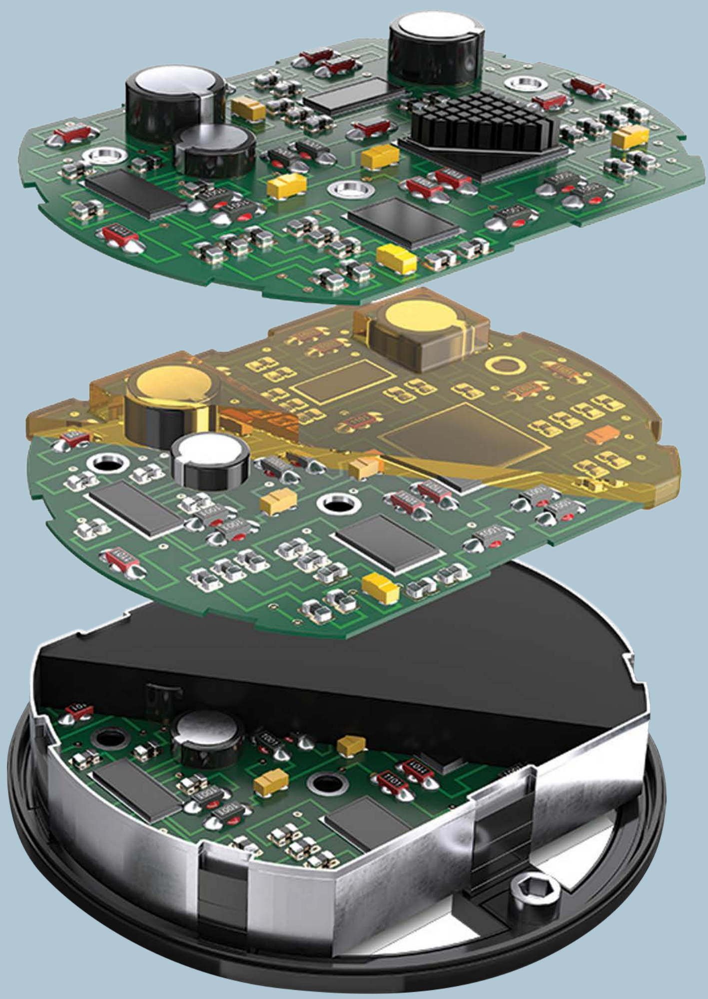
ARE YOUR ELECTRONICS PROTECTED? THAT DEPENDS.

The electronics content in a current-generation automobile, a modern smart home, entertainment devices and many other products that make up our digital existence is significant. For the average car built today, approximately 40% of its cost is derived from electronics, and that figure is expected to be as much as 50% over the next decade.[1] Consumer electronics, which includes many smart home devices, is set to have a record year this year.[2] Even producing electronics has become more digitized. The smart factory, with its automated robots, machines, logic controllers and the like, is run on electronically-controlled mechanical systems. Electronics are everywhere, in critical and recreational applications, ubiquitous across most of modern-day society.



Designing and manufacturing electronic devices comes at a significant cost. Using them requires confidence in their reliability and safety. Protecting them is, therefore, non-negotiable.

With various safeguarding approaches from the printed circuit board (PCB)-level to the components to the entire assembly, it is sometimes difficult to know what protection materials to use. What is the most durable? The most cost-effective? The answer is: 'that depends'. Material selection – or a combination of materials – is contingent on many factors, including the kind of electronics being protected, the end-use/application, the reliability requirement, risk of exposure to certain environmental harms (moisture, chemicals, heat exposure, vibration, etc.) and lifetime expectation.

The below overview of various protection materials, their application, property considerations, processability and benefits may shed some light on how to select and adequately defend electronics against the many challenging environments they might encounter.

