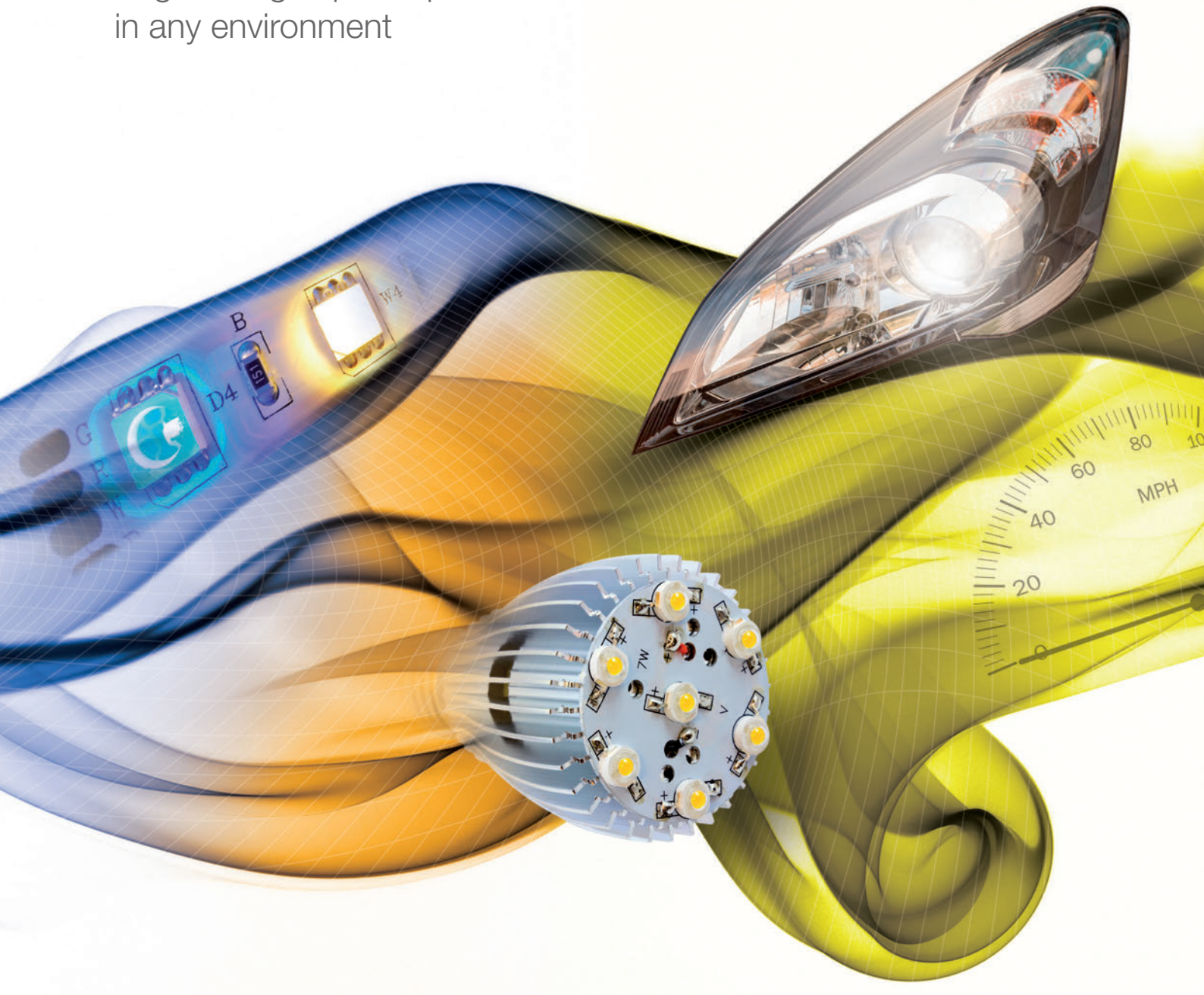


LED A Leading Light

Engineering superior performance
in any environment



ELECTROLUBE
THE SOLUTIONS PEOPLE

Committed to Improving Performance



Since 1941 we have been developing solutions to advance engineering and enhance technological performance. With our expansive range of products and a thirst to push what's possible, there is no end to the applications of electro chemical solutions; including our contributions towards improved capabilities within the LED industry.

