revendication 6, comprenant en outre une source de lumière à une longueur d'onde de 200 et 1 100 nm, ayant au moins une composante à environ 450 nm.

8. Kit de diagnostic selon la revendication 7, dans lequel ladite source de lumière est une lampe de photopolymérisation.

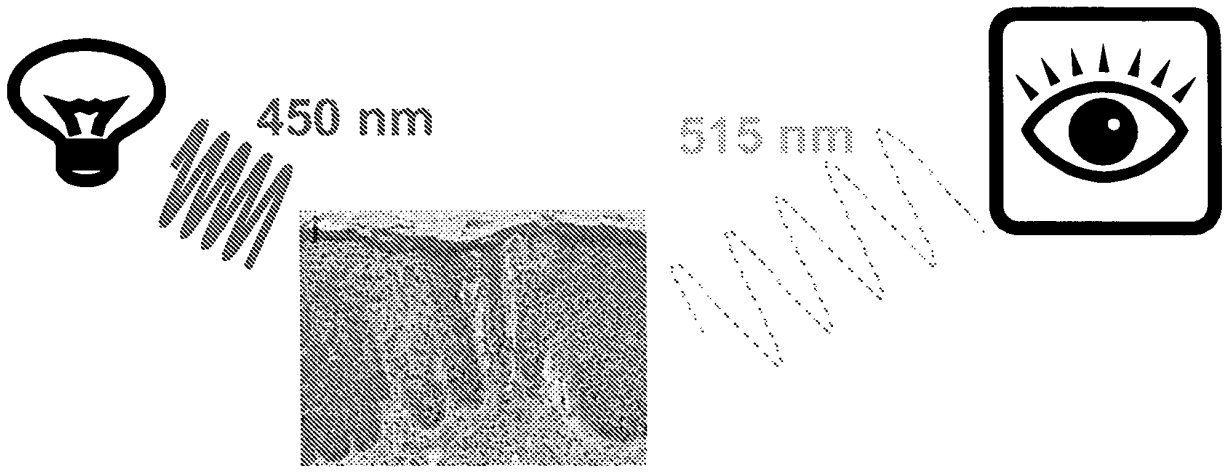

Fig. 1

Fig. 2A

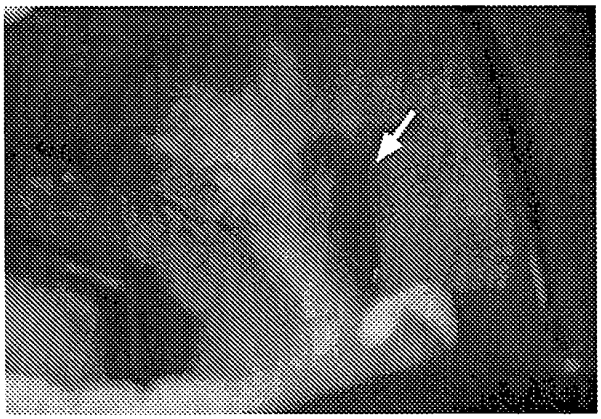

