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Next-generation technology

Biomaterials for ocular therapies advance comfort and utility

Researchers develop contact lens materials, drug-delivery systems, antimicrobial coatings

By Kristi Prado

With the exception of the brain, the eyes are the most complex organ in the human body. Eyes can process 36,000 bits of information every hour and contribute to 85% of a person's total knowledge.

It is not a surprise that ophthalmic technology is constantly evolving to generate treatments for eye diseases and innovative solutions for enhancing vision. Because many ophthalmic disorders are a result of the aging process, ophthalmic products are growing in demand. Biomaterials are playing a significant role in the advancement of many of these new ocular therapies.

Common eye disorders may develop from anatomic changes to the cornea and lens that present as refractive errors. With age and a variety of other factors, including genetic predisposition, varying levels of lost visual function may occur.

Take-Home Message

Because many ophthalmic disorders are a result of the aging process, ophthalmic products are growing in demand. Biomaterials are playing a significant role in the advancement of many new ocular therapies.

Several innovative materials-based solutions are being pioneered for use in products that overcome visual impairment and assure better eye health. Such specialized biomaterials contribute to improved comfort for contact lens wearers, enhanced delivery of pharmaceuticals to the intra- and periocular tissues, and ease of implantation for IOLs.

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Silicone hydrogel contact lenses

The history of contact lenses illustrates the search for novel materials that not only are comfortable, but also deliver enough oxygen to prevent hypoxic events, since the cornea depends on getting oxygen from outside air.

The first generation of silicone hydrogel lenses, introduced with support from materials science, enables the passage of higher levels of oxygen than conventional hydrogel lenses. Lenses incorporating these materials have a reported lower coefficient of friction for improved comfort and allow a greater supply of oxygen for maintaining eye health for millions of contact lens wearers.

Recent developments also include novel high-purity polymerizable hydrophilic silicone monomers (HSMM). The hydrophilic group is attached to the terminal end, away from the polymerizable group, which, upon polymerization and formation of the contact lens, can potentially maintain a high degree of mobility and migrate preferentially to the surface when in contact with ocular tear fluid.

Potential benefits include improved surface wettability and lubricity (Figure 1, Page 14) and elimination of the need for an additional surface treatment process.

As contact lenses evolve, materials continue to be developed for potential use in next-generation lenses, such as non-biofouling coating (VitroStealth, DSM), which is designed to reduce adhesion of proteins and lipids on medical device surfaces. Antimicrobial materials for use in ophthalmic applications are also being developed.

Drug delivery

From ophthalmic diseases affecting the back of the eye, to changing how glaucoma treatments are delivered, the intra- and periocular tissues have proved to be challenging administration routes. Ophthalmic biopharmaceutical companies continue to innovate with the creation of new pharmacotherapies and advancements for the delivery of these compounds. Bioresorbable drug delivery systems, formulation expertise, and sophisticated processing techniques are used in customized polymeric injectable and implantable dosage forms, such as microparticles and microfibers.

These systems offer release times up to several months (Figure 2, Page 14) with improved characteristics, such as burst control, absence of acidic degradation byproducts, and sustained, near zero-order release profiles.

Insertion of an IOL during cataract surgery is the most commonly performed surgical eye procedure, and manufacturers are constantly looking for improved IOL designs and delivery methods.

As an example, customizable hydrophilic coatings (ComfortCoat, DSM) are being developed to impart lubricity to IOL delivery systems, and may allow IOL manufacturers the ability to enable insertion of a lens consistently through a smaller-diameter cartridge tip, reducing incision size and the pressure required. In turn, patients would endure less trauma and experience faster recovery times.

