Conductive Epoxies make the Right connections

How to select conductive Epoxy adhesives

EPOXIES AND ELECTRONICS

Major Advances in electronics are being made every day. Every aspect of our lives relies upon electronic devices, which have become fundamental to the way modern society works. Electronics technology continues to advance in industries such as aerospace, medicine, military systems, automotive, electronics, solar cell, and so on.

Because of today's powerful advances in technology, electronics are now getting smaller and still need to uphold all environmental regulatory and industry requirements. To address these challenges, engineers and scientists are choosing epoxies that have high bond strength, offer electrically conductivity, and meet other critical performance requirements. In response to these demands, electrically and thermally conductive epoxy technology has been advancing. The use of different types of electrically conductive epoxies have come into play for use in micro-electronics and other industries.

Electrically conductive epoxies are used in many applications, such as wind turbines, autos, aerospace, conductive flooring, electronics, sport, leisure, and household applications. Versatile one and two part electrically conductive epoxies are reliable and bonding options which offer extreme resilience, conductivity and resistance to thermal cycling.

Epoxy resin systems are used as they deliver robust cured properties such as strength, adhesion, resistance to chemicals and moisture as well as ease of use and application.

To the left, is ALFA'S E10-101- a One and Two-part Silver Filled Conductive Epoxy.

CONDUCTIVE EPOXIES

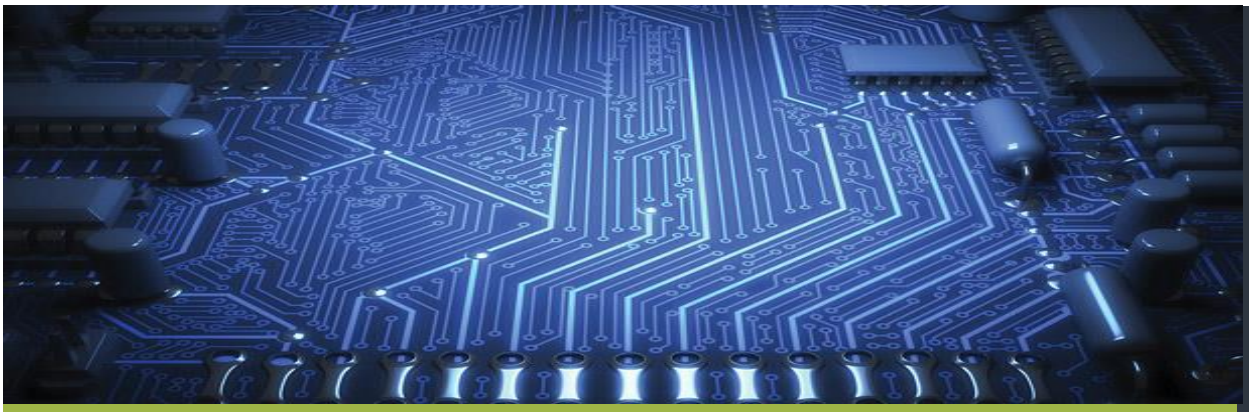
Epoxy adhesives are classified into one and two component systems. In a one-part (single component) system, the curative (Hardener/catalyst) and base (resin) are pre-mixed and cure by heat. This property offers a tremendous benefit of a long work life at room temperature that can last months.

In a two-part epoxy system, the epoxy resin and hardener are packaged separately, and then weighted and mixed together in the correct mix ratio immediately before application and cured at ambient or at elevated temperatures. This allows the epoxy adhesive to adhere and form strong bonds to heat-sensitive substrates. Ambient-cure of a two-part epoxy system is one of most sought out feature for engineers when using electrically-conductive epoxy adhesives with advanced electronics.

Either system, ambient-cure or heat cure, may be applied by a variety of methods including hand-mix, syringe or screen-printed onto substrates such as flex-circuits and circuit boards.

Unfilled epoxies are electrical insulators with high dielectric strength, low dielectric constant and high-volume resistivity and only become conductive when conductive filler is introduced to the formula. Electrically conductive epoxy adhesives are classified both as electrically conductive and as thermally conductive. However, not all the thermally conductive epoxies are electrically conductive. Electrically conductive epoxies formulations become highly conductive when filled with metallic fillers such as gold, silver, nickel, graphite and aluminum in a powder form. Thermal conductivity is achieved in epoxies when metals or inorganic fillers, such as natural graphite, copper, aluminum, zinc oxide, boron nitride, aluminum oxide, diamond and silver powders are used. Pure silver flake has the best electrical conductivity and is second-best in achieving high thermal conductivity. Thus, most of electrically conductive epoxies are filled by more than 70% pure silver to achieve resistivity less than 0.0005 ohm.cm. The choice of filler material depends on conductivity requirements and budget considerations for specific application.