Fig. 2B

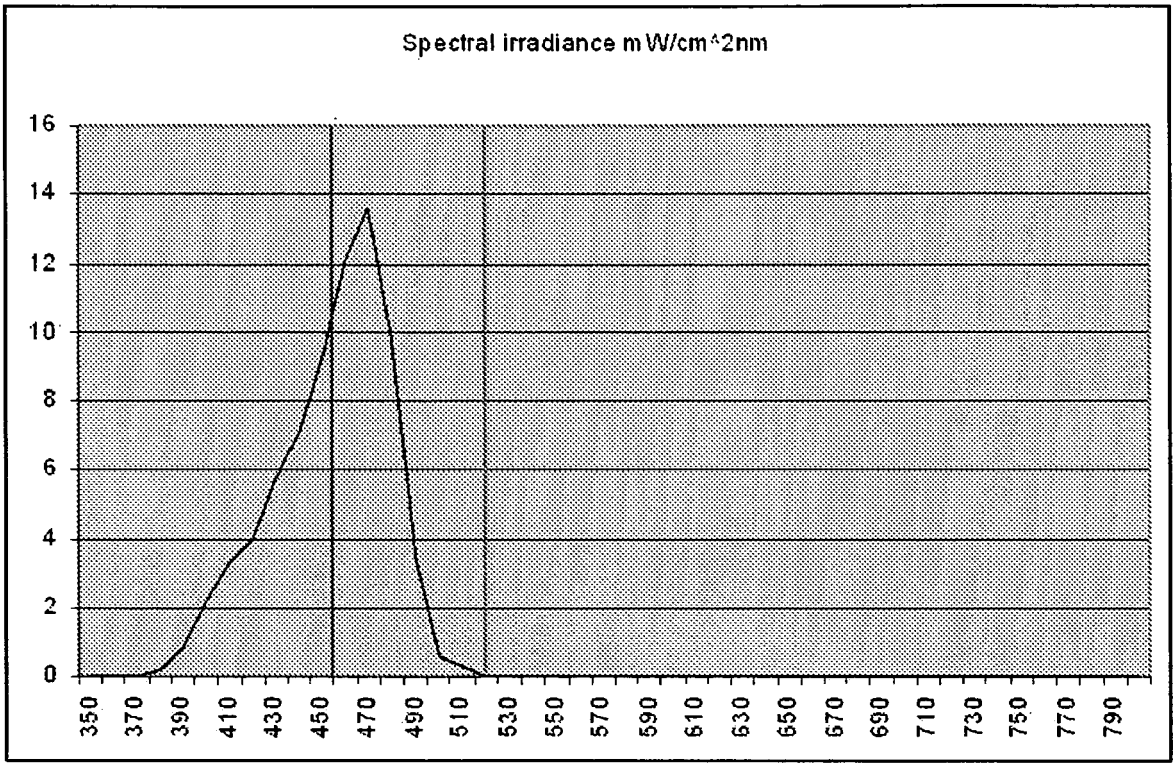
Spectral irradiance mW/cm^2nm
16
14
12
10
8
6
4
2
0
350
370
390
410
430
450
470
490
510
530
550
570
590
610
630
650
670
690
710
730
750
770
790

Fig. 3

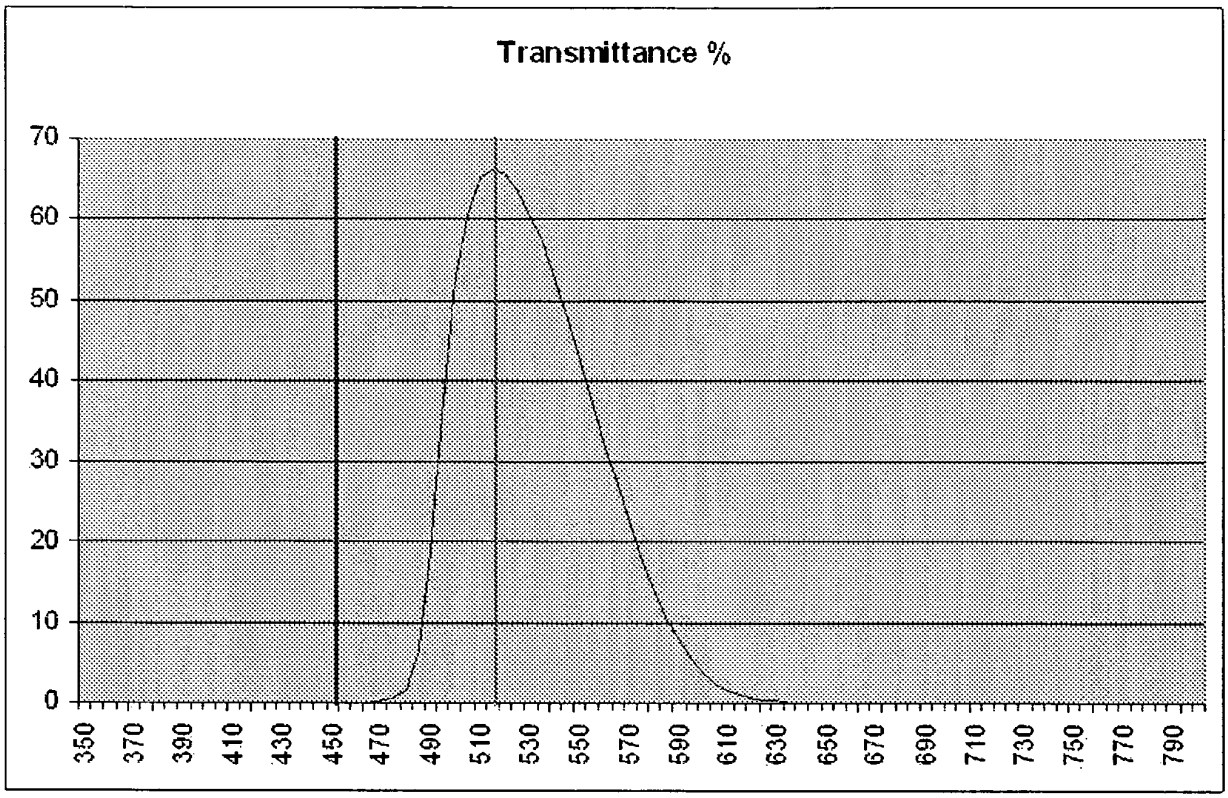
Transmittance %
70
60
50
40
30
20
10
0
350
370
390
410
430
450
470
490
510
530
550
570
590
610
630
650
670
690
710
730
750
770
790