With a strong emphasis on both research and collaboration, we are constantly developing new and environmentally friendly solutions for our customers, old and new.

Because we're represented in over 50 countries, our disciplined network of subsidiaries and distributors can offer all our customers genuine security of scale. This robust supply chain means that when the unexpected happens, we're still capable of delivering a truly bespoke service anywhere in the world.

Our Mission Statement

To strive to exceed our customers' expectations with innovative new products and the highest possible levels of customer service.

We Have the Solution

Our ambition to constantly adapt and improve the performance of any product has contributed to the extent of our expertise, and resulted in a range of products in Electronic and General Purpose Cleaning,

Conformal Coatings, Encapsulation Resins, Thermal Management Solutions, Contact Lubricants, Maintenance and Service Aids. We also offer tailored solutions for those who can't find the perfect solution.

The LED Boom



The LED industry is rapidly expanding offering a vast array of uses for LEDs in all types of lighting, signage and domestic appliance products, to name but a few.

In offering alternatives to halogen, incandescent and fluorescent lighting systems for both interior and exterior applications, the growth of the LED lighting market alone is impressive.

Such growth is attributed to the advantages LEDs offer over traditional lighting forms in terms of adaptability, lifetime and efficiency; they allow more design freedom, offer an exceptionally long life time and they are also considerably more efficient, converting the majority of energy to light and thus minimising the heat given off.

Lighting Designs

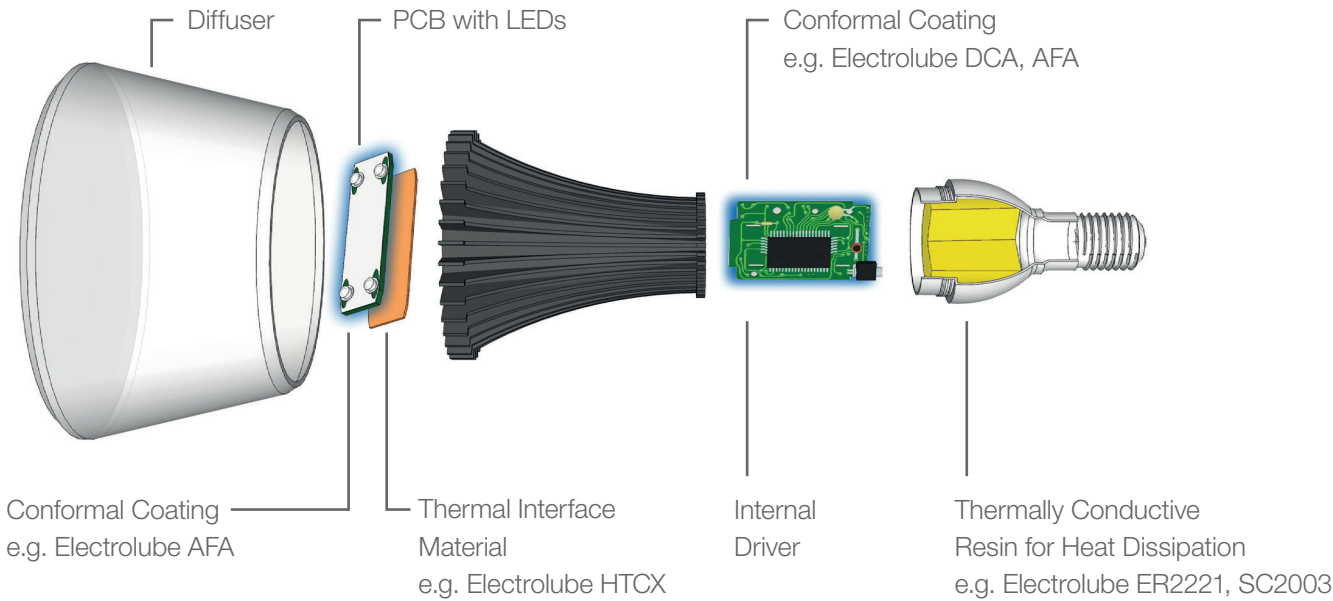
Due to the design freedom an LED offers, applications are becoming more diverse and challenging and whilst achieving the desired aesthetic affect, the reliability and lifetime of the product must also be considered.

