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The Glue that Binds

Thoughts on pressure-sensitive and thermosetting adhesives.

QUESTION: I AM designing a flex that requires several FR-4 stiffeners. What is the best adhesive to use to bond the stiffeners to the flex circuit?

Answer: Assuming that you are referring to a Type 1, 2 or 3 circuit and not a Type 4 (rigid-flex), there are basically two commonly used adhesive systems used to bond stiffeners. The first type is a thermosetting adhesive film, and the other is a pressure-sensitive adhesive film. Both are widely used and have their advantages and disadvantages.

Thermosetting adhesive. This film comes in modified acrylic- and epoxy-based. Both systems have very similar properties and process in the same way. Thermosetting adhesives are supplied to the PCB manufacturer as a thin, dry film. These same adhesives are used to bond coverlays to outer circuit layers and also to bond circuit layers together. The films are tacked to FR-4 material using low heat and pressure prior to drilling and machining the stiffeners. Care must be taken during the tacking step to ensure the temperature is high enough for the adhesive film to stick to FR-4, but not so hot that it causes the adhesive to partially or fully cure. Once the stiffeners have adhesive applied and are drilled and machined to shape, they must be positioned precisely on the circuit and then tacked in place. This secondary tacking operation can be done with heat and pressure

(again making sure the temp is not so high as to advance the cure), or it can be done by wetting the adhesive with a solvent like acetone to make it tacky. If the latter method is used, a low temperature baking step is usually required to ensure all the solvent has been driven out of the adhesive. Once the stiffeners are tacked in place, the circuits are placed in a press or autoclave and laminated with heat and pressure. During this lamination step, the temperature needs to be high enough to fully cure the adhesive.

Pressure-sensitive adhesive film (PSA). As the name implies, this adhesive system only requires pressure in order to bond. There are a *lot* of different types of pressure-sensitive adhesives available and in use today for bonding stiffeners to flex circuits. These adhesives come on a roll with a release liner on one side. As with thermosetting film, PSA is generally applied to FR-4 prior to drilling and machining the stiffeners to shape. Once the stiffeners are ready to install on the flex circuit, the release liner is removed and the stiffener is placed in position. At this point, the stiffener can be bonded with just finger pressure. If a more complete bond is desired, the stiffeners can be tacked in a press at low heat.

Which is best? Thermosetting adhesive systems always bond better than PSA. That is not to say that PSA-bonded stiffeners will not provide a satisfactory bond for many applications.

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FIGURE 1. A stiffener bonded with thermosetting adhesive, which provides uniform lamination and few, if any, voids.



FIGURE 2. A stiffener bonded with pressure-sensitive adhesive. This adhesive is very effective, but will result in a few voids after lamination. These are mainly cosmetic and are not indicative of a poor or incomplete bond.

A stiffener bonded with a thermal setting adhesive generally cannot be removed without causing significant damage to the circuit. A PSA stiffener, on the other hand, can usually be removed without damaging the circuit if care is used. Stiffeners bonded with thermosetting adhesive require significantly more processing steps and time, which of course will add cost to the circuit. Both these adhesive systems are widely used, and the main differentiating factor in my experience seems to be circuit class. Typically, Class 3 (high-reliability) circuits require thermosetting adhesive, while Class 2 (commercial) lean heavily toward PSA due to the lower cost and more-than-adequate performance in virtually all applications. In the vast majority of applications, either would probably work just fine. Stiffeners laminated with thermosetting adhesive usually look

a little "prettier" after lamination because there are few, if any, voids in the adhesive. A typical stiffener bonded with pressure-sensitive adhesive will almost always have a few bubbles visible through the FR-4. IPC-6013 states mechanical stiffeners only provide rigidizing support to the circuit, and void-free lamination is not required. Since every flex

circuit application is different, evaluate circuit class, performance and cost constraints to determine which system is best-suited for your needs. As always, don't hesitate to contact your friendly neighborhood flexible circuit manufacturer for guidance if you still have questions on the best solution for your application. **PCD&F**

PCB Market Forecast for 8% CAGR Through 2017

The global printed circuit board industry is forecast to grow 8.1% compounded annually from 2012 to 2017. Regionally, Asia Pacific will lead the pack during that period, says Research and Markets.

Growth is expected to be driven by expanding demand for high-end products from consumers in India and China.

Several PCB manufacturing companies are moving to the APAC region to leverage the lower cost of production as this region has much lower labor costs than Europe and North America.

"The industry is under tremendous pressure to produce products having features of more compatibility and higher performance. PCB manufacturers are therefore challenged to design their products accordingly," the firm said. "Another challenge is the appreciation of the Chinese currency and the rising price of copper. Combination of factors such as global economic recession and fluctuation in the price of raw materials are affecting the industry."



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