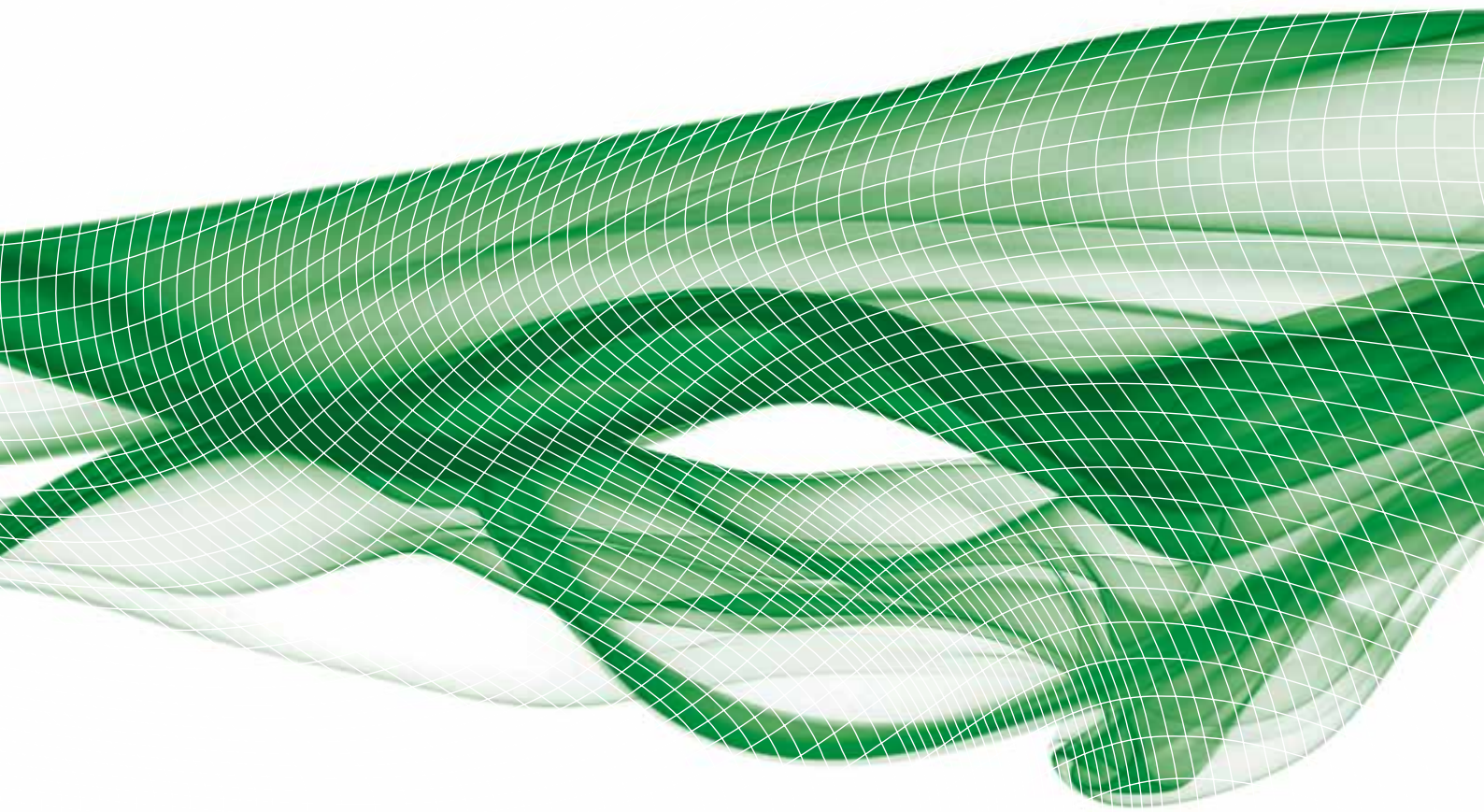


Electronic and General Purpose Cleaning

Wash away the worry of contaminants



ELECTROLUBE
THE SOLUTIONS PEOPLE

Electronic and General Purpose Cleaners



- Flux Removal
- Metal Degreasing
- Flammable & Non-flammable
- Bulk & Aerosol
- Water & Solvent Based

Cleaning is an essential process within electronics manufacture and has been used for many years to remove potentially harmful contaminants during PCB manufacture. Such contaminants include flux, solder and adhesive residues, and other more general contaminants such as dust and debris present from other manufacturing processes.

The purpose of cleaning, specifically within the rapidly expanding electronics industry, is to essentially improve product lifetime by ensuring good surface resistance and by preventing current leakage leading to PCB failure. This developing market sees modern and future electronics becoming smaller and smaller and the requirement for high performance and reliability is stronger than ever. In order to achieve good insulation resistance and ensure adequate adhesion of conformal coatings and encapsulation resins, the cleanliness of the electronic assemblies is essential.

There are many stages where cleaning is required; prior to stencilling and soldering in order to remove contaminants from the many previous production stages, after stencilling to remove excess solder paste/adhesive and after soldering to remove corrosive flux residues and any solder balls.

In industry today, many manufacturers are turning to 'no clean' processes, implying that cleaning is not required after soldering. In the 'no clean' process the solids content of the flux is lower than traditional types, however they still contain rosin and activator. Such residues, along with any other unwanted elements collected due to the missing cleaning stage could cause issues with adhesion and possibly affect the performance of the protecting media applied, i.e. Encapsulation Resins or Conformal Coating. It can therefore be stated that even with advances in new technologies, such as 'no clean' fluxes, cleaning is still an essential multi-stage process within the electronics industry.

Finally, there are also cleaning stages required for the removal of coatings and adhesives when re-work is necessary, for the cleaning of individual components and for maintenance of the production line.

Solvent and Aqueous Cleaners



Electrolube offer a range of solvent-based and aqueous electronic cleaners. Solvent-based systems are very efficient, allowing a convenient single-stage process. They are often flammable and so the health and safety of the operator as well as solvent emission levels must all be considered when using such materials.

With environmental concerns at an all time high many electronics manufacturers are moving away from traditional solvent cleaners that use ozone depleting chemicals or contain a high VOC (volatile organic compound) content, and replacing them with safer alternatives. Despite the easy application of many solvent cleaners, water-based cleaners have several advantages including non-flammable properties, low odour, low/non-VOC and very low toxicity.

There are different application options when using aqueous cleaners, including ultrasonic, spray under immersion or dishwasher type application and so identifying the correct product for the specific job is

essential. Aqueous cleaners can utilise surfactant technology to assist the removal of contaminants from a PCB by reducing the interfacial tensions and suspending or emulsifying them in solution. Alternatively, water-based flux removers work by saponification, neutralising the flux acids.

As cleaning technologies have developed there has been the development of surfactant-free systems; based on glycols, these cleaners combine the advantages of water based and solvent based cleaners with only minimal rinsing required. In a micro-emulsion state, they provide highly efficient cleaning and can be utilised in all types of equipment. Electrolube have also developed materials in concentrate form with built-in corrosion inhibitors, eliminating yet another stage in the process. Supplying in concentrate form also reduces the transport cost, both in monetary and environmental terms.

Volatile Organic Compounds (VOCs)



- Volatile solvents used in electronic cleaners are classed as VOCs (Volatile Organic Compounds).
- VOCs contribute towards the formation of ground level ozone.
- Such pollution can have many detrimental effects the environment, damaging forests and vegetation
- In addition, some materials classed as VOCs can as irritants and over exposure can lead to a variety of health problems.

VOC Definitions

EU Solvents Emissions Directive

'Any organic compound with a boiling point less than or equal to 250°C at a standard pressure of 101.3 kPa.'

Previously the directive referred to the definition as 'Any organic compound, having at 20°C a vapour pressure of 0.01kPa or more, or having corresponding volatility under the particular conditions of use'.

As stated on the European Commission website, either method is suitable:

The "boiling point approach" was adopted for Directive 2004/42/CE because during negotiations Member States were generally more in favour of this definition of VOCs than the "vapour pressure approach" definition

in Directive 1999/13/EC. The main reason is that the boiling point of a substance is easier to identify (and presumably more data are available) than the vapour pressure at room temperature of the same substance. Nevertheless, the results of the two approaches for any one substance are, to the knowledge of the EU Commission, in most cases identical.

EPA

"Volatile Organic Compounds (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate, which participates in atmospheric photochemical reactions"



Electrolube are continually developing ‘greener’ technologies, helping to minimise solvent emissions and their impact on the environment.

As environmental concerns heighten the transition to solvent-free and low-VOC materials continues to increase. Continual investment in research and development facilities allows Electrolube to remain at the forefront of cleaning technology, continually exceeding customers’

expectations throughout this period of change. Electrolube, as a responsible manufacturer, can provide both water-based and solvent based cleaning solutions for a wide variety of applications in the automotive, aerospace, military, domestic and medical sectors.

The Safewash Range

The Electrolube Safewash range is the most effective family of water-based cleaners available on the market. Primarily developed to replace ozone depleting chemicals as well as offering a solution to reduce solvent emissions, the range provides superior cleaning

performance to both military and commercial standards at minimal cost. Water-based cleaning has several advantages over solvent based cleaners including non-flammable properties, low odour, low/non-VOC and very low toxicity.

Solvent Cleaners

Traditionally, chlorinated solvents dominated the market; however, due to their ozone depleting potential, they have been replaced by a more diverse range of solvent cleaners. This category is now typically divided into three sub-sections: flammable and non-flammable solvent cleaners and non-flammable fluorinated solvent cleaners. Electrolube flammable and non-flammable solvent-based materials are single stage cleaners characterised by relatively low levels of toxicity, good

materials compatibility and a wide range of flash points and evaporation rates. Specialist equipment is generally required when using solvent based cleaners in high volume production; however they are essential for cleaning assemblies with unsealed components or water sensitive devices. Electrolube offer a diverse range of solvent based materials including flammable, non-flammable and fluorinated cleaners.

Application Conditions



Cleaning processes can be referred to as batch or in-line processes. Batch systems refer to a batch of PCBs taken through the entire process, whether it is ultrasonic or dishwasher application, for example. Cleaning processes can also be set up as in-line systems where PCBs are constantly transferred through each stage and a continuous production line is formed.

The following information explains the different application processes in more detail for aqueous products. Solvent-based cleaners can be used in ultrasonic and spray applications however the flammability of the solvent

must be considered as well as any emissions given off. Occupational exposure levels must be adhered to in order to ensure operator safety.

For aqueous products, ultrasonic and spray application techniques are also possible however it is important to check the guidelines for each product carefully. A standard product designed for ultrasonic application not be suitable for use in a dishwasher, for example. This is due to the pressure applied in the application, which then generates foam in the cleaning solution and therefore a low foam option is required for such applications.

Ultrasonic and Spray-under-Immersion

1. Cleaning

The Safewash in the first tank dissolves organic residues (grease, flux etc.) and ionic material keeping this contamination in solution. Due to the formulation of Safewash the cleaning also occurs underneath Surface Mount Devices (SMDs) and is complete in approximately 5 minutes (with agitation).

Safewash absorbs very high levels of flux residues before cleaning efficiency decreases. The first stage can use any form of agitation providing it does not damage the PCB or create a foam. Safewash is designed to work efficiently at ambient temperatures (10°- 30°C) but temperatures of up to 45°C may be employed if necessary.

As PCBs are removed from the Safewash cleaning stage, a small amount of Safewash fluid is pulled out with the board and enters into the rinse stage. This is commonly known as drag-out. Fresh Safewash can be added to top up the cleaning tank to maintain cleaning efficiency.

2. Tapwater Rinse

The second stage consists of a rinse in tap water, preferably with some type of agitation. The temperature of the rinsing solution can be ambient, although an increase in the temperature will accelerate and improve rinsing. As small amounts of Safewash are carried over into the rinse water, the rinse water should either be allowed to overflow to drain or be recycled through a carbon filter preventing the rinse water becoming progressively more contaminated.

If allowed to go to drain, your Local Water Authority should be consulted to ensure that the level of contaminated water being put to drain is within their guidelines. The use of a carbon filter, through which tap water is permanently re-circulated, produces no liquid waste, as the filter will remove the Safewash and flux residues from the water.



3. Deionised Water Rinse

The third stage is a deionised water rinse. This removes any contamination present in the tap water from the PCB and gives a final rinse to ensure exceptional cleanliness. This stage may either consist of a re-circulating rinse or a spray system that is activated when the PCBs leave the tap water rinse. If military standard cleanliness is not required, this deionised rinse may not be necessary, though the PCBs may show some white streaking due to tap water impurities.

4. Drying

The final stage is drying. This is enhanced by equipment that uses high air flow as opposed to 'heat only' systems. In general, this stage takes approximately 10 minutes at 90°C. The length of time required to dry the PCB depends on the circuit design and the efficiency of the drying unit itself. Air-knives can be used as an optional extra to reduce temperature or total energy required.

Spray Application

Ready-to-use, concentrated products are available for spray applications. Safewash Total (SWAT) can be used as an example. Safewash Total should be diluted to the required level, i.e. 20% with de-ionised water and applied for a wash time of 5-10 minutes at 40-60°C. The specific cycle required will be dependent on the age and type of residue being removed, the reflow profile and the effectiveness of the cleaning machine. The cleaning stage should be followed by a deionised water rinse and a drying stage. The length of time required for rinsing and drying the PCB depends on the circuit design and the efficiency of the rinsing/drying unit. Air-knives can be used as an optional extra to reduce temperature or total energy required.

A typical cycle using a Miele 6002 Industrial Washer:

1. Cleaning, Safewash Total diluted to 20% v/v, at 50°C for 10 minutes
2. Mains water rinse, 1 minute at 40°C
3. Deionised water rinse, 3 minutes at 70°C
4. Hot air dry, 15 minutes at 115°C

Once cooled to below 30°C the residues and soils will precipitate and can be filtered out of the cleaning solution, extending the life of the cleaner. Typically a 50-75 micron cotton wound filter would be suitable.

Cleanliness Levels



With the cleaning market continually developing to meet the demands of industry expansion, it is important that the level of cleanliness required is clearly defined. A significant proportion of potentially damaging flux residues and contaminants are not visible to the naked eye or even with the aid of magnification. It is therefore vitally important that the correct method is used to determine that the level of cleanliness achieved meets the standard specified by the electronics engineer. There are two types of residues; ionic and non-ionic and there are a number of methods that can assess the level of contamination after cleaning and accurately describe the term 'clean'.

Non-ionic residues including rosin, oils and grease are non-conductive and are usually organic species that remain after board fabrication or assembly. They have insulative properties which are a problem where plug-in contacts or connectors are utilized on assemblies. These can cause poor adhesion of solder mask, conformal coating and potting compounds as well as encapsulate ionic contaminants and foreign debris. Typical test methods include visual examination under magnification alongside other analytical methods, such as Fourier Transform Infrared Spectroscopy (FTIR).

Ionic contaminants are typically flux residues or harmful materials left behind after soldering. Water-soluble organic or inorganic residues that can disassociate in a solution as charged ions increase the overall conductivity of that solution. They can degrade the reliability of the electronic components and assemblies by contributing to current leakage between the circuitry, causing corrosion and promoting dendrite growth.

While both ionic and non-ionic contaminations both impact the operation and reliability of the device on which they are present, ionic contamination account for the larger proportion of failures. A common method of determining the degree of ionic contamination is to measure Resistivity of Solvent Extract (ROSE), also known as Solvent Extract Conductivity (SEC). The industry standard, IPC-TM-650, employs a solution of isopropanol and deionised water to extract the contaminants whilst the meter measures the change in conductivity. This type of testing is widely accepted and offers rapid results, it can be restrictive, however.

Two further methods can also be utilised to provide valuable data. These are Surface Insulation Resistor (SIR) and Ion Chromatography (IC). The former involves measuring the change in electrical current over time via an interleaved comb pattern PCB and is typically performed at elevated temperatures and humidity levels. The presence of contamination lowers the insulation resistance of the material between the conductors. The latter, Ion Chromatography (IC), is a newer method for cleanliness evaluation which can be used to identify and quantify specific ionic species that are present on an electronic device. The test method details a specific list of ionic residues which can be removed using specific media. Subsequent analysis of the fluid can separate, identify and quantify the residue. Substrate handling and preparation are critical for this method making it particularly expensive and time consuming. Therefore it is not used for general quality control purposes but as a more specific analytical technique.

Solution Control: Aqueous Cleaners



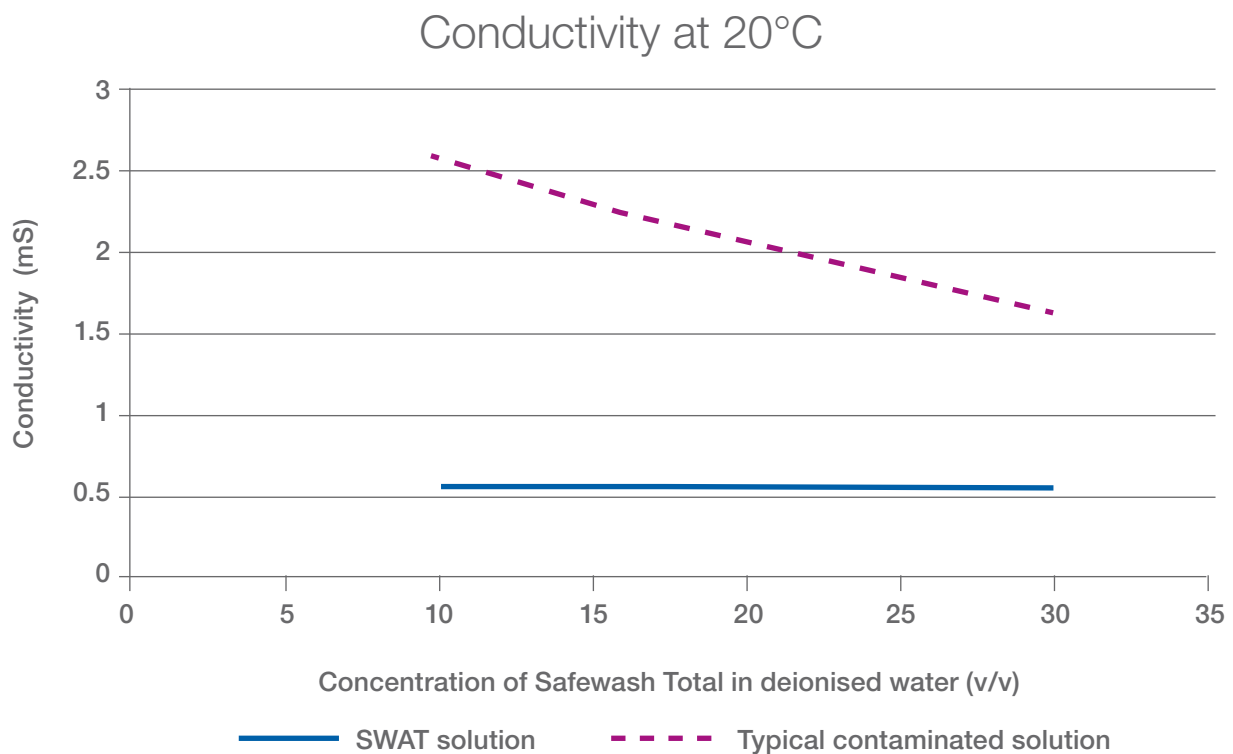
In addition to the level of contamination after cleaning, the control of the cleaning solution itself is essential. The method of solution control will depend on the cleaning chemistry and type of residues being removed; some possible methods shall be discussed, however.

- Acidic flux residues will generally lower the pH and increase the conductivity, while being relatively unaffected by variations in concentration.
- Refractive index, or BRIX, gives a measurement of the solids level in the cleaner. Although this can give some indication of contamination level, changes in refractive index over time are more likely to be

as a result of variations in the concentration of the solution, often affected by drag out of the cleaning solution into the rinsing cycle.

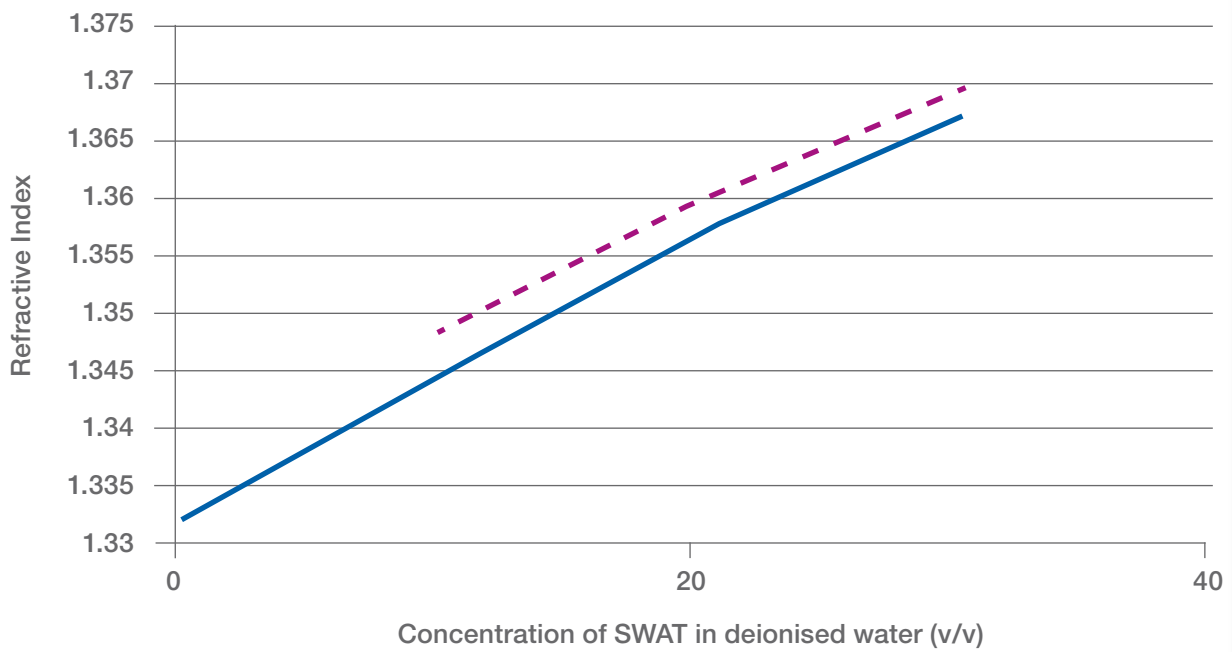
- Cloud temperature measurement is another alternative method to control the solution. Simply warming a small sample of the cleaning solution and noting the temperature at which it becomes cloudy will indicate if the solution has become highly contaminated or the concentration has dropped due to drag out.

All these methods are simple and may require the use of a relatively inexpensive meter.

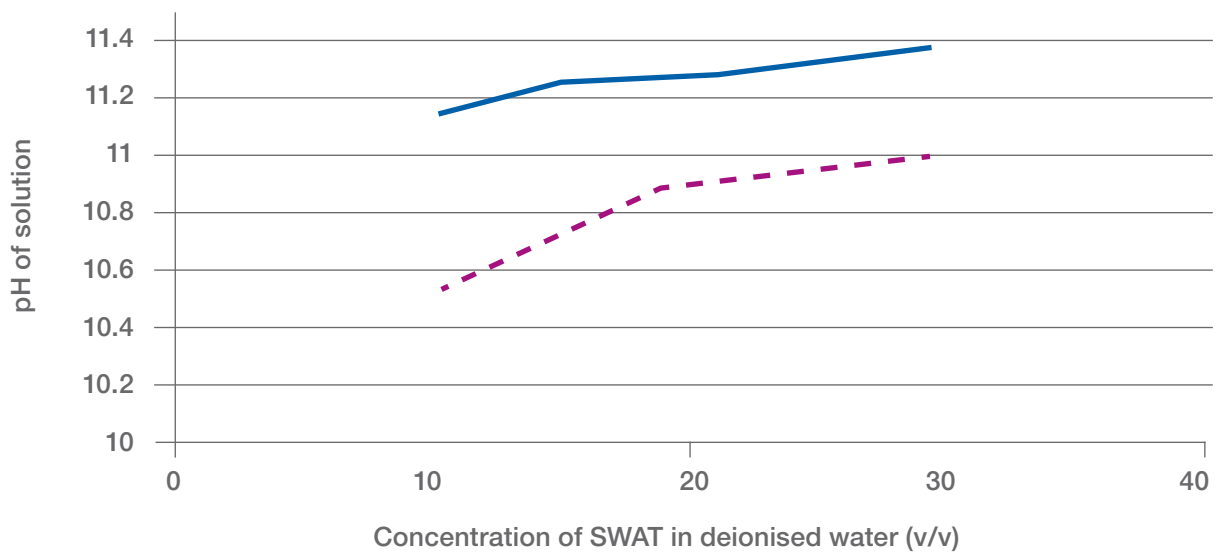




Refractive Index



pH at 20°C



Further information on application parameters and solution control can be found on the individual datasheets for each product.

