

# Principle and mechanism of optical thin film essay example

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## Introduction

Thin-film optics is a division of optics that deals with the very thin structured layers of materials. The condition of exhibiting thin-film optics is that the thickness of the layers of the material should be in order of visible light wavelength usually about 500nm. At this scale, layers can have remarkable reflective properties based on the difference in refractive index and wave interference between layers, the substrate and the air. The effects called thin-film interference alters the way the optic transmits and reflects light and they are observable in oil slicks and soap bubbles.

A dielectric mirror also called is sort of mirror consisting multiple sheets dielectric fabrics basically placed on the substrate of some additional ocular substance or glass. At different wavelength of light, a person can make an optical substrate with précised reflection mechanism based on curious thickness and choice of the type of the electric layers. Mirrors with reflective mechanisms usually Ultra-high valued at 99. 9% or others better than this over a thin choice of wavelengths can be produced using dielectric mirrors utilizing specialized methods (Kaufman 21). The alternative use dielectric mirrors are reflection of a broad spectrum of light like the Ti-sapphire laser or entire visible range. These types of mirrors are common in optics experiments because of their improved techniques that give chance to cheap production of high definition mirrors. The cases of their appliances consist the coating on modern mirror shades, hot and cold mirrors, thin-film beam splitters and laser cavity end mirrors.

## Mechanisms

The functionality of dielectric mirrors is utilized under the intrusion of the reflected light from various layers of dielectric stack. The same mechanism is applied in antireflection coverings that are multilayered and are designed to minimize instead of maximizing reflectivity. The choice of thicknesses of the layers is made such that the difference of the path-length for reflections coming from various high-index layers is multiple integer of the wavelength that the designing mirror takes. Simplified dielectric mirrors work similar to single dimension photonic crystals, which usually contains heaps of layers of high refractive index interlinked with coatings of low refractive index. The reflections rising from the low-index boundaries are one out of two the wavelength in the difference of the path length. However, in comparison to high-to-low index boundary there is 180-degree variation in phase shift at low to high index boundaries, meaning that the reflections are in phase (Nashimoto 18). The mirrors layers exhibit one out of four wavelength thicknesses for the sake of mirrors inclined to the normal.

The thin film coating is very important as it plays a prominent role on the design and manufacture of many electric devices. They are commonly used in application of dopants and sealants to chips and some other microelectronic parts. The thin film layer consists of thickness found at sub-nanometer on the micron range. When light hits on the exterior of that thin film, it is transferred or reflected on the higher surface of the film. The Fresnel equations give a explanation quantitatively of the amount of light that is be reflected and transmitted at the boundary. The reflected light depends on the amount of productive or negative interference on the light

waves (Nashimoto 37). The difference depends on the width of the layer of the film, the index to be refracted on the layer of the film or the original incidence of the angle of the original wave. In addition a phase of 180 degrees is introduced when reflections depends at the boundary, which depends on the refractive indices.

The deposition is applied in the thin film layer as principle of working by the film. The depositions can be either chemical depositions or physical depositions. The chemical depositions are fluid principle that use fluid precursor, which undergoes changes at the solid surface that leaves a solid layer. The depositions happen on the surface of the film concerning the light direction. The chemical deposition includes the plating, which relies on the liquid precursor. It also involves chemical solution deposition, which relies on organometallic powders, which are dissolved in an inorganic solvent. The spin coating is also another chemical deposition. Physical deposition is also used in thin film (Kaufman 56). It uses the electrical, the thermodynamics and mechanical means to produce the thin film solid. Examples include the thermal, which uses an electric resistance to melt the material and raise the vapor to a useful range. It also involves sputtering which relies on plasma to produce atoms.

Antireflection coating is a form of optical coating that covers the surfaces of optical devices including lenses and is used to reduce reflection. Efficiency of such devices is high because they do not lose a lot of light. In devices with high resolution like telescope, stray light is eliminated by reduced reflection thus, there is improved contrast of the images making planetary astronomy much easier (Greenland 36). In simple applications like eyeglasses, reduced

reflection helps to make the wearer's eyes more visible or in binoculars, it reduces glint. It has some special characteristics such as low absorption, low reflection, high light transmission, and broadband coating construction.

Most of the coatings have transparent film structures that have refractive index which are contrasting. The thickness of the layer is chosen to achieve two things that are to achieve destructive interference on the interface beams and secondly constructive interference at the parallel beams. These two effects help to ensure that the incident angle and wavelength change in a way that the oblique angles depict the color effects. During ordering stage or while designing the coating, it is important to specify the wavelength. Effectiveness and good performance of the is always achievable through a wide range of frequencies.

There are several applications where an anti-reflective coating is applied especially where low loss or reflection is required and the light is supposed to go through a photosensitive surface. For instance, the camera lens, corrective lenses whereby an antiglare coating is applied. Antireflection lenses are used in corrective lenses to reduce glare and make the people using them look better. It is commonly used when is driving or while using a computer. Such lenses ensure that those who wear them do not struggle to see. In addition, the visual acuity is high because when more light passes via the lens it increases the contrast. Usually the anti-reflection lenses have an extra coating that repels water and grease thus it is easy to clean (Toor 33). In order to minimize distortions, which are related to reflection away from the surface, the antireflection coatings are usually in microelectronic photolithography. There are various types of coatings which are normally

applied prior or after photo resist that are meant to reduce specular reflections, thin-film interference or standing waves.

There are various types of antireflection coating for instance, index matching. This kind of coating was discovered in 1886 by Lord Rayleigh using pieces of glasses, which are slightly tarnished after he realized that they transmit more light as compared to the clean and new pieces. Tarnish substitutes the interface of air glasses with tarnish glass and air tarnish interface. Given that, the tarnish contains refractive index between the two interfaces, both of them exhibits less reflection as compared to air glass interface. Single layer interference is another type of antireflective coating. The refractive index of the transparent material that makes up this one layer quarter wave is square root of the refractive index of substrate.

Theoretically, center wavelength has zero reflectance and it reduces for broadband wavelengths that surround the center. There is also multilayer-interference that is composed of alternating layers with high and low index materials. It is also important to make coatings that have low reflectivity for a wide band even though it is sometimes expensive and complicated.

Usually optical coatings are designed in a unique way and they possess certain characteristics for instance, at multiple wavelengths they have almost zero reflectance and allow maximum performance at incidence angles and not zero degrees. Absorbing is another category used where high transmission on the surface is not necessary but low reflectivity is still essential. They are cheap give that few layers are enough to produce reflectance (Toor 45). This type of coating applies compound thin films like niobium nitrate or titanium nitrate and is mostly used to replace tinted

glasses or when contrast assessment is required. Other types of antireflective coating are moth eye and circular polarizer.

Coating has two optical effects i. e. the thick and thin film effects. Thick film effects are caused by the difference in refraction index between the upper and the lower layers and is not dependent on the thickness of the coating but the coating must be thicker than the light's wavelength. Thin effects come in whereby the coating is approximately half or quarter the light's wavelength.

## **Works Cited**

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