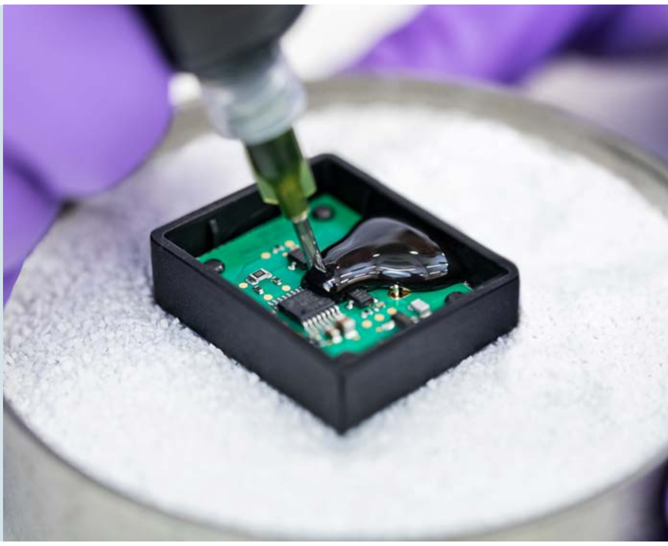
Protection Materials for Electronics

Liquid Potting

Liquid potting materials are formulations that can be dispensed or poured to encapsulate complete electronic assemblies.

They harden after cure to hold all elements in place and protect devices from shock, vibration, liquids, chemicals and other damaging elements.

Watch a video.



When to use: Generally employed for extreme environments (automotive, aerospace, high temperature, high humidity, etc.) and with electronics in an enclosure.

Processing: One- and two-part potting materials are available in multiple chemistries (silicones, urethanes and epoxies) and are dispensed onto the electronics and within the housing, then cured. The process is relatively fast, with maximum protection delivered.

Pros: Provides enhanced mechanical strength, electrical insulation, heat dissipation (some formulas), corrosion and chemical protection, shock and vibration resistance; the ultimate safeguard against moisture and short-circuits.

Cons: Potting is typically permanent and not reworkable. Compared to other encapsulating materials like low-pressure molding, potting is a relatively long process.

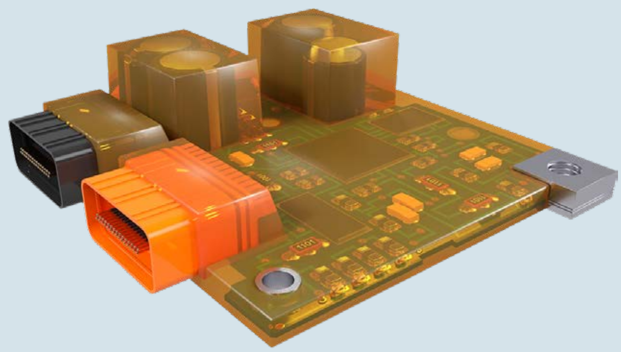
Learn which potting formulation may be right for your application by using this ***Potting Selector Guide.***

Protection Materials for Electronics

Low-Pressure Molding

Versatile low-pressure molding (LPM) materials provide an overmold to create a self-contained electronics housing and can be used across a wide variety of applications – from small electronic devices to LEDs to connectors, cables and wires, to name a few.

Watch a video.



When to use: This encapsulation protection method is ideal for exposed electronic assemblies that require delicate processing, fast and efficient manufacturing and a clean, sustainable approach to reliability improvement with easy handling. LPM materials are versatile and can be applied to numerous designs and end products.

Processing: Similar to plastic injection molding, the part is placed in a mold (or tool) inside molding equipment, hot melt adhesive is heated to a liquid state and fed into the mold, where the part is encapsulated and can be handled immediately after ejecting. LPM is a fast, three-step, affordable solution that can be managed in-house with the appropriate mold machine or via a third-party contractor.

Pros: LPM uses very low pressure compared to injection molding, so it is well-suited for delicate electronics. In most cases, the molded material is waterproof, resistant to vibration and impact, and protected from corrosion and most chemicals. LPM is also very cost-effective. An environmentally friendly, sustainable solution, LPM materials are based on renewable raw materials. The LPM process produces very little waste and, with regard to recycling, can be melted to make component recycling easier.

Cons: LPM is generally not recommended for high-heat, extreme environments.