Fig. 4

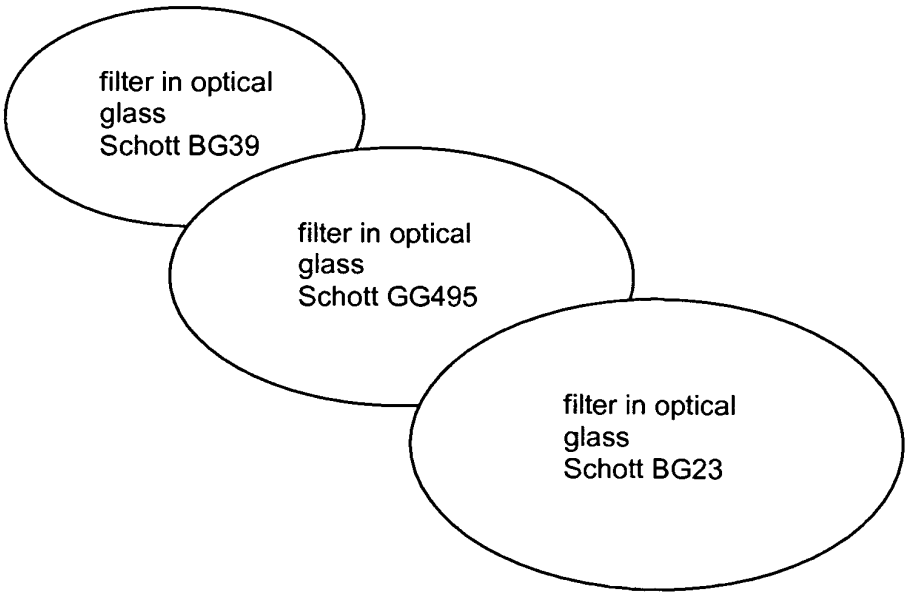
filter in optical glass Schott BG39
filter in optical glass Schott GG495
filter in optical glass Schott BG23