— SWAT solution
 - - - Typical contaminated solution

The Product Range

Safewash Products



SWA/SWAJ/SWAS – Safewash 2000 Range

- The original Safewash (SWA) is ideal for removing flux residues and many other cleaning applications which do not contain sensitive metals. Can be used prior to plating operations as a micro etching process.
- SWAJ is specifically formulated for safe cleaning of all metals including aluminium, copper and brass. SWAJ is also used extensively to clean flow solder jigs or pallets to remove the build up of flux deposited throughout the wave soldering process.
- SWAS is similar to SWAJ but with enhanced cleaning performance. Cleans flux residues and no-clean flux to military cleanliness standards.
- All are low odour, non-hazardous and for use in cleaning systems using ultrasonic or spray-under-immersion.



SWAT – Safewash Total

- Surfactant-free, easy to rinse
- Low-foam
- Suitable for use in all application equipment; ultrasonic, dishwasher, etc.
- Contains a corrosion inhibitor for sensitive metals



SWAX – Safewash Extra

- For removal of solder pastes and surface mount adhesive from screens, stencils, misprinted PCBs and accessories
- Can be used in automated screen cleaning equipment, spray and in-line machines
- Low foam, low odour
- Excellent compatibility with plastics, metals and elastomers



SWAF/SWAP – Low Foam Safewash

- SWAF and SWAP have been designed as an extension to the Safewash range where low foam properties are required
- Suitable for use via high pressure application, such as dishwashers and in-line machines (spray-in-air machines)
- SWAF is supplied as a concentrate, designed to be diluted with deionised water
- SWAP is a ready to use version which includes a corrosion inhibitor for sensitive metals



SWMN/SWMP – Safewash Mechanical

- Designed to clean and degrease mechanical parts
- Removes dirt and grease deposits
- Non-hazardous with very low odour
- SWMP has enhanced performance properties for more stubborn deposits



SWAC – Low Foam Concentrate

- Designed to be diluted with deionised water
- For use with ultrasonic and pressure spray systems
- For removal of reflowed solder pastes and fluxes
- Excellent plastics and metals compatibility



SWNP/SWNS – Safewash Neutral

- Neutral pH for cleaning even the most sensitive surfaces
- Developed for the LCD and OLED manufacturing processes
- SWNS has been designed to remove any excess resin residues
- SWNP has been designed to remove any dust and grease from the LCD surface

The Product Range

Electronic and General Cleaners



ARW – Aerowipes

- Efficient removal of uncured and semi-cured adhesives and sealants
- Designed for the aerospace and automotive industries
- Available in liquid form and impregnated lint-free wipes
- Non-flammable



EWI – IPA Electrowipes

- Impregnated with an isopropanol and de-ionised water blend
- High quality cloths
- Packaged in individual sachets
- Excellent degreaser, also removes flux residues and metal oxide



CCC – Non-flammable Contact Cleaner

- Non-conductive with high materials compatibility
- Instant drying with almost no aroma
- Leaves no residue
- Supplied with brush and extension tube



FLU – Fluxclene

- Fast drying solvent cleaner for efficient removal of flux residues after soldering
- Leaves a perfectly clean, dry surface
- Harmless to most plastics, rubbers and elastomers
- Aerosol versions available with or without a brush applicator



DGC – Non-flammable Degreaser

- Electronics cleaner and degreaser
- Fast evaporating
- Versatile, non-corrosive and safe for use on all types of electrical circuit
- Plastics-safe



FRC – Non-flammable Flux Remover

- Effective on 'no clean' fluxes and many water based fluxes and pastes
- Quick drying and residue free
- Plastics safe
- Supplied with brush and extension tube



ECSP – Electronic Cleaning Solvent Plus

- Very fast evaporating cleaning solvent
- Removes grease, dirt and most fluxes
- Completely residue-free
- Highly flammable – not to be used on live equipment



GLC – Glass Cleaner

- Low-foaming glass cleaner
- Water-based
- Removes grease, oil and light organic contaminants
- Non-flammable



ECW – Engineering Cleaning Wipes

- Non-woven, cellulose/polyester blend
- High quality, general purpose wipes
- Extremely absorbent
- Exceptional tear and wet strength



IPA – Electronic Cleaning Solvent

- Efficient general purpose electronic cleaning solvent
- Removes contamination from PCBs
- Excellent plastics compatibility
- Economic in use



HFFR – Hexane Free Flux Remover

- n-Hexane Free
- Efficient removal of all flux residues
- Harmless to most plastics, rubbers and elastomers
- Leaves a perfectly clean, dry surface with no residue



SRI – Saferinse

- Aqueous, de-ionised solvent blend
- For rinsing electronic assemblies after cleaning with Safewash
- Recommended as a final rinse to ensure removal of all impurities
- Non-flammable



LFFR – Lead Free Flux Remover

- Fast drying solvent cleaner
- For quick removal of lead free flux residues, grease and oils
- Leaves a clean, dry surface
- Harmless to most plastics, rubbers and elastomers



SWA – Safewash Aerosol

- Water-based cleaning solvent
- Removes all types of flux residues
- Aerosol form with brush attachment to aid cleaning
- Non-flammable



ROC – Reflow Oven Cleaner

- Specially formulated micro-emulsion for cleaning reflow ovens
- Removes all types of flux residues
- Contains corrosion inhibitors
- Non-flammable



ULC – Ultraclean

- Highly penetrating cleaning solvent for removing heavy deposits
- Excellent cold cleaner for electronics and engineering
- High flash point, reduces the risk of fire caused by flammable solvents
- Ideal for stencil cleaning



SSS – Screen & Stencil Solvent

- Non-flammable solvent for cleaning of screens and stencils
- Excellent solder paste and adhesive removal
- Non-foaming and biodegradable
- Use with ECW025



ULS – Ultrasolve

- Excellent degreasing properties
- Also removes flux residues from PCBs
- Can be used to remove acrylic conformal coatings
- Harmless to most plastics, rubbers and elastomers



SSW – Screen & Stencil Wipes

- Superb cleaning power that removes pastes and adhesives
- Leaves screens and stencils clean and dry with no staining
- Large size (20x28cm)
- Convenient 100 wipe tub dispenser



WWC – Industrial Cleaning Concentrate

- General purpose industrial cleaner
- Non corrosive to metals
- Easy to use: convenient application methods
- Non-flammable

*Various sizes are available for most products, including bulk

Aqueous Cleaning

		SWA	SWAJ	SWAS	SWAP	SWAT*	SWAX	SWM
		Safewash Original	Safewash Jigwash	Safewash Super	Safewash Pressure-wash	Safewash Total	Safewash Xtra	Safewash Mechanical
Soil Removal	Heavy Grease (& Organics)	Good	Good	Best	Good	Good	No	Excell
	No Clean Fluxes	No	OK	Best	Good	Excellent	No	No
	Flux / Ionics	Good	Excellent	Best	Excellent	Excellent	Good	No
	Uncured Paste	OK	OK	Good	OK	Excellent	Best	No
	Uncured Adhesive	No	No	No	No	Good	Best	No

* Concentrate requires dilution, please refer to the Technical Data Sheet for more information.

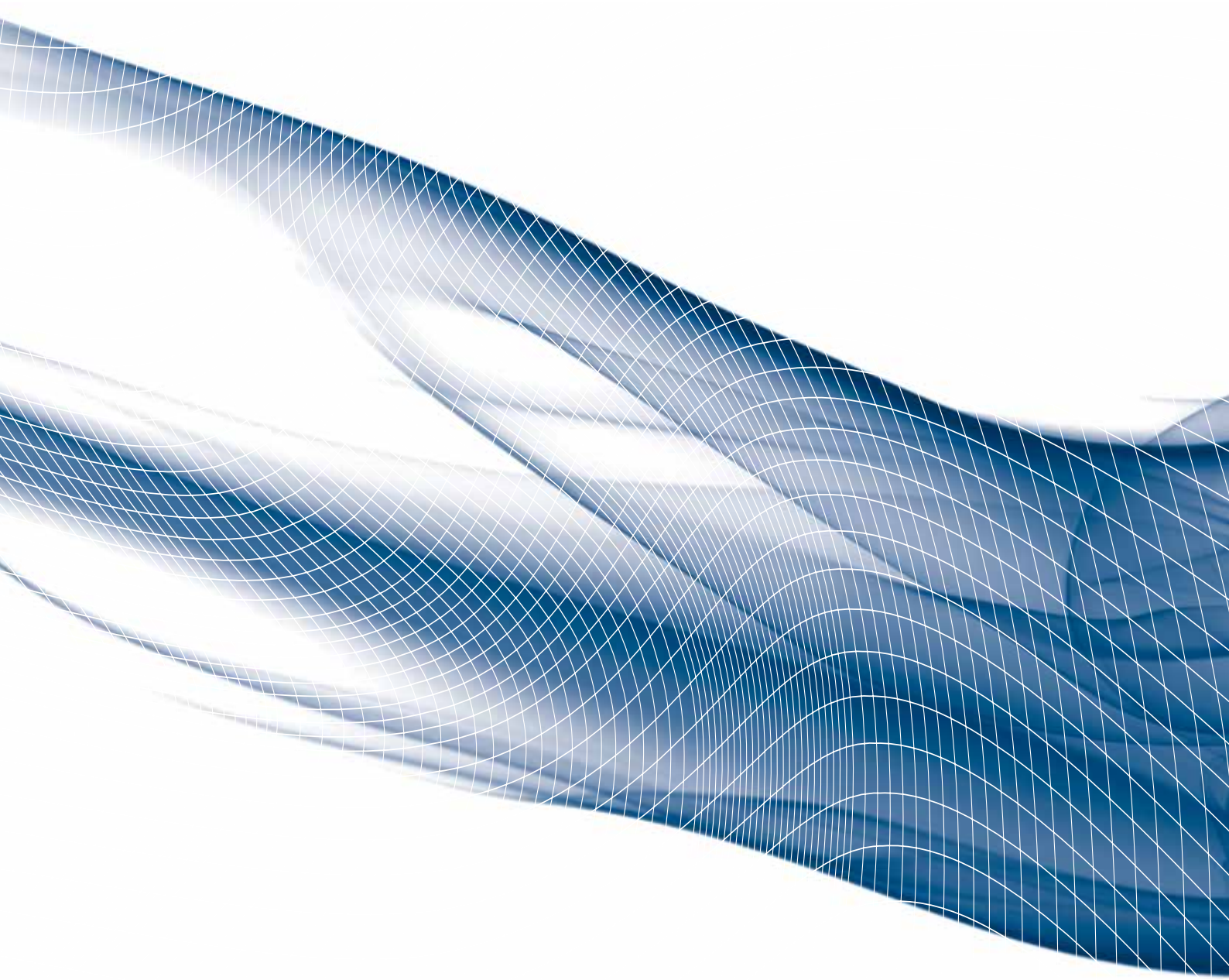
Solvent Cleaning

		HFFR	LFFR	FRC	ULS	DGC	IPA	ECSP	ULC	SS
		Hexane-Free Flux Remover	Lead-Free Flux Residue Remover	Non-Flammable Flux Remover	Ultrasonic Cleaning Solvent	Non-Flammable Degreaser	Electronic Cleaning Solvent	Electronic Cleaning Solvent - Plus	Ultraclean Cleaning Solvent	Screen and
Soil Removal	Heavy Grease (& Organics)	Good	Good	Good	Best	Excellent	Good	Good	Excellent	N
	No Clean Fluxes	Excellent	Best	Good	No	No	No	No	No	N
	Flux / Ionics	Best	Excellent	Excellent	Good	Good	Good	Good	No	N
	Uncured Paste	Good	Good	Good	Good	Good	Good	Good	Excellent	Be
	Uncured Adhesive	No	No	No	No	No	No	No	No	Be

Evaporation Rate: The higher the number the slower the rate of evaporation. *Classified as non-flammable.

Conformal Coatings

Enhanced protection for enhanced PCB performance



ELECTROLUBE
THE SOLUTIONS PEOPLE

Conformal Coatings



- UL, MIL and IPC-CC-830 approved
- Solvent removable and solvent resistance coatings
- Acrylic, Silicone, Polyurethane and Hybrid Materials
- UV cure and water-based options available
- UV trace to aid inspection
- Thinners and masking products

Conformal coatings are designed to protect printed circuit boards and related equipment from their environment. Typically applied at 25-75µm, these coatings ‘conform’ to the contours of the board allowing for excellent protection and coverage, ultimately extending the working life of the PCB.

The use of conformal coatings is particularly important in automotive, military, aerospace, marine, lighting, industrial and green energy applications. Due to the rapid expansion of the electronics industry, conformal coatings are also finding their way into the domestic and mobile electronics industries, providing the necessary combination of high performance and reliability within a vast array of electronic devices.

Conformal coatings can be used in a wide range of environments to protect printed circuit boards from moisture, salt spray, chemicals and temperature extremes in order to prevent corrosion, mould growth and electrical failures, for example. The protection provided by conformal coatings allows for higher power and closer track spacing, in turn enabling designers to meet the demands of miniaturisation and reliability.

Electrolube is among the world’s foremost experts in the formulation and application of conformal coatings designed to meet international approvals (including European and American military specifications). The range of products currently available comprises acrylics, silicones, polyurethanes, hybrid chemistries and environmentally friendly options.

Electrolube can offer both transparent and pigmented coatings to improve or camouflage the appearance of printed circuit boards. The range also includes a number of ancillary products to complement the use of our conformal coatings, including thinners and removers, peelable coating masks and thixotropic materials for dam and fill applications.

Selection and Best Practice



In order to achieve the best performance, it is imperative that the most suitable coating and application methods are chosen. The main considerations during this selection period are:

Application Method

Conformal coatings can be applied via spray, dip or brush methods either by manual or automated application. Products are available in bulk, aerosol and small packaging sizes, therefore the correct method and conditions should be assessed for each application. Careful consideration of the advised humidity and temperature conditions for the selected coating should be taken for both application and curing stages.

As well as working with a number of local and international equipment suppliers to apply conformal coatings, Electrolube also offer a range of water and solvent-based cleaning products to ensure all corrosive residues are removed from the printed circuit board prior to conformal coating application. Electrolube therefore offers superior technical support in ensuring the correct application parameters are identified. Please contact us for further information where required.

Operating Environment

The coating must be suitable for use under the required operating conditions. Technical data is provided based on a range of internal and external tests according to international standards. Tests must also take place to ensure that the coating retains all the required properties throughout the duration of use. This is due to the differing conditions exhibited as a result of varying PCB materials and designs.

Electrical Requirements

Conformal coatings form a protective, insulating layer. The most common electrical parameter tested is the Surface Insulation Resistance (SIR). This measurement is often taken before and after coating and exposure to harsh conditions, thus ensuring the coating continuously provides the level of insulation required. The coating should also exhibit high dielectric strength; the minimum required can be determined from the inter-track separation and the potential difference between adjacent tracks.

Board Layout

The design of the board should include consideration of the placement of components that should not be coated. Selective spray equipment or the application of a peelable coating mask can be used to help avoid such areas. Alternatively, gel materials can be used to form a 'dam' to contain the coating and avoid capillary effects transferring material to unwanted areas, such as connectors.

Rework and Repair

If the assembly requires repair then consideration must be given to the ease of removal of the coating. Electrolube offer products for the effective removal of conformal coatings, including those that are solvent resistant.



Coating Options

ACRYLIC	HPA, APL, TFA, AFA
MODIFIED SILICONE	DCA – SCC3 Range, LFCC, FSC, FSCP
POLYURETHANE	PUC, PUCAF
WATER-BASED	WBP, WBPs
UV CURE	UVCL

Electrolube offer a range of conformal coatings including solvent-based, hybrid chemistries and environmentally friendly products. The most widely used materials are historically solvent-based, the benefits of which include:

- Ease of processing and application
- Simple viscosity adjustment
- Suitability for a range of application methods
- Tailored application and cure

VOCs – The Need for Change

- Volatile solvents used in conformal coatings are classed as VOCs (Volatile Organic Compounds).
- VOCs contribute towards the formulation of ground level ozone.
- Such pollution can have many detrimental effects on the environment, damaging forests and vegetation.
- In addition, some materials classed as VOCs can act as irritants and over exposure can lead to a variety of health problems.

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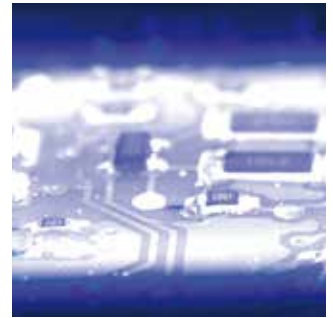
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Low VOC Alternatives

Products such as the Electrolube water-based coatings help to keep VOC levels to an absolute minimum without compromising on performance:

- WBP – Utilising hybrid technology, WBP offers the performance characteristics of a polyurethane coating, exhibiting excellent flexibility and solvent resistance. WBP is for dipping application methods.
- WBPs – Is based on the same chemistry as WBP but specifically designed for spraying applications.

In addition, Electrolube manufacture conformal coatings with alternative curing technologies, such as UVCL, a UV cure conformal coating that completely eliminates the use of VOCs.

Electrolube are continually developing ‘greener’ technologies, helping to minimise solvent emissions and their impact on the environment.

Investigation & Methodology

A coating needs to be exposed to a range of environments via appropriate test conditions to establish its performance range and limitations.

The ideal coating should offer a combination of:

- Good electrical properties
- Low moisture permeability
- Good physical characteristics
- Excellent adhesion to all board materials

Basic tests:

- Electrical performance and accelerated humidity testing.

Advanced testing:

- Severe conditions such as salt mist, temperature extremes or rapid environmental changes.

Approvals

The following Electrolube conformal coatings are approved to the standards listed:

- DCA (SCC3) – UL746, Def Stan 59/47
- TFA – IPC-CC-830, UL746
- HPA – MIL 46058-C
- FSC – IEC 61086
- UVCL – IPC-CC-830

Electrolube put all of their conformal coatings through the test conditions outlined in these specifications and therefore, many other coatings from the range also meet the requirements of these standards.

Performance Criteria

Environmental Testing



Environmental testing is essential to ensure the required level of protection is achieved. End-use conditions should be replicated or accelerated, however care must be taken to ensure accelerated tests are suitable for comparison with end-use conditions:

- Humidity Exposure and Salt Mist Testing
- Thermal Cycling, Shock and Aging
- These parameters are either tested individually or combined depending on the requirements

Environmental Cycling

Based on UL746 test methods, the following environmental cycling profile can also be utilised:

- 24 hours immersed in water, followed by
- 24 hours at 105°C, followed by
- 96 hours at 90%RH, 35°C, followed by
- 8 hours at -70°C – end of cycle
- 3 cycles



Humidity Tests

Humidity tests were carried out on comb pattern boards, similar to those in IPC-TM 650 2.6.3.4:

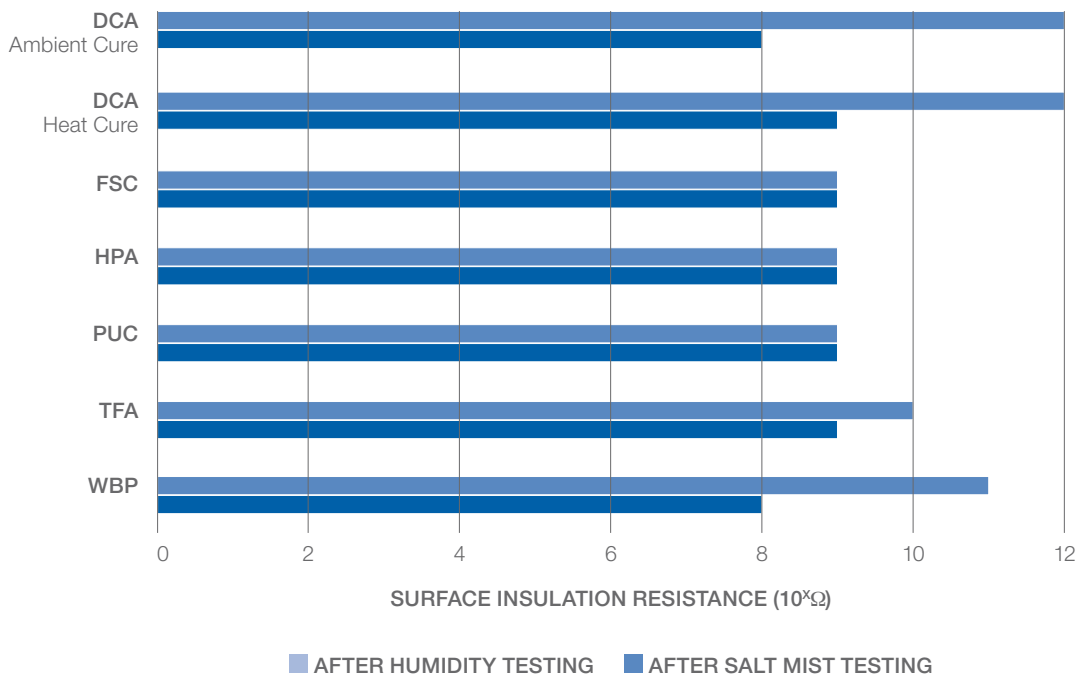
- 85-90% RH, 40°C, 50V DC, 168 hours

Salt Mist Tests

Salt mist tests were carried out in accordance with IEC 60068-2-11:

- 5% salt solution
- 35°C, 168 hours

Environmental Testing

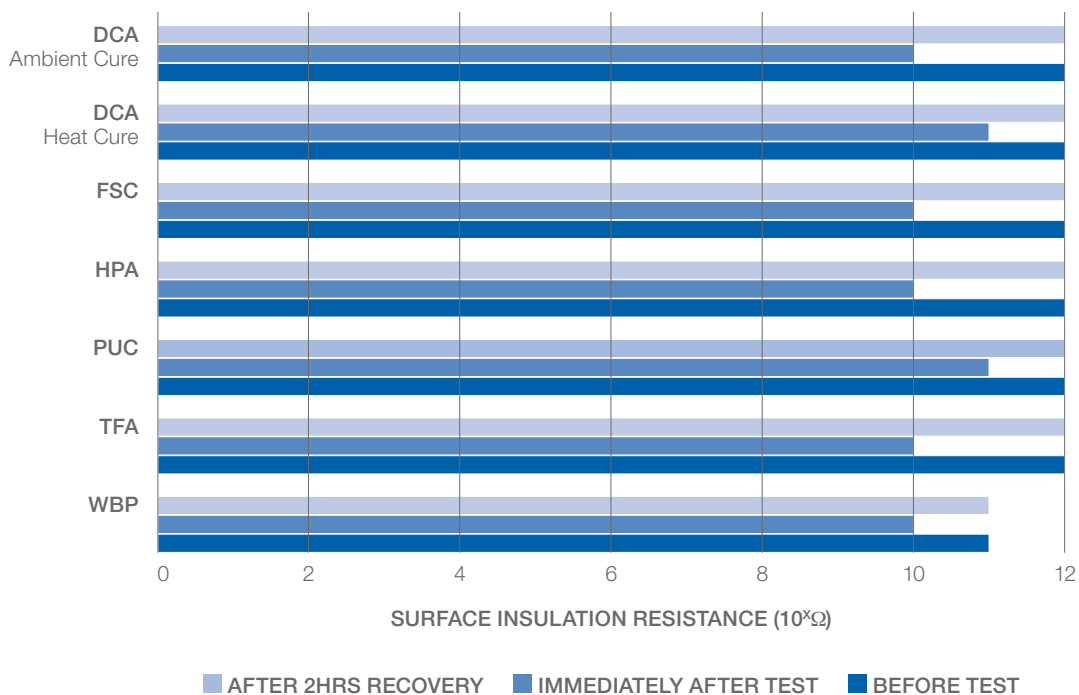




Corrosive Gas Testing

Corrosive gas testing involves exposing PCBs to a mixed gas environment combining hydrogen sulphide and sulphur dioxide – BS EN 60068-2-60, method 1.

