

COMMONWEALTH OF AUSTRALIA
THE PATENTS ACT 1952

DECLARATION IN SUPPORT OF AN
APPLICATION FOR A PATENT

In support of the Application made for a patent

Insert
Title of Invention

for an invention entitled:
"ANTI-REFLECTION FILM FOR AN OPTICAL ELEMENT
CONSISTING OF AN ORGANIC MATERIAL"

Insert
Full Name(s) and
Address(es)

~~We~~ Bernd Neuschäfer and Dr. Hermann Walter
of OPTISCHE WERKE G. RODENSTOCK K.G.
Isartalstr. 43, 8000 Munich 5, Federal
Republic of Germany

do solemnly and sincerely declare as follows:—

Insert Full Name(s)
of applicant(s)

~~xxxxxx/We are authorised by~~

(or, in the case of an application by a body corporate)

1. ~~xxxx~~ We are authorised by OPTISCHE WERKE G. RODENSTOCK K.G.

the applicant(s) for the patent to make this declaration on its/~~their~~ behalf.

~~xxxxxx/We are authorised by~~
application(s)

(or, where a person other than the inventor is the applicant)

2. Melzig Manfred of Sommerstr. 20, 8031 Wessling,
Federal Republic of Germany and Effer Erhard
of Bgm.-Grenzebach-Str. 39, 8134 Pocking of
Federal Republic of Germany

~~is~~ are the actual inventor(s) of the invention and the facts upon which the
applicant(s) is/~~are~~ entitled to make the application are as follows:—

The applicant company is the assignee of the
said invention from the said inventors.

*Note: Paragraphs
3 and 4 need only be
completed for a
Convention Application

3. The basic application(s) as defined by Section 141 of the Act was/~~were~~ made

in ..Federal Republic of Germany..... on 19 July 1985
by ..Optische Werke Rodenstock K.G.....
in on
by

3

The basic application(s) referred to in paragraph 2 of this Declaration was/~~were~~
the first application(s) made in a Convention country in respect of the invention(s)
the subject of the application.

Declared at Munich
Fed. Republic of Germany

29th day of January 19 87

OPTISCHE WERKE G. RODENSTOCK

To: The Commissioner of Patents

Signature of Declarant(s)

~~XX~~
(Bernd Neuschäfer) (Dr. Hermann Walter)
G. R. CULLEN & COMPANY

(12) PATENT ABRIDGMENT (11) Document No. AU-B-61909/86
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 600445

(54) Title
REFLECTION-REDUCING COATING FOR AN OPTICAL ELEMENT MADE OF ORGANIC MATERIAL

International Patent Classification(s)
(51)⁴ G02B 001/10 G02C 007/10

(21) Application No. : 61909/86 (22) Application Date : 21.07.86

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3525892 19.07.85 DE FEDERAL REPUBLIC OF GERMANY

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(56) Prior Art Documents
US 4313647
US 4196246
US 3914023

(57) Claim

1. An anti-reflection film of several layers for an optical element consisting of an organic material with photochromic properties wherein the mean reflection of the film over the range between 330 nm and 380 nm is less than 4% and the mean reflection over the range between 290 nm and 330 nm is greater than 15%, said film characterised by the fact that it has at least five layers which consist alternately of silicon dioxide and a high index material with a refractive index of $n_e \geq 2.0$, and of which the first layer applied directly to the optical element consists of silicon dioxide and has a thickness of about $\lambda/2$,
that the thicknesses of the second, third and fourth layers behave as

(11) AU-B-61909/86
(10) 600445

-2-

$$1 : 2Y : 20Z/3$$

where

$$Y = X \pm 1.5(n_e - 1.8); z = x \pm 0.2;$$

$$X = 1.05 + (n_e - 2) 1/(4 - n_e)$$

and that sum of the thickness of the second to fourth layer is also about $\lambda/2$ with the fifth layer being a $\lambda/4$ layer ($\lambda=350$ nm).

