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Material Properties Overview

Mechanical and Chemical Properties

Mechanical and chemical properties of glass are important to lens manufacturers. These properties can also be significant to the user, especially when the component will be used in a harsh environment. Different polishing techniques and special handling may be needed depending on whether the glass is hard or soft, or whether it is extremely sensitive to acid or alkali.

To quantify the chemical properties of glasses, each glass is rated according to four categories: *climatic resistance*, *stain resistance*, *acid resistance*, and *alkali and phosphate resistance*.

Climatic Resistance

Humidity can cause a cloudy film to appear on the surface of some optical glass. Climatic resistance expresses the susceptibility of a glass to this process. In this test, glass is placed in a water-vapor-saturated environment and subjected to a temperature cycle which alternately causes condensation and evaporation. The glass is given a rating from 1 to 4 depending on the amount of surface scattering induced by the test. A rating of 1 indicates little or no change after seven days of exposure; a rating of 4 means a significant change occurred in less than 30 hours.

Stain Resistance

Stain resistance expresses resistance to mildly acidic water solutions, such as fingerprints or perspiration. In this test, a few drops of a mild acid are placed on the glass. A colored stain, caused by interference, will appear if the glass starts to decompose. A rating from 1 to 5 is given to each glass, depending on how much time elapses before stains occur. A rating of 1 indicates no observed stain in 100 hours of exposure; a rating of 5 means that staining occurred in less than 0.2 hours.

Acid Resistance

Acid resistance quantifies the resistance of a glass to stronger acidic solutions. Acid resistance can be particularly important to lens manufacturers because acidic solutions are typically used to strip coatings from glass or to separate cemented elements. A rating from 1 to 4 indicates progressively less resistance to a pH 0.3 acid solution, and values from 51 to 53 are used for glass with too little resistance to be tested with such a strong solution.

Alkali and Phosphate Resistance

Alkali resistance is also important to the lens manufacturer since the polishing process usually takes place in an alkaline solution. Phosphate resistance is becoming more significant as users move away from cleaning methods that involve chloro-fluorocarbons (CFCs) to those that may be based on traditional phosphate-containing detergents. In each case, a two-digit number is used to designate alkali or phosphate resistance. The first number, from 1 to 4, indicates the length of time that elapses before any surface change occurs in the glass, and the second digit reveals the extent of the change.

Microhardness

The most important mechanical property of glass is microhardness. A precisely specified diamond scribe is placed on the glass surface under a known force. The indentation is then measured. The Knoop and the Vickers microhardness tests are used to measure the hardness of a polished surface and a freshly fractured surface, respectively.

The catalogs of optical glass manufacturers contain products covering a very wide range of optical characteristics. However, it should be kept in mind that the glass types that exhibit the most desirable properties in terms of index of refraction and dispersion often have the least practical chemical and mechanical characteristics. Furthermore, poor chemical and mechanical attributes translate directly into increased component costs because working these sensitive materials increases fabrication time and lowers yield. Please contact us before specifying an exotic glass in an optical design so that we can advise you of the impact that that choice will have on part fabrication.

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