Surface insulation resistance (SIR) was used to determine the performance of each coating in this environment:

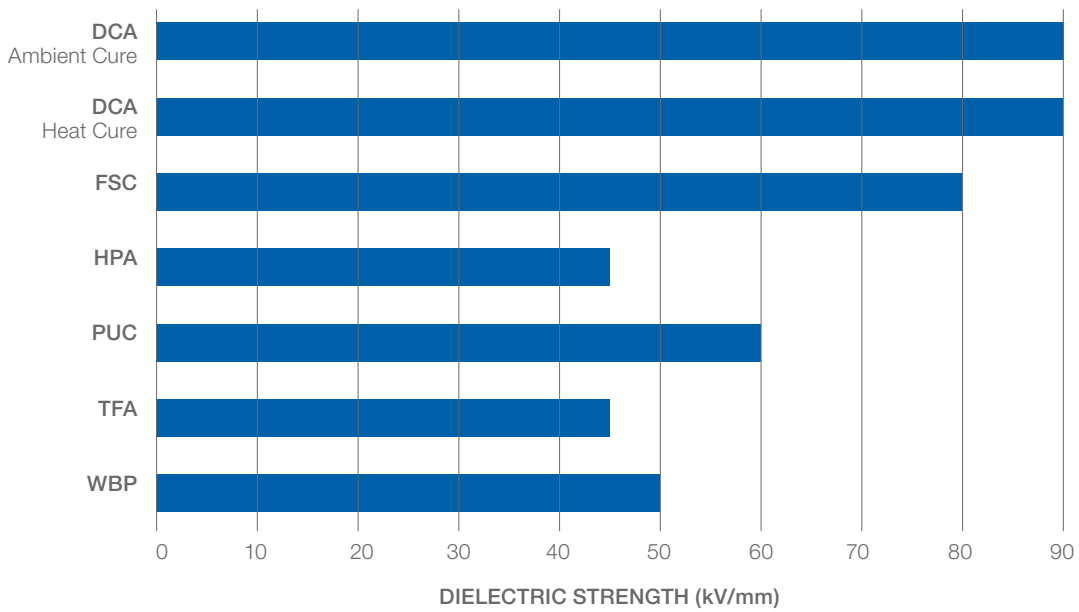
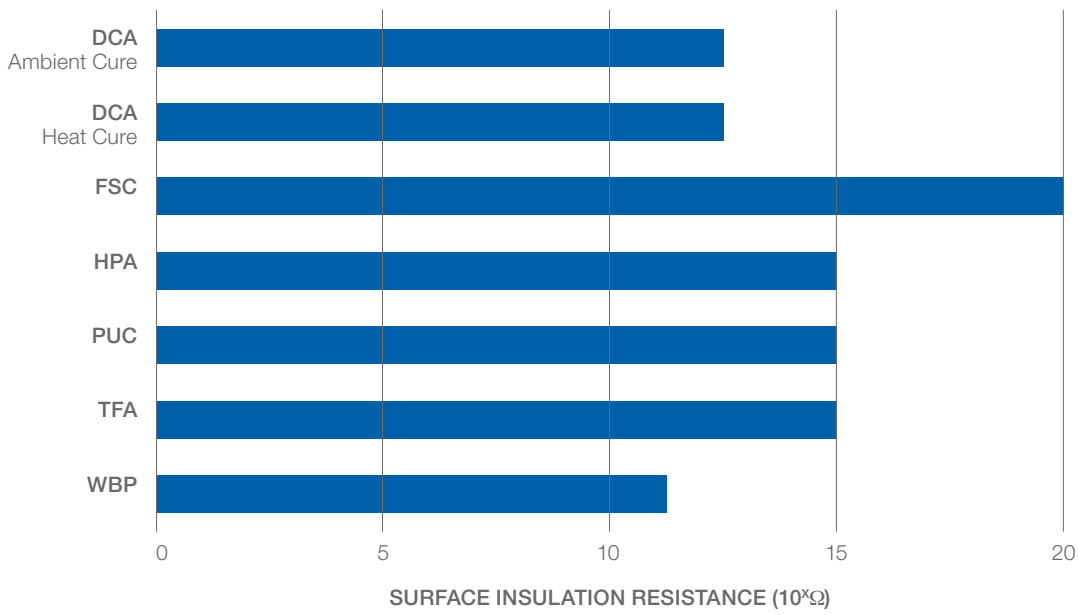


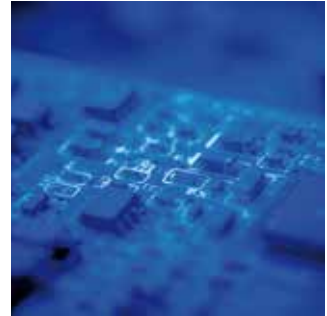
Electrical Testing

Evaluation of electrical properties is essential in all conformal coating applications. Some typical tests include:

- Dielectric Strength
- Dielectric Constant
- Dissipation Factor
- Surface Insulation Resistance
- Comparative Tracking Index (CTI)

Electrical Testing

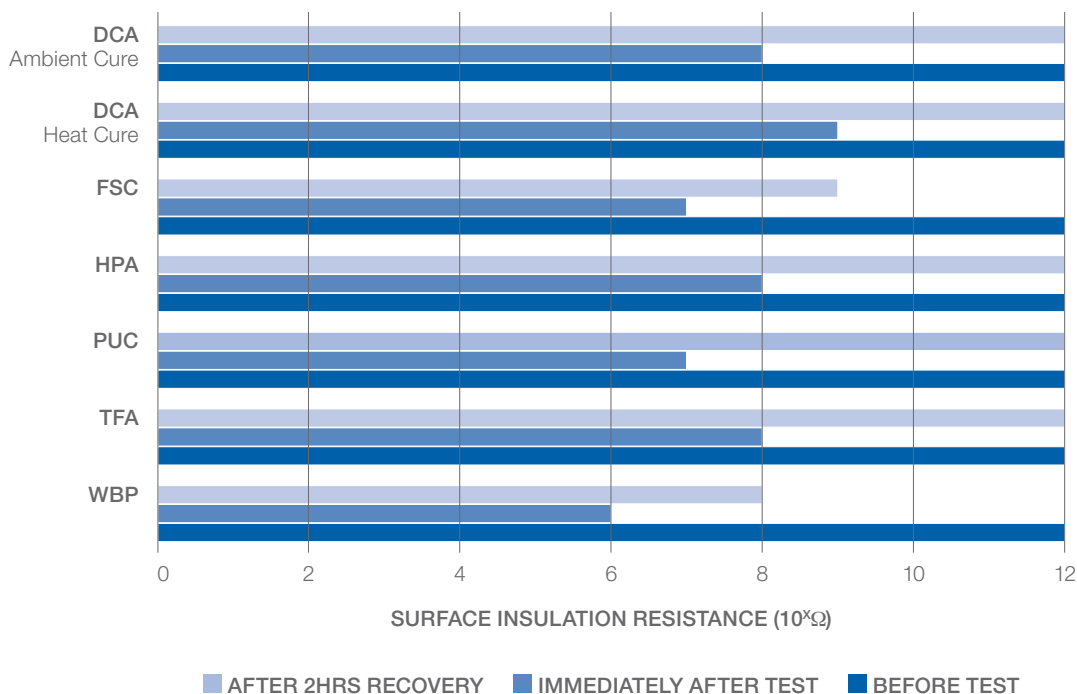




Water Immersion

Immersion in water is an extremely harsh test for a conformal coating to pass. Most coatings will resist immersion for short periods of time however prolonged exposure can highlight issues.

- Coated boards were immersed for 7 days and the SIR results compared.
- For continuous or frequent immersion in water we advise Electrolube Encapsulation Resins



Solvent Resistance

Solvent resistance tests can be carried out in accordance with IEC 61086-2. The performance of the coating will largely depend on the solvents used during the test. Those marked excellent will have a very high level of solvent resistance; Electrolube offer CCRG, a highly efficient coating remover for such products. Those marked 'good' have a reasonable solvent resistance to materials such as IPA but may be easily reworked with specialist products such as Electrolube ULS.

DCA Ambient Cure	GOOD
DCA Heat Cure	EXCELLENT
FSC	GOOD
HPA	GOOD
PUC	EXCELLENT
PUCAF	GOOD
TFA	GOOD
UVCL	BEST
WBP	EXCELLENT

Thermal Cycling



A thermal cycling profile was set up as per IEC 60068-2-14:

- -55°C to +125°C, 25 minutes at each temperature
- 12°C/min rate of temperature change
- 20 cycles

Coated tin, copper, aluminium and FR4 panels were subjected to the cycling and then tested for adhesion (BS EN ISO 2409) and flexibility (3mm mandrel – IPC-TM 650 2.4.5.1)

All Electrolube conformal coatings pass this test when applied to the substrates described above.

UV Resistance

Electrolube have carried out weathering resistance tests on a number of available conformal coatings. Tests were in accordance with ISO 4892, Part 3, Cycle 1: 'Plastics Methods of Exposure to Laboratory Light Sources' and carried out in a QUV SE Accelerated Weathering Tester. After 1000 hours exposure, the results indicated that Electrolube acrylic coatings, AFA, APL, HPA and TFA, have superior resistance to UV light, maintaining their clarity throughout the exposure testing.

Exposure intensities will vary depending on geographical locations and therefore it is important to establish the correct accelerated exposure time for your region. As an example, this test is roughly equivalent to 4 years weathering resistance in a typical Northern European climate.

The Product Range



DCA – SCC3 Conformal Coating

- High specification flexible modified silicone resin conformal coating
- UL746 approved
- May be ambient cured or heat cured for enhanced performance
- Excellent chemical and solvent resistance when heat cured
- May be soldered through for rework
- Extremely wide operating temperature range



DCA-FD – Fast-Dry DCA

- Touch dry in 20 minutes
- Higher solids content offering greater coverage
- Meets UL746 standard for conformal coating
- Excellent chemical and solvent resistance when heat cured
- May be soldered through for rework
- Extremely wide operating temperature range



DCR/DCRT/DCB

- Modified versions of DCA – SCC3 Range
- DCR is an opaque red version
- DCB is an opaque black version
- DCRT is a thickened opaque red product for covering difficult areas, such as lead ends
- Excellent for camouflaging commercially sensitive circuit board designs
- Meet UL746 standard for conformal coatings



AFA – Aromatic Free Acrylic Coating

- Excellent clarity, ideal for LED applications
- Free of aromatic solvents
- Meets UL746 and IPC-CC-830 industry standards
- Very fast touch-dry time
- May be removed with solvents such as Ultrasolve (ULS)
- UV trace to aid inspection



TFA – Toluene Free Acrylic

- Reduced hazard solvent-based acrylic coating, toluene-free
- Excellent clarity, ideal for LED applications
- IPC-CC-830 and UL746 approved
- Excellent protection in humid environments
- May be removed with solvents such as Ultrasolve (ULS)
- UV trace to aid inspection



HPA – High Performance Acrylic

- High performance flexible acrylic coating
- Approved to US MIL-1-46058C
- UV trace to aid inspection
- Excellent electrical properties
- Excellent clarity, ideal for LED applications
- May be removed with solvents such as Ultrasolve (ULS)



APL – Acrylic Protective Lacquer

- Excellent clarity, ideal for LED applications
- Offers excellent adhesion to all substrates
- Good temperature range and dielectric properties
- May be soldered through for rework
- UV trace to aid inspection
- May be removed with solvents such as Ultrasolve (ULS)



UVCL – UV Cure Conformal Coating

- VOC-free
- Exceptionally fast curing
- Low viscosity, ready to use for selective spray application
- Long shelf life
- Excellent flexibility, even after thermal cycling
- UV trace to aid inspection



FSC – Flexible Silicone Coating

- Solvent removable, modified silicone conformal coating
- May be removed with solvents such as Ultrasolve (ULS)
- High level of protection offered in humid environments
- May be soldered through for rework
- Very high surface insulation resistance
- Wide operating temperature range



WBP/WBPs – Aquacoat Plus

- Water-based coating, very low VOC content
- Excellent solvent resistance
- Resistance to mould growth
- N-Methyl pyrrolidone, isocyanate and phenol free
- Wide operating temperature range
- UV trace to aid inspection



LFCC – Lead Free Conformal Coating

- Compatible with lead free flux residues
- N-Methyl pyrrolidone, isocyanate and phenol free
- Wide operating temperature range
- UV trace to aid inspection
- Excellent electrical properties
- Excellent protection in humid environments



PUCAF – Aromatic Free Polyurethane Coating

- No aromatic content
- Fast touch-dry time
- Excellent adhesion to a wide variety of substrates
- Wide operating temperature range
- Resistant to mould growth
- UV trace to aid inspection



CPL – Clear Protective Lacquer

- General purpose coating for PCBs giving high quality glossy finish
- Ideal for protecting ferrous metals from corrosion
- Good resistance to humidity
- May be soldered through for rework
- No UV trace
- Also used as a top coat for protecting conductive lacquers



PUC – Polyurethane Coating

- Excellent abrasion resistance and mechanical strength
- Excellent adhesion under all climatic conditions
- UV trace to aid inspection
- High level of flexibility, even at low temperatures
- Excellent resistance to a wide range of chemicals and solvents
- Resistant to mould growth



TFCF – Fluorocoat Surface Modifier

- Thin-film coating, excellent coverage
- Reduces surface tension of substrates, protecting from a range of chemicals and solvents
- Superior moisture resistance
- Removed with light mechanical wear, allowing for assemblies to be coated without masking
- Ideal for connectors
- UV trace to aid inspection

Associated Products



The Safewash Range

- Water-based cleaning products for use before conformal coating
- Environmentally friendly
- Efficient removal of all flux residues
- Ensures cleanliness to military standards is achieved
- Products available for ultrasonic, spray under immersion and dishwasher application
- Products available for stencil cleaning and uncured adhesive removal



CCRG – Conformal Coating Removal Gel

- Thixotropic gel specifically formulated to remove Electrolube's solvent resistant coatings
- Allows localised removal of components
- Can be used in conjunction with RRS, Resin Removal Solvent for complete coating removal
- Water rinsable
- DCA, DCB, DCR, DCRT, DCE, WBP/S, PUCAF and PUC can be removed
- Does not contain methylene chloride



PCM – Peelable Coating Mask

- Flexible latex for masking components
- Manual removal, leaving no residue
- Solvent resistant and does not contaminate conformal coatings
- Dries at room temperature
- High film strength, does not break easily
- Can be accurately applied using automated dispensing machines



ULS – Ultrasolve Cleaning Solvent

- Allows efficient rework of solvent removable conformal coatings
- Excellent degreasing properties
- Fast evaporation
- Compatible with most plastics, rubbers and elastomers
- APL, FSC, HPA, AFA, TFA can be removed
- Available in bulk, aerosol and aerosol brush version



PCS – Peelable Coating Mask Synthetic

- Thermal cure
- Ammonia free – no odour
- Manual removal, leaves no residues
- Does not dissolve in solvents or contaminate conformal coatings
- Suitable for use with dip, spray or brush applied coatings
- Can be accurately applied using automated dispensing machines



HFFR – Hexane-Free Flux Remover

- N-hexane free
- Efficient removal of all flux residues
- Harmless to most plastics, rubbers and elastomers
- Leaves a perfectly clean, dry surface with no residue
- Fast evaporation
- Available in bulk, aerosol and aerosol brush version



IMC – Industrial Machine Cleaner

- Designed for general cleaning of automated dispensing equipment
- Ideal for cleaning selective spray equipment prior to and following the use of UVCL Conformal Coating
- Non-flammable
- Prevents machine blockages
- Low toxicity
- Very low vapour pressure

*Various sizes are available for most products, including bulk

Conformal Coatings

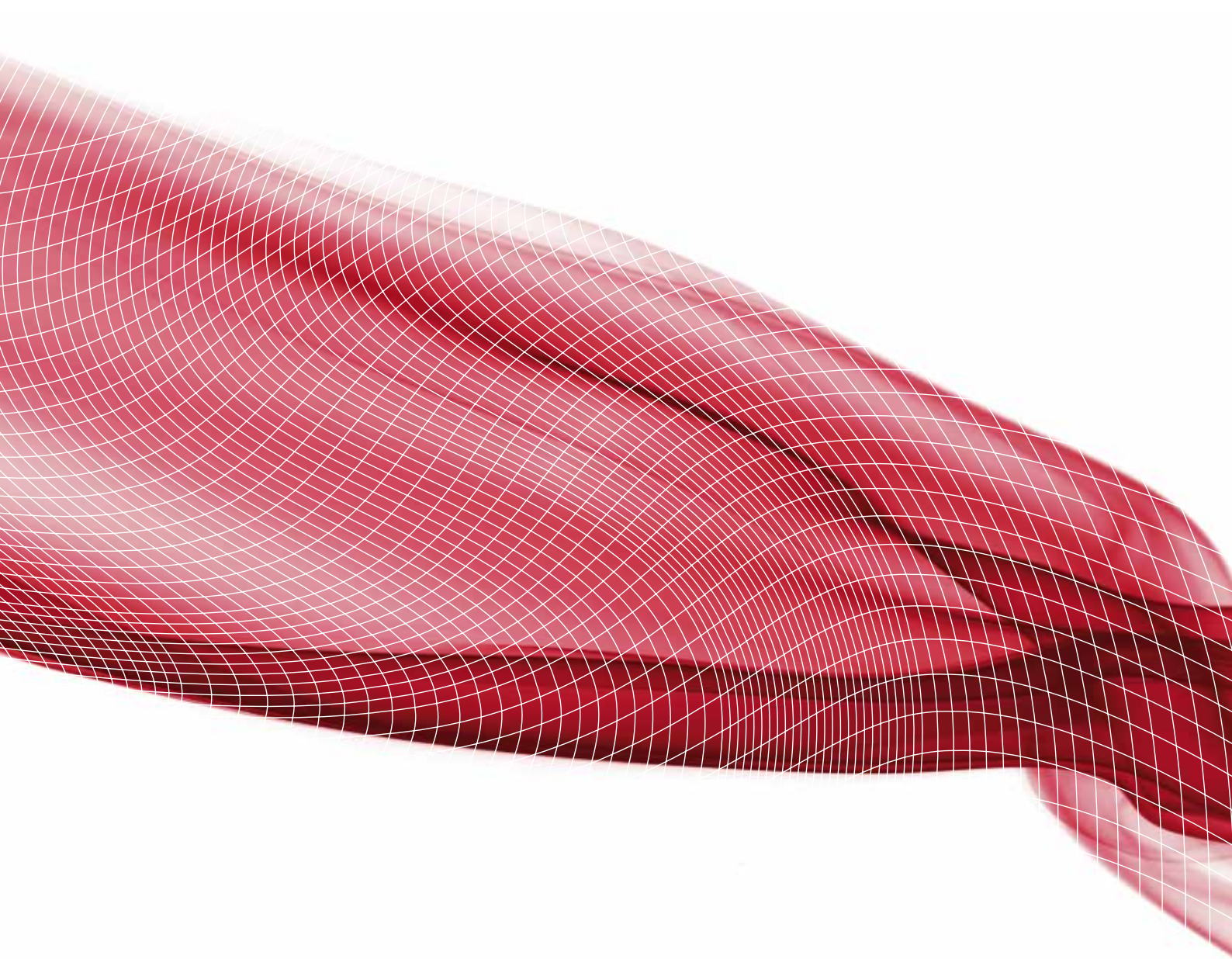
	DCA	DCB/DCR	FSC	WBP/WBPS	HPA	TFA	PUCAF	UVCL	TFCF
	Silicone Conformal Coating (SCC3)	Silicone Conformal Coating (SCC3)	Flexible Modified Silicone Coating	Aquacoat Plus/Sprayable	High Performance Acrylic	Toluene Free Acrylic	Aromatic-Free Polyurethane Coating	UV Cure Conformal Coating	Fluorocoat
Colours Available	Clear	Black/Red	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Viscosity (mPa s @ 20°C) (Bulk)	200	200/500	550	200/80	300	260	90	200	2
Flashpoint (°C) (Bulk)	27	27	27	None	-7	-7	27	>90	7
Solids (%) (Bulk)	37	47/60	50	35	35	36	37	100	2
Dielectric Strength (kV/mm)	90	90	80	50	45	45	60	27	90
Insulation Resistance (Ω)	1 x 10 ¹⁵	1 x 10 ¹⁵	1 x 10 ²⁰	5 x 10 ¹¹	1 x 10 ¹⁵	1 x 10 ¹⁵	1 x 10 ¹⁵	7 x 10 ¹²	1 x 10 ¹⁵
Temp. Range (°C)	-70 to +200	-70 to +200	-50 to +125	-60 to +125	-55 to +130	-65 to +125	-55 to +130	-65 to +135	-50 to +125
Touch Dry Time (Mins @ 20°C)	50-55	50-55	10-15	25-35	10-15	15-20	10	-	5
Cure Time (Hours @ 20°C)	2 @ 20°C & 2 @ 90°C*	2 @ 20°C & 2 @ 90°C*	24	24	24	24	24	-	24
Solvent Resistance	Excellent	Excellent	Good	Excellent	Good	Good	Good	Best	Good
Humidity Resistance	Excellent	Excellent	Excellent	Good	Excellent	Excellent	Good	Excellent	Excellent
Mould Resistance	Excellent	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Good
Thinners	DCT	DCT	DCT	DI Water	UAT	DCT	FTH	-	N/A
UV Trace	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Approvals	UL746		IEC61086		MIL-I-46058C	IPC-CC-830, UL 746		IPC-CC-830	

*The SCC3 range may also be cured at ambient temperature however the solvent resistance will be reduced.

**Please refer to the technical data sheet for more information on UV Curing Parameters.

Contact Lubricants

Switch to a superior performance



ELECTROLUBE
THE SOLUTIONS PEOPLE

Contact Lubricants



- Extends the operating life of switches
- Improves signal quality
- Reduces operating temperature
- Controls switch 'feel'
- Prevents contamination
- Silicone free

Electrolube have been the leading supplier of contact lubricants since their invention by the founder in the 1950s. They increase the reliability and lifetime of current carrying metal interfaces, including switches, connectors and busbars.

Electrolube has earned an unsurpassed reputation for the manufacture and supply of specialist lubricants to the automotive, military, aerospace, industrial and domestic switch manufacturing sectors. The range has been developed over the years to accommodate many advances in such rapidly advancing industries; combining excellent electrical properties and lubricity with plastics compatibility.

Contact lubricants are specially formulated greases and oils that reduce friction and enhance the electrical performance of current carrying metal interfaces in switches and connectors. Electrolube products are electrically insulative in thick films, preventing tracking in ultra thin films, i.e. between closed metal contacts they allow the current to flow, owing to the 'Quantum Tunnelling Effect'. They also exhibit a neutral pH thereby avoiding surface corrosion.

The effectiveness of even perfectly designed switches can be improved by contact lubricants and, when considered at the design stage, significant production cost savings can be achieved by the use of less expensive plastics and contact metals.

Tests have shown that contact lubrication can extend the lifetime of switches by more than 300%, producing excellent performance under all circumstances and preventing the need for expensive maintenance.



How Contact Lubricants Work

Contact technology is constantly developing with new alloys, plastics and customer demands. However, it is still impossible to solve the main cause of switch malfunction i.e. the inability to produce a perfectly smooth metal contact surface.

As no metal interfaces are entirely even and smooth, when applied to such surfaces in thin films contact lubricants fill in all surface imperfections, in turn improving contact and electrical performance as well as prolonging the contact life by reducing hot spots, fretting and arcing.

By filling in the air gaps between the contacts, contact lubricants dramatically increase the effective surface area, in turn preventing arcing and the related temperature rise and oxide formation. They also provide a barrier to airborne contamination and reduce the effects of friction by facilitating smooth movement. In addition, the use of contact lubricants are typically evaluated for their 'feel' characteristics, improving the quality of movement of a switch or in simple plastic/ plastic contacts, for example.

Heat Generation

If there is insufficient surface contact, the current is only carried by a fraction of the 'designed surface area' and the heat generated will be concentrated at the contact points. This, in turn, causes the formation of high resistance oxide layers and 'hot spots' are observed. The overall efficiency of the switch will be reduced and can eventually lead to complete failure as the two surfaces weld together

Arcing (mini-lightning strikes)

This can also occur with un-lubricated contacts; ionisation of the air and the associated rise in temperature causes metal transfer between the contacts, resulting in new 'peaks and troughs' on the surfaces.

Mechanical Wear

Metal interfaces, whether static or moving, suffer from mechanical wear. In the case of static contacts, this is called 'fretting'; the small movements of contacts caused by vibration, temperature changes, etc. As the surfaces fret, friction causes metal particles to be removed from the peaks, breaking through plated surfaces. This exposes surface and underlying metal to the effects of oxidation and wear. Additionally the detached metal particles can cause intermittent signal transmission and ultimately switch failure.

Silicone Contamination

As silicones can "creep" great distances, these products should not be used in switch assembly areas. When silicone is present between moving or vibrating contacts, they react under arcing conditions to form silicon carbide. These crystals abrade the contact surface and cause electrical breakdown. Electrolube contact lubricants also eliminate the problems associated with silicone contamination, providing they are applied prior to the introduction of silicone.

Switch Operation

The way a switch 'feels' when operated has become an indicator of quality, particularly within the automotive industry. Contact lubricants, in addition to their technical benefits, can also determine the 'feel' of a switch, whether it be strong and decisive for the dashboard of a commercial vehicle, or smooth and quiet for a luxury car.

Automotive Applications



Electrolube's automotive lubricant product range helps engineers meet the huge demands they face on a daily basis. Design engineers are under pressure to keep costs down by the correct selection of materials for complex, innovative designs.

