The Design of an Efficacious Anti-infrared Goggles for Workers to Prevent Cataracts

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***Abstract*—The study applied the composite materials SiO_2 and ZrO_2 as anti-infrared coating material in order to prevent cataracts. The UV-VIS / NIR analyzer is used for experimental measurement. The lens can effectively reflect about 60% of near-infrared light, and reflect about 95% of the UV wave band.**

Keywords—anti-infrared goggles; prevent cataracts;

I. INTRODUCTION

Under the rapid development of technology industries, good working environments are emphasized by modern people. Unfortunately, working environments in some traditional industries have not been effectively promoted. It is reported that a large proportion of workers, in the social population structure, are exposed to infrared environments over a long period of time. Statistics revealed the higher percentage of workers in such environment suffering from cataract.

On the other hand, the advance of optical technology has resulted in the emergence of products with infrared band, such as heating equipment of infrared light-emitting diodes, infrared semiconductor diode lasers, and heat lamps. The invisible radiant heat emitted infrared would reduce the quality of air in the environment and enhance the temperature in surroundings.

Accordingly, people have more chance to be exposed to infrared environments. To reduce the damage of infrared to human eyes, a pair of anti-infrared goggles, which is actually coated anti-infrared materials on the glasses, is designed in this study. With the test of UV-VIS/NIR spectrophotometer, the optical glasses of the proposed goggles could effectively filter 780nm~1400nm infrared. Besides, 780nm~1400nm infrared is projected to general glasses and the anti-infrared goggles with the same distance. The experimental result shows that the anti-infrared goggles could reduce infrared transmittance and cumulative power. It verifies that the anti-infrared goggles could effectively filter infrared band and release energy accumulation.

II. SYSTEM DESIGN

The resin lens (Mitsui Chemical,CR39) is used in this study. When the material processing, the hardened material will be added to make lens hard and not easy to scratch. The reason of choosing material of CR39 is the characteristics of cutting off UV wavelength (408-415nm). The composite materials SiO_2 and ZrO_2 are used on the coating material. After the two materials are stacked and aligned, the film is evaporated and attached by vacuum plating, and the total number of coating layers is 16. The SiO2 material can cut off infrared light and endothermic. It has excellent performance in surface scratch resistance, and also commonly used on low refractive index film. The ZrO_2 material can cut off ultraviolet light and thermal effect. The actual result is shown in Fig. 1.

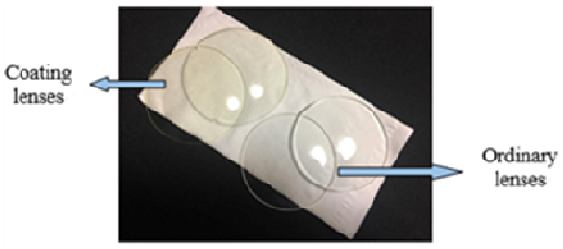

Fig. 1. The actual result of lenses

The UV-VIS / NIR analyzer is used for experimental measurement, and the measuring range is from ultraviolet to near infrared wavelength(190nm ~ 2700nm). When testing, the lens is placed inside the instrument, and set the measurement medium and baseline. Assuming as a general environment, the external material medium is set as air. The testing light emerges from both sides, and through the center of the lens. Finally, according to the measurement result of sensor, the

transmittance and absorption rate are used to evaluate the effectiveness of coating.

III. RESULT

According to CIE TC-6-49 report, the analysis of the absorption of infrared wavelengths by eyeballs shows that there is a correlation between corneal, aqueous humor and crystalline lens in the IR spectral region between 800nm and 1900nm and the risk of cataract [1]. However, the International Commission on Non-Ionizing Radiation Protection introduced a spectral weighting factor to find that the effect of the wavelength between 780 nm and 1000 nm would increase to 3,33 times[2]. In addition, the spectral peak 270nm is the cause of glaucoma and corneal (keratoconjunctivitis) photochemical damage[3].