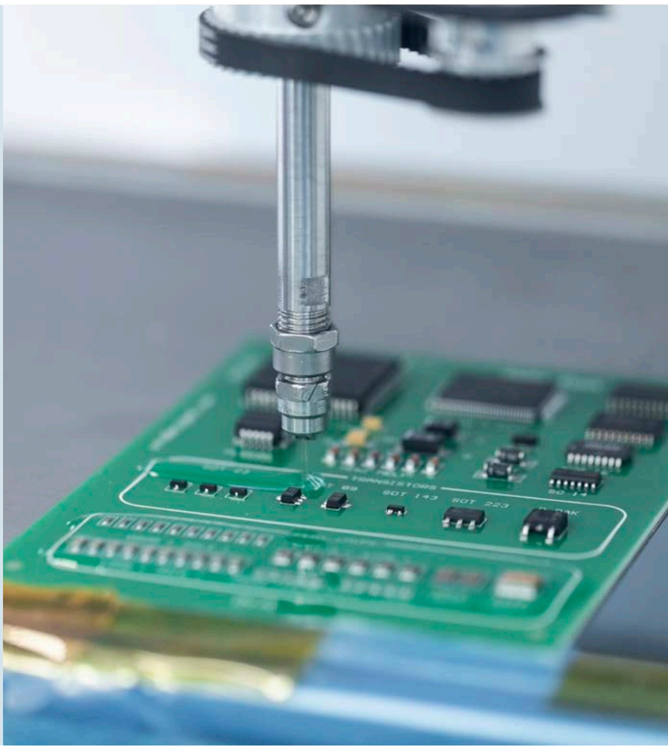
Protection Materials for Electronics

Conformal Coating

Conformal coatings are thin, polymeric materials applied to a printed circuit board (PCB) to protect it from environmental influences that may cause corrosion or other degrading conditions. Formulated using a variety of chemistries (epoxy, acrylic, polyurethane, silicone, etc.), conformal coatings are essential for high-reliability applications such as automotive, aerospace, and industrial.

However, the materials are used throughout electronic devices, including those found in mobile telecom products, among others.

Watch a video.



When to use: The coatings can be used for applications where high reliability is required and/or where a long lifetime is an expectation. Because the materials protect against conditions that can cause electrical failures or voltage leaks, they allow for higher voltages and densities (tracks/traces) so are important where miniaturization is a factor.

Processing: Cleaning the PCB before coating is recommended and, depending on the application, masking areas that are not to be coated might be required. Manual application of conformal coatings includes brush, aerosol, or spray atomization methods. Automated application can be carried out via dip coating (slow by comparison to spraying) or by selective spray equipment. Coating thickness is chemistry- and application-dependent and cure mechanisms can vary (UV, heat cure, moisture cure, solvent evaporation).

Pros: Conformal coatings provide maximum environmental protection against temperature extremes, moisture, salt, chemicals, corrosion and voltage leakage. They can be applied fast and cured quickly for compatibility with high-volume and/or high-mix environments and provide high reliability for PCB assemblies.

Cons: Erroneously coating areas/certain components (electromechanical, optics, etc.) intended to be left uncoated can degrade functionality, so precision application is critical. In addition, some conformal coatings prevent component rework or make it more difficult and time-consuming.

Protection Materials for Electronics

Encapsulants

Chip-on-Board (COB) encapsulants protect bare chips (not enclosed in a molded package) on a substrate.

Generally categorized in one of two classes – glob top and dam-and-fill – the materials are either applied as one dispensed deposit or with a material perimeter that is then filled, as the names suggest.

When to use: COB encapsulants are recommended when localized protection of sensitive components is required and when packages have to meet specific reliability targets. Because the encapsulants minimize corrosion by protection against moisture and act as a dielectric by isolating wires from each other, they are often used to protect wire bonded die.

Processing: COB encapsulants are deposited onto chips that are directly attached to a substrate without overmolding or other protection. After the chips are encapsulated, no other molding or protective materials are required. Both glob tops and dam-and-fill encapsulants are usually applied using an automated dispensing system, though they can be managed manually if needed for rework or other low-volume manufacturing. The process is simple, but the volume and shape of the deposits need to be precise to avoid interference with other downstream assembly processes or final product footprints.