The development of Electrolube's lubricants, together with leading automotive manufacturers, has led to materials with enhanced performance across wide temperature ranges, improved resistance to the external environment and overall development of the electrical and mechanical properties of these materials. In addition, Electrolube lubricants are compatible with the most sensitive of plastics and are continually reviewed to meet the latest regulatory requirements.

Dual Purpose Lubrication

The most important role of lubricating greases is to protect from wear and corrosion. Damping lubricants are materials which ergonomically control free motion and noise in mechanical components whilst giving a "quality feel" to hand operated mechanisms. For current carrying metal interfaces, the major advantage is that they increase the reliability and lifetime of these components by preventing corrosion and wear, which could include sensors, switches, potentiometers and connectors, for example.

The following information covers each of these applications in more detail and provides some starting suggestions for choice of lubricants. Technical data sheets can be referred to for additional information on each product and in all applications the lubricant must be fully tested in representative end-use conditions to confirm correct selection.

Connectors

Contact lubricants are used extensively for connectors. Connectors in early automotive applications were plagued with "fretting corrosion" problems. Although tin and silver plated contacts are more commonly used, gold plated contacts are also apparent in some connector designs. Gold is a soft material and can exaggerate fretting corrosion.

A lubricated switch is subject to far less mechanical wear as the lubricant facilitates smooth movement. Friction and wear are therefore greatly reduced, extending switch lifetime, improving electrical efficiency and allowing the use of a wider selection of materials.

Such improvements are extremely important in the challenge of meeting the energy efficiency requirements of today's more fuel economical and hybrid/electric vehicles.

Example Applications

Gold Plated Contacts/Air-Bag Connectors	CG60/SOK
High Insertion Force Applications	EGF
Slip Ring Devices	SOB/CO70

Switches and Contacts



High Current Arcing Switches or Contacts

As un-lubricated contacts open and close, arcing (mini lightning strikes) can often occur. Ionisation of the air and the associated rise in temperature causes metal transfer between the contacts, resulting in the formation of new 'peaks and troughs' – a common problem found in high power contacts. The problem of arcing is also compounded in 'make and break' switches, where every time the circuit is opened, the contacts may bounce several times before finally mating. This exacerbates the problems discussed previously and subjects the circuit to repeated surges of current giving a poor signal to noise ratio.

This problem is not found in lubricated switches, as the lubricant fills the air gap between the contacts, preventing arcing, related temperature rises and corrosive chemical formation; as air is excluded from the metal surfaces, airborne contamination cannot form insulative barriers on the metals. Finally, contact lubricants provide a cushion between the contacts to dampen the effects of bouncing.

Example Applications

Starters/Ignition	CG53A
Heating and Ventilation	CG71/SOK

Medium Current Switches or Contacts

These types of switches vary in design parameters and materials usually employed. Typically more sensitive plastics and elastomers are used and therefore compatibility with all lubricant materials must be tested.

In such applications lubricants are used to dramatically increase the effective surface area of the contact, thus eliminating hot spots, improving efficiency and ensuring that contact resistance remains low and stable.

Example Applications

Windscreen Wipers	CG71
Central Locking Switches	CG60/CG71
Power Seat Switches	CG60/CTG/EGF
Dashboard Control Mechanisms	CG70
Power Window Switches	CG70/CG53A
Micro Switches	EML/CO70/SON

Low Current Carrying Switches and Contacts

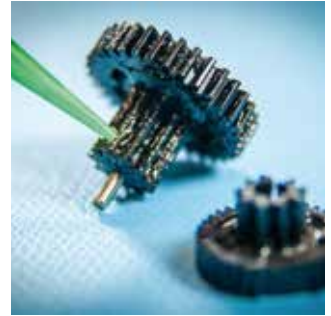
Low current carrying switches and contacts are typically made with the most sensitive plastic and elastomer rubbers, yet being low current carrying, demand the best electrical performance from contact lubricants.

Electrolube's contact lubricants have been used extensively for high quality audio applications and ergonomic controls. The application of lubricants prevents corrosion of the metal interfaces, whilst providing the switch with low levels of electrical noise and a very stable signal.

Example Applications

Steering Wheel Switches	CG71
Light Switches	LCG
Low Contact Pressure Switches	SOA/CO70/SGN
Audio Switches	CG71/LCG

Sensors and Non-Electrical



Sensors and Potentiometers

Potentiometers have low contact forces and must stay in contact with the resistor; a high viscosity grease would not allow close contact with the resistor, therefore the most suitable materials are constructed from low viscosity base oils, coupled with an effective, non-carbonising thickener.

As well as functioning at very high temperatures, fluorinated lubricants have exceptional plastics compatibility and solvent resistance and are therefore ideal for fuel level sensors, particularly in oil form where a thin, uniform application of a long lasting lubricant can be applied to the surface.

Example Applications

Fuel Level Sensors
 Seat Position
 Electronic Throttle

EOF/DOF
 EGF/CG60
 EGF/EOF

Interior Components – Non Electrical

Interior components requiring lubrication come in many combinations:

- Metal-metal contacts – seating tracks, sunroof tracks, etc.
- Plastic-plastic contacts – windscreen wiper gears, window visor, cup holders, grip handles, etc.
- Plastic-metal contacts – cables, glove compartment locking mechanisms, etc.

Each application requires a certain grease characteristic to provide damping of free movement and noise as well as providing a quality feel. Electrolube's damping lubricants offer engineers an economical route to quality.

Example Applications

Medium-Heavy Viscosity:

Dashboard Needle Gauge	SPG/SCO
Window Visor	SPGA
Window Tracks	CTG/SGN

Light Viscosity:

Cup Holders, Ashtrays, Grip Handles	SPG
Ventilation Air Flaps	SPG/SCO
Sunroof Mechanisms	SPG/SGN
Mirror Adjustments	SPG/SCO

Product Selection

Plastics Compatibility



It is important to discuss the options available at the design stage to ensure correct product selection and application. Many factors must be considered when choosing a contact lubricant, among the areas to be considered are; voltage, current, operating temperature range, environmental conditions, contact metals, number of cycles and associated plastics.

Plastic test bars were coated in various Electrolube lubricants and placed on a test rig under strain. The samples were then conditioned for 7 days at 40°C before inspection

Key

1. Fail – snapped
2. Severe stress cracking but not snapped
3. Stress cracking seen
4. Pass – some very slight stress cracking
5. Pass – no incompatibility seen

Plastic Grade	EGF	CTG	SPG	CG60	CG70	CG71	SGB	SGA
PC + PBT/PET – Makroblend DP 7665/MBS162	5	5	5	5	5	1	5	1
PC + PBT/PET – Makroblend KU27915	5	5	5	5	4	5	5	5
PC + PBT/PET – Makroblend S7916	5	5	5	5	5	4	4	5
PC – Makroblend 2407	5	5	5	3	1	2	1	1
PC + ABS – Bayblend T45	5	5	5	5	5	1	1	1
PC + ABS – Bayblend T8SXF	5	5	5	4	1	4	1	1
PBT – Ultradur B4300G6	5	5	5	5	5	5	5	5
PBT – Ultradur B4520	5	5	5	4	4	4	4	4
PA – Ultramid B3WG6	5	5	5	4	4	4	4	4
PA – Ultramid A3WG6	5	5	5	5	5	5	5	5
PA – Ultramid B35	5	5	5	5	5	5	5	5
PA – Ultramid A3K	5	5	5	5	5	5	5	5
PBT – Crastin CR SK605	5	5	5	5	5	5	5	5
PBT – Crastin CRS620F20 NC10	5	5	5	4	4	4	4	4
PP – 3150 – MX5	5	5	5	5	5	5	4	5
PP – 3060 – MW5	5	5	5	5	5	5	5	5
PP – 3120 – MU5	5	5	5	5	5	5	5	5

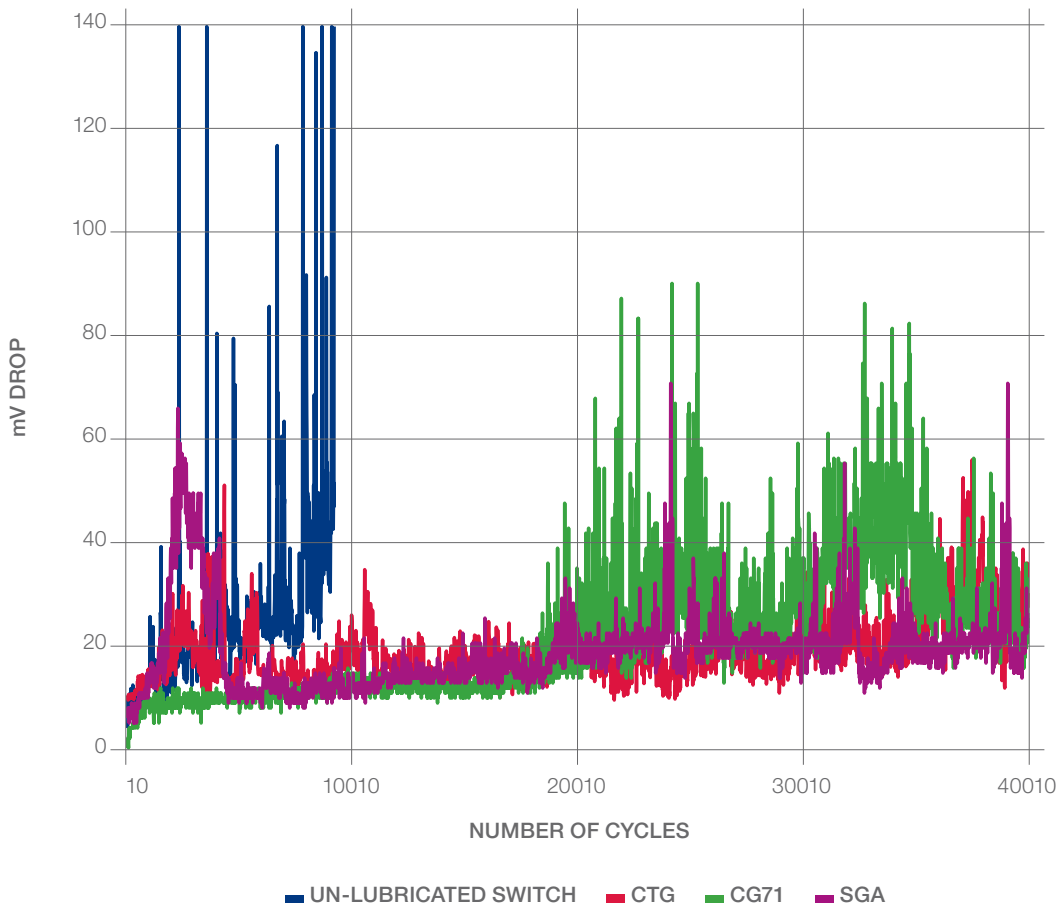
ABS = Acrylonitrile butadiene styrene PA = Polyamide PBT = Polybutylene terephthalate PC = Polycarbonate
 PET = Polyethylene terephthalate PP = Polypropylene



Electrical Testing

Electrolube have a custom built switch rig for the lifetime testing of contact lubricants. Every product is subjected to this test, using a standard automotive switch for comparison purposes.

The results provide a measurement of mV drop over the cycling period and show how the use of contact lubricants can dramatically increase switch performance and lifetime.

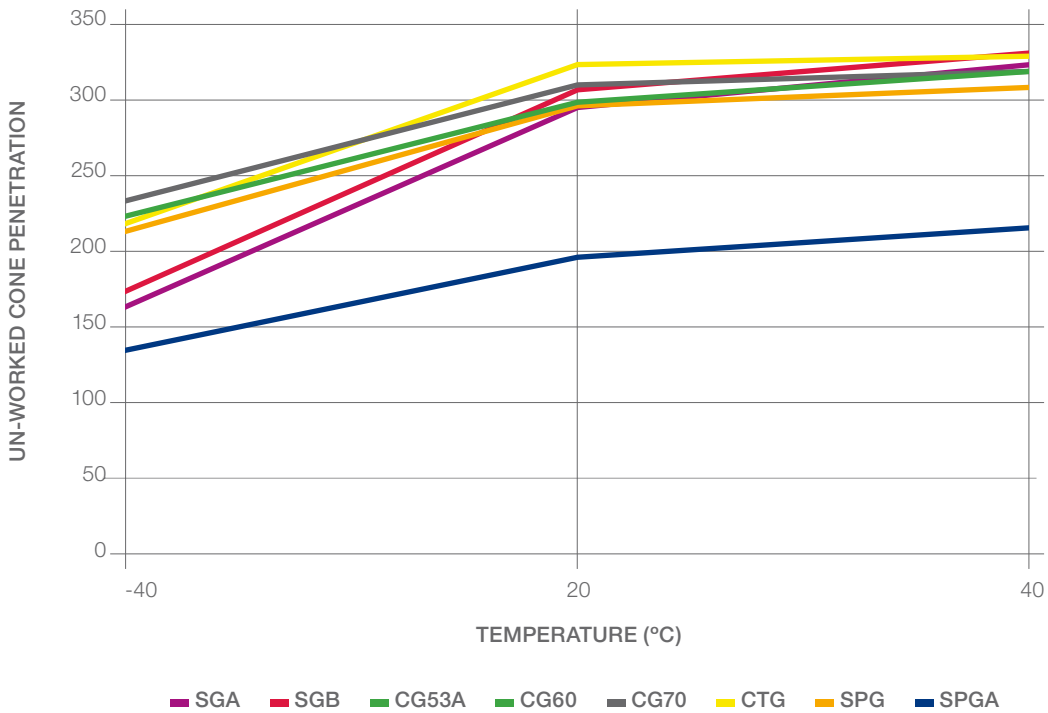


Cone Penetrations



To establish the consistency and possible variations in performance at a range of temperatures, the cone penetration values were measured according to ASTM D217.

The un-worked cone penetrations of various Electrolube contact lubricants were tested at -40°C, 20°C and 40°C:





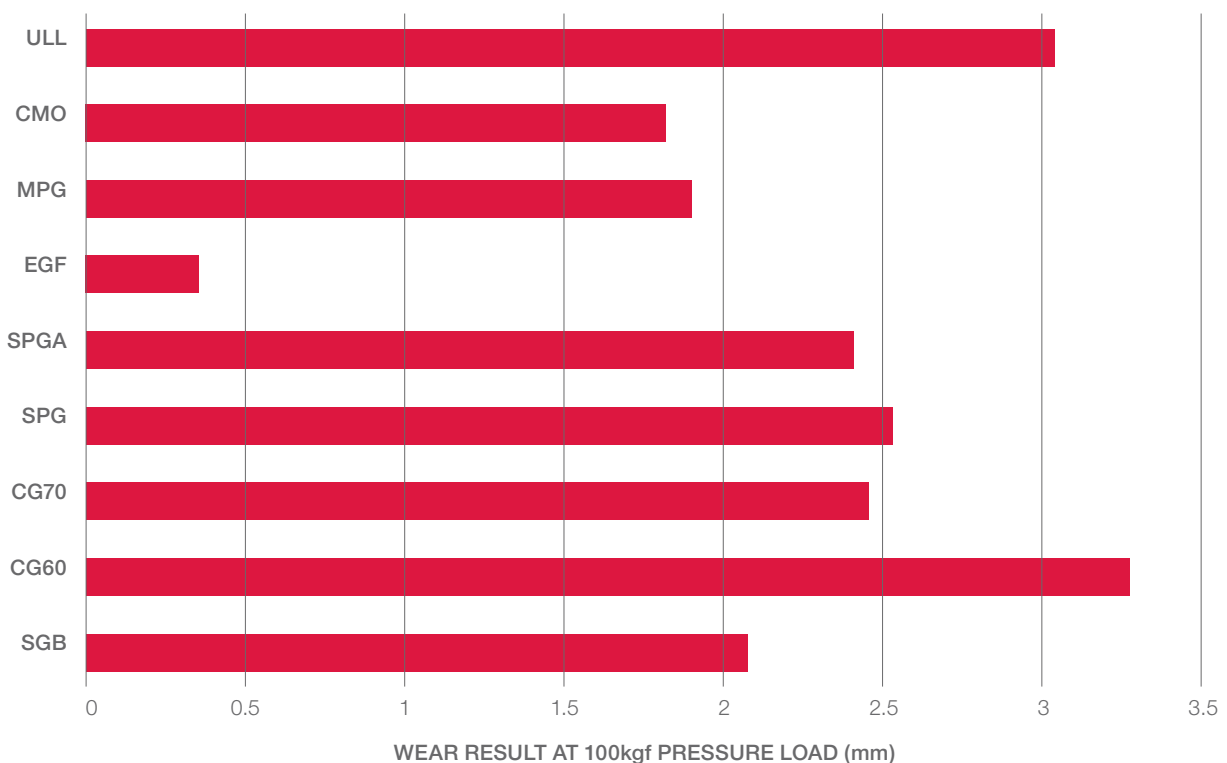
Mechanical Testing

To establish the mechanical performance of the various contact lubricants, 4-ball wear testing was completed to ASTM D 2596/87. Included in this testing were some lubricants from the general maintenance range where the end application is more mechanical lubrication than electrical contact improvement.

The test consists of loading the grease into equipment that has four balls under a defined rotation. A pressure load is introduced onto the balls and the load increased according to a logarithm function.

The results are given as a pass value and a wearing value at the pass value. The wearing value is measured in mm and quantifies the amount of wear observed on the balls utilised in the test.

The weld point is the end of the test where the wearing of the balls was more than 4mm (the maximum according to the methodology). This value is usually only used for indication, the pass and wearing values are the most important for selection purposes.





Protection in Humid / Corrosive Environments

A test schedule was constructed in order to establish which products provide the highest level of protection in high humidity and corrosive environments.

Steel and copper panels were coated in a variety of Electrolube contact and mechanical lubricant products and subjected to 90% humidity at 35°C for 3 weeks, followed by 1 week in the salt spray chamber, utilising a 5% salt solution at 35°C.

The conditioned panels were visually inspected and the % corrosion/oxidation present was recorded.

Grease	% Corrosion on steel	% Oxidation on copper
SGA	40	100
SGB	100	0
CG53A	10	0
CG60	5	10
CG70	5	70
CG71	50	10
CTG	5	0

The results are comparisons, therefore 100% relates to the highest level of oxidation observed on all test substrates.

Protection of Gold and Silver Contacts

The protection of gold and silver contacts is also very important. A range of gold and silver plated contacts were coated with various contact and mechanical lubricants and placed into the salt spray chamber for 7 days. The settings were 5% salt solution, 35°C.

The majority of the Electrolube products performed exceptionally well as the gold and silver plated contacts showed no signs of corrosion following the test.

The following products provided a very high level of protection for the gold and silver plated contacts; EGF, E3C-CA, CG60, CG70, CG71, CG53A, CTG, SGB.

The only product to show signs of corrosion on the gold and silver plated contacts was MPG. This product is therefore not advised for use on gold and silver surfaces, particularly where high levels of humidity or salt spray are present.

Chlorine Resistance

This test was devised to determine which contact lubricant products provide the best protection against oxidative environments. Copper panels were coated in various contact and mechanical lubricants and subjected to 2 months at 35°C in an oxidative atmosphere containing chlorine.

The results showed that E3C-CA gave the best protection, followed by CG53A, CG60, CG70 and CTG.

The Product Range



CG60 – Contact Grease

- Excellent high performance lubricant
- Reduces electrical background noise
- Excellent plastics compatibility
- Contains a UV trace to allow easy inspection



CG70 – Contact Grease

- Exceptional performance at low temperatures
- Very good plastics compatibility
- Good electrical performance
- Oil version available (CO70)



CG71 – Contact Grease

- Enhanced electrical properties, gives a consistently low mV drop
- High level of oxidation stability
- Low wear characteristics
- Good plastics compatibility



CG80 – Contact Grease

- Excellent performance at high temperatures
- Good electrical properties
- Low evaporation weight loss
- Contains a UV trace to allow easy inspection



CG52B – Contact Grease

- Reduces contact resistance
- Suitable for both moving and static contacts of all metal types
- Developed initially for the automotive industry
- Successful connector lubricant



CG53A – Contact Grease

- Excellent electrical properties
- Good plastics compatibility
- Superior protection in harsh environments
- Wide operating temperature range



SGA – Special Contact Grease

- Effective treatment for all types of contacts
- Reduces contact resistance and arcing of contacts from small relays to high capacity contactors
- Will not migrate from vertical contacts or surfaces
- Oil version available (SOA)



SGB – 2GX Contact Treatment Grease

- High quality, non-melting contact grease
- Hard consistency version (SGBH) and oil version (SOB) available
- Reduces contact wear and arcing
- Good plastics compatibility



SOK – 8X Contact Treatment Oil

- Contact oil for switch applications
- Non-flammable and silicone free
- Excellent electrical properties
- Reduces arcing and hence contact wear



SON – 10X Contact Treatment Oil

- Extremely effective at low operating temperatures
- Low viscosity oil
- Grease version (SGN) available
- Ideal for low contact pressure applications such as micro switches



CTG – Contact Treatment Grease

- Excellent protection in corrosive environments
- Wide operating temperature range
- Good electrical performance
- Excellent plastics compatibility



EGF – Eltinert F Grease

- Excellent chemical resistance
- Exceptionally wide operating temperature range
- Prevents and cures high contact resistance caused by silicone contamination
- Oil version (EOF) and dilute oil version (DOF) available



SPG – Special Plastic Grease

- Synthetic grease offering outstanding low temperature performance
- Excellent compatibility with thermoplastics, including ABS and Polycarbonate
- Effective lubrication of plastic-to-plastic and plastic-to-metal contact surfaces
- More adhesive version available (SPGA)



E3C-CA – Electrolytic Cell Connection Compound

- For use on connections and switches in electrolytic, electro-plating and anodising plants
- Reduces temperature at contact surfaces
- Improves plant productivity and reliability, thus reducing maintenance costs
- Superior corrosion protection and oxidation stability



EML – Contact Cleaner Lubricant

- Cleans and lubricates switches, connectors and slip rings
- Removes dirt and protects from further contamination
- Reduces contact resistance
- Commonly known as switch cleaner



EPC – Electro-Plating Compound

- Especially developed for use on electro-plating and anodising plants
- Inhibits against corrosion
- Improves electrical contact on anode and cathode bars, pick-up shoes, rack contacts, busbar joints etc.
- Formulated to assist in the removal of tarnish and corrosion



SWC – Non-Flammable Switch Cleaner Lubricant

- Provides protection against arcing and corrosion
- Non-flammable, can be used on live equipment
- Safe to use on most plastics
- Contains high quality contact treatment oil



CCS – Contact Cleaning Strips

- Easy to use
- Impregnated, mildly abrasive card
- Cleans, refurbishes and lubricates metal contacts
- High quality contact lubricant



ULL – Ultralube

- Tenacious long lasting and non-staining lubricant
- Ideal for use on printer mechanisms
- Can be used as an edge connector lubricant, particularly for gold contacts
- Can be used as a silicone inhibit for relays

*Various sizes are available for most products, including bulk.