Epoxies also resist water and chemicals, fill gaps, and achieve high strength and durability within timely cure schedules- all critical requirements and features needed to keep up with the fast-growing advances in technology we all see today. Electronic assemblies are often systems connected with dissimilar metals. When epoxy resin is placed in between these metals, and cured, a barrier against galvanic corrosion is created. This is a key characteristic offered by epoxy adhesives. Epoxy adhesives also are insulative and are therefore fit for applications involving electrical and electronic assemblies being made with shorter circuits.



TYPES OF CONDUCTIVE EPOXIES AND THEIR PERFORMANCE CRITERIA

Electrically conductive epoxy products are mainly used for electronics applications where components need to be held in place where an electrical current can be passed between them. They are also used in applications where the risks of mechanical and thermal cracking are very high, as well as when there are concerns about damaging heat sensitive components on the PCB during soldering. It creates an electrically conductive pathway between the bonding substrates through particle to particle contact between the conductive filler (usually silver) within the adhesive. This performance is all dependent on the amount of filler in the resin. The higher the conductive filler volume in the resin, the higher the conductivity will be.

Soldering methods were widely used for making electrical connections and packaging for electronic components.

Tin/leaded solders are used much less often now for a variety of reasons including a major concern over lead's toxicity. Because of these rising concerns, manufactures and the electronic industry are now substituting lead soldering with environmentally friendly products-such as silver filled electrically conductive epoxies, at a very rapid pace.

Another issue with lead-free solder is that it is less elastic than leaded solder. This means that lead-free solder joints will be more brittle and more susceptible to developing cracks compared to lead-based solder-especially during temperature cycling. Electrically conductive epoxies are an alternative to leaded and unleaded solders. They have low curing temperatures that helps reduce the risk of damage to heat sensitive components and are also more resilient to thermal and mechanical stress.

SELECTING AN ELECTRICALLY CONDUCTIVE EPOXY ADHESIVE

To fully understand the properties of an electrically conductive epoxy adhesive, a technical data sheet (TDS) and a safety data sheet (SDS) should be read and understood in order to select the right product for certain applications. TDS's and SDS's are important resources in understanding key properties such as application, characteristics before and after curing, ranges of viscosity, work-life, mixing ratio, type of packaging, curing conditions, cure speed, room temperature or heat cure, electrical and other performance properties. Other properties include, electrical conductivity as well as characteristics such as thermal-resistance, specific gravity, die-shear and tensile lap shear.

Another important factor to help engineers determine which product is most suited for a specific application is to consider the appropriate dispensing process. The dispensing process will depend upon factors such as conductive filler particle size (for selecting a dispense needle), work-life, viscosity, and cure method.

The potential presence of volatile components in epoxy formulations may require consideration of out-gassing and many applications call for low-VOC adhesives. "NASA out gassing requirements", are frequently called upon as a performance measure for high performance applications.

ALFA INTERNATIONAL

ALFA INTERNATIONAL'S ROLE AND CONTRIBUTION

ALFA International Corp. has a reputation for developing robust and highly reliable formulations for demanding applications. Considerable effort has been applied by ALFA International for over that past three decades to develop and introduce an electrically conductive epoxy line for use in many demanding electronic applications.

ALFA's **E10** Electrically conductive line includes one and two part-silver and nickel filled epoxy at affordable costs. ALFA's **E10-101,** silver filled conductive epoxy has been in the market for almost 20 years and is among and most highly effective products available. **E10-101** has played a critical role as a versatile material in the micro-electronics marketplace. It provides reliable component protection in applications such as heat sink bonding, solderless connections, die attach and surface mount. **E10-101** is designed to meet the challenges of heat dissipation that result from increasing line densities and shrinking geometries such as wireless communications, satellite transmission and circuit board manufacturing. It is also designed and engineered to optimize performance across a broad range of applications, to withstand a variety of environmental conditions while complying with regulatory and industry requirements. **E10-101** passed NASA out gassing requirements and is listed on NASA records.

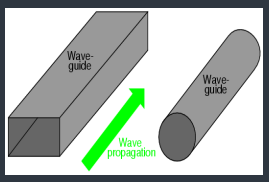
WHY CHOOSE ALFA's E10-101

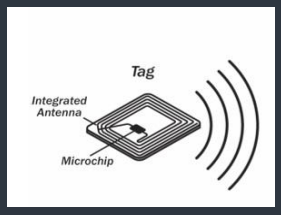
1. Excellent choice for any application that cannot withstand the high temperature associated with soldering.
2. Cures at room temperature or elevated temperature.
3. RoHS compliant, lead free.
4. Environmentally friendly that achieve high bond strength and meet other stringent performance requirements.
5. Super electrical conductivity.
6. Excellent thermal conductivity.
7. Passed NASA low outgassing specifications.
8. Meets USP class VI biocompatibility requirements.
9. Excellent resistance to most chemicals, solvents and moisture.
10. Excellent thermal-cycling resistance.
11. Continues use of temperature as high as 400F.
12. Bonds to glass, ceramics, metals and plastics, as well as dissimilar materials.
13. Non-corrosive.
14. Low shrink during cure.
15. Excellent moisture resistance.
16. Excellent chemical resistance.
17. Good electrical properties.
18. Increased mechanical and fatigue strength.
19. Impact resistant.
20. No VOCs.
21. Long shelf life.
22. No volatile agents or liberated during cure or after cure that can lead to voids or that can act as plasticizers.