Electrolube products can be used to assist Design Engineers in protecting LED systems in a variety of conditions, including the installation of lighting designs in corrosive environments, for example.

Electrolube also offer products that can be incorporated into the design of the product for cosmetic reasons as well as helping to provide key functional improvements such as increased efficiency and reduced energy consumption.



LED Lamp Application



Enhancing Performance in Challenging Environments

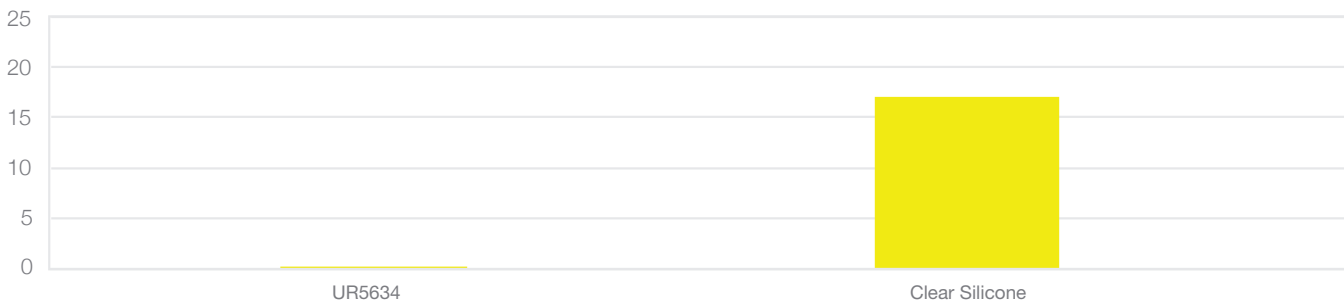
The environment that the LEDs and associated electronic components are used in will have an effect on the type of product required to protect the system and ensure reliability.

Whether the conditions provide a humidity, chemical, salt mist or corrosive gas challenge, Electrolube can offer conformal coatings and encapsulation resins to

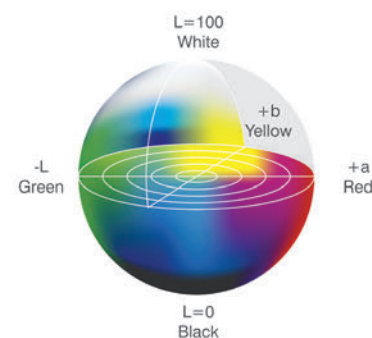
enhance performance and ensure reliability throughout the lifetime of the device.

With a wide variety of products available, Electrolube can also offer materials to work in conjunction with particular LED requirements, such as low or zero VOC options, for example.

% Reduction in Luminous Flux after H₂S Exposure



Enhancing LED Performance



Chemistry Options

As well as offering a range of product types, Electrolube also work with a number of different base chemistries to provide solutions for a vast array of applications.

Depending on the product type there are epoxy, polyurethane, silicone, acrylic and non-silicone, synthetic material blends available.

Such a vast array of chemistry types provides a range of properties including toughness, flexibility, high temperature resistance, clarity, chemical resistance, low temperature performance, adhesive strength, to name just a few.