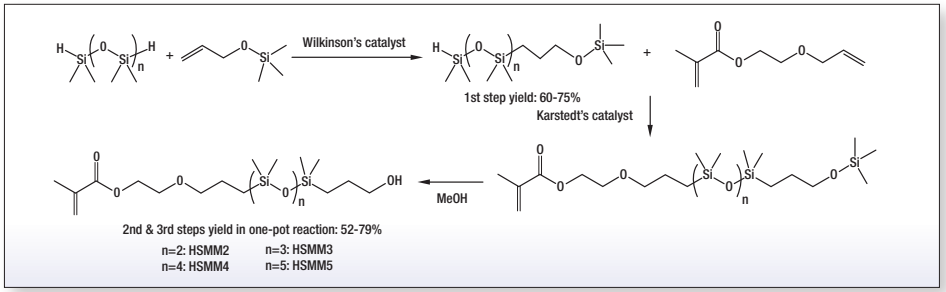

Figure 1 Synthesis of hydrophilic silicone monomers (HSMM).

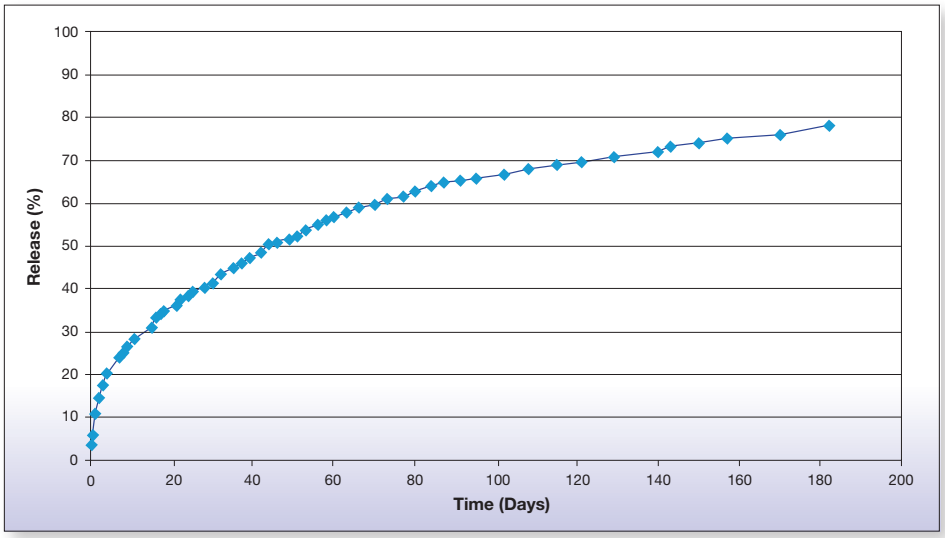

Figure 2 **Average latanoprost release (%); 10% latanoprost/PEA release data, averaged daily release ~1 to 2 µg/day. Daily release can be modified by choice of PEA, formulation, and/or processing techniques chosen.** (Figures courtesy of DSM Biomedical)

Getting to market

Due to the intricacies of ophthalmic technologies, reaching commercial viability is a substantial challenge to manufacturers. This requires support from materials partners who not only can provide superior materials and high-quality processing capabilities, but also the ability to scale-up under the care of strict quality systems.

The market for ophthalmic biomaterials will continue to expand and evolve as researchers explore diverse solutions for the treatment of chronic eye disorders, as well as advancements in contact lenses and control of lens-associated infections. Researchers will continue to meet the market demands by providing next-generation contact lens materials, advancing development of superior drug delivery systems and improving ophthalmic devices with lubricious and antimicrobial coatings. As the ophthalmic market explores the use of microelectronics, artificial retinas, and contacts that are capable of much more than correcting refractive problems, researchers will continue to work with market leaders in order to continue supporting improved patient outcomes.**OT**

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author info

Kristi Prado became interim business director/biomaterials in October 2012 for which she is responsible for overseeing all biomaterial business segment teams of the biomedical business of DSM. Prado joined The Polymer Technology Group (PTG), now part of DSM Biomedical, in 2001 as its director of business development, bringing with her more than 15 years of business management experience. Prado has been managing the ophthalmic business segment since 2008.