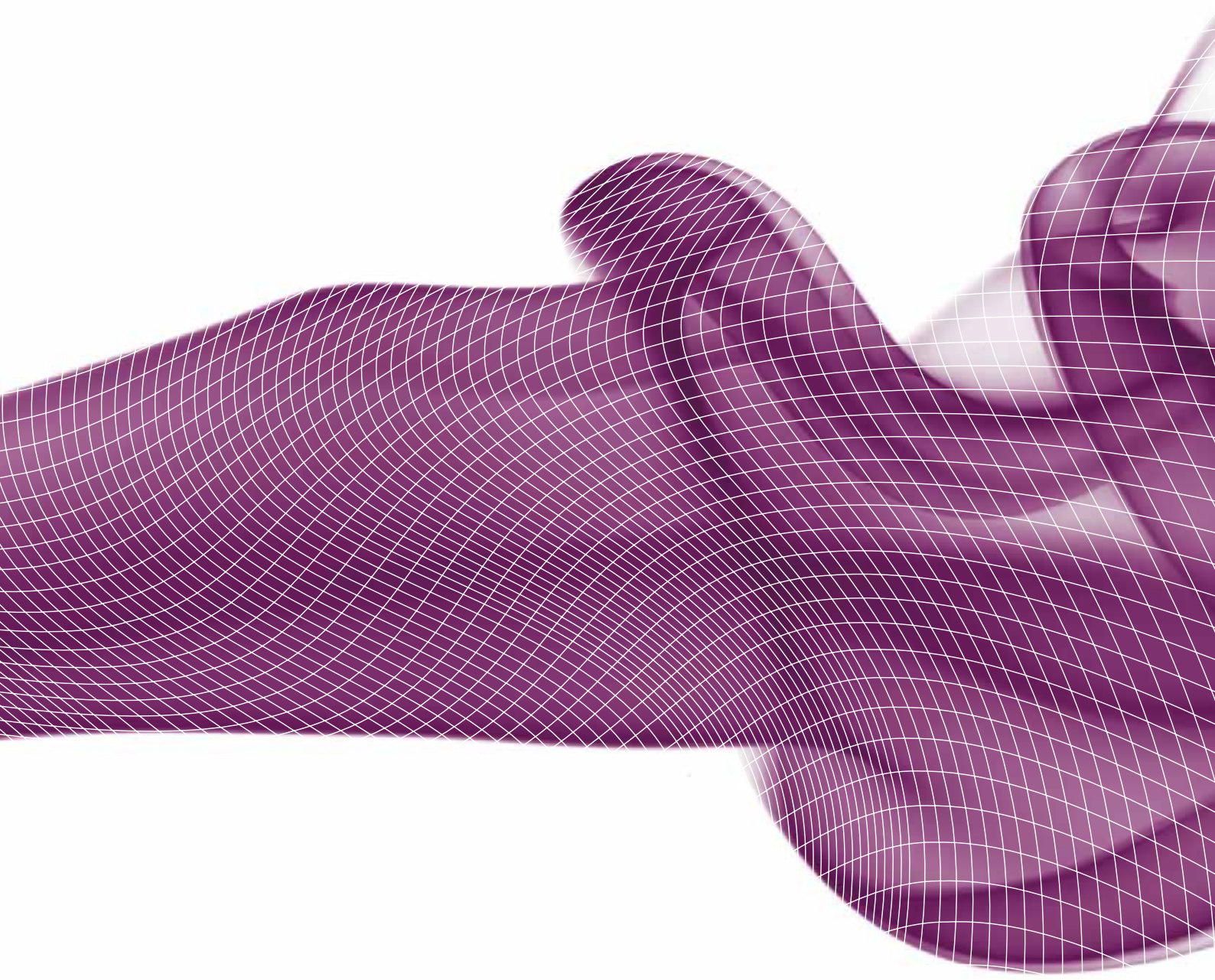
Contact Lubricants

	SGA	SGB	CG53A	CG60	CG70	CG80	EGF	SPG	CTG
<i>Specialist Property</i>	Low mV Drop	General Purpose	High Voltage	Plastics Compatibility	Low Temperature Performance	High Temperature Performance	High Temperature	Plastic Mechanical Lubrication	Moisture Resistance
Pour Point (base oil, °C IP-15)	-54	-37	-37	-54	-70	-35	-25	-57	-62
% Evaporation Weight Loss (IP-183 100°C)	0.90	0.93	0.21	0.30	0.30	0.20	<0.10	0.20	0.30
Drop Point (°C IP-31)	>250	>250	200	200	200	200	>250	>250	>200
Penetration (Worked, Cone, 20°C IP-50)	320	320	320	330	320	320	280	320	330
Temperature Range (°C)	-40 to +125	-35 to +130	-35 to +130	-45 to +130	-55 to +130	-30 to +160	-25 to +300	-40 to +125	-50 to +130
Mechanical Lubrication	Good	Good	Excellent	Excellent	Excellent	Excellent	Good	Excellent	Good
Electrical Performance	Excellent	Good	Good	Excellent	Excellent	Excellent	Good	OK	Excellent
Humidity Resistance*	OK	Good	Excellent	Excellent	Good	Excellent	OK	Good	Best
Plastics Compatibility**	Poor	OK	OK	Excellent	Excellent	OK	Excellent	Excellent	Excellent
UV Trace	No	No	No	Yes	Yes	Yes	No	No	No
Oil Version Available	SOA	SOB/ EML	No	No	CO70	No	EOF/ DOF	No	No

*Based on accelerated testing. **Compatibility may differ from quoted results – Testing should always take place prior to production.

Maintenance and Service Aids

A total solution for maintenance, repair and overhaul



ELECTROLUBE
THE SOLUTIONS PEOPLE

Maintenance and Service Aids



- Syringes, pump sprays, tubes, aerosols, wipes, pens
- Airduster and freezer sprays
- Cleaners and wipes
- Greases and oils
- Encapsulation resins and conformal coatings
- Maintenance, test, repair and small scale production
- Paints and galvanising sprays

Electrolube manufactures a wide range of maintenance products to complement the major product groups. Whether used by OEMs or subcontractors, these products are supplied in convenient packaging, covering a wide range of applications and requirements.

Specific products in this range include:

- Airdusters – For the removal of dust and dirt from hard to reach places, for example, in photographic and electrical equipment. They can also be used to blast off water or solvents for rapid drying.
- Freezer Sprays – For the identification of faulty components by rapidly cooling components to -55°C. Freezers are available in standard or minimal charging forms, enabling safe use on static sensitive components.
- General Maintenance – Including hard surface cleaners, cyanoacrylate adhesives, tamper evident seals and contact cleaner lubricants.
- Industrial Maintenance – Including high quality paints, galvanising sprays, polyurethane foam, lubricants and graffiti removers.

Electrolube can provide a total solution for mobile mechanics and service engineers through the wide range available. Products are supplied in a range of packaging dependent upon their application and end use. These include aerosols, pump sprays, syringes, tubes, pens, sachets and small tins.

The Product Range

Lubricants & Greases



ACL – Adhesive Chain Lubricant

- Highly tenacious
- Excellent resistance to water and high temperatures
- Good mechanical stability
- Good penetration at low temperatures



DAS – Silicone Mould Release

- Colourless silicone lubricant
- Ideal for all mould release applications
- Very good thermal stability
- Reduces surface friction



AGC – Copper Anti-Seize Fluid

- Provides anti-seize and anti-corrosion protection
- Ideal for use on threaded components
- Excellent water resistance
- Effective at high temperatures



DDF – Leak Detector

- Allows immediate detection of air and gas leaks from all types of pipework
- Non-flammable and safe to use
- Water-based
- Contains anti-corrosion additives



CCS – Contact Cleaning Strips

- Specialist cleaning cards impregnated with contact lubricant
- Increases reliability of contacts by reducing contact resistance
- Reduces mechanical wear and contact erosion
- Increases the life of contacts



DGT – Penetrating Fluid

- Penetrates and lubricates mechanical parts
- Produces a highly water resistant film, providing long term corrosion protection
- Loosens seized assemblies and prevents friction noise
- Ideal for breakdown and maintenance services



CMO – Clear Mechanical Oil

- Clear lubricant with excellent mechanical properties
- Outstanding performance in extreme conditions
- Highly resistant to water
- Contains Molybdenum Disulphide



DFL – Dry Film Lubricant

- High purity PTFE based lubricant
- Water repellent with a low co-efficient of friction
- May be used where silicones or mineral oils are unsuitable
- Can be used as a cold mould release



EPE – Permagard

- De-watering and penetrating fluid
- Excellent lubricating properties
- Dries out damp electrical connections
- Protects against rust and corrosion



HTG – High Temperature Grease

- High quality mechanical grease for lubrication and protection
- Wide temperature range
- Fortified with anti-wear and anti-oxidant additives
- Water resistant



FFL – Fuser Film Lubricant

- Provides high quality mechanical lubrication
- Designed for use on fuser films in toner cartridges
- Excellent thermal resistance
- Excellent plastics compatibility



HVG – High Voltage Grease

- Developed for use on high voltage/high current contacts
- Dramatically reduces wear and arcing
- Low oil bleed even at elevated temperatures
- Good low temperature performance



FSL – Food Safe Lubricant

- USDA H-1 food contact approval
- Incidental or indirect food contact environments
- Resistant to detergents
- Excellent materials compatibility



MPG – Multi-purpose Grease

- General purpose grease
- Wide temperature range
- Safe on most thermoplastics
- Good lubricating and thermal properties



HCG – Highly Conductive Grease

- Very low electrical resistivity
- High thermal conductivity
- Excellent performance at high temperatures
- Excellent adhesion characteristics



OSL – Silicone Oil

- High quality, multi purpose mechanical lubricant
- Silicone spray with excellent water repellency
- Long term lubrication for line printers, keyboards, platens, bearings, etc.
- May also be used as a mould release agent



SCO – Silicone Grease Compound

- High quality, multi-purpose electrical insulating compound
- Excellent water and moisture repellency
- Chemically inert, odourless and non-toxic
- Excellent resistance to tracking and corona discharge



ULL – Ultralube

- High performance dry lubricant
- Ideal for regular maintenance jobs
- Extremely long life with excellent wear characteristics
- Wide operating temperature range



SPG – Special Plastics Grease

- Excellent plastics compatibility
- Offers outstanding low temperature performance
- Efficient mechanical lubricant for plastic/plastic or plastic/metal friction
- Ideal to reduce wear in timers, plastic cogs and gears etc.

Airduster Sprays



EAD/EADI – Airduster

- Inert, pure compressed gas for dust removal
- Available in standard (EAD) and invertible versions (EADI)
- Ideal for removing particulates from inaccessible areas on delicate equipment
- Non-flammable



EADP/EADPI – Airduster Plus

- Ultra high power, inert, pure compressed gas airduster
- Available in standard (EADP) and invertible versions (EADPI)
- High pressure blast for removing stubborn particulates
- Non-flammable



EADH – Airduster with low GWP

- Inert, pure compressed gas for dust removal
- Environmentally friendly fluorinated propellant with low GWP
- Safe for use on electrical and electronic equipment
- Non-flammable



GDP – High Powered Airduster

- High powered, inert pure compressed gas airduster
- Powerful initial blast and minimal drop off
- Use to remove dust and dirt from delicate and inaccessible areas
- Non-flammable

Freezer Sprays



FRE – Freezer

- Standard freezer for non-sensitive, electronic fault finding
- Can aid mechanical shrink fitting
- Non-flammable, cools down to -55°C
- Prevents damage to components from overheating during soldering



MCF – Minimal Charging Freezer

- Freezer spray for static sensitive devices
- Unique additive minimises static build up whilst still allowing frost formation
- Fast fault finding in electronics
- Non-flammable, cools down to -55°C



FREH – Freezer with low GWP

- Environmentally friendly fluorinated refrigerant with low GWP
- Freezer spray for electronic fault finding
- Non-flammable, cools down to -55°C
- Prevents component damage from overheating during soldering.

General Purpose Cleaners



ARW – Aerowipes

- Efficient removal of uncured and semi-cured adhesives and sealants
- Designed for the aerospace and automotive industries
- Available in liquid form and impregnated lint-free wipes
- Non-flammable



EWI – IPA Electrowipes

- Impregnated with an isopropanol and de-ionised water blend
- High quality cloths
- Packaged in individual sachets
- Excellent degreaser, also removes flux residues and metal oxide



CTC – Carterclene

- Heavy duty, anti-static foaming cleaner
- Removes ingrained dirt and grime
- Provides long lasting anti-static properties
- Apply and wipe with Anti-Static Cloths (AAC)



GLC – Glass Cleaner

- Low-foaming glass cleaner
- Water-based
- Removes grease, oil and light organic contaminants
- Non-flammable



ECW – Engineering Cleaning Wipes

- Non-woven, cellulose/polyester blend
- High quality, general purpose wipes
- Extremely absorbent
- Exceptional tear and wet strength



IPA – Electronic Cleaning Solvent

- Efficient general purpose electronic cleaning solvent
- Removes contamination from PCBs
- Excellent plastics compatibility
- Economic in use



ROC – Reflow Oven Cleaner

- Specially formulated micro-emulsion for cleaning reflow ovens
- Removes all types of flux residues
- Contains corrosion inhibitors
- Non-flammable



ULS – Ultrasolve

- Excellent degreasing properties
- Also removes flux residues from PCBs
- Can be used to remove acrylic conformal coatings
- Harmless to most plastics, rubbers and elastomers



SRI – Saferinse

- Aqueous, de-ionised solvent blend
- For rinsing electronic assemblies after cleaning with Safewash
- Recommended as a final rinse to ensure removal of all impurities
- Non-flammable



WWC – Industrial Cleaning Concentrate

- General purpose industrial cleaner
- Non corrosive to metals
- Easy to use: convenient application methods
- Non-flammable



SWA – Safewash Aerosol

- Water-based cleaning solvent
- Removes all types of flux residues
- Aerosol form with brush attachment to aid cleaning
- Non-flammable

Encapsulation Resins and Conformal Coatings



ER2188 – Epoxy Resin

- General purpose epoxy resin
- UL94 V-0 approved
- Excellent adhesion to a wide variety of substrates
- Good chemical and water resistance



TFA – Toluene Free Acrylic

- Reduced hazard solvent-based acrylic coating, toluene-free
- Excellent clarity, ideal for LED applications
- IPC-CC-830 and UL746 approved
- Excellent protection in humid environments



GLR – Glob Top Resin

- One-part epoxy resin
- Thixotropic for localised protection of electrical components
- Fast cure at elevated temperatures
- Excellent electrical properties



CCRG – Conformal Coating Removal Gel

- Thixotropic gel formulated to remove Electrolube's solvent resistant coatings
- Allows localised removal of components
- DCA, DCB, DCR, DCRT, DCE, WBP/S PUCAF and PUC can be removed
- Does not contain methylene chloride



UR5604 – Polyurethane Resin

- General purpose polyurethane resin
- UL94 V-0 approved
- Good flexibility even at low temperatures
- Low mixed system viscosity



RRS – Resin Remover Solvent

- Designed to swell and soften cured coatings and resins
- May be used for reworking electronic devices
- Also suitable for use on production equipment, jigs, tools, etc.
- Does not contain methylene chloride



SC2001 - Silicone Resin

- General purpose silicone resin
- Excellent high temperature performance
- Simple 1:1 mix ratio
- Excellent chemical and water resistance

Anti-Static Products



AAC – Anti-Static Wipes

- 100% Pure cotton wipes
- Lint-free and non-abrasive
- Suitable for use with Electrolube anti-static products
- Ideal for use on delicate equipment



ASC – Anti-Static Glass Cleaner

- Anti-static cleaner for glass, anti-glare filters and monitors
- Reduces dust build up
- Safe to use on most coated glass
- Non-flammable



AFC – Anti-Static Foam Cleaner

- Protects against static build-up
- Safe on all plastics
- Non-flammable
- Apply and wipe with Anti-Static Cloths (AAC)



CTC – Carterclene

- Heavy duty, anti-static foaming cleaner
- Removes ingrained dirt and grime
- Provides long lasting anti-static properties
- Apply and wipe with Anti-Static Cloths (AAC)



ASA – Anti-Static Spray

- Powerful non-foaming cleaner
- Prevents static build-up
- Non-flammable
- Suitable for a wide variety of surfaces



MCF – Minimal Charging Freezer

- Freezer spray for static sensitive devices
- Unique additive minimises static build up whilst still allowing frost formation
- Fast fault finding in electronics
- Non-flammable, cools down to -55°C

Prototype and Repair



ES501 – Under Fill Resin

- Designed to improve adhesive strength of devices during vibration, etc.
- Will not degrade thermal cycle performance
- High flexibility provides enhanced repairability
- Ideal for high volume assembly processes



DB1003/DB2003 – Desolder Braid

- Fast, effective wicking when removing components
- Utilises no-clean flux
- Economic 3m length
- Available in two widths – 1.5mm (DB1003) and 2.00mm (DB2003)



ES807 – Surface Mount Adhesive

- Designed for bonding of surface mount devices prior to wave soldering
- Suitable for applications requiring high dispense speeds
- High dot profile and high wet strength
- Good electrical characteristics



ESLE10 – Silver loaded epoxy

- One part silver loaded epoxy resin used for conductive bonding applications
- Excellent adhesion to a wide variety of substrates
- Exhibits excellent electrical and thermal conductivity properties
- Can be used for conductive bonding, solder repair, static discharge, etc.



ES808 – Surface Mount Adhesive

- For bonding of surface mounted devices prior to wave soldering
- Ideal for pin transfer and stencil print
- Ideal for medium to high dispense speeds
- Low viscosity, good electrical characteristics, and good humidity resistance



FCC – Ferric Chloride

- Ferric Chloride hexahydrate crystals
- Used for etching copper clad boards to produce PCBs, signs, pictures etc
- Does not absorb moisture quickly
- Economic in use



SMA – Surface Mount Adhesive

- One-part adhesive with excellent mechanical strength
- Resistant to cleaning solvents
- Long term stability after cure cycle
- Syringe can be used by hand or dispensing equipment



PDN – Photoresist Developer

- Aqueous alkaline developer
- Used in conjunction with PRP and other positive photo resists
- Convenient solution form
- Economic in use



SMF/SMFL – Surface Mount Rework Flux

- Quick drying, mildly activated (RMA type) no-clean flux
- For use with hot air, hot gas or conventional soldering techniques
- Zero halide content so no cleaning is required
- Supplied in pen (SMF) and aerosol (SMFL) form



PRP – Positive Photoresist

- Fast drying positive photoresist
- Used for reproduction of circuits, images, PCBs, signs and diagrams
- Fine resolution down to 0.1mm
- Ideal for prototyping

Paints and Paint Removers



GRG – Graffiti Remover Gel

- High viscosity gelled product – clings to vertical surfaces
- Low odour, low volatility – longer contact time
- Removes graffiti from porous and non-porous surfaces e.g. wood, brick, vinyl
- Harmless to most plastics and metals



PNM/PAM – High Temperature Paints

- Heat resistant paints suitable for objects exposed to temperatures up to 650°C
- Excellent coverage and flow characteristics
- Good adhesion and anti-corrosion properties
- Available in matt black (PNM) and aluminium grey (PAM)



GRS – Graffiti Remover for Sensitive Surfaces

- Removes graffiti from porous and semi-porous surfaces, e.g. vinyl and laminates
- Pleasant light odour
- Contains non-chlorinated solvents
- Compatible with most plastics and metals



PWB/PVB/PBB/PJB/PRB/PNB – High Gloss Paints

- Quick drying, high quality, universal spray paints
- Suitable for use in manufacturing, repair, workshop and home
- Excellent coverage and flow
- Colours: White, Blue, Yellow, Black, Red, Green



NSCP – Nickel Screening Compound PLUS

- Efficient EMI/RFI screening coating
- Enhanced adhesion to wide variety of substrates
- Fast drying at room temperature
- Also available in bulk



SCP – Silver Conductive Paint

- Highly conductive silver loaded paint
- Ideal for track repair and pinpoint shielding
- Fast drying
- Excellent adhesion to most substrates



PGB/PGM – Galvanising Spray

- Cold galvanisation paint for metal surfaces
- Protects against oxidation and corrosion
- Very fast drying with excellent adhesion properties
- Available in gloss (PGB) and matt finishes (PGM)

General Maintenance



BLV/R – Bloc'lube

- Tamper evident seal
- Green (BLV) or red (BLR) colour available
- Supplied with integral brush for easy application
- BLR available in a syringe



HDC – Cutting Fluid

- Industrial grade metal cutting oil
- Powerful lubricant suitable for ferrous metals, stainless and heat resistant steels
- Allows high speed punching
- Extends tool life



CPL – Clear Protective Lacquer

- General purpose coating for PCBs giving high quality glossy finish
- Ideal for protecting ferrous metals from corrosion
- Good resistance to humidity
- Available in pen form for easy and direct application



ICEE – De-icer

- Provides rapid ice and frost removal
- Water soluble blend of alcohols and glycols
- Effective at low temperatures (-11°C)
- High powered spray designed to cover large areas



CYL – Cyanolube

- Fast curing cyanoacrylate adhesive
- High bond strength
- Bonds most common substrates
- Adheres well to most plastics



LRM – Label Remover

- Paper label remover
- Aerosol with brush enables mechanical scrubbing action to aid removal
- Handy pen version available
- Harmless to most plastics



DEI – Demineralised Water

- Provides a final rinse to circuit boards and assemblies
- For use after a tap water rinse
- Ideal for use with the Safewash range of cleaners
- Suitable for use in trigger spray bottle (TSB000) or air powered bottle (APB000)



MPU – Polyurethane Foam

- One-part ready to use self-expanding PU foam
- Cures quickly to form a tough, waterproof layer
- Excellent for filling and sealing spaces around cables, window frames, etc.
- Provides good thermal and acoustic insulation



PBS – Antispatter Spray

- Prevents adhesion of weld spatter
- Suitable for protecting nozzles, weld units and tools
- Non-flammable and silicone free
- Very fast drying



SGL – Silica Gel

- Ideal for protecting assemblies from moisture ingress
- Non-indicating
- Inert to most non-aqueous chemicals
- Available in 10g, 50g and 100g sachets



RRR – Rubber Roller Restorer

- Restores textures to rubber rollers in office equipment
- Prolongs the lifetime of rubber rollers, preventing costly replacement
- Supplied in pump spray
- Leaves no residue

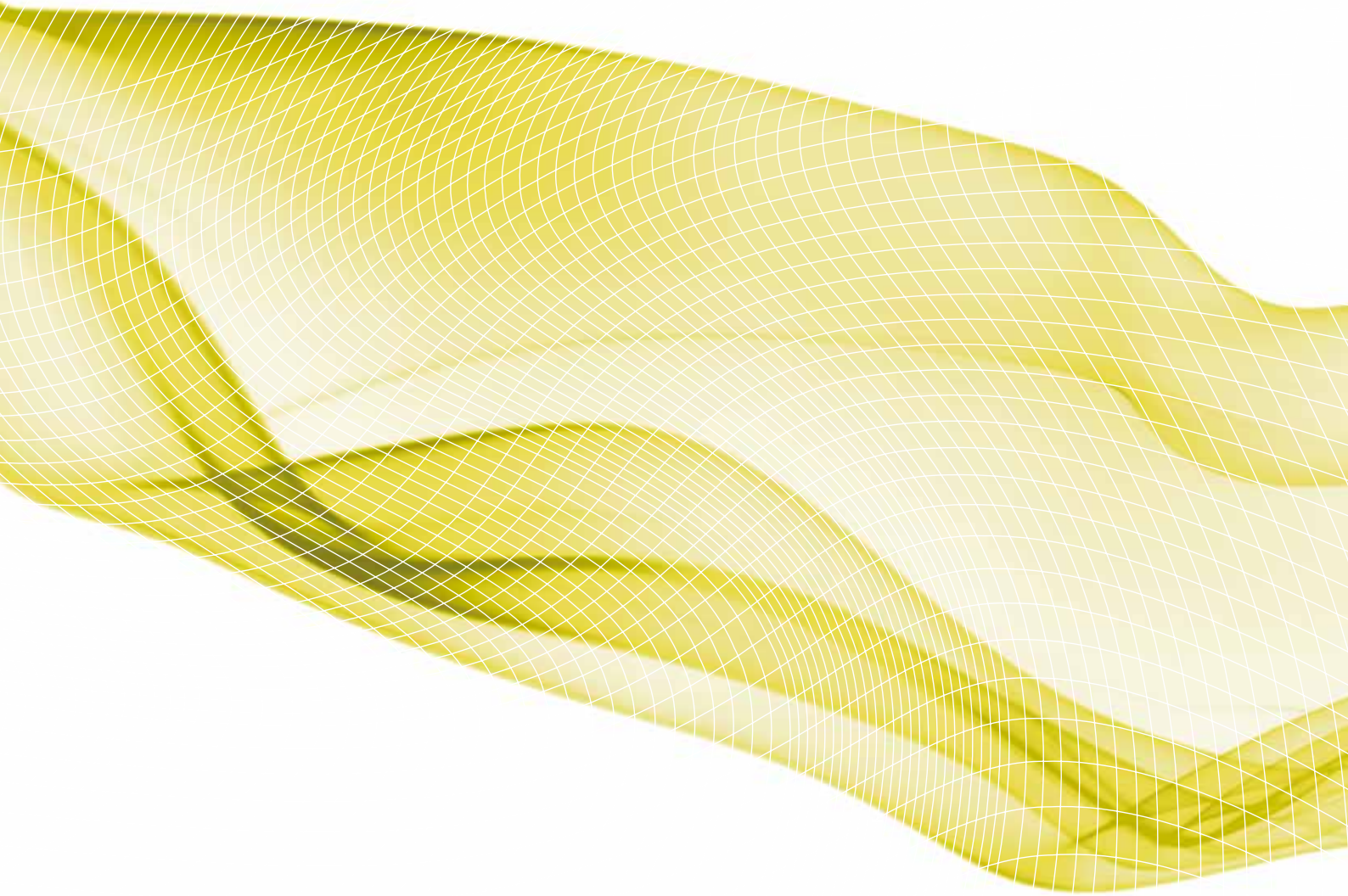


TSB – Trigger Spray Bottle

- Re-usable bottle for spraying various solutions
- Volumetric graduation marks on the side of bottle
- Holds up to 600ml
- Controlled usage with adjustable spray

Encapsulation Resins

Meeting the challenge of challenging environments



ELECTROLUBE
THE SOLUTIONS PEOPLE

Encapsulation Resins



- UL approved
- Potting / encapsulating
- Sealing and protection
- Cable jointing
- Coloured and optically clear
- Bespoke and ex-stock

Resin systems are designed to protect and insulate printed circuit boards (PCBs) and electronic components from the threats of harsh and challenging environments, including; moisture, vibration, thermal or physical shock and general contamination. By encapsulating the entire device, resins can form a complete barrier against such environments offering superior performance under extreme conditions.

