

THE YEARS BETWEEN 2004 TO 2014

MITSUI CHEMICALS' VIEW OF THE LAST TEN YEARS

The development of new monomers for spectacle lenses is a long and complicated process, until finally the spectacle lenses made of a brand new material are ready for market. It is not just a matter of developing a new raw material – the monomer has to be suitable for casters and labs, as well as processing and machining too. Thus it is difficult to write about the development of monomers over the past ten years. Read what has been done during this time at one of the leading international monomer developers, because even away from product development a lot can happen.

By Robert Kaster

Mitsui Chemicals Inc. (Mitsui) has a long track record in the development of high refractive index monomer for ophthalmic lenses. The last big innovation by Mitsui that had been made commercially available through Mitsui's customers is MR-174. This was around the year 2000.

Since this time many major casting companies and lens manufacturers have adopted the full range of high refractive index lens monomers in their production process, offering eyecare practitioners and consumers the benefits of thin and light glasses combined with great optical and mechanical properties.

Since lens monomers are the very basis of product innovations in every field of ophthalmic optics, it takes some time to adapt new lens materials in such a way that they are commercially available for the eyecare practitioner as well as for the consumer.

In order to successfully commercialise new

lens materials, a series of steps needs to be considered carefully. Even though the list below is not complete, it shall provide a brief overview of the most important steps:

- | The so-called casting process which is transforming the lens monomers into a polymer, in the shape of either finished or semi-finished lenses
- | Cutting and polishing to achieve the correct prescription and optical properties based on the cast semi-finished lenses
- | Tinting the lenses, either for prescription sunglasses or slightly tinted lenses for fashion aspects
- | Hard and AR-coating
- | Applying photochromic or polarized lens technology
- | Edging the lenses to the shape of the frame and mounting the lenses in the frame

Having mentioned all of the above, it becomes obvious that the introduction of new lens materials usually takes more time than the introduction of a new lens design.

However, looking back the last ten years, Mitsui has been very active in the wide field of Vision Care related materials. For Mitsui it is and has been a prime target to combine expertise from different fields in order to develop new products and technologies. Expertise can be obtained by cooperation with external partners or by sharing within the Mitsui Vision Care group companies. In order to increase this cooperation, Mitsui has acquired a series of companies or shares in companies that are experts in the field of Vision Care related materials.

In 2008 Mitsui acquired SDC Technologies (SDC), a California based premium coating material company.

SDC is a pioneer of innovative performance-based abrasion resistant coatings used in a variety of applications from aerospace and automotive parts to eyewear. Established in 1986, SDC develops, manufactures and globally distributes abrasion resistant coatings for application to plastic, glass and metals. These coatings add premium performance, appearance

and durability to eyewear, sunglasses, safety lenses, and other custom applications.

In 2010 SDC acquired FSI Coating Technologies (FSI), formerly Film Specialties: The company was founded in 1986 to develop and market anti-fog scratch resistant hard coatings, film and sheet products for commercial and industrial markets.

In 2011 Mitsui acquired Acomon. The optical lens material manufacturer is well known for its RAV 7 Series of refractive index 1.50 lens materials that offer exceptional clarity and durability. The comprehensive portfolio of Mitsui's MR-Series premium high-index, and Acomon's RAV 7 low index optical lens materials combined with SDC innovative coatings allows Mitsui to deliver a complete product solution to the ophthalmic community. In 2013 the Korean KOC Solution (KOC) joined the Mitsui group. KOC is a manufacturer and distributor of plastic optical lens monomers. With its middle to high index lens monomers the company greatly enhances Mitsui's product portfolio. The globally recognised KOC product range includes mid and high index, photochromic as well as impact resistant lenses. This acquisition also provides opportunities for the expansion in the growing Chinese market through the manufacturing and sales sites owned and operated by KOC.

In 2014 the subsidiary SDC purchased a majority ownership of Lens Technology

International (LTI), strengthening its advanced technology and global expansion in high performance abrasion resistant coating solutions. LTI is the recognised leader in the development and manufacture of high performance, proprietary UV curable anti-scratch coatings for the ophthalmic market. In May 2014 Mitsui acquired SunSensors from Corning, entering in the rapidly growing global market of photochromic lens material.

SunSensors is a patented in-mass technology for plastic photochromic lenses and compatible with most AR- and hard-coating treatments. Under AS/NZS 1067 when outdoors the lenses are classified as sunglasses.

Due to the growing network of companies, each with its own expertise, Mitsui is in the position of combining the know-how of lens materials with coating technologies. For example, by developing solutions in order to increase the impact resistance of a lens, the lens material developers of Mitsui, Acomon and KOC set out to improve the Izod impact strength a quantitative impact test that is more suitable to discriminate than the FDA drop ball test. In order to preserve the higher impact resistance, a suitable coating is then specially developed by SDC to guarantee a maximum result. Only such combination of expertise will lead to real benefits for Mitsui's customers, eyecare practitioners as well as consumers.

Over the last years, Mitsui has seen an increasing demand for high refractive index materials.

The increasing demand seems to be caused by various factors:

- | The ratio of mineral lenses was decreasing over the last ten years. Obviously this trend differs per continent and also per country, but looking at developed markets such as Germany, the conversion from mineral to plastic started relatively late compared to other countries. On the other hand the ratio of mineral lenses went down from around 33% of all ophthalmic lenses sold in the German market to less than 10% over the last 10 years.
- | Consumer research shows that in developed as well as emerging markets, consumers are willing to spend more money on their glasses if they can be made thinner and lighter. It is recognized by the consumer that thin and light glass will not result in more aesthetic bad comfortable glasses.
- | Progressive myopia is increasing, mainly in Asia, but this trend is also seen in other regions. Based on this development, children need glasses earlier, and due to higher power, the need for thin and lightweight glasses is higher.
- | Emerging markets are looking for high-end eyewear. In emerging markets, there is a growing middle class which recently can afford more expensive eyewear, and who are looking for the most comfortable eyewear.

