Epoxy adhesive films and preforms for electronics manufacturing

Electronics manufacturers are constantly looking for ways to improve product quality, speed time to market, and reduce production costs. To optimize manufacturing, engineers carefully consider the three major aspects of production: technology, processes, and materials. More and more, manufacturers are turning to innovative adhesives as a means to achieve multiple technical goals. Continuous advances in polymer chemistry and delivery mechanisms offer manufacturers a rich set of options to choose from — and the ability to optimize production processes to achieve economic benefits.

Adhesives play an important role in electronics manufacturing. They are commonly used for substrate, component, die, and heat sink attach, as well as lid sealing, and other applications in the packaging and assembly of electronics. Although liquid and paste adhesives are well suited for the majority of electronics applications, they may be challenging to use in certain cases. When large surfaces are to be joined, for example, a uniform bond line is very difficult to achieve with a liquid adhesive. Fixturing, or applying contact pressure to the parts to be joined, is often required to ensure the liquid or paste adhesive remains aligned when heat cured. Additionally, squeeze out may pose a problem when joining parts that are located near a channel through which a liquid must flow, since excess adhesive may block or restrict the flow. For such applications, epoxy adhesive films offer a viable solution.

Film adhesives offer alternatives to liquid adhesives
Adhesive films consist of solid epoxy adhesives that are typically sold as small sheets of film which can be cut to the appropriate size by the user prior to application. These films have a slight natural tack and are usually supported by a fiberglass mesh or other reinforcement material placed on a release liner. There are two major types of epoxy adhesive films: premixed frozen adhesive films and B-staged adhesive films.

Premixed frozen adhesive films are manufactured by precisely measuring and mixing epoxy resin and hardener, then freezing the mixture in sheet form. Premixed frozen films are shipped in dry ice, must be stored at -40°C (-40°F), and because they are fragile, must be reinforced. They have a limited working life once thawed, cure at slightly elevated temperatures, and offer a wide range of properties.

B-staged adhesive films are solid epoxy adhesives that have been partially cured by the formulator (see B-Staging Epoxy Adhesives). Typically sold in sheet form, B-staged adhesives can also be die cut or laser cut by the adhesive manufacturer into custom shapes, known as preforms, according to precise specifications provided by the user. B-staged adhesive films and preforms are designed to be fully cured after application. They cure to a fully crosslinked structure in one hour or less at a minimum cure temperature of 250-300°F. Once cured, the properties of B-staged

epoxy adhesive films and preforms are comparable to those of liquid adhesives. Characterized by high bond strength, these solid adhesives adhere well to both similar and dissimilar substrates and provide excellent resistance to chemicals and moisture. B-staged adhesive films and preforms offer storage stability at ambient temperatures, and longer storage life with refrigeration.

Adhesive manufacturers typically offer several grades of epoxy films and preforms optimized to meet specific performance objectives. Through the use of various fillers, these solid adhesives can be engineered to be thermally conductive and electrically isolating, thermally and electrically conductive, or thermally and electrically isolating. Some grades are reinforced with a fiberglass mesh or similar material to provide mechanical support. Formulations can be varied to achieve other desired performance requirements, such as increased flexibility, enhanced chemical resistance, and higher temperature resistance, along with increased tackiness for handling purposes.

B-Staging epoxy adhesives

Many epoxy adhesive films and preforms are based on a process known as B-staging. B-staging is an innovative packaging technique in which an epoxy system is partially cured to form a solid, which can be deposited and cured to completion at a later time. This is very different from typical epoxy system processing, in which the epoxy is deposited as a liquid or paste and cured to completion in a single step.

In B-staging, the resin and hardener are blended, a heat cure is initiated, but the reaction is arrested by quenching (cooling) while the adhesive is still fusible and soluble. Typically, the material is less than 10% cured and crosslinking — the formation of bonds between polymer links — has not yet occurred. Having been “staged” for processing at a later time, B-staged materials are packaged by the formulator into one of several different forms. Some B-staged materials are made into films or cut to precision preforms. Others are poured while hot into cans or molds, after which they solidify and are sold in cans or as cookies. Depending on the material, these B-staged epoxy systems can be used for bonding, encapsulation, potting, or coating.

An added benefit of B-staged adhesives is that they can be deposited at one time or location and undergo final cure at a later time — allowing for increased efficiency in the manufacturing process. B-staged adhesives can even be applied at one facility and shipped to another facility for final assembly and cure.

Film adhesives offer unique process advantages

Epoxy adhesive films and preforms offer several advantages over liquid and paste adhesives. They are exceptionally easy to handle and require no solvents for dilution or cleaning, making cleanup as simple as discarding inert carriers. They require no metering or mixing — eliminating mix ratio tolerance concerns and ensuring product consistency from lot to lot. Depending upon the application, adhesive films are available in tacky formulations which eliminate the need for fixturing. Squeeze out is minimal for films and preforms, so there is very little waste after application and minimal risk of interfering with nearby channels or contaminating sensitive components.