Potting and encapsulation resins also offer excellent mechanical protection. Mechanical protection can be identified in a number of ways; superior performance is evident in applications involving prolonged exposure or immersion in harsh chemicals, or those exposed to vibrational, thermal or physical shock, for example. The higher level of protection is achieved through the mass of the resin surrounding the unit. This is different for every application however potting and encapsulating resins always provide a far more substantial covering than that offered by conformal coatings.

Due to the bulk of material surrounding the PCB, potting and encapsulation resins are commonly two-part systems which when mixed together form a solid, fully cured material, with no by-products. In cases where the conditions are not considered extreme, Electrolube offer a range of conformal coatings which provide a combination of protection in humid and corrosive environments with ease of application. They can be used for complete coverage or selective application onto the PCB, thus minimising the weight added as a result of applying a protective material.

Resin Types



The extensive Electrolube product range consists of epoxy, polyurethane and silicone resin systems available for general purpose and customer specific applications. Typically, polyurethanes are used for their flexibility, variable shore hardness and short pot life. In general, epoxy resins are much harder materials, offering superior chemical resistance and physical protection to the polyurethane type. Silicone resins are typically used for high temperature applications and offer excellent protection in extremely harsh conditions.

Epoxy Resins

- Very tough systems
- Easy to apply
- Low coefficient of thermal expansion
- Excellent protection against humidity and harsh chemicals

Polyurethane Resins

- Good flexibility, even at low temperatures
- Ideal for delicate components
- Exceptionally wide range of hardness options available
- Excellent water resistance; formulated products designed specifically for marine applications

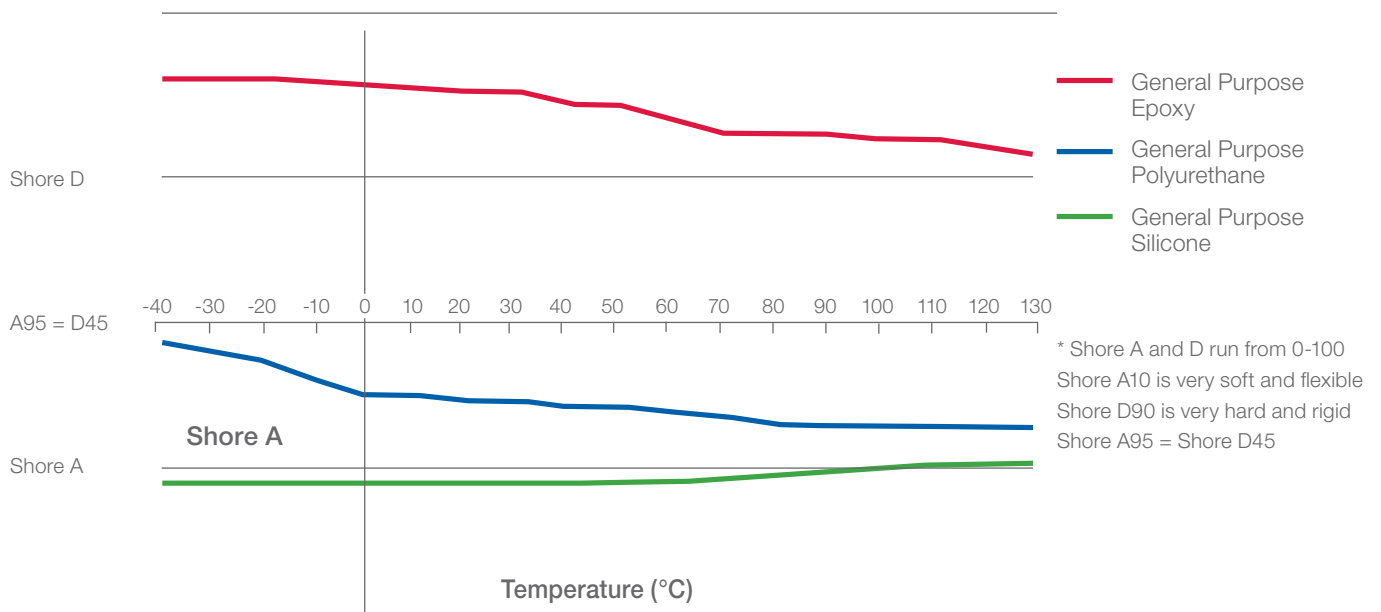
Silicone Resins

- Very wide operating temperature range
- Exceptional performance at high temperatures
- Excellent flexibility
- Optically clear options available, ideal for LED applications

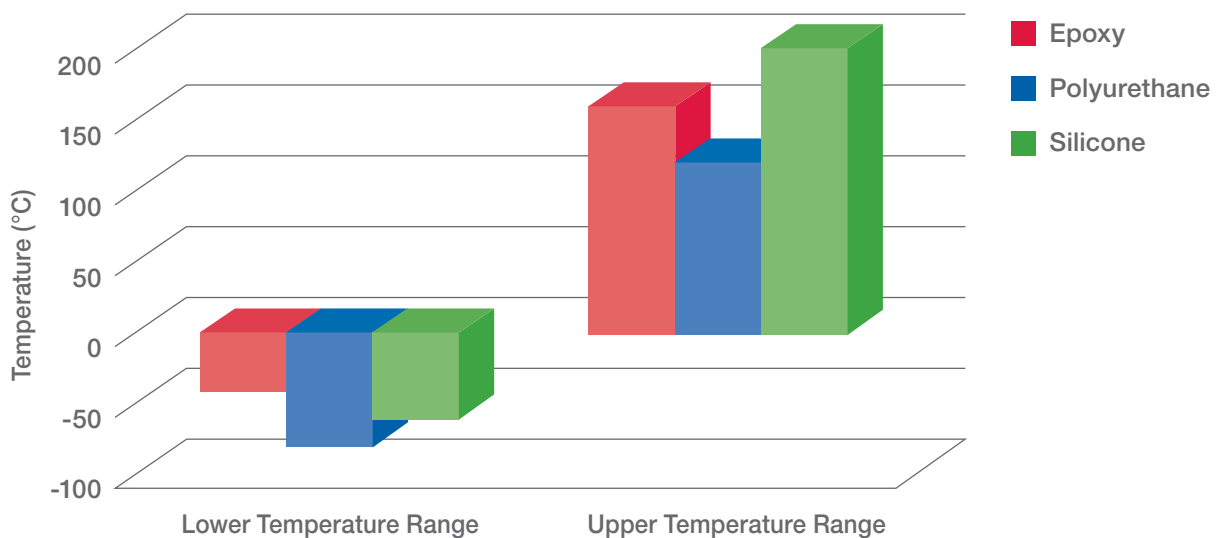
The majority of Electrolube resins are two part systems that when mixed together in the correct ratio, react to form polymeric materials. By careful formulation, the properties of the cured resin can be tailored to meet individual customer requirements. The Electrolube range therefore offers many resins of varying hardness, viscosity and gel time as well as differing electrical and thermal properties. Further products and bespoke materials are available upon request.



Comparison of Shore Hardness vs. Temperature



Comparison of Typical Operating Temperature Ranges



Product Choice



The electronics industry is one of the most rapidly expanding industries to date, with new applications seemingly endless. Printed circuit boards (PCBs) are found in many domestic, industrial, automotive and military devices, to name but a few. In order to ensure reliability of these critical devices it is essential that the PCBs are protected to prevent reduced performance or in the worst case, complete failure.

Electrolube offer a comprehensive range of resins to meet the increasing demands of the electronics industry. Examples of a few applications and suitable product choices are provided as a starting point for selection, however, due to application variances, it is vital that the entire unit is tested in an appropriate environment for its intended end use; this can be exact conditions or carefully planned accelerated testing.

General Purpose Protection

Many applications require the protection level of an encapsulation resin in a general use environment, for example, protection from vibration in standard atmospheric conditions. These applications are diverse however Electrolube offer general purpose resins to fit many such requirements. Example products include:

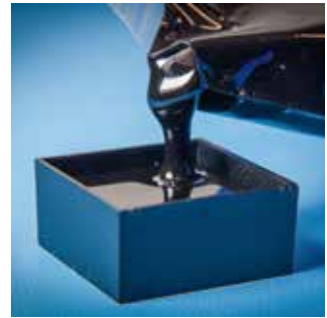
- ER2188 – General Purpose Epoxy
- UR5604 – General Purpose Polyurethane
- SC2001 – General Purpose Silicone

LED Applications

There are a number of potential requirements for protection compounds within LED applications. Typical examples are optically clear compounds for protecting the LED itself and thermally conductive materials to help dissipate heat away from the LED or unit. With the growth of LED applications there are also a number of other potential requirements for such products, these include UV resistance, colour stability of the resin and minimal colour temperature shift of the LED. Example products include:

- UR5562 – Optically Clear Polyurethane
- SC3001 – Optically Clear Silicone
- ER2220 – Thermally Conductive Epoxy

In addition to offering optically clear systems, Electrolube also offer resins with excellent UV stability. Electrolube have carried out weathering resistance tests on a number of available encapsulation resins. Tests were in accordance with ISO 4892 part 3 cycle 1 'Plastics Methods of Exposure to Laboratory Light Sources' and carried out in a QUV SE Accelerated Weathering Tester. After 1000 hours exposure, the results indicated that Electrolube optically clear polyurethane and silicone resins, UR5562 and SC3001, have superior resistance to UV light, maintaining their clarity throughout the exposure testing. Exposure intensities will vary depending on geographical locations and therefore it is important to establish the correct accelerated exposure time for your region. As an example, this test is roughly equivalent to 4 years weathering resistance in a typical Northern European climate.



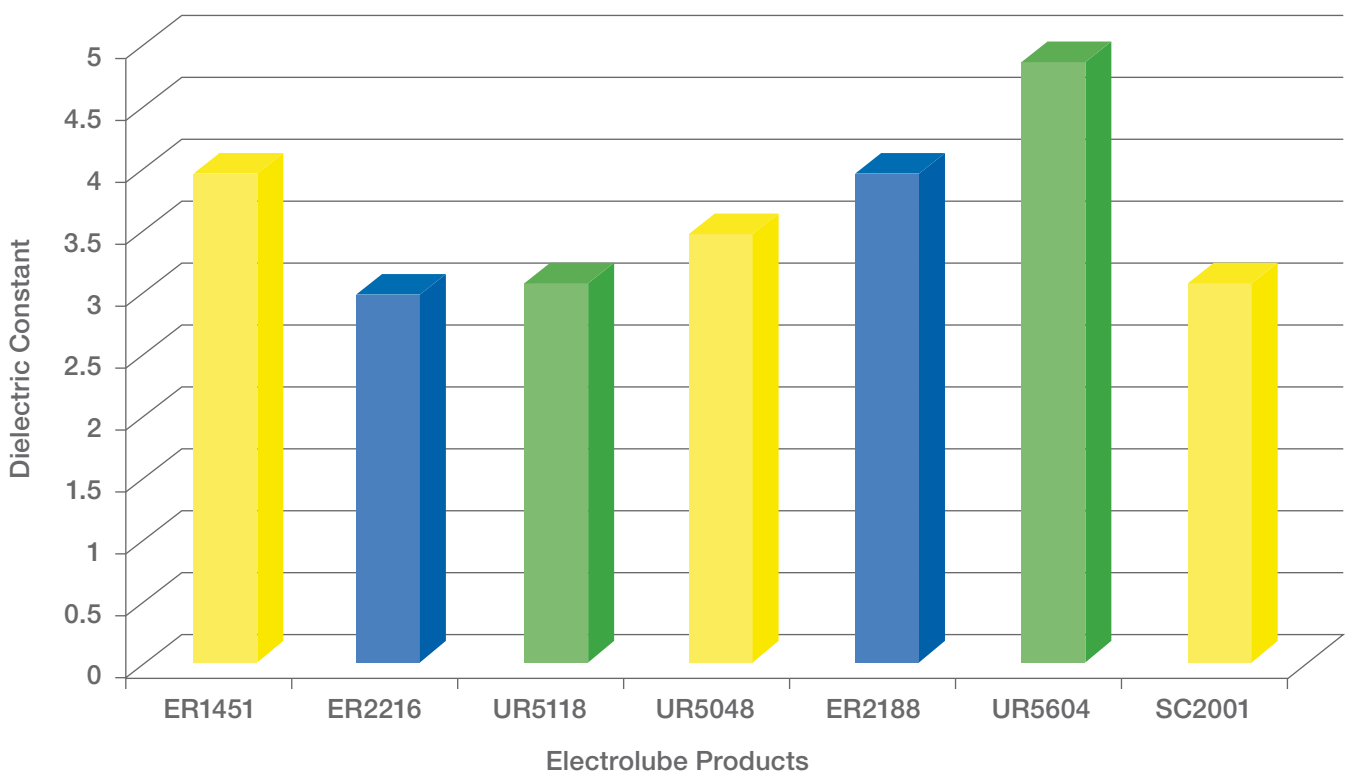
RF Applications

Applications where RF signals are transmitted require encapsulation resins that will not interfere with the information transfer. Such applications are rapidly increasing and the automotive industry is just one example; an increase in intelligent systems has resulted in information being transferring from various sensors positioned on a car to the dashboard display. The key property to refer to in this case is the dielectric constant or permittivity. High frequency devices, for example, would require a low dielectric constant of 3-3.5. These systems may include specialist fillers to obtain the lowest possible value, such fillers can also make the

resin harder to mix and dispense due to the resultant high viscosity, however. Thus, using a specialist formulation and eliminating the fillers to achieve a slightly higher dielectric constant of 4, may result in the best compromise. In any case, it is important to test suggested resins in order to determine the optimum dielectric constant requirement for the application.

- ER1451 – Unfilled Epoxy Resin
- UR5118 – Unfilled Polyurethane Resin
- SC2001 – Silicone Resin

Comparison of Dielectric Constant



Marine Environments



Applications in marine environments require excellent resistance to immersion in salt water; there are often other application requirements that must also be considered, however. Typical applications may include under-water cable jointing, protection of LED lighting on ship decks and protection of various sensor devices. In such cases, clear or coloured resins may be needed and must offer high adhesion and low dielectric constant throughout the lifetime of the device operating in harsh conditions.

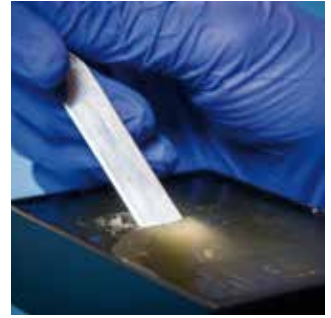
- UR5041 – Highly Water Resistant Polyurethane Resin
- UR5083 – Recoverable Polyurethane Gel
- UR5528 – Tough Polyurethane Resin with Excellent Adhesion

Jointing and Adhesive Applications

There are many applications where a high level of adhesion is required, either in terms of bond strength due to potential mechanical forces being applied to the unit or in applications such as cable jointing. Such resins may be directly applied or used in conjunction with a primer. In addition, the surface of the substrate will also affect the adhesion properties of an encapsulation resin; surfaces must be clean and dry and very smooth surfaces will be harder to adhere to. Difficult substrates are those with a very low surface tension, such as PTFE.

- ER1122 – Highly Adhesive Epoxy Resin
- UR5545 – Fast Set Polyurethane Resin
- ER2195 – Flame Retardant Epoxy Resin

Specific Properties



There are also a number of specialist properties that may be required for certain applications. Electrolube offer a range of products to cover a wide variety of requirements, some of which are listed below:

Flame Retardant

A product may be UL94 approved, with V-0 being the highest level of flame retardancy. In addition, Electrolube offer in-house testing to this standard in order to grade non-approved products.

- UL Approved Epoxies – ER2165, ER2188, ER2195
- UL Approved Polyurethanes – UR5044, UR5097, UR5604
- Other UL approved products are also available

Thermally Conductive

Some techniques only measure the sum of the materials' thermal resistance and the material/instrument contact resistance. Electrolube use a version of the heat-flow method that measures both of these values separately, giving a much more accurate bulk thermal conductivity measurement.

- ER2220 – Thermally Conductive Epoxy
- UR5633 – Thermally Conductive Polyurethane
- SC2003 – Thermally Conductive Silicone

Highly Chemically Resistant

Most encapsulation resins in the Electrolube Range will offer protection against short-term exposure to chemicals such as solvents, oils and fuels. In some cases, this exposure may be frequent or for longer periods of time and in this case, specialist materials are needed.

- ER2162 – Chemically Resistant Epoxy
- UR5528 – Tough Polyurethane Resin
- SC2001 – General Purpose Silicone

Very Soft/Re-workable

An encapsulation resin may need to have an extremely low hardness to maintain flexibility at low temperatures, for example. This is particularly critical where devices have sensitive components and may frequently be exposed to rapid changes in temperature. In addition, some devices may need to be reworked; in general encapsulation resins can be difficult to remove however specialist formulations may offer the opportunity to rework by cutting the bulk of resin out of the unit.

- UR5048 – Ultra Soft Polyurethane Resin
- UR5044 – UL Approved, Re-workable Polyurethane
- SC2001 – Soft Silicone Resin

Single-Part Systems

In some cases, it may be more effective to use a single-part system and cure using heat. Applications include 'glob-top', where a select component or area of a PCB is protected with a resin as opposed to encapsulating the entire unit.

- ER2136 – Single-Part Epoxy Resin
- GLR – Single-Part Glob-Top Resin
- ER2219 – Single-Part Flame Retardant Epoxy Resin

Application Considerations



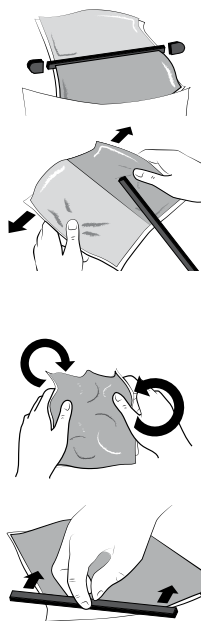
Prior to the application of encapsulation resins it is important to consider what contaminants may be present on the PCB or device. In a 'no-clean' process for example, the residues left on the PCB will be non-corrosive however there may be other possible sources of contamination. Any potentially harmful contaminants left on the PCB before encapsulating with a resin material can result in failure of the device. In addition, some residues may cause issues with adhesion of the encapsulation resin to the PCB or outer casing, in turn, reducing the protection level offered.

Electrolube also offer a range of water and solvent-based cleaning products to ensure all corrosive residues are removed from the printed circuit board prior to any other process. Electrolube therefore offers superior technical support in ensuring the correct application parameters are identified. Please contact us for further information where required.

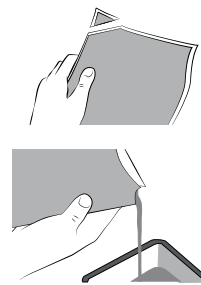
The majority of encapsulation resins are two part systems, therefore both the mixing and dispensing process needs to be considered in order to ensure successful application. Both manual and automatic processes are possible for all resin types and cure times may be reduced by using elevated temperatures.

Manual Processes

Electrolube encapsulation resins are available in resin packs;



1. A pre-weighed pack containing the correct amount of each component, separated by a clip.
2. The resin and hardener are mixed by removing the clip and mixing the contents. To remove the clip, remove both end caps, grip each end of the pack and pull apart gently.
3. Mix the contents by moving them around inside the pack until thoroughly mixed.
4. Using the removed clip, take special care to push unmixed material from the corners of the pack. Mixing normally takes from two to four minutes depending on the skill of the operator and the size of the pack. Both the resin and hardener are evacuated prior to packing so the system is ready for use immediately after mixing.



5. The corner may be cut from the pack so that it may be used as a simple dispenser.

NOTE:

It is important not to remove the aluminium outer wrapping on polyurethane resins until immediately before use; leaving out of the aluminium outer will lead to moisture ingress and insufficient cure when mixed. To open, cut the aluminium outer being very careful not to damage the inner pack; discard the molecular sieve sachets. When mixing the pack, ensure all surfaces are clean and the pack is mixed thoroughly but gently; pack defects from mixing include split and pin hole formation which again lead to moisture ingress, resulting in air bubbles and insufficient cure.

Application Considerations



Bulk Mixing

When mixing, care must be taken to avoid the introduction of excessive amounts of air. Automatic mixing equipment is available which will not only mix both the resin and hardener accurately in the correct ratio but do this without introducing air. Containers of Part A (Resin) and Part B (Hardener) should be kept sealed at all times when not in use to prevent the ingress of moisture. Bulk material must be thoroughly

mixed before use. Incomplete mixing will result in erratic or partial curing. Electrolube work closely with equipment suppliers to ensure the correct selection of equipment and accessories is obtained; it is possible to heat tanks to reduce viscosity, add molecular sieve towers to ensure moisture ingress is kept to a minimum and stirrers to eliminate the problems associated with sedimentation of filled systems.

Curing

Do not heat cure large volumes immediately, they should be allowed to gel at room temperature first. Depending on the product, elevated temperatures can be used to reduce cure times; product data sheets should be consulted for specific information. Encapsulation resins generate a small amount of heat

during the curing process; this is often below 35°C however some materials may exhibit higher exotherm values. The exotherm therefore must be considered to ensure compatibility with all components and to avoid excessive heat generation when considering heat curing.

Important Considerations

It is essential that the inclusion of air during mixing and potting of encapsulation resins is kept to an absolute minimum. In the case of epoxy resins, the introduction of air can lead to voids in the potting compound, thus affecting the protection level offered and creating potential problems with differences in coefficients of thermal expansion.

Polyurethane resins are susceptible to moisture due to the hardener. Typically, polyurethane resins are cured using isocyanates, which will prefer a reaction with moisture over a reaction with the resin. In this case, if moisture ingress has occurred then bubbles will form in the resin following the release of carbon dioxide, possibly resulting in insufficient cure, leaving a soft or tacky resin. It is therefore important to ensure that containers are kept closed at all times when not in use, that molecular sieve towers are fitted to automated

equipment and regularly monitored and finally, that the relative humidity of the mixing, dispensing and curing environments is monitored and ideally kept below 70%.