Protection Over the LED – Clarity and Hazy Resin

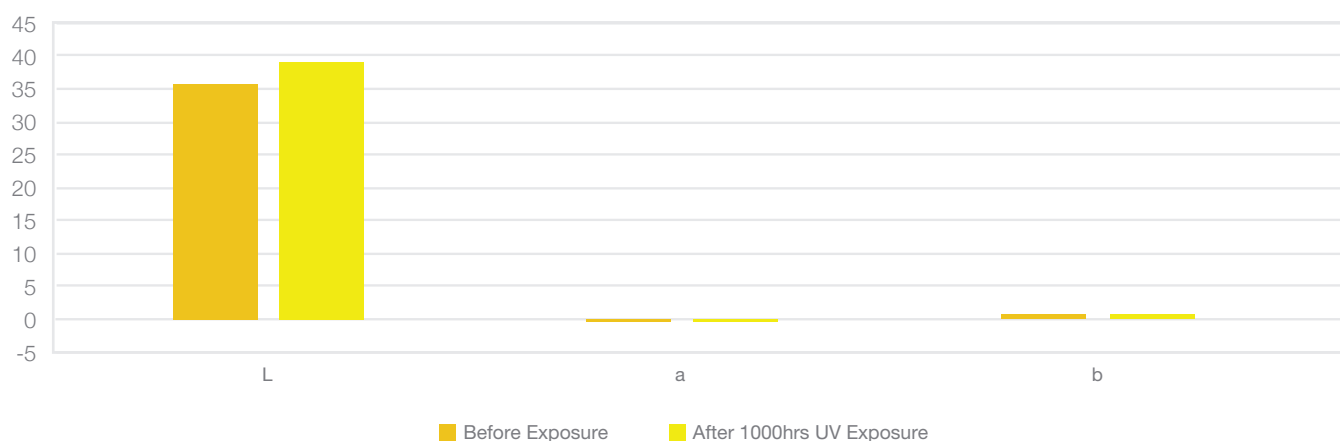
When directly protecting the LED there are a number of factors that must be considered. The clarity of the material applied is crucial to ensure the maximum utilisation of light output from the LED. In addition, any potential changes that can occur over the lifetime of the LED must also be considered.

Electrolube products SC3001, UR5634, UR5635, UR5562, AFA, HPA, APL, have been tested to show their UV stability, utilising a QUV SE Accelerated Weathering Tester and testing for colour change using the L*a*b colour space system. In accordance with ISO 4892, Electrolube resins and coatings were exposed to 1000 hours of UV light; conditions roughly equivalent to 4 years weathering resistance in a Northern European Climate.

Typically categorised by colour temperature, LEDs are also available in a huge number of colour variants. The colour temperature of the LED can be affected by the protection media applied and therefore the potential colour temperature shift should be tested in accordance with the LED used. Electrolube can also offer guidance for the correct selection and application of products in order to find the optimum balance of minimising colour temperature shift whilst obtaining the required protection level.

In addition to offering clear products with a high clarity, Electrolube can also offer solutions such as UR5635, that offer both light dissipation and protection of the LED in one package, thus eliminating the need for diffuser covers in some applications.