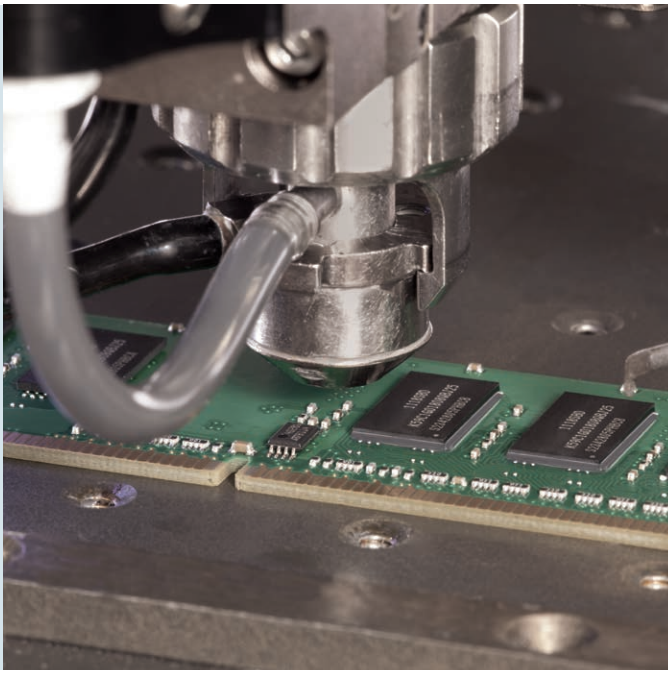
Pros: COB encapsulants protect against thermal shock, chemical contamination and mechanical damage to enhance reliability. The materials provide electrical insulation, a low coefficient of thermal expansion (CTE) to limit warpage and stress, excellent temperature stability and are a low-cost solution.

Cons: The materials and processing must be tightly controlled to keep the dispensed encapsulant free of voids.

Underfill

Underfills are polymer-based materials that improve the reliability of arrayed components (BGAs, CSPs, flip-chips, etc.) or bare die by protecting interconnects from thermo-mechanical damage induced through CTE mismatches between the component and the substrate, especially during thermal cycling.

Watch a video.



When to use: Underfills are typically used when arrayed components are failing during reliability testing to strengthen the interconnects of the components. Bump heights and pitches are becoming tighter, so capillary flow underfills (CUFs) are generally standard practice for BGA and CSP packages, as well as flip-chip-on-board applications.

Processing: Following solder reflow and the formation of the electrical interconnects, underfill material is dispensed along one or two edges of the component, after which it flows underneath by capillary force between and around the solder joints to encapsulate and protect the device from thermal cycling and/or mechanical stress. The process is fast but requires heat cure. Formulation expertise is essential to ensure ideal filler loading, good viscosity, no voiding and fast flow.

Pros: Underfills protect solder joints against CTE-induced mechanical stress, as well as from shock, drop and vibration, which can all cause electrical failure if an interconnect is broken. Contaminants and moisture protection is also provided through the use of underfills, acting as a barrier against corrosion and oxidation.

Cons: The underfilling process can add time and cost to PCB assembly, as compared to a standard surface-mount device process where no underfilling is required.

Conclusion: Protection = Reliability

Securing electronics for long-term, dependable performance typically requires that many protective materials be used in combination – a conformal coating, an underfill, and a potting material, for example. Therefore, working with a supplier that has expertise in multiple safeguarding strategies and formulations, and understands various material compatibilities is advised to ensure the most cost-effective and reliable solution – no matter the application.

Discover the benefits of Henkel's electronic protection materials portfolio. Talk to a Henkel team member about your latest design and the best safeguarding options.

Kris Machiels

The Author

Kris Machiels currently serves as Henkel's Application Engineer for circuit-board protection solutions within the company's Adhesive Technology business unit. He joined Henkel in 2017, as a Technical Customer Service Engineer. With over 20 years of experience in flexible packaging and electronics manufacturing industry, supporting different markets and technologies, he has worked in various roles in product development and technical customer service. To support customers in building new applications to meet future needs, Kris is passionate about collaborating with customers early in the design phase and providing a variety of services to define the best solutions. Based in Belgium, Kris holds a Bachelor's degree in Chemistry, and a Master's in Biochemistry from KU Leuven.

Sources

[1] *www.octopart.com/blog/archives*
[2] *www.electronicsweekly.com/news/business*

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