MULTILAYER BLOOMING PROCESS INCLUDING PRECOATING OF THE SUBSTRATE USED FOR MONITORING

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ABSTRACT

A method of carrying out multilayer blooming which includes means to more accurately measure the thickness of the layers during blooming which consists in the use of a stack having at least one layer thereon to enhance the light transmission or reflection difference as the blooming layers are deposited on the stack during blooming of the articles, the stack preferably comprising a substrate having precoated thereon alternately high and low refractive index materials having an optical thickness of a quarter wavelength or multiples thereof at a selected wavelength.

8 Claims, 6 Drawing Figures
This invention relates to a method of and means for effecting multilayer blooming of lenses or the like, and includes a novel process of precoating the substrate used for monitoring before applying the blooming layers, whereby checking the thickness of the layer deposited is facilitated by increasing the sensitivity to variation of light transmission or reflection between a light source and a photometer as the layer is deposited to a stage where exact measurements are readily achieved.

One of the problems when depositing blooming layers on lenses and the like in a vacuum chamber is to be able to measure the exact thickness of a deposited layer, and the object of this invention is to provide means whereby the checking of the deposition can be effected in a better and more exact manner, and with simple equipment, this being achieved as indicated by so arranging a test piece, which also receives the blooming layers, that the test piece enhances the transmission or reflectance differences due to the blooming layers thereby improving measurement accuracy.

It is already known in the art to coat glass with successive layers having different refractive indices, and to do this in such a way that reflection from the surface is materially reduced. It is also known that a high reflecting stack can be formed by depositing first a layer of a substance such as lead fluoride which has a relatively high refractive index, then a layer of magnesium fluoride which has a lower refractive index and then another layer of lead fluoride which again has a higher refractive index than the previous layer. It is also known that if successive layers of certain materials are deposited on this stack the variations of light transmission or reflection caused by the presence in these layers, can be different from the variations which would have taken place in the absence of the high reflecting stack.

The present invention makes use of what could be termed a high reflecting stack on a surface placed into the chamber where vacuum deposition is taking place so that this stack receives on it an equal deposition to the deposition being applied to the lenses or the like in the chamber. Such deposition on the stack, when the stack is correctly selected, then changes the light transmitting or reflecting characteristics of the stack with the blooming thereon so that a very much greater differential exists than would exist if light was simply transmitted through or reflected by the lenses and blooming layers to a photometer or similar recording device.

Therefore, there is obtained on the test piece a much greater differential than would otherwise exist, and by suitably selecting the stack, conditions can be so arranged that with each successive stage of blooming the further blooming on the stack will have a transmission change intensified sufficiently on the photometer to result in ready reading of the thickness of the deposited layer.

It should be stated at this point that triple layer antireflection coatings on glass for visible and near infrared light is already known and reference can for instance be had to an article by J. T. Cox and G. Hass in the Journal of the Optical Society of America Volume 52 No. 9 dated Sept. 1962 where a relative complete discussion exists of triple layer blooming, but if the layers are deposited in accordance with this article it will be clear (From Fig. 3 which will be later referred to) that triple layer blooming gives rise to such small variations in reflection or transmission at critical stages in the blooming process that detection and reading of these variations becomes very difficult particularly if a simple DC photometer system is used resulting in high inaccuracies in layer thicknesses and low efficiency blooming, when however the deposition is made on a specially selected stack as taught by this invention, the variations are intensified on a scale where it is possible to effectively read the differences in thickness of deposit because of the intensification effect which then exists, and from the graphs which form part of the specification and which have reference to actual examples of the process, this intensification effect will be readily appreciated.

In the illustrations designated respectively FIGS. 1 to 6, FIG. 1 shows a glass member having one form of the invention applied thereto,

FIG. 2 showing a typical setup, while

FIGS. 3 to 6 inclusive are graphs of progressive steps in the prior art and the present invention.

The stack generally comprises a substrate having precoated thereon a number of alternately high and low refractive index materials having an optical thickness of a quarter wavelength or multiples thereof at a selected wavelength. Suitable materials are ZnS, Cryolite, MgF₂, PbF₂ and the like.

In FIG. 1 a glass member with a refractive index 1.51 shows on it a precoated stack comprising two quarter wavelength layers of Zinc Sulphide separated by a quarter wavelength layer of cryolite, the same appropriately selected wavelength being considered in all cases, these being deposited on the glass prior to blooming using only a simple photometer to determine the thickness in each case and the glass member then installed between a light system and photometer as shown in FIG. 2, the stack being positioned to accept coating similarly to the lenses which may be mounted on the rotating carrier and which may be masked in a particular way to modify the distribution of the material.