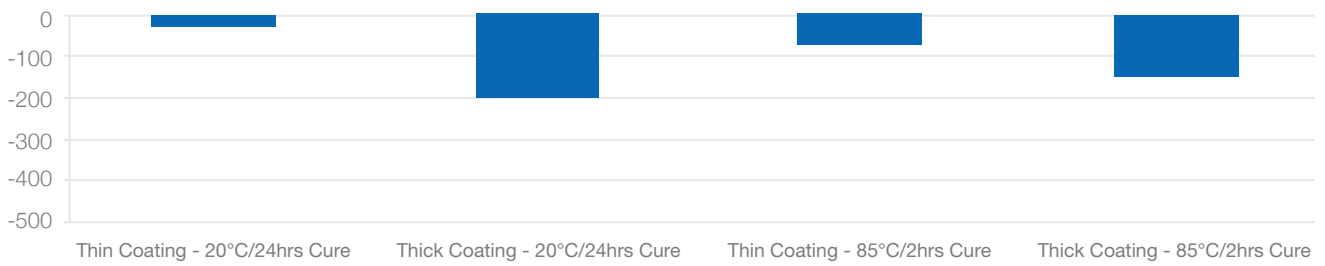
SC3001 UV Exposure Testing



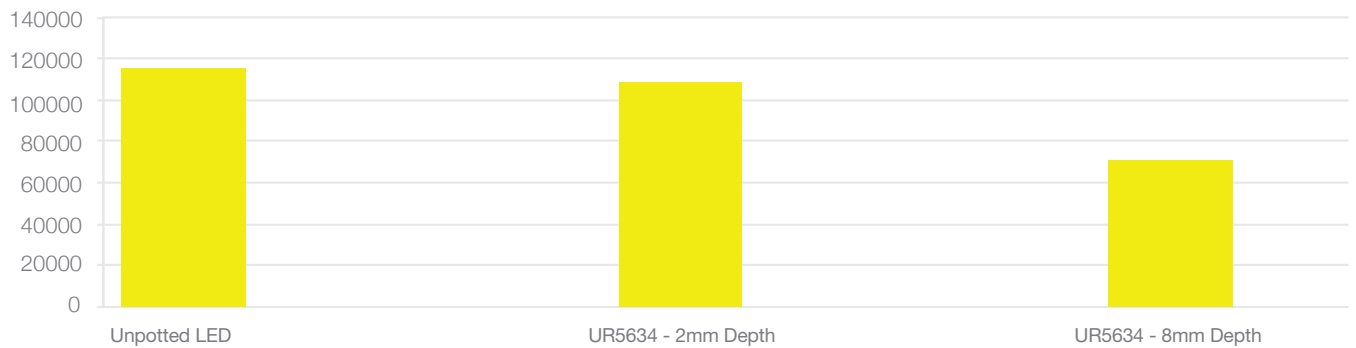
Product Tests



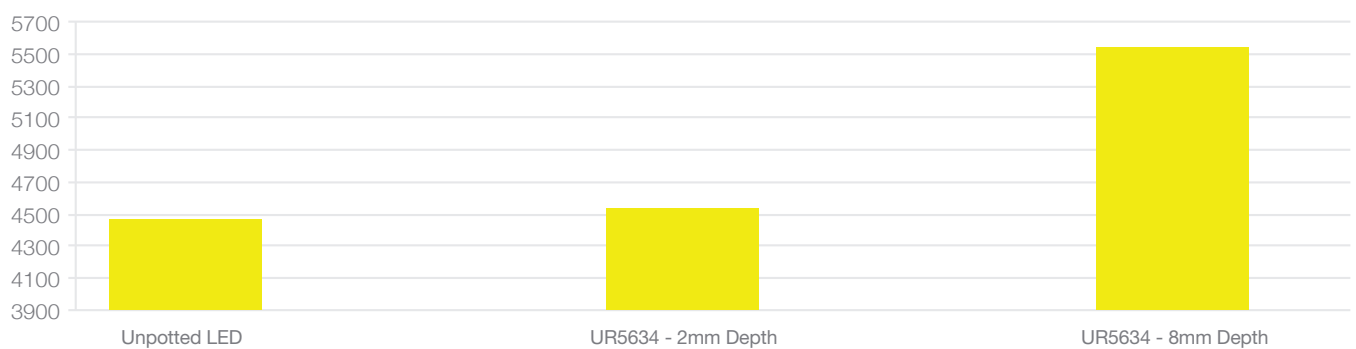
AFA – Colour Temperature Shift Comparison



