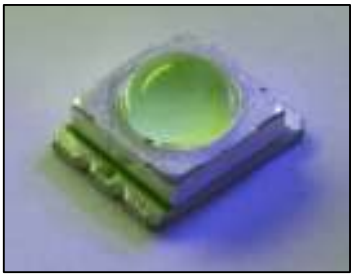
Technical Application Report

Silicones for LED's



LED's (Light Emitting Diodes) are one of the fastest growing new technologies within the electronics industry. They are and will continue to revolutionise lighting technologies across a wide range of industries.

Key features include

- High efficiency – low power consumption, reduced energy costs
- Long working life – reduced replacement costs and maintenance, down time etc
- Versatility - electronic control, miniaturisation
- Cold front end light

Applications

- Automotive vehicle lighting
- Display for sports and advertising
- Back lighting for LCD screens
- Signage
- Aviation display lighting
- Airport lighting
- Street lighting
- Stage & theatre lighting
- Rail & road signalling systems
- Architectural lighting
- Domestic lighting
- Industrial machine lighting
- Medical

Design challenges for LED applications

Many lighting applications require strict control of the colour output of the light unit whether incandescent, fluorescent or LED. Manufacturers of white High Brightness (HB) LED's have struggled to produce consistent product with tight colour output specifications. In order to increase market penetration they will need to improve the power output of white HB LED's. Although LED's produce cold light; that is to say there is no heat produced in front of the light source, they do produce heat at the rear of the diode. If this heat is not dissipated away from the diode the performance will deteriorate dramatically, the working life will be shorter and power consumption will increase.

A key factor in the performance of all LED lighting is good thermal design in order to maintain the optimum operating temperature together with optical systems that allow the maximum amount of light to be transmitted and focused away from the diode.

Use of silicone encapsulants

Sensitive LED's need protection from moisture and other harsh environmental hazards. This protection is normally provided on two levels, the micro and macro. Silicones can also be used to improve the light output and overall optical efficiency of the device.

Micro level

In these applications clear silicone gels and elastomers are used to encapsulate individual diodes. In addition to providing protection they can be used to improve the light output of the LED. Silicones with a high refractive index or one that is matched to the lens material, produce significant improvements. Silicones used at the micro level may also be required to have very low ionic content which will reduce the risk of interference with the electrical properties of the diode.

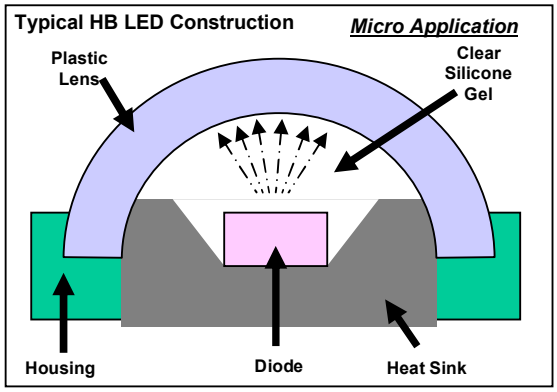
Any yellowing of the encapsulant due to heat exposure or UV light will also have a detrimental effect on the light output and particularly, the colour temperature index of the light produced by the LED. Modern reflow

soldering of diodes onto PCB's requires temperatures up to 260°C which can cause this discoloration in epoxy and other resin based encapsulants, but not silicones.

The delicate wire connections between PCB and diode are vulnerable to mechanical stress caused by fluctuations in temperatures therefore, it is also important the chosen encapsulant has low modulus properties and a high Coefficient of Thermal Expansion (CTE).

Features of silicone encapsulants for Micro protection

- UV resistance
- Non-yellowing
- High refractive index 1.40 to 1.57
- Low impurity levels
- Low modulus
- High CTE
- High and low temperature resistance -55 to +260ºC
- Optical clarity



Macro level

Many of the applications listed previously will require further protection for the final packaged lighting device. This protection may take the form of encapsulation, coating or sealing.

Outdoor display screens, lights, signs and many more products will need sealing against moisture ingress. Automotive and aviation applications may also require protection from vibration and heat. Thermal design may require any encapsulant used to have a degree of thermal conductivity in order to transmit heat away from the diode to a suitable heat sink.

Silicone elastomers can be formulated to meet many of the physical properties required by designers working with LED's. Choice of silicone will very much depend on the application, production methods, working conditions and technical requirement of the elastomers.

Features of silicones used in Macro applications

- 1 & 2 Part systems
- Heat or RTV cure
- Range of hardness from Gel to 80 Shore A
- Thermal conductivity 0.30 to 2.5 W/mK
- Wide operating temperature -115 to +300ºC
- Optically clear or opaque
- Self bonding
- Electrically insulating
- Water repellent
- Vibration resistant
- Non-corrosive
- UV resistant
- UL94 V-0 approved
- Wide viscosity range - paste to low

Example of typical application in mega screen display

Large outdoor mega screens are made up of many thousand LED's arranged in RGB formation. Once assembled these banks of LED's need to be potted for two reasons:

1) Protection from the environment
2) To improve definition and reduce reflection

Protection can be provided using a flowable silicone which has been designed to flow around the individual LED's.

Definition is improved by making the silicone black. This has two advantages. Firstly none of the electronic components supporting the LED's are seen and secondly unwanted light reflection is reduced to a minimum.

The silicone will with stand all weathers and provide protection during transportation of mobile units.

ACC Silicones Products for LED's

Optically Clear Encapsulants

These products are typically made using Dimethyl polymers and will have a refractive index in the range of 1.38 to 1.41.

Product Code	Description	RI	Duro Shore A
QGel300	Tough silicone Gel	1.40	Gel
QGel301	Fast cure silicone gel	1.40	Gel
EGel3000	General purpose silicone gel	1.40	Gel
QGel311	Silicone gel encapsulant	1.40	Gel
QGel330	Tough, low viscosity silicone gel	1.40	Gel
QSil216	Optically clear 2-Part encapsulant	1.40	40
QSil218	Optically clear 2-Part encapsulant	1.40	59
QSil222	Optically clear 2-Part (self bonding)	1.40	59
QLE1102	Optically clear 2-Part (low viscosity)	1.40	45

Thermally Conductive Encapsulants

When selecting a thermally conductive encapsulant there is generally a trade off between flexibility and thermal conductivity due to the nature of the fillers used as you raise the conductivity you will also see a rise in hardness. QSil553 has been proven to provide a good balance offering reasonable conductivity whilst retaining a low modulus and hardness, thus reducing stress during the thermal cycle.

Product Code	Description	Colour	Duro Sh A	Thermal Conductivity W/mK
QSil556	2-Part Addition Cure	Grey	46	0.32
QSil550	2-Part Addition Cure	Grey	55	0.37
Silcoset 101	2-Part High Temperature Rubber	Red	61	0.37
SE2008	Thermally Conductive Silicone Encapsulant	Black	48	0.50
QSil553	Thermally Conductive Silicone Encapsulant	Grey	32	0.68
QSil573	2-Part Thermally Conductive Encapsulant	Grey	65	0.90
SE2003	Thermally Conductive Silicone Encapsulant	Brick Red	80	1.27
AS1421	1-Part Thermally Conductive Heat Cured	Grey	56	2.10

General Encapsulants

SE 2008 has successfully been used in the mega screen manufacture.

Product Code	Description	Colour	Duro Shore A
SE2005	2-Part Silicone Encapsulant	White	40