CHARACTERIZATION OF CONTACT LENS PLASTICS

Lyle M. Bowman, Thomas B. Harvey, III, William E. Meyers
Sola/Barnes-Hind
810 Kiffer
Sunnyvale CA, 94086

In the development of contact lens material, characterization of the materials includes measurement of gas transport, and mechanical properties, including the modulus of elasticity, tensile strength, percent elongation and tear strength. Physical properties determined on contact lens plastics include percent hydration, wetting angles, glass transition temperature, percent visible transmission, indentation hardness, refractive index, and percent linear expansion. In addition to polymer measurements, the protein and lipid deposition must be measured to determine biocompatibility in the eye. Each of the measurements must be performed on a finished contact lens which weighs 10 mg at a thickness 0.01 cm. This paper will describe how each of the listed measurements is performed on a contact lens and representative measurements will be given for contact lens polymers. This data will include both rigid gas permeable and hydrogel contact lenses.

INTRODUCTION

In the present contact lens marketplace there currently exist two types of lenses. These are rigid gas permeable (RGP) lenses, commonly called "hard" lenses, and hydrogel lenses called "soft" lenses. All lenses currently in the marketplace are based on methacrylate chemistry. The rigid gas permeable contact lens materials are silicone-methacrylate copolymers and the hydrogel materials are hydrophilic methacrylates with water contents from 38 to 90%. Additionally, some of the newer RGP materials are also fluorosilicone-methacrylate copolymers. The methods for characterization of rigid gas permeable materials and hydrogel materials are often quite different. In this paper we will describe the methods used to characterize both types of plastics. As referenced, hydrogel materials are lathed as dry materials and then hydrated to become the contact lens hydrogel.
**BASIC PROPERTIES**

**Hardness**

In determining whether a polymer will make a good lathe cut lens candidate, the first property measured on the material is indentation hardness. This measurement is either done using a Shore D or Rockwell M durometer. As a general rule any material with a Shore D hardness of 83 units or greater will be able to be lathed into a contact lens. For reference, PMMA has a Shore D hardness of 90. Figure 1 shows the Shore D hardness of silicone-methacrylate copolymers for materials with oxygen permeability values from 10 to $115 \times 10^{-10}$ (cm ml(O₂)/cm²·sec·cmHg).

**Contact Angles**

Contact angles of lens plastics may be measured by one of three methods including the sessile drop, captive bubble and Wilhemy plate techniques. These measurements are generally performed on lenses or squares of material polished in the same manner as the contact lenses. The preferred and most accurate measurement used in our laboratories is the Wilhemy plate technique where advancing and receding contact angles are measured. This method is least sensitive to operator technique and simulates a contact lens in the eye. Captive bubble measurements are also done as a good wetting indicator for RGP plastics but are less precise. Figure 2 shows a plot of captive bubble contact angles for silicone-methacrylate plastics with variable concentration of wetting agent.

![Figure 1. Plot of the Shore D hardness values versus the silicone content for RGP plastics.](image)