Luminance [cd/sqm] - UR5634



Correlated Colour Temperature (CCT) [K] - UR5634



Performing When the Heat is On



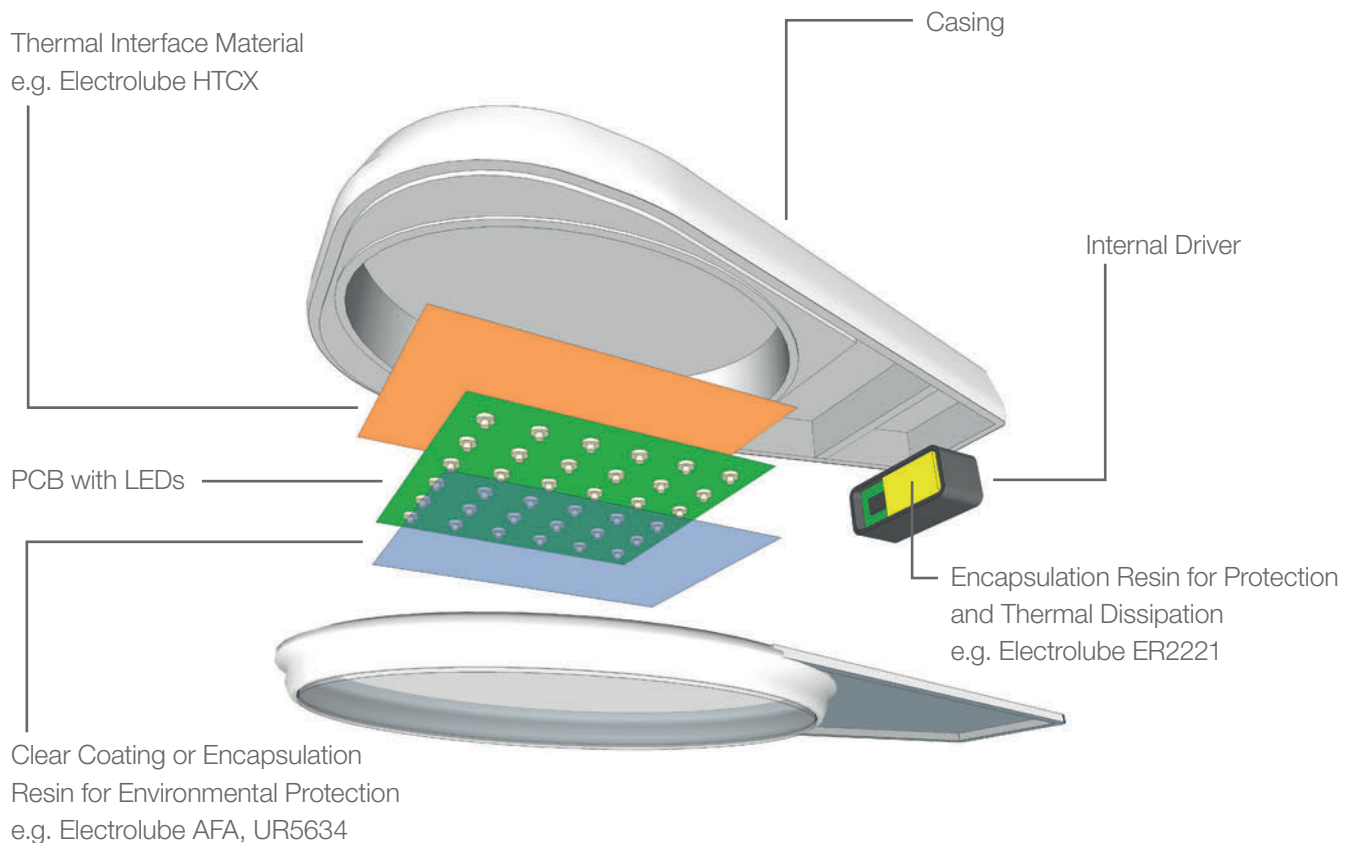
Although LEDs are considerably more efficient than traditional lighting forms, they do still produce some heat. This heat can have an adverse effect on the LED and therefore must be managed to ensure the true benefits of this technology are realised.

Electrolube can offer a range of thermally conductive products to help reduce the operating temperature of the LEDs, thus increasing the efficiency and operational lifetime.

Thermal interface materials (TIM) can be provided in both curing and non-curing forms, allowing for bonding of the surfaces or alternatively, offering heat transfer in a fully reworkable package.

In addition to thermal interface materials, Electrolube can also offer solutions for thermally conductive encapsulation for dissipating the heat away from power components such as LED drivers.

LED Street Light



Protection of LED Components



Thermal Dissipation

Power components, such as the LED driver, may also require protection from the external environment and in some cases, heat dissipation may also be required. The need for a clear material in such cases is replaced by the requirement for a robust resin with a good level of thermal conductivity.

Depending on the environment the resin will be exposed to, there is the possibility to choose between different chemistry types. For example, if the assembly will be exposed to frequent and rapid changes in temperature,

a flexible polyurethane or silicone material will offer better performance than a tough, rigid epoxy.

When choosing a protective material for LED assemblies, good thermal conductivity and moisture protection should be combined with ease of processing to ensure complete encapsulation. Electrolube can assist in choosing between a number of solutions, for heat transfer at the thermal interface and for full protection via encapsulation, thus selecting the most appropriate combination of processing and in-use performance.

Removing Heat from the LED – Thermal Interface Materials

Thermal interface materials are used between the PCB and the heat sink in order to dissipate heat away from the LED, in turn reducing the junction temperature and prolonging the life of the LED.