According to the content of the literature, the temperature of eye changes obviously in the IR-A wavelength. After reference to ISO 15004-2: 2007 and CIE report TC6-49, it is found that these two are very similar in terms of setting the harmful near-infrared wave band. Therefore, the data analysis is from 780 nm to 1400 nm[1]. From Table 1, It shows that the coated lenses can effectively resist infrared light and transmittance significantly decreased by 55%. The absorption is increased from 0.0532% to 0.3960%, and it can also effectively reflect about 60% of near-infrared light. The lens effectively reduces the absorption of the eyeball in the wave band of 780 nm to 1400 nm and the possibility of suffering from cataract.

TABLE I. THE RESULT OF IR MEASURMENT

	Transmittance	Absorbance	Reflectance
Coating lenses	39.4756%	0.3960%	60.2895%
General lenses	88.6954%	0.0532%	11.4125%

The analysis results of wavelength 270nm is shown in Table 2. From the result, it can be learned that the material of the lens can prevent glaucoma caused by the ultraviolet light in the human eye.

TABLE II. THE RESULT OF UV MEASURMENT

	Transmittance	Absorbance	Reflectance
Coating lenses	0.0042%	4.3472%	95.6484%
General lenses	0.0052%	4.2895%	95.7052%

The results of 190nm ~ 2000nm are shown in Fig. 2, Fig. 3 and Fig.4.

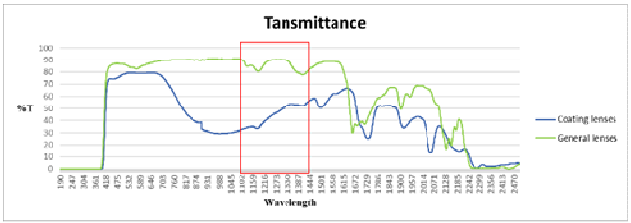

Fig. 2. Ordinary lenses and coated lenses Tansmittance Relationship

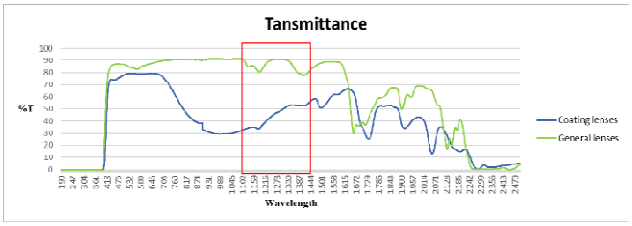

Fig. 3. Ordinary lenses and coated lenses absorbance Relationship

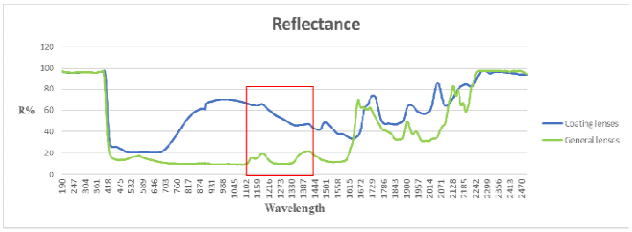

Fig. 4. Ordinary lenses and coated lenses Reflectance Relationship

IV. CONCLUSIONS

In this study, a new cross stacking multilayer film of SiO_2 and ZrO_2 was proposed. The cross stacking order is not affected its characteristics. With the UV-Vis / NIR analyzer, the lenses have excellent anti-performance at 780nm~1400 nm and 270 nm. The lens can effectively reflect about 60% of near-infrared light, and reflect about 95% of the wave band. This result shows the technical success of the coating. With our proposed method, the workers who works long-term in high temperature environment, but the probability of suffering from cataracts will be reduced. In the future, we hope this technology will be applied to different fields, and develops new application for different needs.

ACKNOWLEDGMENT

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REFERENCES

[1] TSUTOMU, OKUNO. "Thermal effect of visible light and infra-red radiation (ir-A, ir-B and ir-C) on the eye: a study of infra-red cataract based on a model." The Annals of occupational hygiene 38.4 (1994): 351-359.

[2] ACGIH, 2014. Light and near-infrared radiation. In: ACGIH, 2014. TLVs and BEIs. pp. 148

[3] ACGIH, Cincinnati. ICNIRP GUIDELINES ON LIMITS OF EXPOSURE TO LASER RADIATION OF WAVELENGTHS BETWEEN 180 nm AND 1,000 μ m, : HEALTH PHYSICS 105(3):271 - 295; 2013