PCT

AU-AI 61909/86

WELTORGANISATION FÜR GEISTIGES EIGENTUM
Internationales BüroINTERNATIONALE ANMELDUNG VERÖFFENTLICHT NACH DEM VERTRAG ÜBER DIE
INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT)

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G02C 7/10, G02B 1/10

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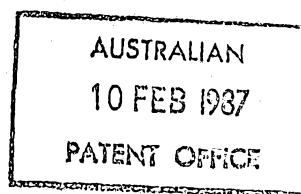
(74) Anwalt: MÜNICH, Wilhelm; Münich, Neidl-Stippler, Schiller, Willibaldstr. 36, D-8000 München 21 (DE).

(81) Bestimmungsstaaten: AT (europäisches Patent), AU, BE (europäisches Patent), CH (europäisches Patent), DE (europäisches Patent), FR (europäisches Patent), GB (europäisches Patent), IT (europäisches Patent), JP, LU (europäisches Patent), NL (europäisches Patent), SE (europäisches Patent), US.

Veröffentlicht

*Mit internationalem Recherchenbericht.
Vor Ablauf der für Änderungen der Ansprüche zugelassenen Frist. Veröffentlichung wird wiederholt falls Änderungen eintreffen.*

A. O. J. P. 12 MAR 1987



(54) Title: REFLECTION-REDUCING COATING FOR AN OPTICAL ELEMENT MADE OF ORGANIC MATERIAL

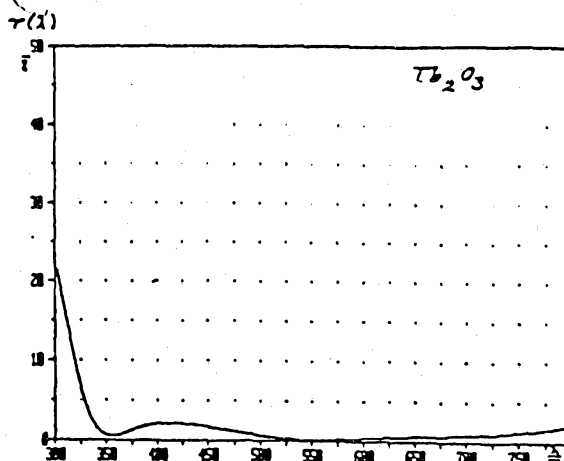
(54) Bezeichnung: REFLEXIONSVERMINDERNDER BELAG FÜR EIN OPTISCHES ELEMENT AUS ORGANISCHEM MATERIAL

(57) Abstract

A multi-layered reflection-reducing coating for an optical element made of organic material with phototropic properties. The coating is characterized by the fact that the reflection of the coating transmitted in the spectral range between 330 nm and 380 nm is less than 4% and the reflection in the spectral range between 290 nm and 330 nm is greater than 15%. This reflection behaviour ensures that the excitation of the phototropic effect with unduly short-wave light does not reduce the duration of the phototropic effect. In addition, by appropriately selecting the reflection properties, it is possible to achieve a desired excitation of phototropic molecules incorporated in specific steric places, and thus an influence on the kinetics and colour of the phototropic effect.

(57) Zusammenfassung

Ein reflexionsvermindernder Belag aus mehreren Schichten für ein optisches Element aus organischem Material mit phototropen Eigenschaften. Der erfindungsgemässe Belag zeichnet sich dadurch aus, dass die über den Spektralbereich zwischen 330 nm und 380 nm gemittelte Reflexion des Belags kleiner als 4% und die über den Bereich zwischen 290 nm und 330 nm gemittelte Reflexion grösser als 15% ist. Durch dieses Reflexionsverhalten wird verhindert, dass die Anregung des phototropen Effekts mit zu kurzwilligem Licht die Lebensdauer des phototropen Effekts herabsetzt. Darüberhinaus lässt sich durch geeignete Wahl der Reflexionseigenschaften eine gezielte Anregung von in bestimmten sterischen Lagen eingebauten phototropen Molekülen und damit eine Beeinflussung der Kinetik und der Farbe des phototropen Effekts erreichen.



A B S T R A C T

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An anti-reflection film of several layers is described for an optical element consisting of an organic material with photochromic properties.

The film according to the invention is characterised by the fact that the mean reflection of the film over the spectral range between 330 nm and 380 nm is less than 4% and the mean reflection over the range between 290 nm and 330 nm is greater than 15%. This reflection behaviour serves to prevent the stimulation of the photochromic effect by light with too short a wavelength from reducing the useful life of the photochromic effect. In addition, a suitable choice of the reflection properties means that a deliberate stimulation of photochromic molecules situated in certain steric positions and so influence on the kinetics and colour of the photochromic effect can be obtained.