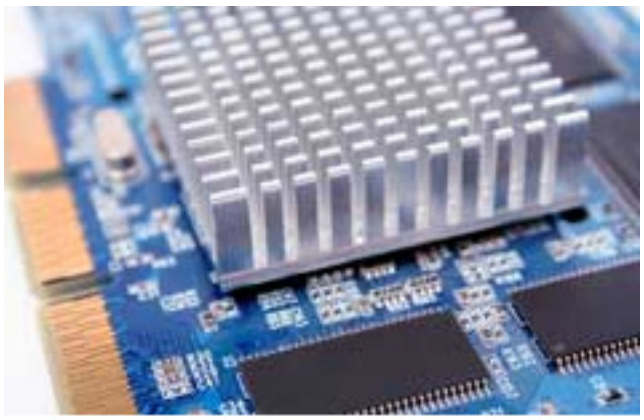
A key advantage of adhesive films and preforms is their bond line uniformity. Because they can be applied uniformly to substrates with minimal waste, they are ideal for joining parts with intricate shapes and for other applications that require exceptionally precise bond lines. They are also well-suited for adhering large surface areas in addition to smaller parts. Equally important is their ability to remain in place after application — an enormous advantage over liquid adhesives, which can sag or slump after dispensing and even during cure, causing them to move beyond the application area. This combination of bond line uniformity and precision control of the application process is the main reason users choose epoxy adhesive films over liquids or pastes.

Epoxy preforms are designed to fit intricate parts.

Using adhesive films instead of liquid adhesives may result in process cost reductions, depending on the specific manufacturing scenario. Savings may result from reduced labor associated with metering, mixing, and maintaining clean equipment, and from increased manufacturing yields attributable to the improved consistency of solid adhesives. Additionally, adhesive films sold in sheet form can be compatible with specialized manufacturing processes, leading to even greater efficiencies.

The unique properties of B-staged adhesive films present additional opportunities to increase manufacturing process efficiencies. Partially-cured adhesives can be applied in one manufacturing process stage and cured to completion during a later stage — even at an entirely different facility. B-staged films can be applied to a part by the part manufacturer, sold as a single unit to an electronics manufacturer, and then bonded to the target adherend and cured during the assembly process.

With the right equipment, B-staged adhesive films can be custom cut to meet exacting size and shape requirements. Integrated computer-aided design (CAD) systems enable adhesive formulators to create custom preforms designed to precisely match intricate parts, using specifications provided by the manufacturer. By using custom preforms, manufacturers can greatly simplify the assembly process, reduce labor costs, and improve yields — at the expense of additional upfront costs for the custom adhesive.

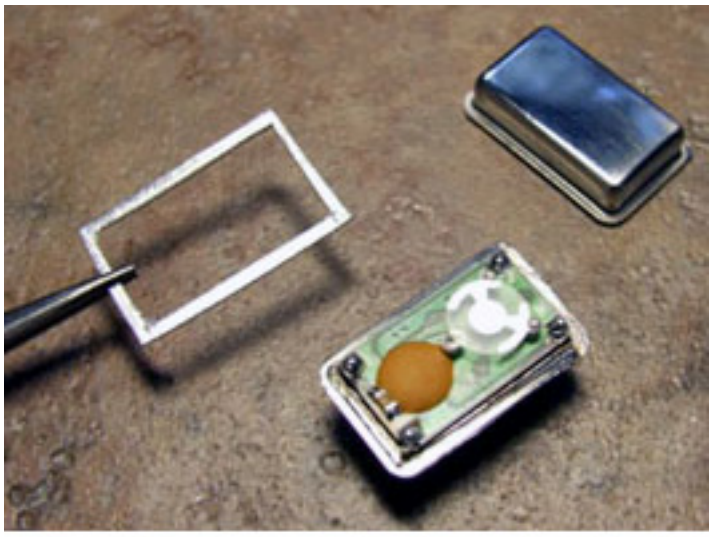


Thermally conductive epoxy films simplify heat sink attachment.

Precision placement and bond lines enhance product quality

Epoxy adhesive films and preforms are often preferred over conventional liquid adhesives for a variety of applications in the electronics industry. Heat sinks, which are used to conduct heat away from components in electronic and optoelectronic devices, are attached to components over a relatively large surface area. Using a thermally conductive epoxy adhesive film cut to the size of the heat sink ensures good adhesion between the dissimilar substrates, a uniform bond line with minimal gaps, and efficient heat dissipation. Thermally conductive adhesive films are also used for many other applications requiring good heat transfer capabilities.

Applications that call for precise bond lines with minimal squeeze out are best served by solid epoxy adhesives. Electrically conductive epoxy preforms are often used to seal lids to electronic component packages. In fact, some lids are supplied with a B-staged adhesive pre-attached. Epoxy adhesive preforms are ideal for bonding connectors and other electronic assemblies, since the adhesive will not bleed into and block socket holes or other channels. Adhesive films are used to attach substrates into microelectronic package housing and for applications involving sensors and other sensitive electronic components.



Epoxy adhesive films are ideal for lid sealing applications.

Adhesive films can also be used for

structural bonding and for applications requiring stress absorption. Electrically conductive adhesive films can be used for applications that require good electrical conductivity.

High-performance films simplify complex assembly processes

Easy-to-handle epoxy adhesive films and preforms offer uniform bond lines and superior consistency along with excellent performance characteristics. They simplify the assembly process for applications requiring minimal squeeze out or precise bond lines, making them the preferred choice over conventional liquid adhesives for many complex electronic assembly applications. Continuous advances in adhesive formulations and delivery mechanisms promise to give manufacturers many more choices and capabilities in the future.

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