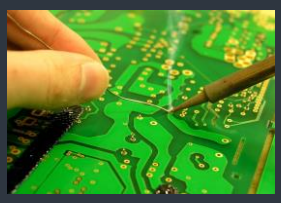
APPLICATIONS of ALFA's E10-101

- General heat conductive cement for heat sensitive components
- Automotive rear window defogger and antenna circuits repair
- Die attach and surface mount
- Solderless wire connections
- Electrical modules
- Screen-printing
- PCB repair (printed circuit board repair)
- Catheters
- High frequency shields
- Wave guides
- EMI/RFI shielding
- Entertainment systems
- Specialty heat sinks
- Static discharge/grounding
- Interconnection repair
- Cold solder, electrical solder replacement
- Digital signal processors
- Electric motors
- Grounding X-Ray
- Shielding
- Bonding quartz crystals
- Hybrid microelectronic packaging
- Electronic test equipment
- Thermal management dissipation
- Wave guides
- Solar cell manufacturing
- Electrical ground plane interface
- RFID tagging
- Printed wiring board applications
- LCD panels, organic EL and LED displays, and CCD devices, which are particularly sensitive to high temperature
- Wireless headsets
- Wafer lamination
- Membrane switches
- Antenna assemblies
- Stack bonding
- Copper/polyamide (PI) circuits
- Integrated circuitry
- Flip chip attachments and packaging
- Thermistors
- Microprocessors
- Stress control devices
- Wire tacking
- SMD attachment
- Hermetic lid-seal processes
- Communication systems

E10-101 passes NASA's outgassing testing ASTM E-595 and is listed in NASA's Outgassing Data for Selecting Spacecraft Materials list.







HANDLING AND PROCESSING CONSIDERATIONS

Handling and processing techniques should be considered when choosing a conductive epoxy. Because every application involves different performance standards and requirements and because all epoxies have different properties, it is necessary to distinguish differences between one and two-part epoxies to ensure optimum results. When choosing a one-part epoxy, factors such as heat cure, cure temperature, and shelf life should be considered for application. If choosing a two-part epoxy, factors such as room temperature cure and gel or open time should also be taken into consideration.

SAFETY FIRST: Before any use of a resin product, the manufacturers product instructions and Material Safety Data Sheet (SDS) should be read and understood. SDS's are usually found with the product package or can be obtained from the supplier.

Most epoxy resins are nontoxic polymers upon cure (hardened). In the hardened state, they do not irritate the skin. However, in the liquid state both the resins and hardeners are skin and eye irritants. If planning to work with epoxies, "Good Industrial Hygiene" is required. Good ventilation is a requirement.

COMMON CAUSES FOR ADHESIVE PROBLEMS:

1-Since the filler content in conductive epoxy is more than 70%, fillers could settle in the original container. Mixing each component to consistent homogenous paste is essential before use to achieve maximum properties.

2-Variation of mix ratio of two-part epoxy system has been seen to have significant influences on ultimate cure properties. Deviations from ideal stoichiometry produced noticeable differences in the finally cured network.

3-Application technique, manual or automated, must be consistent for each unit. Some two-part epoxies with short work-life may cure partially with subsequent viscosity rise during dispensing which results in the unit lagging and preventing a consistent amount of material applied to each part. This will result in inconsistent and poor adhesion.

4-Contamination: Any presence of impurities on the surface such as silicone release agent, oil or water can potentially cause loss of adhesion.

5-Surface preparation: Clean, dry, consistent surfaces are necessary for reliable epoxy bond production. Probably the greatest single cause of unsatisfactory bonding is failure to prepare the surface properly. The usual surface preparation method can be classified as physical or chemical; often a combination of both is used.

SUMMARY

Electrically-conductive epoxies have become ever more sophisticated as performance requirements become more stringent and demanding. Various driving forces are leading microelectronics companies and researchers to rely on silver filled epoxy, which provides significant advantage in overall physical and electrical properties. Choosing the right conductive epoxy is paramount in achieving successful outcomes. Engineers and scientists should work closely with conductive epoxy formulators and designers like ALFA INTERNATIONAL to custom design the right conductive epoxy for the right application. ALFA's **E10-101** two-part silver filled epoxy has 20 years outstanding performance. It meets RoHS standards and passes NASA outgassing testing. **E10-101** is currently in use for applications in medical, space and electronics industries.