Anti-reflection Film for An Optical Element
Consisting of an Organic Material

D e s c r i p t i o n

Technical Background

The invention relates to an anti-reflection film for an optical element consisting of an organic material with photochromic properties, and in particular to a spectacle lens of this type.

State of the Art

In the past a number of proposals have become known to design optical elements consisting of an organic material and, in particular, spectacle lenses consisting of an organic material with photochromic properties. In this context "photochromic" is to be understood as the property of the colour impression and of the darkening of the optical element of changing with the amount of illumination, i.e. with the intensity of the radiation.

The photochromic properties of optical elements consisting of an organic material are, as a rule, obtained by introducing organic substances with photochromic properties, for example, spiro-oxazine compounds, into the matrix of the optical element or by applying them to the optical element.

On the other hand, at present most spectacle lenses are provided with an anti-reflection film which will usually consist of several high refractive index and low refractive index layers. Up until now, the question as to which anti-reflection film is best suited to a spectacle lens consisting of an organic material with photochromic properties has not



been considered in the literature. The same anti-reflection films are applied to actually developed spectacle lenses consisting of an organic material with photochromic properties as are also used for spectacle lenses consisting of an organic material without photochromic properties.

Representation of the Invention

It has now been recognised in accordance with this invention that the properties of spectacle lenses consisting of an organic material into which photochromic substances have been introduced or onto which photochromic substances have been applied, can be influenced by the suitable choice of an anti-reflection film.

For this reason, it is the object of this invention to demonstrate an anti-reflection film for an optical element consisting of an organic material with photochromic properties.

A solution to this object in accordance with this invention is characterised with its further developments in the patent claims.

In accordance with this invention it has been recognised that an anti-reflection film of several layers for an optical element consisting of an organic material with photochromic properties must possess the following characteristics:

1. In the wavelength-range between 330 nm and 380 nm the reflection should be as low as possible to ensure a sufficient stimulation of the photochromic substance or, in the case of several substances having been introduced, of the different substances.



2. In the wavelength range below 330 nm the reflection should increase steeply as radiation in this wavelength range, which also stimulates the photochromic effect, will - as has also been recognised in accordance with the invention - reduced the life of the photochromic effect.

3. In the wavelength range below 290 nm the reflection properties of the anti-reflection film no longer play a decisive role as the absorption properties of the atmosphere prevent such radiation from stimulating and so perhaps damaging the organic substances to any noticeable extent.

This means that the anti-reflection film provided in accordance with this invention differs from the films used up to now for both spectacle lenses in plastic without photochromic properties and for such with photochromic properties in that it has defined reflection properties not only in the range of visible light from 380 nm to 780 nm but also in the range from 290 nm to 380 nm. No consideration has been given up to now to the curve behaviour below 380 nm.

The film in accordance with the invention for an optical element consisting of an organic material and, in particular, for a spectacle lens with photochromic properties so has the following advantages:

It ensures a sufficient stimulation of the photochromic effect in dependence on the pertaining amount of illumination. As a result, when the anti-reflection film according to the invention is used, the kinetics of the photochromic effect is better than when conventional films are used.

It prevents the life of the photochromic effect from being



reduced by the stimulation of the photochromic effect by light with too short a wavelength.

In addition, further unexpected advantages are produced by the use of the photochromic film according to the invention:

Due to the different steric positions of the photochromic molecules in the plastic matrix, these molecules show different absorption and kinetic properties. With a suitable choice of the reflection properties of the film a deliberate stimulation of photochromic materials situated in certain steric positions and so influence on the kinetics and colour of the photochromic effect can be obtained.

If at least two different photochromic substances which have different absorption spectra are integrated in the matrix of the optical element, which, for example, may consist of organic material, then a considerable influence on the colour of the photochromic effect can be obtained by means of the design of the reflection properties in the range between 290 nm and 380 nm.