Silicone resins can be affected by certain materials, chemicals, curing agents or plasticizers for example. These can inhibit the cure of silicone encapsulants and therefore all preparation surfaces and equipment must be kept clean and contact with the following avoided:

- Organotin and other organometallic compounds
- Silicone rubber containing organotin catalyst
- Sulphur, polysulphides, polysulphones or other sulphur containing materials
- Amines, urethanes or amine-containing materials
- Unsaturated hydrocarbon plasticisers
- Some solder flux residues

The Product Range

Epoxy Resins

ER1122 (Clear Amber)

- Excellent adhesion to a wide variety of substrates
- Mix ratio can be altered to vary flexibility
- Good electrical properties
- Can be used as an adhesive or encapsulant

ER1426 (Water white)

- Excellent clarity
- Very low viscosity
- Long useable life
- Ideal for impregnation applications

ER1451 (Clear) and ER1450 (White)

- High water resistance
- Excellent adhesive properties
- Low dielectric constant
- Very low viscosity

ER2162 (Black)

- Exceptional chemical resistance
- Ideal for applications where frequent immersion in fuels may occur
- Good electrical properties
- Flame retardant

ER2183 (Black)

- Good thermal conductivity
- Low viscosity alternative to ER2220
- Enhanced machine mixing and dispensing
- Good all round protection

ER2188 (Black)

- Flame retardant - certified to UL94 V-0
- General purpose potting resin
- Excellent all round protection
- High hardness material

ER2195 (Black)

- Flame retardant - certified to UL94 V-0
- Tough resin with increased durability
- Excellent thermal shock resistance
- For transformers, large castings, rotor arm sealing, pyrotechnical cables, diesel sensors and other automotive applications

ER2218 (Black)

- Low viscosity
- Flame retardant, meets UL94 V-0
- Excellent high temperature stability
- Ideal for applications involving thermal cycling or extreme temperatures for short periods of time, such as reflow applications

ER2219 (Black)

- Single-part epoxy
- Flame retardant
- Heat cure product
- Suitable for dipping and glob-top

ER2220 (Grey)

- Excellent thermal conductivity
- Flame retardant
- No abrasive fillers
- For potting PCBs, power supplies, converters and temperature sensors

Silicone Resins

SC2001 (Dark Grey)

- General purpose silicone resin
- Exceptional flexibility
- Good chemical and water resistance
- Flame retardant

SC2001FD (Dark Grey)

- Fast cure version of SC2001
- Good chemical and water resistance
- Exceptionally wide operating temperature range
- Flame retardant

SC2003 (Dark Grey)

- Highly thixotropic two part potting compound
- A 1:1 ratio for ease of processing
- Flame retardant
- High thermal conductivity

SC3001 (Optically Clear)

- Optically clear, two-part potting compound
- Suitable for use in LED applications or where high level of clarity is required
- Offers exceptional protection for electronics
- Low viscosity – easy to apply even in thin films

Polyurethane Resins

UR5041 (Black)

- Excellent resistance to sea water
- High toughness and tear resistance
- Good adhesion to most substrates
- Properties retained at temperatures down to -60°C

UR5044 (Dark Blue)

- Flame retardant, certified to UL94 V-0
- Soft, re-workable resin
- Flexible even at temperature extremes
- Ideal for prototype circuitry, silicone replacement, and control units

UR5048 (Clear Straw)

- Low viscosity and very low hardness
- Transparent – clear to allow fast fault finding
- Low embedment stress
- Ideal for protecting delicate components from mechanical and thermal shock

UR5083 (Clear Straw)

- Self-healing polyurethane gel
- Low viscosity
- Excellent water resistance
- Ideal for underwater cable jointing

UR5097 (Black)

- Flame retardant, certified to UL94 V-0
- High thermal conductivity
- Low water absorption
- Excellent electrical properties

UR5118 (Black)

- Excellent electrical properties
- Low dielectric constant
- Excellent resistance to sea water
- Very low viscosity

UR5528 (Black)

- Durable with a high degree of toughness
- Excellent adhesion to a wide variety of substrates
- Low viscosity allowing ease of application
- Excellent resistance to acids, alkalis and other aqueous materials

UR5545 (Black)

- Fast-cure system
- Tough, resilient polyurethane resin
- Low viscosity
- Suitable for cable jointing applications

UR5547 (Black) or (UR5581) White

- Semi rigid, flame retardant casting resin
- Water and impact resistant
- Excellent adhesion to a wide variety of substrates
- Ideal for use in potting or cable jointing applications

UR5562 (Optically Clear)

- Water white transparency, ideal for potting LEDs
- Excellent resistance to yellowing when exposed to UV light
- Excellent scratch and mark resistance
- High resistance to weather, acids and alkalis, water and mould growth

UR5604 (Black)

- Flame retardant, certified to UL94 V-0
- Low mixed system viscosity
- Excellent adhesion to a wide variety of substrates
- Good thermal conductivity

UR5608 (Black) or UR5623 (White)

- Flame retardant, certified to UL94 V-0
- Semi-rigid polyurethane resin with exceptional toughness
- Excellent adhesion and chemical resistance
- Fast cure version available

UR5633 (Black)

- Exceptionally high thermal conductivity
- Excellent electrical properties
- Very low water absorption
- Flame retardant

Electrolube also offer an extensive range of bespoke resins, please contact us for further information

Associated Products



OP9020 – Machine and Resin Remover

- Solvent cleaner for general machine maintenance
- Removes epoxy and polyurethane resin in the uncured state
- Fast evaporating
- Does not contain methylene chloride



RST – Resin Stop

- Provides a non-stick coating, excellent for jigs, etc.
- Silicone free
- Dry film – eliminates unwanted transfer
- Reduces the frequency to clean mould tools etc.



PCM – Peelable Coating Mask

- Flexible latex for masking components
- Manual removal, leaving no residue
- Dries at room temperature
- High film strength, does not break easily



The Safewash Range

- Water-based cleaning products for use before encapsulation
- Efficient removal of all flux residues
- Products available for ultrasonic, spray under immersion and dishwasher application
- Products available for stencil cleaning and uncured adhesive removal



PCS – Peelable Coating Mask Synthetic

- Thermal cure
- Ammonia free – no odour
- Manual removal, leaving no residue
- High film strength



ULS – Ultrasolve Cleaning Solvent

- Excellent degreasing properties
- Fast evaporation
- Compatible with most plastics, rubbers and elastomers
- Available in bulk, aerosol and aerosol brush version



RRS – Resin Remover Solvent

- Blend of solvents designed to soften and dissolve cured resins
- Will enable removal of epoxy, polyurethane and other resins from substrates
- Can be used on containers, tools and jigs for example
- Does not contain methylene chloride

Polyurethane Resins

	UR5041	UR5048	UR5044	UR5528	UR5562	UR5633	UR5604
<i>Specialist Property</i>	Water Resistance	Soft, Low Stress	Soft, Re-enterable	Tough, High Adhesion	Optically Clear	Thermally Conductive	Tough, Flexible
Colour (Mixed System)	Black	Clear Amber	Dark Blue	Black	Water White	Black	Black
Cured Density (g/ml)	1.18	0.95	1.49	1.07	1.02	1.65	1.54
Mixed System Viscosity (mPa s @ 23°C)	2500	980	3400	2000	300	30000	2000
Mix Ratio by Weight (by Volume)	3.6:1 (3.9:1)	14:1 (19:1)	13.4:1 (20:1)	2.4:1 (2.9:1)	2.2:1 (2.3:1)	12.2:1 (8.8:1)	5.2:1 (3.9:1)
Usable Life (Minutes @ 23°C)	20	20	25	20	17	15	40
Gel Time (Minutes @ 23°C)	60	40	40	35	22	40	90
Cure Time (Hours @ 23°C/60°C)	24/4	24/4	24/3	24/5	24/4	24/4	24/3
Shore Hardness	A85	A12	A40	D57	A95	A90	A75
Thermal Conductivity (W/m.K)	0.25	0.20	0.25	0.25	0.20	1.24	0.45
Temperature Range (°C)	-60 to +125	-60 to +100	-60 to +120	-50 to +125	-40 to +120	-50 to +125	-40 to +130
Maximum Temperature - Short Term (°C)	+130	+100	+130	+130	+130	+130	+155
Dielectric Strength (kV/mm)	20	18	18	25	11	18	18
Volume Resistivity (Ω-cm)	10 ¹⁵	10 ¹⁴	10 ¹⁰	10 ¹⁴	10 ¹⁴	10 ¹⁴	10 ¹⁴
Flame Retardency Level	-	-	V-0	-	-	V-0	V-0
UL94 Approval	No	No	Yes	No	No	No	Yes
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes

For exact calculated ratios please see the technical data sheet.

Epoxy Resin

	ER2188	ER2220	ER2183	ER2218	ER1426	ER1450	ER1122
<i>Specialist Property</i>	General Purpose	High Thermal Conductivity	Low Viscosity, Thermally Conductive	High Temperature Stability	Optically Clear	Very Low Viscosity	Excellent Adhesion
Colour (Mixed System)	Black	Grey	Black	Black	Water white	White	Clear Amber
Cured Density (g/ml)	1.69	2.22	1.95	1.16	1.05	1.10	1.05
Mixed System Viscosity (mPa s @ 23°C)	9000	15000	5000	500	100	250	12000
Mix Ratio by Weight (by Volume)	11:1 (5.5:1)	2.8:1 (8.2:1)	12.8:1 (5.6:1)	3.6:1 (2.8:1)	4:1 (3.4:1)	2.5:1 (2.2:1)	1:1 (0.8:1)
Usable Life (Minutes @ 23°C)	60	120	120	40	120	15	90
Gel Time (@ 23°C)	2.5 hrs	3.0 hrs	7.0 hrs	50 mins	4.0 hrs	30 mins	4 hours
Cure Time (Hours @ 23°C/60°C)	24/2	24/4	24/4	24/4	36/8	12/2	48/4
Thermal Conductivity (W/m.K)	0.91	1.54	1.10	0.28	0.20	0.20	0.20
Temperature Range (°C)	-40 to +120	-40 to +130	-40 to +130	-50 to +150	-40 to +120	-50 to +130	-40 to +120
Maximum Temperature – Short Term (°C)	+140	+150	+150	+245	+130	+150	+140
Dielectric Strength (kV/mm)	10	10	10	10	10	10	12
Volume Resistivity (Ω-cm)	10 ¹⁴	10 ¹⁵	10 ¹⁵	10 ¹⁴	10 ¹⁴	10 ¹⁵	10 ¹⁴
Shore Hardness	D85	D90	D90	D55	D85	D50	D80
Flame Retardency Level	V-0	V-0	V-0	V-0	-	-	-
UL94 Approval	Yes	No	No	No	No	No	No
RoHS Compliant	Yes	Yes	Yes	Yes	Yes	Yes	Yes

For exact calculated ratios please see the technical data sheet.

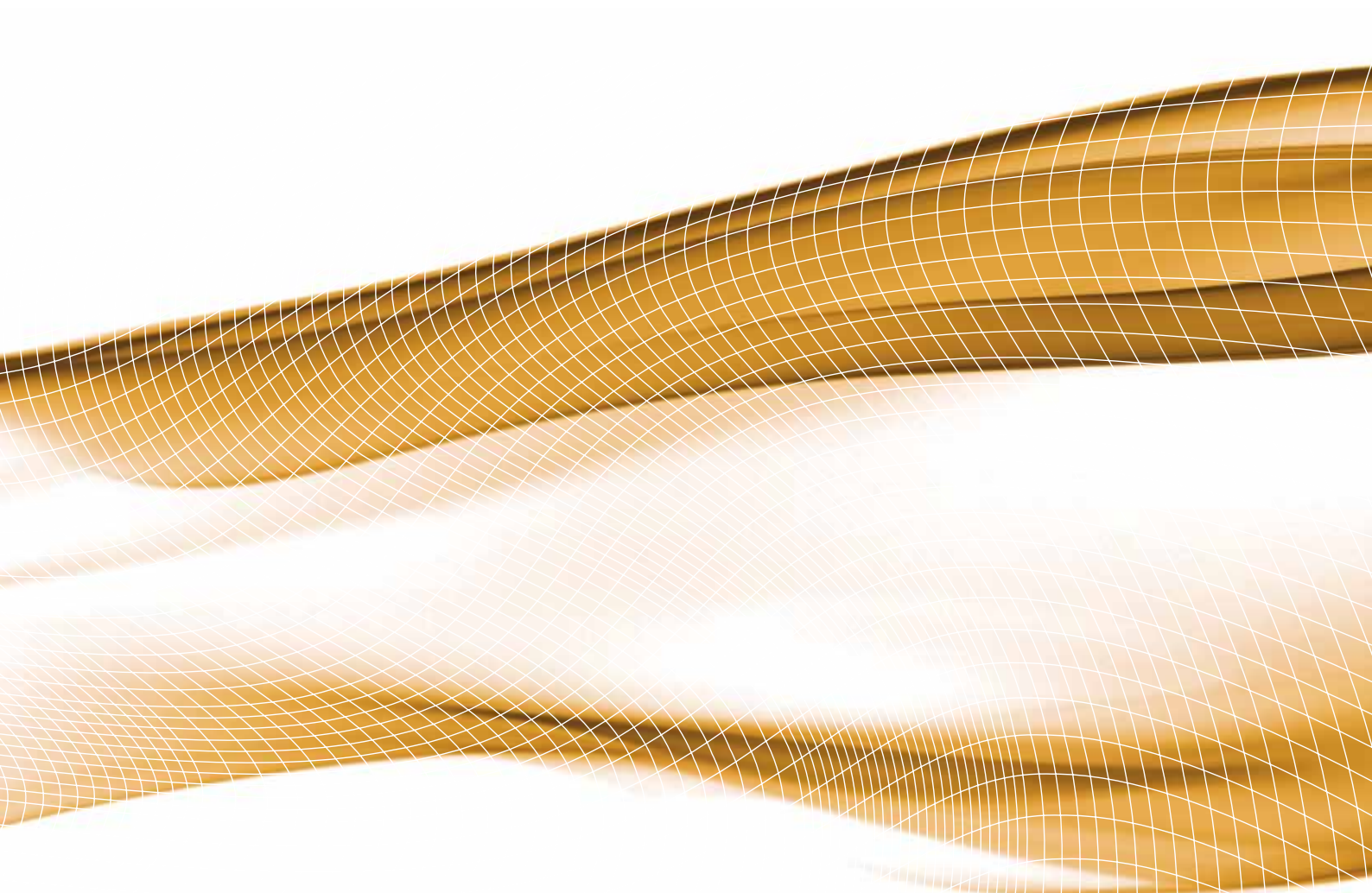
Silicone Compounds

	SC2001	SC2001FD	SC2003	SC3001
<i>Specialist Property</i>	High Temperature Resistance	Fast Cure	Thixotropic	Optically Clear
Colour (Mixed System)	Dark Grey	Dark Grey	Dark Grey	Optically Clear
Cured Density (g/ml)	1.40	1.15	1.60	1.04
Mixed System Viscosity (mPa s @ 23°C)	3500	1800	30000	1800
Mix Ratio by Weight (by Volume)	1:1 (1:1)	1:1 (1:1)	1:1 (1:1)	13:1 (12:1)
Usable Life (Minutes @ 23°C)	30	4	40	30*
Gel Time (Minutes @ 23°C)	60	8	80	180*
Cure Time (Hours @ 23°C)	24	4	24	24*
Shore Hardness	A50	A40	A50	A20
Thermal Conductivity (W/m.K)	0.6	0.4	0.8	0.2
Temperature Range (°C)	-50 to +200	-45 to +200	-60 to +200	-60 to +200
Maximum Temperature - Short Term (°C)	+225	+225	+225	+250
Dielectric Strength (kV/mm)	20	21	20	-
Volume Resistivity (Ω-cm)	10 ¹⁵	10 ¹⁵	10 ¹⁵	10 ¹⁴
Flame Retardancy Level	V-0	V-0	V-0	HB
UL94 Approval	No	No	No	No
RoHS Compliant	Yes	Yes	Yes	Yes

*Cure times will be dependent on ambient humidity.
For exact calculated ratios please see the technical data sheet.

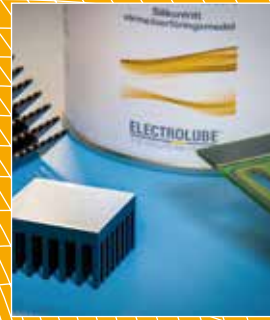
Thermal Management Solutions

Created to perform when the heat is on



ELECTROLUBE
THE SOLUTIONS PEOPLE

Thermal Management Solutions



- Non-Silicone Pastes
- Silicone Pastes
- RTVs and Bonding Products
- Encapsulation Resins
- 0.9 to 3.4W/m.K

During use, some electronic components can generate significant amounts of heat. Failure to effectively dissipate this heat away from the component and the device can lead to reliability concerns and reduced operational lifetimes.

Newton's law of cooling states that the rate of loss of heat is proportional to the temperature difference between the body and its surroundings. Therefore, as the temperature of the component increases and reaches its equilibrium temperature, the rate of heat loss per second will equate to the heat produced per second within the component. This temperature may be high enough to significantly shorten the life of the component or even cause the device to fail. It is in such cases that thermal management measures need to be taken. The same considerations can be applied to a complete circuit or device which incorporates heat producing individual components.

Heat is lost from a component to its surroundings at the surface of the component. The rate of loss of heat will increase with the surface area of the component; a small device producing 10 watts will reach a higher temperature than a similar powered device with a larger surface area.

This is where heat sinks are used – varying in size and shape, heat sinks can be designed to offer a significantly increased surface area to maximise heat dissipation. They are typically connected to components which generate a large amount of thermal energy when used and therefore dissipate such energy away from the device to avoid failure due to over-heating.

Heat sinks have proven to be very effective over the years however in order to ensure full contact and therefore maximum efficiency, thermal management products are used alongside.

Metal surfaces, even when polished to a fine degree have a certain amount of roughness. It can therefore be deduced that when two metal surfaces are placed together contact is not 100% and there will always be an air gap between the two surfaces. The use of thermal interface material between such gaps ensures complete contact between the two surfaces and in more efficient heat conductance.

The ongoing trend for product miniaturisation – coupled with more modern, higher powered devices – has ensured that efficient thermal management is an essential part of both modern and future electronics design, the LED lighting market being just one example. Thermal management products are also offering solutions for greater efficiency in green energy development; photovoltaic inverters – which are known to be particularly sensitive to temperature; connections between the heat-pipe and water storage tank for solar heating applications; hydrogen fuel cells; wind power generators, are just a few examples.

Thermal Pastes



Thermally conductive pastes consist of thermally conductive fillers in a carrier fluid. Thermal pastes do not cure; therefore, they offer the best solution when rework is important and provide versatility by avoiding geometrical restrictions affecting cure.

Silicone and Silicone-Free

Electrolube offers silicone and non-silicone thermal pastes. The silicone products offer a higher upper temperature limit of 200°C and a lower viscosity system, due to the silicone base oil used.

The use of products based on, or containing, silicone may not be authorised in certain applications. This could be due to a number of factors, for instance certain electronic applications or where problems exhibited in cleaning or adhesive processes are observed.

Such issues are due to the migration of low molecular weight siloxanes; these volatile species can lower the surface tension of a substrate, making them extremely difficult to clean or adhere to. In addition, the migration of low molecular weight siloxanes can lead to failures in electronic applications, through the formation of insulative byproducts.

Electrolube products are formulated from raw materials specifically designed for the electronics industry. Thus, silicone containing products are only utilised where the low molecular weight fractions are monitored and kept to an absolute minimum. As an alternative, a range of non-silicone products are also provided for critical applications.

The 'Plus' Range

Electrolube's 'Plus' range contains a specialist blend of fillers carefully designed to achieve an optimised particle size combination and therefore can achieve higher thermal conductivity values than the Electrolube standard range.



The 'Xtra' Range

Electrolube's 'Xtra' range of thermal products are enhanced versions of the non-silicone products HTC and HTCP. These 'X' versions are manufactured using one of the company's proprietary technologies and possess the following benefits with almost no compromise in usability and viscosity: an increase in the comparative thermal conductivity, lower oil bleed and lower evaporation weight loss. HTCPX is mainly used as a gap filler and has been approved by one of the top manufacturers in the automotive industry.

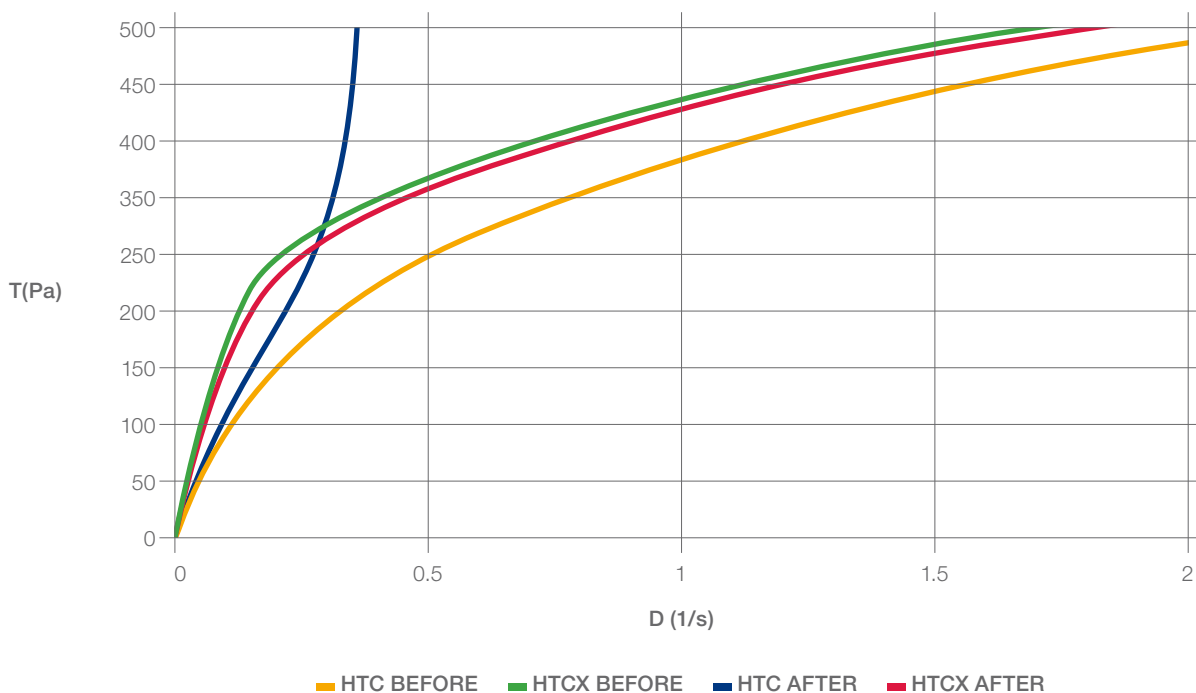
The 'Xtra' range of products are also more resistant to humidity and thermal cycling (rapid changes in heating and cooling) than the standard range.

The following graph shows the effects of humidity (1 hours, 25°C, 90% RH) and thermal cycling (25 cycle between -25°C and 65°C) on HTC and HTCX.

The results show that the rheology of HTC changes exposure to such conditions and as a result the viscosity also increases with increasing shear rate, exhibiting dilatant behaviour.

HTCX however shows greater stability under such conditions with the rheology and viscosity remaining unchanged after the exposure. HTCX exhibits pseudoplastic behaviour; decreasing viscosity with increasing shear rate.

RHEOLOGY OF HTC AND HTCX BEFORE AND AFTER HUMIDITY AND THERMAL CYCLING TESTING



Adhesives & Encapsulants



Adhesives and RTVs

Electrolube offer a thermal bonding adhesive called TBS, as well as two RTV (room temperature vulcanising) products: TCOR and TCER.

TBS (Thermal Bonding System) is a two-part, high strength epoxy adhesive designed to bond a heat sink to the component. In addition to the mineral fillers, the adhesive contains small glass beads of controlled diameter: these allow for a set thickness of 200 microns to be achieved, providing optimal performance.

TCOR and TCER are Electrolube's silicone RTV products. TCOR is an oxime-cure RTV, and TCER is an ethanol-cure version. TCER has the advantage that it is very low in viscosity and higher in thermal conductivity compared to TCOR; however, TCOR exhibits improved bond-strength properties.

Encapsulation Resins

For certain types of heat generating circuitry, it may be beneficial to encapsulate the device in a heat-sink enclosure using a thermally conductive potting compound. This method offers both heat dissipation and protection from the surrounding environment, such as high humidity or corrosive conditions.

Electrolube produces a variety of two-part encapsulation solutions utilising epoxy, polyurethane and silicone technologies:

ER2220 provides the highest level of thermal conductivity combined with environmental protection afforded from the encapsulation process. This highly-filled epoxy resin possesses very high thermal conductivity (1.54 W/m.K), resulting in a high viscosity (15,000 mPa s).

ER2183 is a lower viscosity version of ER2220 (5000 mPa s). The reduced filler content required to achieve this viscosity has little effect on the thermal conductivity performance: ER2183 is 67% lower in viscosity, but only exhibits a 28% decrease in thermal conductivity as a result (1.10 W/m.K).

UR5633 is a polyurethane encapsulation resin that offers very good thermal conductivity of 1.24 W/m.K. This is ideal for applications where thermal conductivity and a degree of flexibility are required.

SC2003 is a silicone encapsulation resin, offering a good level of thermal conductivity (0.80 W/m.K) over an exceptionally wide temperature range (-60 to +200°C). The product is thixotropic, making it ideal for applications where the resin should not flow through small gaps.