Electrolube offer thermal bonding products as well as non-curing options, thus providing the complete solution whether the assembly is to be permanent or where the requirement for replacement of LEDs is present.

The choice of thermal interface material will also depend on the operating environment and power of the luminaire. Silicone and non-silicone options are available as well as mid-range and high thermal conductivity options.

The application of the thermal interface material is also crucial. Electrolube's non-curing thermal management pastes can be applied in thin layers, dramatically reducing the thermal resistance at the interface.



Conformal Coatings



Coating Options

Typically applied at 25-75µm, these coatings 'conform' to the contours of the board allowing for excellent protection and coverage, ultimately extending the life of the luminaire.

They are simple to apply and fast drying, thus offering the ideal combination of protection and quick throughput for high volume manufacture.

| | AFA | AFA-F | AFA-S | APL | HPA |
|-----------------------------------|-----------------------|------------------|------------------|----------------------------|--------------------------|
| Description | Aromatic-Free Acrylic | AFA - Film Coat | AFA - Spray Coat | Acrylic Protective Lacquer | High Performance Acrylic |
| Viscosity (mPa s) | 175 | 65 | 45 | 325 | 300 |
| Solids Content (%) | 33 | 20 | 14 | 35 | 35 |
| Touch Dry Time (minutes @ 20°C) | 5-10 | 5-10 | 10-15 | 10-15 | 10-15 |
| Operating Temperature Range (°C) | -65 to +125 | -65 to +125 | -65 to +125 | -55 to +125 | -55 to +130 |
| Surface Insulation Resistance (Ω) | 10 ¹⁵ | 10 ¹⁵ | 10 ¹⁵ | 10 ¹⁵ | 10 ¹⁵ |
| Humidity Resistance | Excellent - Best | Excellent - Best | Excellent - Best | Good | Very Good |
| UV Trace | Yes | Yes | Yes | Yes | Yes |
| Approvals | UL746 - UL94 V-0 | UL746 - UL94 V-0 | UL746 - UL94 V-0 | - | MIL-I-46058C |

Thermal Interface Materials



Non-Curing Pastes

Thermal interface materials are used to improve the effective surface area of heat transfer. Non-curing pastes enable the application of thin films to ensure the maximum efficiency of heat transfer by keeping the thermal resistance to a minimum.

| | HTCX | HTC | HTCP | HTS | HTSP |
|----------------------------------|--|-------------------------------------|--|---------------------------------|--------------------------------------|
| Description | Non-Silicone Heat Transfer Compound Xtra | Non-Silicone Heat Transfer Compound | Non-Silicone Heat Transfer Compound Plus | Silicone Heat Transfer Compound | Silicone Heat Transfer Compound Plus |
| Thermal Conductivity (W/m.K) | 1.35 | 0.90 | 2.50 | 0.90 | 3.00 |
| Viscosity (mPa s) | 130,000 | 203,000 | 105,000 | 210,000 | 45,000 |
| Operating Temperature Range (°C) | -50 to +180 | -50 to +130 | -50 to +130 | -50 to +200 | -50 to +200 |
| Evaporation Weight Loss (IP-183) | ≤0.4% | ≤1.0% | ≤1.0% | ≤0.8% | ≤0.8% |
| Volume Resistivity (Ω-cm) | 10 ¹⁴ | 10 ¹⁴ | 10 ¹⁴ | 10 ¹⁵ | 10 ¹⁵ |

Curing

Thermal interface materials that cure can be used for bonding the heat sink to the PCB/component, thus offering some structural support as well as enhancing the efficiency of heat transfer.

| | TCOR | TCER | TBS |
|----------------------------------|--------------------------------|---------------------------------|------------------------|
| Description | Thermally Conductive Oxime RTV | Thermally Conductive Ethoxy RTV | Thermal Bonding System |
| Thermal Conductivity (W/m.K) | 1.80 | 2.20 | 1.10 |
| Viscosity (mPa s) | 145,000 | 85,000 | 75,000 |
| Operating Temperature Range (°C) | -50 to +230 | -50 to +230 | -40 to +120 |
| Cure Type | Moisture | Moisture | 2-Part |
| Volume Resistivity (Ω-cm) | 10 ¹⁴ | 10 ¹⁴ | 10 ¹⁴ |

Resins



Clear / Reflective Resins

Our encapsulation resins are complementary products to the conformal coating products, offering enhanced protection in very challenging environments.

