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Plasma Surface Modification of Intraocular Lenses

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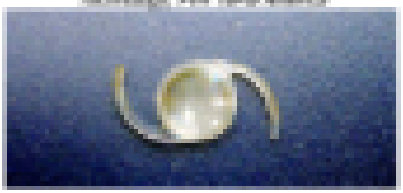
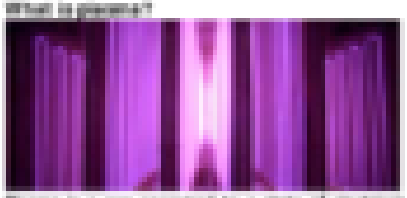


The replacement procedure of diseased or damaged natural eye lenses by artificial intraocular lenses (IOLs) requires an incision in the eye of just 2 - 3 millimeters. IOLs are manufactured using soft polymers that can be folded or rolled into a cartridge and delivered into the eye through a narrow tube. These advantageous deformational properties have a drawback in that they are inherently tacky causing unfolding issues inside the eye. Plasma surface modification of IOLs removes the surface tack, ensuring safe insertion and automatic unfolding of the IOL to its original configuration once inside the eye.

The optic portion of IOLs are lathed into shape, this results in a spiral pattern of machining lines from the center of the lens out towards the edges. These machining lines are traditionally removed by an extensive polishing procedure, however plasma surface treatment can readily remove these machining lines in a simple, dry processing step.

What is plasma?



Plasma is a gas energized to a state of electrical conductivity. Chemically it is a highly reactive environment that is used to change the properties of surfaces without affecting the bulk material. Plasma is a powerful tool in solving surface preparation problems. It provides a reliable, consistent, and environmentally friendly method of reducing surface tack of elastomeric materials.

Reduction of surface tack

Soft polymers used in IOL fabrication allow good recovery of rolled or folded devices after insertion into the eye. The disadvantage of these materials is their surface tack. This can cause self adherence issues preventing deformation recovery and the surgeon may need to manually unfold the IOL *in situ*. This manipulation may be further complicated by the IOL sticking to the surgeon's tools.

Plasma reduces the surface tack while preserving the bulk properties of the material. This is achieved in part by physically altering polymer chain terminations. Polymer chains extending from the surface can entangle with chains from other surfaces resulting in some physical attachment. Plasma acts either to break these surface chains or reduce them to cross link with each other. The result is a smoother, less tacky surface. Plasma also chemically alters the hydrophilicity of the surface encouraging wetting when placed in viscoelastic polysaccharide solution.

The left image shows an untreated IOL unable to unfold automatically after being rolled for loading into the delivery cartridge. The right image shows a plasma treated IOL after being delivered in the same manner and allowed unfold of its own accord.

Plasma lens polishing

In addition to removing surface tack, plasma can also remove the machining lines on the lens improving its optical properties. The plasma accomplishes this by breaking polymer chains where they are most exposed. Highest exposure is at the crest of the ridge lines. As these bonds are broken by the plasma they either leave the surface or reconfigure in more energetically favorable configurations, such as in the troughs of the ridge lines. The result of this dynamic process is an overall leveling effect on a macroscopic scale. In terms of optical clarity there is a noticeable improvement in lens haze.