Fig. 5

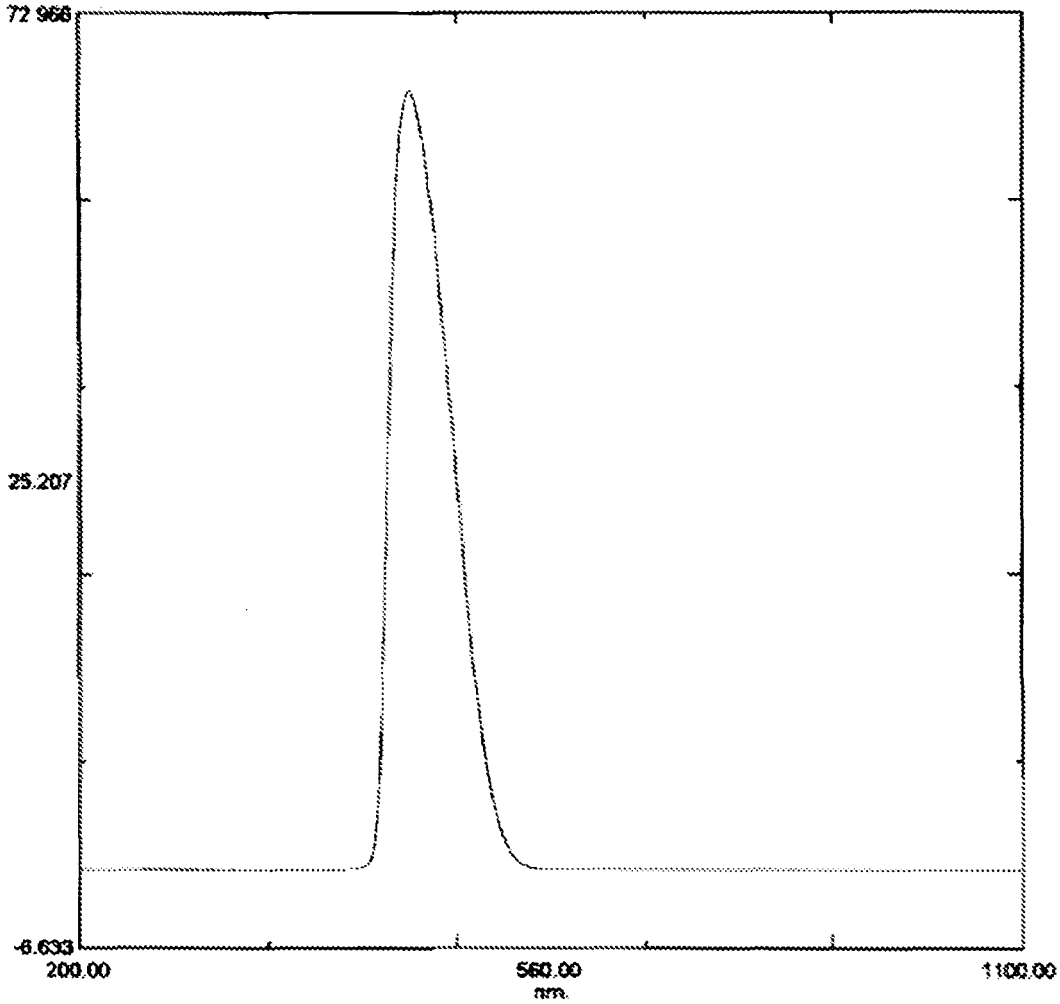

Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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Non-patent literature cited in the description

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- **E. SVISTUN et al.** *Vision enhancement system for detection of oral cavity neoplasia based on autofluorescence,* 2004 **[0017]**

专利名称(译)	可穿戴视觉设备		
公开(公告)号	EP2537009B1	公开(公告)日	2016-04-20
申请号	EP2011710326	申请日	2011-02-16
申请(专利权)人(译)	大学天主教圣心		
当前申请(专利权)人(译)	PIERREL PHARMA S.R.L.		
[标]发明人	DI NARDO FRANCESCO MORO ALESSANDRO PELO SANDRO		
发明人	DI NARDO, FRANCESCO MORO, ALESSANDRO PELO, SANDRO		
IPC分类号	G01J3/02 G01J3/10 G01J3/44 A61B5/00 G02B5/22 G01N21/64 G01J3/12		
CPC分类号	A61B5/0088 G01J3/02 G01J3/0208 G01J3/10 G01J3/4406 G01J2003/1213 G01N21/6447 G01N21/6486		
代理机构(译)	ROMANO，GIUSEPPE		
优先权	RM2010000061 2010-02-16 IT		
其他公开文献	EP2537009A1		
外部链接	Espacenet		

摘要(译)

本发明的目的是提供用于通过荧光，易于使用，简单，轻便和节省空间的诊断试剂盒来诊断患上口腔粘膜癌的风险的替代方法，以及包括上述装置的诊断试剂盒。

Table 2

Wavelength nm.	Raw Data ...	Wavelength nm.	Raw Data ...	Wavelength nm.	Raw Data ...
200.00	0.000	370.00	0.000	540.00	52.588
205.00	0.000	375.00	0.000	545.00	47.888
210.00	0.000	380.00	0.000	550.00	42.834
215.00	0.000	385.00	0.000	555.00	37.549
220.00	0.000	390.00	0.000	560.00	32.227
225.00	0.000	395.00	0.000	565.00	27.063
230.00	0.000	400.00	0.000	570.00	22.266
235.00	0.000	405.00	0.000	575.00	17.834
240.00	0.000	410.00	0.000	580.00	13.892
245.00	0.000	415.00	0.000	585.00	10.461
250.00	0.000	420.00	0.000	590.00	7.617
255.00	0.000	425.00	0.000	595.00	5.347
260.00	0.000	430.00	0.012	600.00	3.650
265.00	0.000	435.00	0.000	605.00	2.417
270.00	0.000	440.00	0.000	610.00	1.526
275.00	0.000	445.00	0.000	615.00	0.928
280.00	0.000	450.00	0.000	620.00	0.537
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295.00	0.000	465.00	0.085	635.00	0.073
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315.00	0.000	485.00	6.104	655.00	0.000
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350.00	0.000	520.00	65.637	690.00	0.000
355.00	0.000	525.00	63.623	695.00	0.000
360.00	0.000	530.00	60.718	700.00	0.000
365.00	0.000	535.00	56.970	705.00	0.000