Referring now to the graph designated FIG. 3 in which wavelength in angstrom units is plotted against reflection percentage in a typical coated lens surface as known heretofore.

In this the line designated 1 consists of a quarter wavelength thickness of CaSiO₃, while the second line shows this together with a similar thickness of ZrO₂.

In line 3 a further quarter wavelength layer of ZrO₂ is added, and the fourth line shows the final blooming which then comprises a system of layers 1/4 of CaSiO₃ + 1/2 of ZrO₂ + 1/4 of MgF₂.

Table 1 shows the following approximate differences in reflectivity between successive layers at about 5,000 angstrom.

| (1) between glass and 1st graph line | 69% |
| (2) between 1st and 2nd lines | 5.8% |
| (3) between 2nd and 3rd lines | 5.8% |
| (4) between 3rd and 4th lines | 10% |

The significance of these figures will be later appreciated.

Referring now to the graph designated FIG. 4 in which wavelength in angstrom units is again plotted against reflectance percentage we find the curves for a typical high reflecting stack in which curve 1 represents the first layer, being a quarter wavelength layer of ZnS, curve 2 represents the curve when a quarter wavelength layer is cryolite superimposed, the curve 3 shows the final stack characteristic when a further similar layer of ZnS has been added. This then forms the stack shown at the base of FIG. 4. To on which the blooming layers are to be evaporated simultaneously with the evaporation on the lenses.

We turn now to the graphs designated FIGS. 5 and 6 which show the reflectivity differences in a typical example of this invention in which the stack of FIG. 4 is first applied to the test glass and four layers similar to the layers of FIG. 3 are then applied as the blooming materials. It will now be noted that the percentage figures for the readings of each layer are very considerably altered so that we now have the following table based on the same conditions as table 1.

| (1) between precoated stack and line 4 | 49% |
| (2) between lines 4 and 5 | 42% |
| (3) between lines 5 and 6 | 42% |

TABLE 1

TABLE 2
Referring this to Table 1 it will at once be obvious that the reflection differences according to our invention are significantly greater, thus enabling a much greater accuracy to be obtained.

The above description, for clarity, considers reflection differences (whereas FIG. 2 and earlier description considers transmission). However, it should be appreciated that with this type of thin film system reflection and transmission differences are the same, the absorption being effectively zero.

What I claim is:

1. The method of carrying out a multilayer blooming process which comprises placing an object to be bloomed into a vacuum chamber, positioning in the chamber a substrate having precoated thereon a number of alternately high and low refractive index materials to enhance the light transmission or reflection differences due to the blooming layers at a selected wavelength, successively evaporating the blooming layers onto both the object to be bloomed and the precoated substrate, and measuring the transmission or reflection of light changes which take place during deposition of each blooming layer whereby to improve measurement accuracy by such enhancement and hence precision of control of the thickness of deposits and hence quality of blooming.

2. The method of claim 1 wherein the light is passed through or reflected from the precoated substrate to a simple photometer.

3. The method of claim 1 wherein the stack comprises a light transmitting base having coated thereon two quarter wavelength layers of ZnS separated by a quarter wavelength of cryolite.

4. The method of claim 1 in which the number of alternately high and low refractive index materials have an optical thickness of a quarter wavelength or multiples thereof at a selected wavelength.

5. The method of claim 1 in which the alternately high and low refractive index materials have an optical thickness of a quarter wavelength or multiples thereof at a selected wavelength and wherein the high index material is ZnS and the low index material is cryolite.

6. The method of claim 1 in which the number of alternately high and low refractive index materials have an optical thickness of a quarter wavelength or multiples thereof at a selected wavelength and wherein the high index material is ZnS and the low index material is MgF₂.

7. The method of claim 1 in which the number of alternately high and low refractive index materials have an optical thickness of a quarter wavelength or multiples thereof at a selected wavelength and wherein the high index material is PbF₂ and the low index material is MgF₂.

8. The method of claim 1 wherein the stack comprises a light transmitting base having precoated thereon two quarter wavelength layers separated by a quarter wavelength layer of a further material selected, so that the second layer reduces the reflectivity curve of the first layer, and the third layer enhances the final reflectivity curve.