Lecture -2-

Ophthalmic Lens Materials

Before 300 years ago all lenses are made from glass. But from 300 year till 1938 the virtually single vision lenses were made from particular variety of glass known as ophthalmic Crown glass, which has an index of refraction of 1.523.
For any refracting material with a uniform refractive index the power to bend light rays increases with the thickness of the material. Also, assuming a uniform thickness of different refracting materials, the material with the highest refractive index will refract light more powerfully.

Other varieties of glass like flint glass were first used for special purposes such as for making reading segments in bifocals.
Recently high index lenses have pervaded the market for general use in single vision, bifocal and multifocal lenses.

Manufacture of optical glass and lenses:

Optical glasses: fabrication and optical properties:

What is optical glass?

Optical glass is ***optically homogeneous* glass**, free from defects such as striae and bubbles, which is used with optical functionalities, for example in the form of lenses or prisms.

Types of optical glass

The first optical quality (*flint*) glasses were developed by Otto Schott (in Jena, Germany), around 1890, he also invented Ba *crown* glass, enabling the fabrication of lenses corrected for chromatic aberration.

The compositions of the more traditional optical glasses are usually based on multi-component silicates, including heavy elements such as Pb, Ba, La, Gd, Ta and Nb. The basic compositions usually fall into two categories:

(1) High dispersion *flint* glasses (normally containing PbO);
(2) Low dispersion *crown* glasses (often containing Ba or La).

The main Varieties of glass are:

1- Ophthalmic Crown
2- Flint Glass
3- Barium Crown Glass

Ophthalmic Lens Materials

Lecture -2-

1- **Ophthalmic Crown** is made of 70% Silica (sand), 14-16% Sodium Oxide, 11-13% Calcium Oxide and 1-5% of Potassium, borax, antimony and arsenic
Ophthalmic Crown is used for the majority of single-vision glass lenses available today and for the distance portion of most glass bi-and tri-focal.

2- **Flint Glass** is made of 45-65% lead oxide, 25-45% silica and about 10% mixture of soda and potassium oxide.
Flint glass has a higher refractive index than ophthalmic crown. It is used mainly for bifocal segments in some fused bifocals.

3- **barium Crown Glass** is made of 25-40% barium oxide and the result is silica and Potassium oxide.
The **barium** is increasing the refractive index like the lead oxide but does not increase the chromatic dispersion as much as lead oxide does.
It is mainly used for the segment portion of a specific type of fused bifocal.

Manufacture of Optical glass:

The glass is melting at high temperature so it is need a very careful technique to get the lens at the end.
The important thing is that:

- ✓✓ The whole glass showed reach the melting point at the same time
- ✓✓ The glass showed start to cooling until reach the cooling temperature at the same time
- ✓✓ The glass ingredient almost oxides or salts of metals, including silica, sodium, potassium, calcium and aluminum.

Types of manufacture techniques:

1- **continuous flow process** is the nowadays technique.
2- **batch process** technique is the old one

Lecture -2-

Plastic materials:

Plastic lenses are generally made from two different materials. They are:
1. Original plastic lens made of (PMMA) Polymeric materials (Usually organic)
2. Modern hard resin lens from ally1 diglycol carbonate (CR 39) which is harder and more resistant to scratches than other plastic lens materials.

Advantages:

Plastic lenses are made from a very high quality material as glass. Plastic lenses are about half the weight of glass and are highly impact-resistant. It has a central thickness of 3.0mm without special hardening process. Plastic lenses have a thicker profile than glass, get scratches more easily and do not protect the eye from UV rays unless properly tinted. Glass lenses unlike plastic must be treated to resist breakage. They can be hardened by chemical or heat processes.

Optical and physical properties of plastic ophthalmic lenses:

CR-39 type:
Advantages:
1- **CR-39 type** has a half weight of ophthalmic crown glass with similar prescription and of identical size
2- they are fairly impact resistant in their natural state
3- CR-39 types are very inert and are resistant to almost all solvent and chemicals except perhaps, highly oxidizing chemicals
4- CR-39 is more resistant than glass to pitting from small hot substances.
5- CR-39 has much lower thermal conductivity than glass and less prone to fogging
6- CR-39 lenses can be tinted to almost any color
7- reduces the manufacturing price than glass forms as a result of the material nature.

Disadvantages
1- it is soft and easy to scratches
2- thicker than crown glass they has the same power although it has fairly low refractive index.
3-They has inferior photo-chromic qualities when compared with glass lenses

Lecture -2-

Polycarbonates:

Advantage

1- they are vastly superior to ophthalmic glass and CR-39 in term of impact resistant
2- it have high R.I (1.586)slightly higher than the ophthalmic crown glass.
3- it have a specific gravity of 1.20 (as compared with 1.32 for CR-39) and therefore lenses made of this material is the lightest spectacle lenses in production
4- these lenses are easily tented and an abrasion resistant coating wich also absorbs uv radiation is applied to both front and back surface.

Disadvantage

1- it has a low nu value (dispersion or Abbe value) and hence gives rise to a higher amount of chromatic dispersion than glass or Cr-39
2- the surfaces of polycarbonate lenses are such that it is difficult to mold them such that imperfections are completely eliminated.