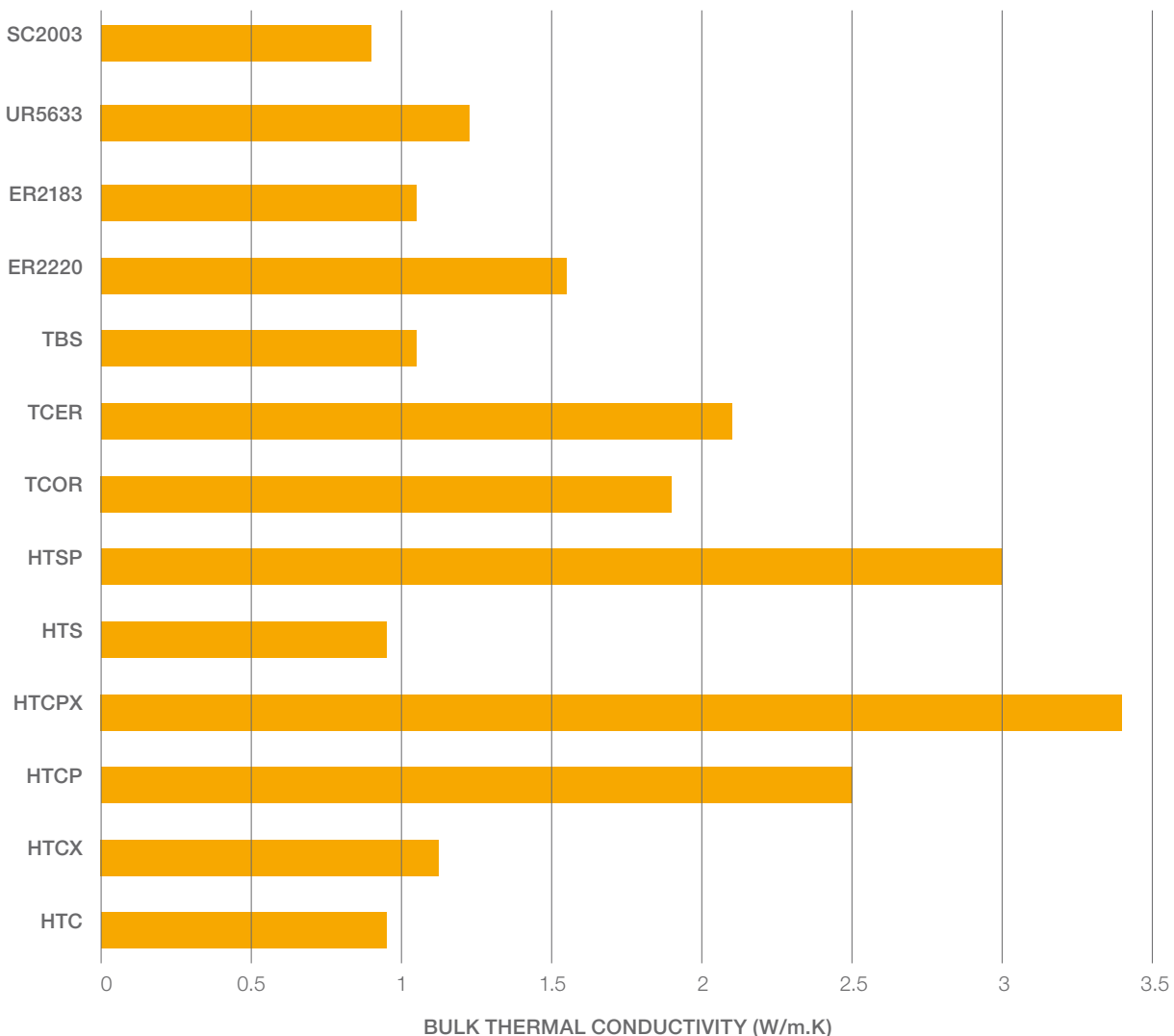
Typical Properties



Thermal Conductivity

Thermal conductivity, measured in W/m.K, represents a materials' ability to conduct heat. Bulk thermal conductivity values give a good indication of the level of heat transfer expected, allowing for comparison between different materials. Some techniques only measure the sum of the materials' thermal resistance and the material/instrument contact resistance.

Electrolube use a version of the heat-flow method that measures both of these values separately, giving a much more accurate bulk thermal conductivity measurement. The following graph shows the comparative thermal conductivities of Electrolube's thermal products:



NOTE: Thermal Conductivity of air = 0.024 W/m.K

Thermal Conductivity



Relying on bulk thermal conductivity values alone will not necessarily result in the most efficient heat transfer, however.

Thermal resistance, measured in $K\text{ cm}^2/W$, is the reciprocal of thermal conductivity. It takes into account the interfacial thickness and although it is dependent on the contact surfaces and pressures applied, some general rules can be followed to ensure thermal resistance values are kept to a minimum and thus maximising the efficiency of heat transfer.

As discussed, a thermal interface material (TIM) would be used between a heat generating device and its associated heat sink. As the heat sink will have a significantly higher thermal conductivity than the interface material, it is important that only a thin layer of the interface material is used; increasing thickness will only increase the thermal resistance in this case. Therefore, lower interfacial thicknesses and higher thermal conductivities give the greatest improvement in heat transfer. In some cases, however, utilising a material with a higher bulk thermal conductivity could be to the detriment of contact resistance and thus, no improvement will be accomplished.

An example of this difference can be drawn from the comparison of thermal pastes and thermal pads. Thermal pads are solid, polymerised materials of a fixed thickness which are available in a variety of thermal conductivities. Thermal pastes, as discussed above, are non-curing compounds and as a result, their viscosity can alter slightly as the temperature increases. This allows for a further reduction in interfacial resistance. In the case of thermal pads, high pressures are needed to achieve an adequate interface, thus, a paste and pad of similar bulk thermal conductivity may have very different thermal resistance measurements in use, and as such a difference in the efficiency of heat transfer will be observed.

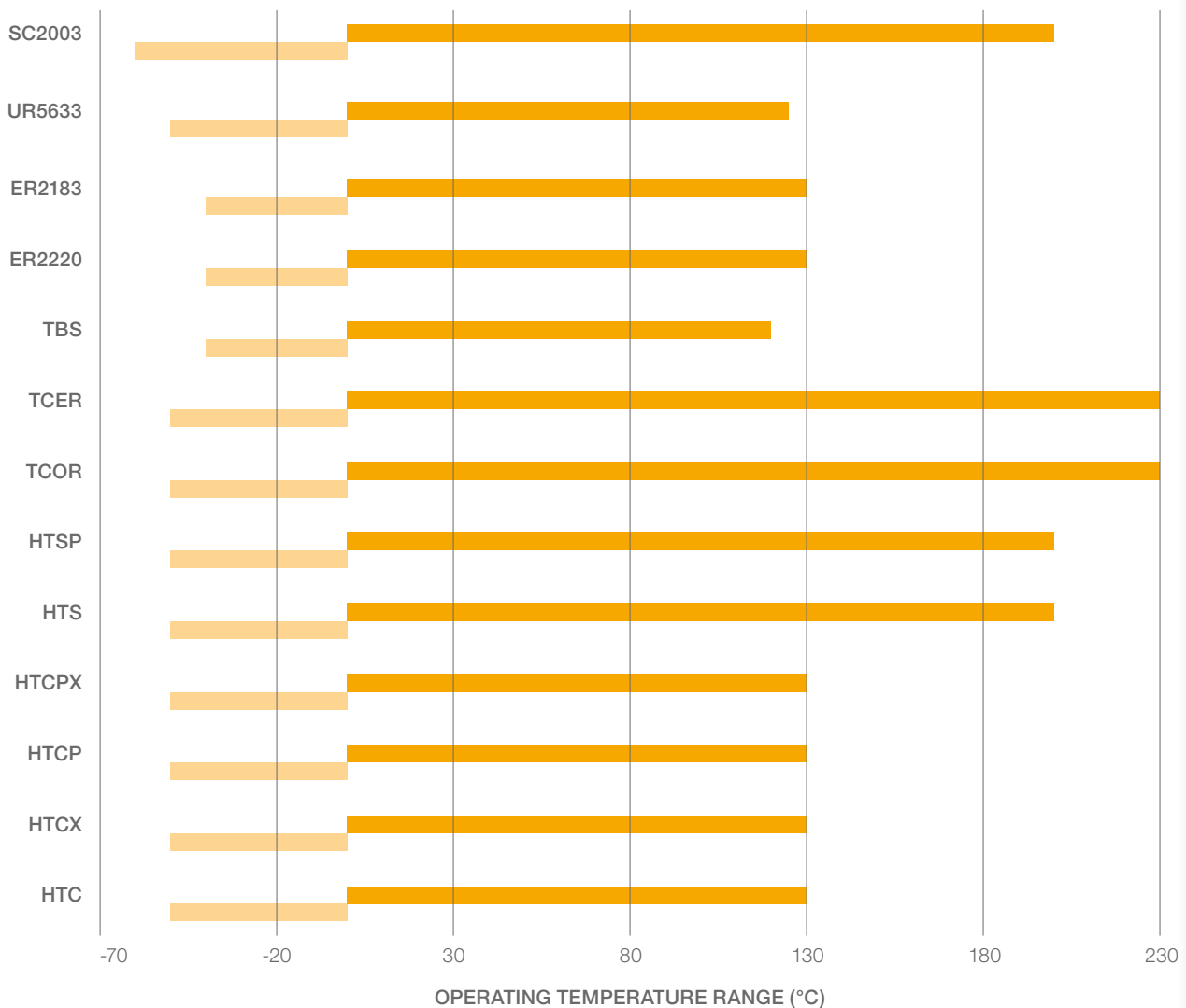
Users must address bulk thermal conductivity values, contact resistance and application thicknesses and processes in order to successfully achieve the optimum in heat transfer efficiency.



Temperature Range

Electrolube's thermal management products cover an extensive operating temperature range. It is important that the temperature extremes experienced during application fall within the operating temperature range of the product selected.

Depending on the type of product and chemistry chosen, the temperature range will differ. Some products may be suitable for short-term excursions outside of the recommended operating temperature ranges. Testing in representative end-use conditions is always advised.

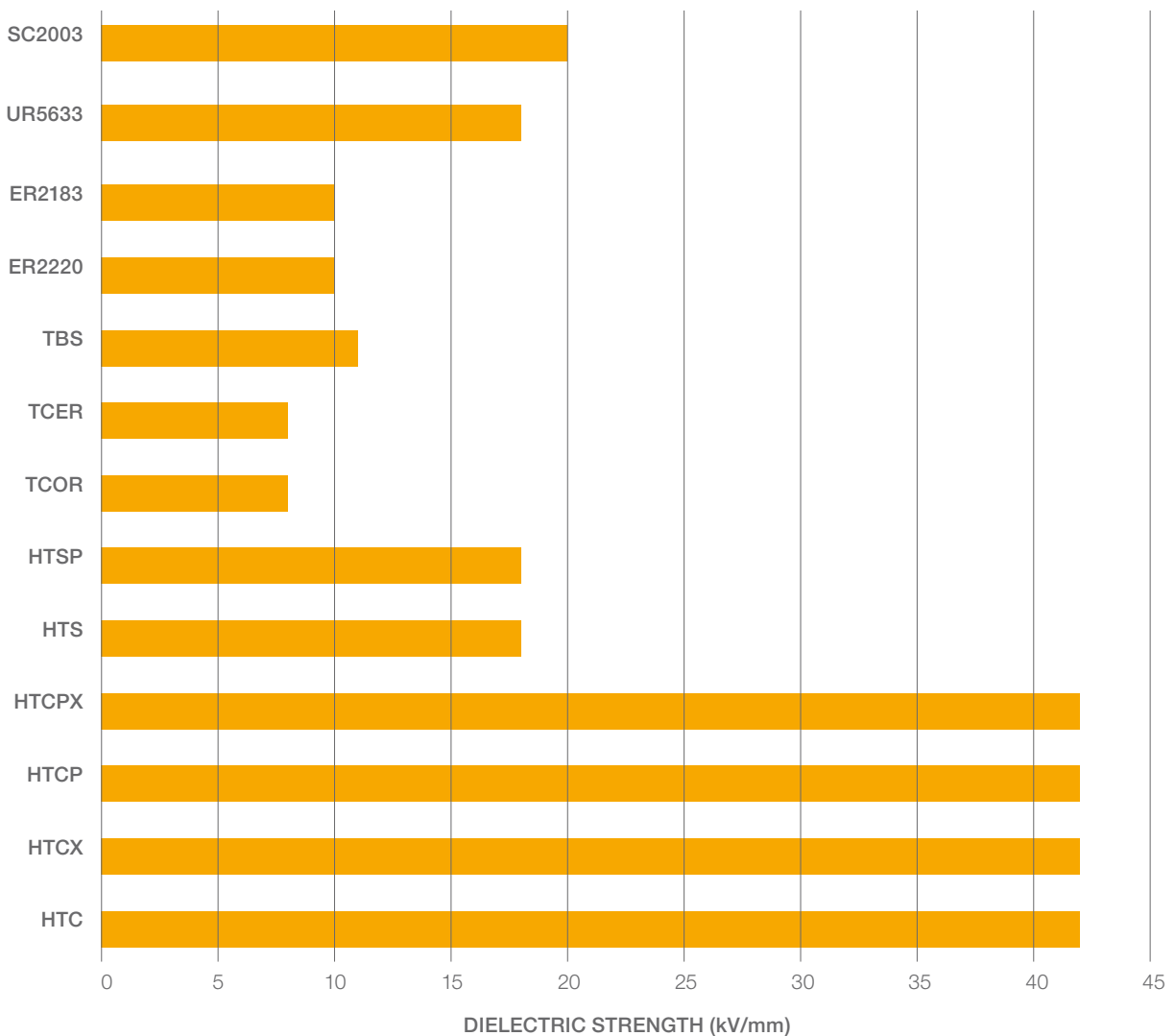




Dielectric Strength

Thermal management products are used within electrical applications and therefore must not have any detrimental effect on the performance of the device. Measurements of the electrical properties of such products can assist in proving suitability for use. For example, the dielectric strength is the maximum electric field strength that a product can withstand intrinsically without breaking down, i.e. without experiencing a failure of its electrical properties.

This is sometimes also referred to as the dielectric withstanding voltage. Conversely, the breakdown voltage is the minimum voltage that causes a portion of an insulator to become electrically conductive.



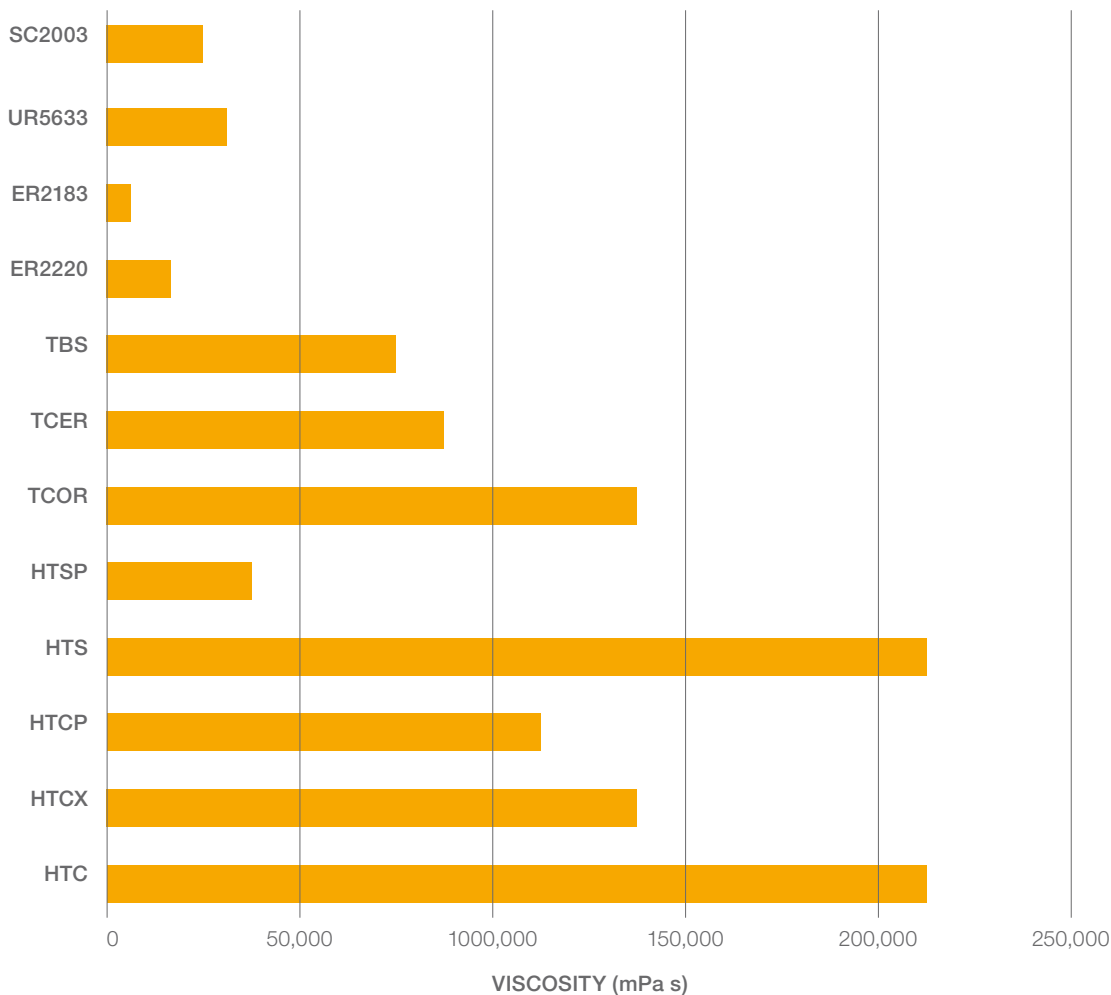


Viscosity

The viscosity of thermal pastes will affect the processing parameters of application as well as the performance of the product in use. For example, the standard range of products are designed as thermal interface materials (TIM) and so should be applied in a thin layer. The stability of these products avoids problems associated with 'pump out' (changing viscosity with temperature, causing the paste to gradually move out from between the interface) but only when used in thin films.

Gap filling materials, such as HTCPX, are designed to offer the ultimate in stability, even in high thicknesses and under vibration. Consequently, this increase in stability also means that the viscosity of the material is very high.

The viscosity of thermal management materials that cure, such as RTV's or encapsulation products, is only relevant for application purposes and must be considered when choosing suitable dispensing equipment or application methods; once the material is applied to the unit/substrate, it will cure to a solid material. A comparison of the various product viscosities is given in the graph below:



Application Options



Thermal Pastes

As highlighted previously and with the exception of gap filling products, it is important that thermal interface materials (TIM) are applied in the thinnest layer possible to reduce the effects of thermal resistance. Therefore, the application of thermal pastes can be as important as the product selection stage.

Thermal pastes can be applied via a range of methods, either manual or automated.

- i. Manual applications can be carried out using a roller, squeegee or spatula; often a roller is the best method to ensure a thin even film is deposited across the entire surface.
- ii. Automated applications involve the use of specialist equipment. This usually consists of an applicator head where the material is fed to the applicator via dispensing equipment. Due to the viscosities of these materials, the dispensing equipment is usually a follower-plate system which connects to the thermal paste container as supplied. Please contact Electrolube where container dimensions are required.

RTVs

Electrolube RTVs are supplied in ready-to-use cartridges and should be used with the TCR Gun applicator. Please contact Electrolube regarding bulk quantities.

These materials are often used for combined thermal transfer and fixing, therefore a thin layer should be applied and tests conducted to ensure the level of bonding achieved is sufficient for the application.

As these are moisture cure products, ambient humidity must be considered during application. Extreme conditions (very dry or very wet) will inhibit the cure and elevated temperatures will not speed up the process, unless humidity is also increased.

Encapsulation Resins

Encapsulation resins are two part systems which can be applied manually or through automated equipment. In all cases, the mixing procedure used should avoid the introduction of air; the introduction of air or moisture can affect the cure process of these materials as well as leave air voids in the cured product, which will significantly reduce the thermal conductivity.

- i. Electrolube supply encapsulation resins in resin pack form; a pouch divided by a clip and rail which separates the Part A and B until the time of mixing. These packs are ideal for air-free mixing and are advised for all manual application of encapsulation resins. When supplied in an aluminium outer, this outer material should not be removed until immediately before use.
- ii. Automated mixing and dispensing machines are also available either in benchtop or large scale models. Electrolube work with a number of local and international equipment manufacturers, please contact us for further information.

The Product Range

Thermal Pastes



HTC – Non-Silicone Heat Transfer Compound

- Excellent non-creep characteristics
- High thermal conductivity: 0.90 W/m.K
- Wide operating temperature range: -50°C to +130°C
- Low evaporation weight loss
- Available in aerosol form, HTCA
- Low in toxicity



HTS – Silicone Heat Transfer Compound

- Excellent non-creep characteristics
- Very wide operating temperature range: -50°C to +200°C
- Very low evaporation weight loss
- High thermal conductivity even at high temperatures: 0.90 W/m.K
- Low in toxicity and economic in use
- White colour enables treated parts to be easily identified



HTCP – Non-Silicone Heat Transfer Compound Plus

- Excellent non-creep characteristics
- Very high thermal conductivity: 2.50 W/m.K
- Wide operating temperature range: -50°C to +130°C
- Low evaporation weight loss
- White colour enables treated parts to be easily identified
- Low in toxicity



HTSP – Silicone Heat Transfer Compound Plus

- Superior thermal conductivity even at high temperatures: 3.0 W/m.K
- Excellent non-creep characteristics
- Very wide operating temperature range: -50°C to +200°C
- Very low evaporation weight loss
- Low viscosity for ease of processing
- Low in toxicity



HTCPX – Non-Silicone Heat Transfer Compound Plus Xtra

- Excellent non-creep characteristics
- Vibration stable, designed for gap filling applications
- Wide operating temperature range: -50°C to +130°C
- Exceptional thermal conductivity: 3.40 W/m.K
- Low in toxicity
- Low evaporation weight loss



HTCX – Non-Silicone Heat Transfer Compound Xtra

- Very low oil bleed and evaporation weight loss
- Reduced viscosity for ease of application
- Excellent non-creep characteristics
- Wide operating temperature range: -50°C to +130°C
- Excellent thermal conductivity: 1.35 W/m.K
- Low in toxicity

Adhesives and Encapsulants



TCOR - Thermally Conductive Oxime RTV

- Single part, low odour RTV
- Very high thermal conductivity: 1.80 W/m.K
- Exceptionally wide operating temperature range: -50°C to +230°C
- Moisture cure – releasing oxime upon cure
- Easy to apply – use with TCR Gun Applicator
- Good bond strength and remains flexible at high temperatures



ER2220 – Thermally Conductive Epoxy Resin

- Very high thermal conductivity: 1.54 W/m.K
- Flame retardant
- Utilises non-abrasive fillers
- Used for encapsulating PCBs or devices requiring effective thermal dissipation
- Provides environmental protection
- Wide operating temperature range: -40°C to +130°C



TCER - Thermally Conductive Ethoxy RTV

- Single part, low odour RTV
- Very high thermal conductivity: 2.20 W/m.K
- Moisture cure – releasing ethanol upon cure
- Low viscosity for ease of application – use with TCR Gun Applicator
- Remains flexible and elastic at high temperatures: -50°C to +230°C
- Low bond strength for ease of rework



ER2183 – Low Viscosity, Thermally Conductive Epoxy Resin

- Low viscosity alternative to ER2220: 5000mPa s
- High thermal conductivity: 1.10 W/m.K
- Easy to mix, uses non-abrasive fillers
- Used for encapsulating PCBs or devices requiring effective thermal dissipation
- Provides environmental protection
- Wide operating temperature range: -40°C to +130°C



TBS – Thermal Bonding System

- Two part epoxy bonding system
- Very high bond strength
- High thermal conductivity: 1.10 W/m.K
- Eliminates need for mechanical fixing by providing a permanent bond
- Wide operating temperature range: -40°C to +120°C
- Include glass beads for a set thickness to be applied



UR5633 – Thermally Conductive Polyurethane Resin

- Flame retardant
- Excellent thermal conductivity: 1.24 W/m.K
- Excellent electrical properties
- Wide operating temperature range: -50°C to +125°C
- Very high water resistance
- Excellent performance in harsh conditions such as marine, automotive and tropical environments



SC2003 – Thermally Conductive Silicone Resin

- Flame retardant
- Good thermal conductivity: 0.80 W/m.K
- Excellent electrical properties
- Exceptionally wide operating temperature range: -60°C to +200°C
- Simple mix ratio: 1:1
- Especially suited to potting of electrical and electronic devices operating in high temperatures

*Various sizes are available for most products, including bulk.

Thermal Management

	HTCX	HTCP	HTCPX	HTS	HTSP	TCOR	ER2220	ER2183	UR5633	SC2
	Non-Silicone Heat Transfer Paste Xtra	Non-Silicone Heat Transfer Paste Plus	Non-Silicone Heat Transfer Compound Plus Xtra	Silicone Heat Transfer Compound	Silicone Heat Transfer Compound Plus	Thermally Conductive RTV	2 Part Epoxy Resin	2 Part Epoxy Resin	2 Part Polyurethane Resin	
Thermal Conductivity (W/m.K)	1.35	2.50	3.40	0.90	3.00	1.80	1.54	1.10	1.24	0
Density (g/ml)	2.61	3.00	3.10	2.10	3.00	2.30	2.22	1.95	1.65	1.
Viscosity/mPa s**	130,000	105,000	640,000	210,000	45,000	145,000	15,000	5,000	30,000	30,
Cure Time (Hours @ 20°C / 60°C)	N/A	N/A	N/A	N/A	N/A	24*	24/4	24/4	24/4	24
Temperature Range (°C)	-50 to +130	-50 to +130	-50 to +130	-50 to +200	-50 to +200	-50 to +230	-40 to +130	-40 to +130	-50 to +125	-60 to +200
Evaporation Weight Loss (96hrs @ 100°C IP-183)	≤0.40%	≤1.00%	≤1.00%	≤0.80%	≤0.80%	N/A	N/A	N/A	N/A	N
Dielectric Strength (kV/mm)	42	42	42	18	18	>8	10	10	18	2
Volume Resistivity (Ω-cm)	1 x 10 ¹⁴	1 x 10 ¹⁴	1 x 10 ¹⁴	1 x 10 ¹⁵	1 x 10 ¹⁵	1 x 10 ¹⁴	1 x 10 ¹⁵	1 x 10 ¹⁵	1 x 10 ¹⁴	1 x 10 ¹⁴

* Requires moisture to cure, elevated temperatures not recommended unless moisture is present. **This information should be used as a guideline only.