



Contact Lenses – The Material Benefits

Daily disposable contact lenses and now silicone hydrogel products have given further success to the cast-moulded contact lens. For the specialist lens manufacturer there is a greater need to provide unique solutions to ensure their continued success.

Contact lens materials have evolved considerably in recent years, particularly with products providing greater levels of oxygen to the cornea. These materials, referred to generically as silicone hydrogels, will without doubt become the dominant material for contact lens products in the very near future. Despite this significant shift in the types of contact lenses available, there has been no evolution of the classification system for contact lenses. This is further evidenced when consideration is extended to include novel material solutions that are now available to the speciality lens manufacturers.

The ISO 11539 standard for the classification of contact lenses, describes the use of a six part code to describe a material type.

prefix – stem – series suffix – group suffix – Dk range – modification code

Prefix and series suffix are both terms that are administrated by the United States Adopted Names (USAN) Council and as such are only relevant for materials with FDA approval.

Two types of stem are used. The filcon stem is affixed to the prefix and is applied for materials which contain >10% water by mass (hydrogel materials). The focon stem is affixed to the prefix and is applied for materials which contain <10% water by mass (non-hydrogel materials). The group suffix is detailed in Table 1 and the Dk range in Table 2.

Table 1 – Group Suffix for Filcon and Focon Stem

Group Suffix	Filcon (hydrogel)	Focon (non-hydrogel)
I	Low water content, non-ionic <50% EWC, <1% ionic monomer	no silicone + no fluorine
II	High water content, non-ionic >50% EWC, <1% ionic monomer	silicone + no fluorine
III	Low water content, ionic <50% EWC, >1% ionic monomer	silicone + fluorine
IV	Low water content, non-ionic >50% EWC, >1% ionic monomer	no silicone + fluorine

EWC – Equilibrium Water Content

Table 2 – The Dk Range for oxygen permeability

Oxygen Permeability (Dk range)	
0	<1 Dk unit
1	1 to 15 Dk units
2	16 to 30 Dk units
3	31 to 60 Dk units
4	61 to 100 Dk units
5	101 to 150 Dk units
6	151 to 200 Dk units
7	Increasing in increments of 50 Dk units

Although an ever-increasing number of silicone hydrogel lenses are appearing on the market, it is inappropriate to think of these as the same. Significant differences exist among these lenses, not least of which are the recommended wear periods, which are governed by the oxygen transmissibility and a range of silicone containing components are used to provide increased oxygen transport properties. The practical problems of combining silicone-containing components with hydrophilic monomers have been well documented in the past. The novel approaches used to overcome the basic chemistry issues with these materials are not the only differences in the current offering of silicone hydrogels. Other distinctions include the use of plasma treatment to modify surface characteristics and the inclusion of additives, claimed to improve surface wettability.

Silicone hydrogels are currently classified as hydrophilic materials, which seems reasonable. Since all currently available lenses are non-ionic and contain less than 50% water, they are all Filcon I materials. However they contain significant proportions of silicone and in some cases fluorine components and could be also be categorised using the Focon stem. Given the significant step forward that these hydrogels represent, it seems logical to introduce a new stem dedicated to this class that combines the elements of the two more traditional types of materials. A group suffix describing a relevant property such as modulus may also prove a useful addition.

The success of silicone hydrogel contact lenses has resulted in demand for these types of materials for the speciality lens manufacturer. However developing a silicone hydrogel material for the speciality contact lens industry is not a straightforward proposition. There are various obstacles to overcome before producing the material in button form that can be processed into a contact lens. Raw material costs for silicone hydrogels are relatively significant. Commercial constraints are also a factor - companies have invested millions of pounds developing these materials and considerable knowledge has been derived by these activities with any significant breakthroughs being carefully protected by the enforcement of patents.

The lathing of silicone hydrogel materials will provide further challenges to the speciality lens industry. Inclusion of what is essentially a silicone elastomer component, results in such materials being relatively soft in nature. The lathe turning of such materials to produce lenses with acceptable optical quality will, at the very least require the highest performing machine platforms currently available. The use of additional speciality equipment may also be a necessary requirement.

At this stage attention should be drawn to some more controversial products being made available. The current popularity of all things silicone hydrogel is leading to a number of products claiming such status when in fact they are best classified by more traditional terms. These include hydrophilic materials, which contain small levels of silicone – so small that any advantageous oxygen permeability being offered would need to be questioned. Another term is that of a rigid silicone hydrogel – a material with a very low water content is best described as an RGP material.

The emphasis on the speciality lens manufacturer is to continue to produce innovative lens designs until silicone hydrogel materials become available.

More challenging lens designs are being produced in an effort to differentiate the speciality lens from its cast-moulded counterpart. This is being achieved via the high precision machining platforms that exist in the market. However the material suppliers within the industry also have a part to play in this evolution of lens designs. The development of new materials, which offer specific improvements in performance including composite materials, are enabling lens designs to expand the performance envelope.

The contact lens industry as a whole has voiced considerable protest after a recent prediction of the demise of the gas permeable contact lens. Actually, the superior visual performance of this type of materials is possibly the main driving force behind various other material options that are now being vigorously promoted.

GP materials with high levels of oxygen permeability have been widely available for some time and the initial perceived comfort of these materials has been difficult to improve. However GP material manufacturers have taken note of the use of plasma treatment to improve the surface characteristics of silicone hydrogels. Indeed Contamac is supplying lens manufacturers who possess the required equipment support in optimising this technology, to improve even further the excellent surface properties of the Optimum range of materials. The inclusion of the modification code (m) in the ISO standard provides indication when materials have been subjected to surface treatment.

The re-emergence of a 2 part contact lens is also progressing. A number of materials utilise a GP material for the central optic portion of the lens and a flexible material for the periphery. This is by no means a new concept - the Saturn lens and subsequent Softperm lens are of similar design. A range of approaches is being followed in providing a flexible edge to the lens. Both hydrophilic materials and soft elastomeric materials have been used for this application. It should be noted that the classification of these material types using the current ISO system is not clear. It may be possible to describe individually the two or more materials that form a multi-component material, however a single description for the combined material has yet to be devised.

The continued evolution of contact lens materials will result in the emergence of materials offering increased performance for more complex lens designs particularly in conjunction with high precision machine platforms. Indeed the complimentary material and machine solutions provided amongst others by Contamac ensures the continued success of the speciality lens industry in anticipation of silicone hydrogel materials becoming widely available.