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Experimental Paper

Effect of Refractive Index on Diopter Glasses for Optical Analysis of Human Eye Using Electromagnetic Wave at Ophthalmology Systems

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Abstract

The detection of the refractive error is important for the utilization of the optical lens in eye diseases and the determination of the refractive properties is a key parameter at optical sensor systems. Refraction detection is one of the procedures performed by ophthalmologists, and the detection of this feature in the lens of the eye is one of the basic ophthalmology topics to decide the use of the high diopter glasses.

Keywords: Coating; Diopter Glasses; Refractive Index

Introduction

Refraction is the physical principle that light changes its angle and velocity when transiting from one medium to another in ophthalmology. The pure mineral oxides with high refractive power are used to make a multi-layer and anti-reflection coating that is resistant to abrasion and thermal shocks at the acrylic glassy structures [1-4]. As the breaking power of glass increases, the number of Abbe decreases. The Abbe number indicates the chromatic aberration or diffraction property at the glass, and the smaller this number, the more color dispersion and reflections in the glasses. Thin films with a high refractive index can be used in antireflective structures and various assemblies in optical waveguides, antireflective thin-film components [5,6]. The companies that started commercial production researches in the 1990s have developed DRAM: Dynamic Random-Access Memory capacitor applications that store information in 0 and 1 structure, which they use while accessing the information on the computer, using ultra-thin films with high refractive index. In the 2000s, thin-film layers with high refractive index are still being used in glass production and photographic lenses.

Today, antireflective layers are developed for use with devices in IoT applications and acrylic glassy structures are researched for use in ophthalmic lenses which can connect to systems compatible with Industry 4.0.

Experimental

The usage of glass with a high refractive index is necessary to obtain high diopter glasses in ophthalmology. The refractive index can reach to n = 1.7 by adding titanium into the raw material of glass. The heavy flint (BaSF) glass (n = 1.9) can be obtained by adding barium to glass. Glasses with different chemical compositions such as borosilicate glasses can be used in the production of photochromic glasses.

For ophthalmological use the hard and dense coatings can be obtained by using cost effective coating methods such as the dipping method and spin coating (rotation) methods. In the dipping coating method, it is important that the coated carrier is quickly removed from the solution used in the coating. Because if this time is not considered, different thicknesses can occur in the coating. In order to prevent the formation of different thicknesses in the coating, all devices carrying the solution must be mounted without vibration. In the spin-coating method, a small amount of a coating solution is dropped onto the cleaned glass surface while in a very rapid rotation of the spin-coating device. After the coating process, the coated glass is tempered and hardened. Thus, it is possible to obtain a scratch-resistant glass surface and the items used daily for cleaning the glass cannot spoil this coating.

Results and Discussions

In multilayer coating, the glass is overlaid with both less indexed and higher index layers than the refractive index of the glass depending on the utilization purpose. The glass can be coated against scratch at the top (such as SiO_2, n = 1.45). In the coating process titanium oxide (TiO_2) can be synthesized to obtain the highest refractive index (n= 2.35) in nature. Tantalum oxide (Ta_2O_5) is another alternative coating layer with high refractive index (n = 2.18).

Thin-film layers can be derived due to the high refractive index for the use demand in glass and lenses. Multi-layer anti-reflective coatings are effective on a wide spectrum. Hence, reflections can be reduced from each of the inner and outer surfaces of the glass to less than 0.3% and the light transmittance of the lens can be increased up to ~ 99%, depending on the type and property of the multi-layer glass substrate. While the glass is tilted slightly, weak light shining in golden yellow or bluish-green color can be seen on the coating according to the antireflective property.

Conclusion

The refractive index of the deposited film cannot be the constant because most materials evaporate incongruently. But, dip coating and spin coating technique present an opportunity to obtain homogeneous refractive index on glass.

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