As has further been recognised in accordance with the invention, the properties according to the invention of the anti-reflection film for an optical element consisting of an organic material with photochromic properties can only be fulfilled with a layer system of more than three layers. Preferred version forms of this layer system are characterised in claims 4 to 6. With a film which has 5 layers consisting alternately of silicon dioxide and a material with a high refractive index, the behaviour provided in accordance with the invention between 290 nm and 380 nm can only be obtained satisfactorily,



if in accordance with claim 5 the high-index material has a refractive index n_e which is at least 2.0.

Brief Description of the Drawing

The invention is described in more detail below by means of version example with reference to the drawing in which

Fig. 1 shows a film in accordance with the invention with 5 layers
and

Fig. 2 - 5 show reflection curves of different version examples.

Method of Performing the Invention

Fig. 1 shows a film in accordance with the invention with 5 layers of which the first layer 1 applied directly to the optical element 0 consists of SiO_2 , the second layer 2 of a high-index metal oxide, the third layer 3 of SiO_2 , the fourth layer 4 again of a high-index metal oxide and the fifth layer 5 consists of SiO_2 .

Furthermore, it is also possible to split up layer 1 into three partial layers 1', 1'', 1''' consisting of SiO_2 , a high-index metal oxide and SiO_2 .

In the following Table 1, the design of the layer system with 5 layers is shown for different high-index materials (HIM) as is the refractive index n_e of the high-index material, i.e. the refractive index for light with a wavelength of 546.1 nm. It is assumed here that the substrate 0 has a refractive index of (about) 1.502.



Table 1

HIM	Tb ₂ O ₃	Nd ₂ O ₃	Ti ₂ O ₃	
Layer/n _e	2.00	2.10	2.23 2.33	
1 (SiO ₂)	175	175	180	nm
2 (HIM)	17.3	14.2	12.9	nm
3 (SiO ₂)	36.4	37.1	35.3	nm
4 (HIM)	121.3	123.8	120.8	nm
5 (SiO ₂)	87.5	87.5	91.2	nm

In Table 2 a version example is shown for a layer system with 7 layers.

Table 2

HIM:	Ti ₂ O ₃	; n _e = 2.23	
1' (SiO ₂) =	50	; 1'' (HIM) = 5.2;	1''' (SiO ₂) = 112.3
2 (HIM) =	10.9;	3 (SiO ₂) = 37.3;	4 (HIM) = 115.6
5 (SiO ₂) =	78.4		

Figures 2 to 5 show the reflection factors $r(\lambda)$ (in %) of the layer systems shown in Table 1 or 2 as a function of the wavelength λ of the incident light. As a common property of all layer systems it can clearly be seen that the maximum $r(\lambda)$ value of the reflection does not exceed a value of 6% in the range between 330nm and 380 nm while the mean reflection $\bar{r}(\lambda)$ calculated by

$$\bar{r}(\lambda) = \int r(\lambda) d\lambda / \int d\lambda$$

is less than 3% over this wavelength range. In the range between 290 nm and 330 nm the maximum value of the reflection



exceeds the value of 25% with the mean reflection over this range being greater than 15%. The fall below 290nm, which occurs with some reflection curves, is without meaning as radiation plays no role in this wavelength range due to the absorption properties of the atmosphere.

The invention has been described by means of examples above. However, it goes without saying that within the central idea according to this invention, the life, the kinetics and, when differently colouring photochromic substances are used, the colour impression can be influenced by a suitable design of the anti-reflection film and that the most varied modifications are possible.

For example, the layer system in accordance with the invention can not only be used for photochromic optical elements with a refractive index of around 1.5 but also for elements with a higher refractive index. It is also possible to use the most varied materials with other refractive indices instead of the high-index materials shown in the examples as long as the other refractive indices are greater than or equal to 2.0. Different high-index materials can also be used on one layer system.

However, in each case it is of particular advantage to keep to the condition for the thickness ratio given according to this invention. But it also goes without saying that the relationship given need only be met within certain, material-dependent tolerances.