In addition to protection from humidity, chemicals, etc. Encapsulation Resins can also offer protections against physical and thermal shock.

| | UR5634 | UR5635 | UR5637 | UR5562 | SC3001 |
|----------------------------------|------------------|------------------|------------------|------------------|------------------|
| Description | Polyurethane | Polyurethane | Polyurethane | Polyurethane | Silicone |
| Colour | Clear | Hazy | White | Clear | Clear |
| Mix Ratio by Weight (by Volume) | 0.9:1 (1:1) | 0.9:1 (1:1) | 0.9:1 (1:1) | 2.2:1 (2.3:1) | 13:1 (12:1) |
| Mixed System Viscosity (mPa s) | 1,050 | 1,050 | 1,050 | 300 | 1,800 |
| Gel Time (minutes @ 23°C) | 20 | 20 | 20 | 22 | 180 |
| Cure Time (hours @ 23°C/60°C) | 24/4 | 24/4 | 24/4 | 24/4 | 24* |
| Shore Hardness | A80 | A80 | A80 | A95 | A20 |
| Operating Temperature Range (°C) | -40 to +120 | -40 to +120 | -40 to +120 | -40 to +120 | -60 to +200 |
| Volume Resistivity (Ω-cm) | 10 ¹⁴ | 10 ¹⁴ | 10 ¹⁴ | 10 ¹⁴ | 10 ¹⁴ |

*Cure times will be dependent on ambient humidity

Thermally Conductive Resins

Thermally conductive resins offer an enhanced protection of the luminaire from the surrounding environments as well as providing efficient heat dissipation, reducing the overall operating temperature.

| | ER2183 | ER2221 | ER2220 | UR5097 | UR5633 | SC2003 |
|----------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Description | Epoxy | Epoxy | Epoxy | Epoxy | Polyurethane | Polyurethane |
| Thermal Conductivity (W/m.K) | 1.10 | 1.20 | 1.54 | 0.65 | 1.24 | 0.80 |
| Mix Ratio by Weight (by Volume) | 12.8:1 (5.6:1) | 13.9:1 (7:1) | 20.8:1 (8.15:1) | 7.5:1 (6:1) | 12.2:1 (8.8:1) | 1:1 (1:1) |
| Mixed System Viscosity (mPa s) | 5,000 | 3,000 | 15,000 | 6,000 | 30,000 | 30,000 |
| Gel Time (minutes @ 23°C) | 420 | 360 | 180 | 80 | 40 | 80 |
| Cure Time (hours @ 23°C) | 24 | 24 | 24 | 24 | 24 | 24 |
| Shore Hardness | D90 | D90 | D90 | A85 | A90 | A50 |
| Operating Temperature Range (°C) | -40 to +130 | -40 to +150 | -40 to +130 | -40 to +110 | -50 to +125 | -60 to +200 |
| Volume Resistivity (Ω-cm) | 10 ¹⁵ | 10 ¹⁰ | 10 ¹⁵ | 10 ¹⁴ | 10 ¹⁴ | 10 ¹⁴ |

ELECTROLUBE

THE SOLUTIONS PEOPLE

China Headquarters / Manufacturing

Building No2, Mauhwa Industrial Park,
Caida 3rd Street, Caiyuan Industrial Zone,
Nancai Township, Shunyi District
Beijing, 101300
Peoples Republic of China

T +86 (10) 89475123
F +86 (10) 89475123
E info@electrolube.co.uk

www.electrolube.com

UK Headquarters / Manufacturing

Ashby Park
Coalfield Way
Ashby de la Zouch
Leicestershire
LE65 1JR
United Kingdom

T +44 (0)1530 419600
F +44 (0)1530 416640
E info@electrolube.co.uk

www.electrolube.com

A division of H K Wentworth Limited
Registered office as above
Registered in England No. 368850



ISO 9001 Certification No. FM 32083
ISO 14001 Certification No. EHS 601527
OHSAS 18001 Certification No. OHS 601528