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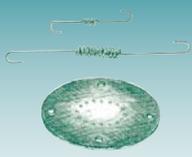
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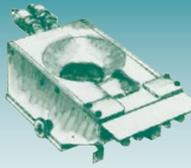
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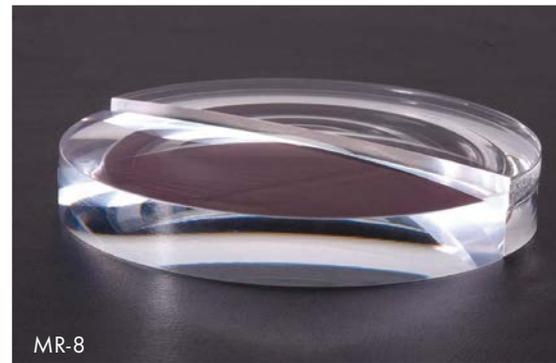
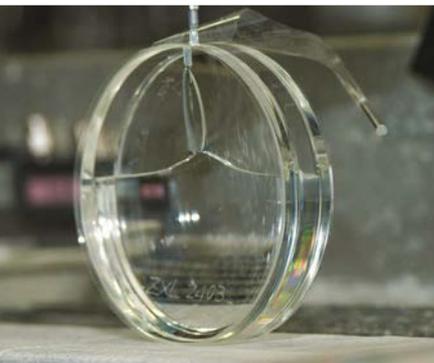
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Recently Mitsui has released information about new product developments. The products are currently in different phases commercial availability.

- | MR-8 Plus: no primer in need to pass the FDA drop ball test
- | Do-Green: ecological lens material
- | PET technology: polarized lenses without decolorization
- | UV+420cut: protection against harmful light
- | Materials for plastic frames

NO PRIMER IN NEED TO PASS THE FDA DROP BALL TEST

Many markets are focusing on high impact resistance, especially the United States. This is one of the reasons why polycarbonate has a very high market share.

Apparently this trend is ongoing despite its poor optical and processing properties.

Even though the current commercially available version of MR-8 can be processed such that it will pass the requirements of the FDA drop ball test, Mitsui has recently introduced MR-8 Plus. With this improved version, lenses do not need to be treated with a primer in order to pass the FDA drop ball test. MR-8 Plus comes with the same optical properties as the current version of MR-8 (Abbe value 39) and a similar specific gravity (1.30 g/cm³). An additional benefit for Rx labs is its improved tintability.

ECOLOGICAL LENS MATERIAL

Mitsui is the first supplier of high refractive index lens monomers to introduce an ecological lens material. This monomer series is called Do-Green and is based on biomass components. Do-Green is available in refractive indices of 1.60, 1.67 and 1.74. Depending on the refractive index, the ratio of biomass material differs from 20% (refractive index 1.67) up to 90% (refractive index 1.74).

All Do-Green materials have the same or similar optical and mechanical properties as conventional Mitsui products.

POLARIZED LENSES WITHOUT DECOLORIZATION

The current technology for polarized lenses uses PVA (polyvinyl alcohol) film. PVA is reactive to water and temperature, thus the film will decolorize in contact with water. PET (polyethylene terephthalate) almost does not react with water, so decolorization is no issue in polarized lenses when using a PET film.

Additionally Mitsui's PET polarized film has a high refractive index, so it is almost free of interference, even with a lens material of refractive index 1.67. This provides the possibility of high refractive index polarized lenses which are very durable and aesthetic, especially considering the increasing demand of thin and lightweight lenses.

The PET polarized technology has been co-developed in cooperation with Hopnic. Hopnic is a Japanese casting company known for its high quality. They are specialized in the field of casting polarized semi-finished lenses.

PROTECTION AGAINST HARMFUL LIGHT

In recent years the impact of so called HEV (high energy visible) light on eye health has been subject to research and there have been several related product introductions. Recently there seems to be proof that HEV is likely to increase the risk of AMD (age-related macular degeneration). Blue light (HEV) is also said to have a significant impact on the circadian rhythm. Mitsui has recently introduced UV+420cut technology. This only slightly tinted technology can be applied to refractive index 1.60, 1.67 and 1.74 lenses. It protects the

wearer against harmful UV light below 400nm as well as potentially harmful HEV up to 420nm. UV+420cut can be combined with regular AR coatings to improve transmittance and avoid potentially disturbing reflection, which is especially important when driving at night.

MATERIALS FOR PLASTIC FRAMES

Since Mitsui is active in several other areas of chemicals and plastics, it has recently developed a thermoplastic polyurethane (TPU) material with unique properties to be used in frames. This material is light, flexible, UV resistant, easy to process and very easy to tint.

TPX is a worldwide exclusive 4-methylpentene-1 copolymer from Mitsui, with the lowest density (0.83 g/cm³) among all thermoplastics polymers, ensuring TPX articles unique floatability properties.



Robert Kaster

Robert Kaster is a graduated engineer in ophthalmic optics. Over the last ten years Rober Kaster was working for the ophthalmic lens industry in the fields of R&D as well as Marketing with national and international responsibilities. Since summer 2014 he is Marketing Manager for Vision Care Materials at Mitsui Chemicals Europe GmbH.