In addition, optical elements can also be coated which do not consist of an organic material as long as the



photochromic substances they contain have similar properties to those given above.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An anti-reflection film of several layers for an optical element consisting of an organic material with photochromic properties wherein the mean reflection of the film over the range between 330 nm and 380 nm is less than 4% and the mean reflection over the range between 290 nm and 330 nm is greater than 15%, said film characterised by the fact that it has at least five layers which consist alternately of silicon dioxide and a high index material with a refractive index of $n_e \geq 2.0$, and of which the first layer applied directly to the optical element consists of silicon dioxide and has a thickness of about $\lambda/2$,

that the thicknesses of the second, third and fourth layers behave as

$$1 : 2Y : 20Z/3$$

where

$$Y = X \pm 1.5(n_e - 1.8); z = x \pm 0.2;$$

$$X = 1.05 + (n_e - 2)^{1/(4-n_e)}$$

and that sum of the thickness of the second to fourth layer is also about $\lambda/2$ with the fifth layer being a $\lambda/4$ layer ($\lambda=350$ nm).

2. A film according to Claim 1, wherein the mean reflection over the wavelength range between 330 nm and 380 nm is less than 2.5%.

3. A film according to Claims 1 or 2, wherein the maximum reflection in the wavelength range between 290 nm and



330 nm is greater than 25%.

4. A film according to any of the Claims 1 to 3, wherein the maximum reflection in the wavelength range between 330 nm and 380 nm is less than 5%.

5. A film according to any one of the preceding claims, wherein the first layer is split up into three partial layers consisting of silicon dioxide, a high-index material and again silicon dioxide, and that the thickness of the middle high-index layer is $\lambda / 100$ to $\lambda / 50$.

6. A film according to any one of the preceding claims, wherein the high-index material is neodymium oxide, titanium oxide or terbium oxide.

DATED this 11th day of November, 1988.

OPTISCHE WERKE G. RODENSTOCK K.G.

By their Patent Attorneys

G.R. CULLEN & CO.



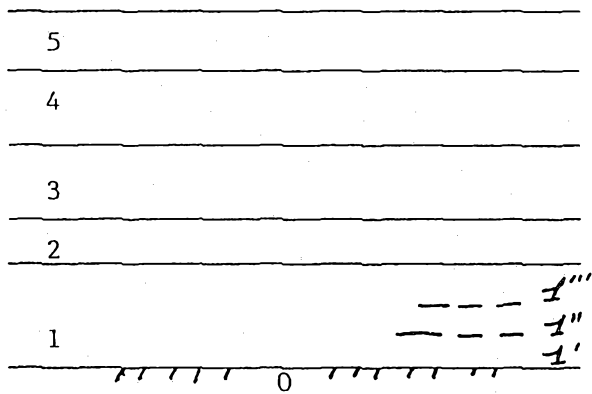


FIG 1

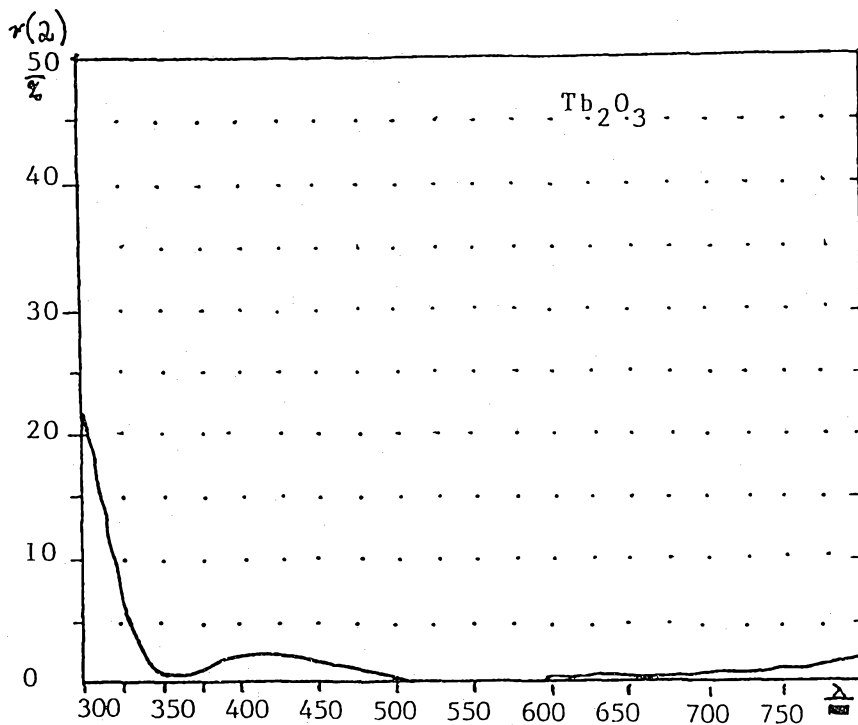


FIG 2

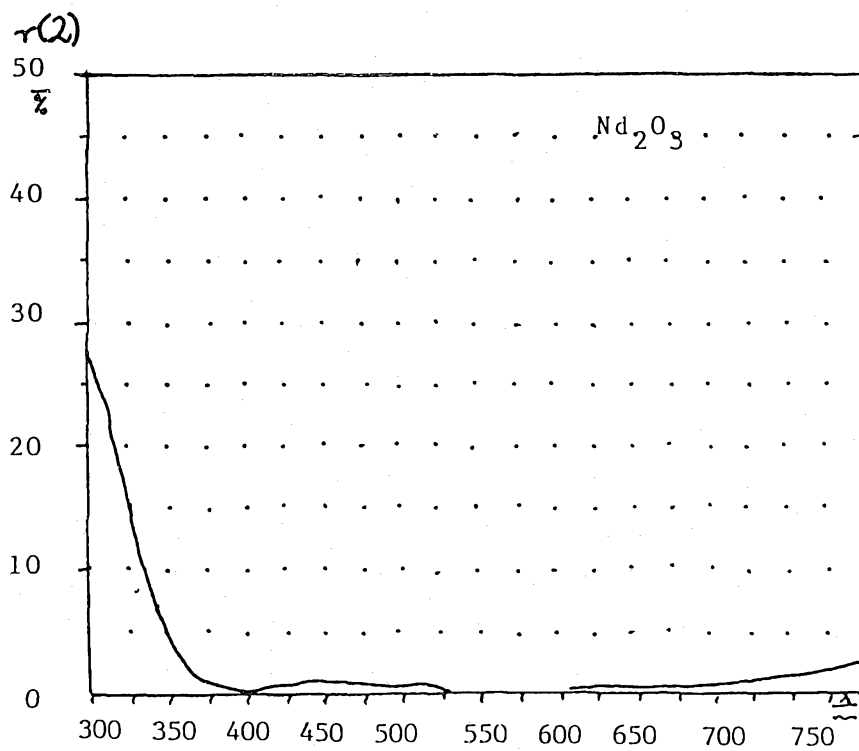


FIG 3

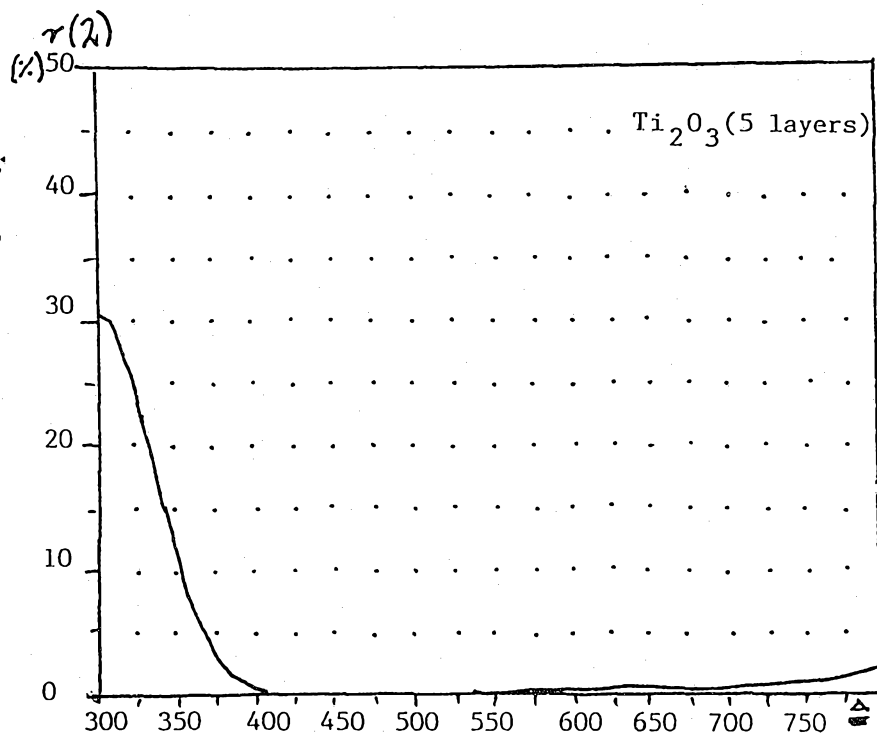


FIG 4

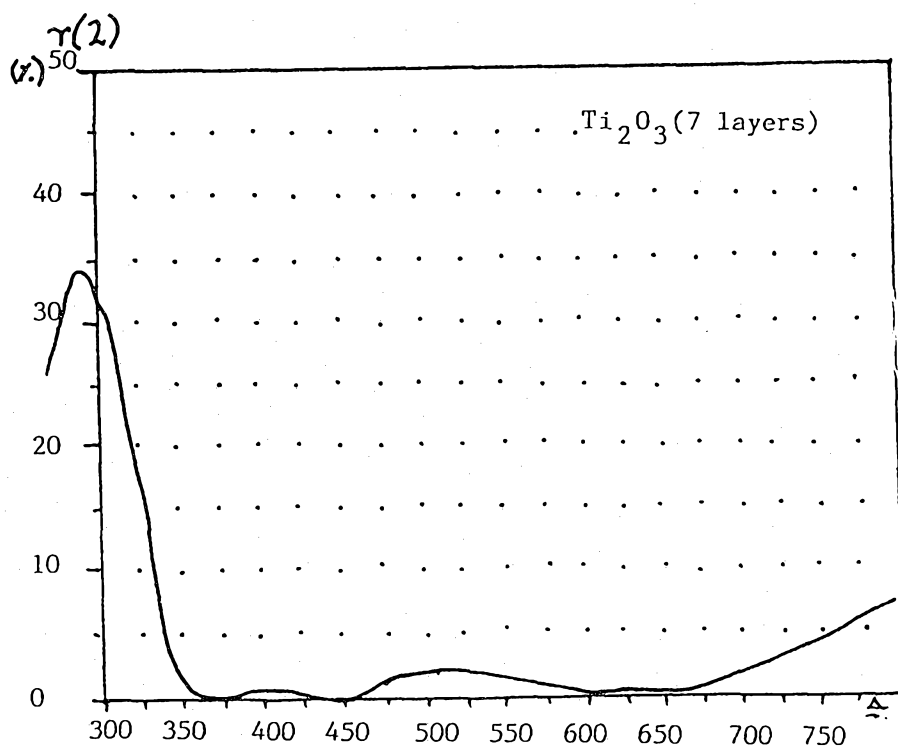


FIG 5

INTERNATIONAL SEARCH REPORT

International Application No PCT/DE 86/00299

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. ⁴ : G 02 C 7/10; G 02 B 1/10		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. ⁴ :	G 02 C 7/10; G 02 B 1/10; G 02 B 5/23	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category [*]	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	EP, A, 0140096 (OPTISCHE WERKE G. RODENSTOCK) 8 May 1985, see abstract; claims	1, 7
A	US, A, 4045125 (G.FARGES) 30 August 1977, see abstract; claims	1, 7
A	US, A, 4070097 (R.M. GELBER) 24 January 1978, see claims	1
A	US, E, 27473 (P.B. MAUER) 5 September 1972, see abstract; claims	1
A	US, A, 4313647 (E. TAKAZAWA) 2 February 1982, see claims	1
.....		
[*] Special categories of cited documents: ¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "A" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
27 October 1986 (27.10.86)		27 November 1986 (27.11.86)
International Searching Authority		Signature of Authorized Officer
European Patent Office		

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/DE 86/00299 (SA 13979)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 05/11/86

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0140096	08/05/85	WO-A- 8501361	28/03/85
		DE-A- 3332872	04/04/85
		AU-A- 3430784	11/04/85
		EP-A- 0155307	25/09/85
		JP-T- 60502173	12/12/85
US-A- 4045125	30/08/77	FR-A, B 2276601	23/01/76
		DE-A, C 2528814	15/01/76
		GB-A- 1497467	12/01/78
US-A- 4070097	24/01/78	JP-A- 51095858	23/08/76
US-E- 27473	05/09/72	None	
US-A- 4313647	02/02/82	JP-A- 52076942	28/06/77
		JP-A- 52076943	28/06/77

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82