Can Tomorrow's A&D Designs Handle the Heat?

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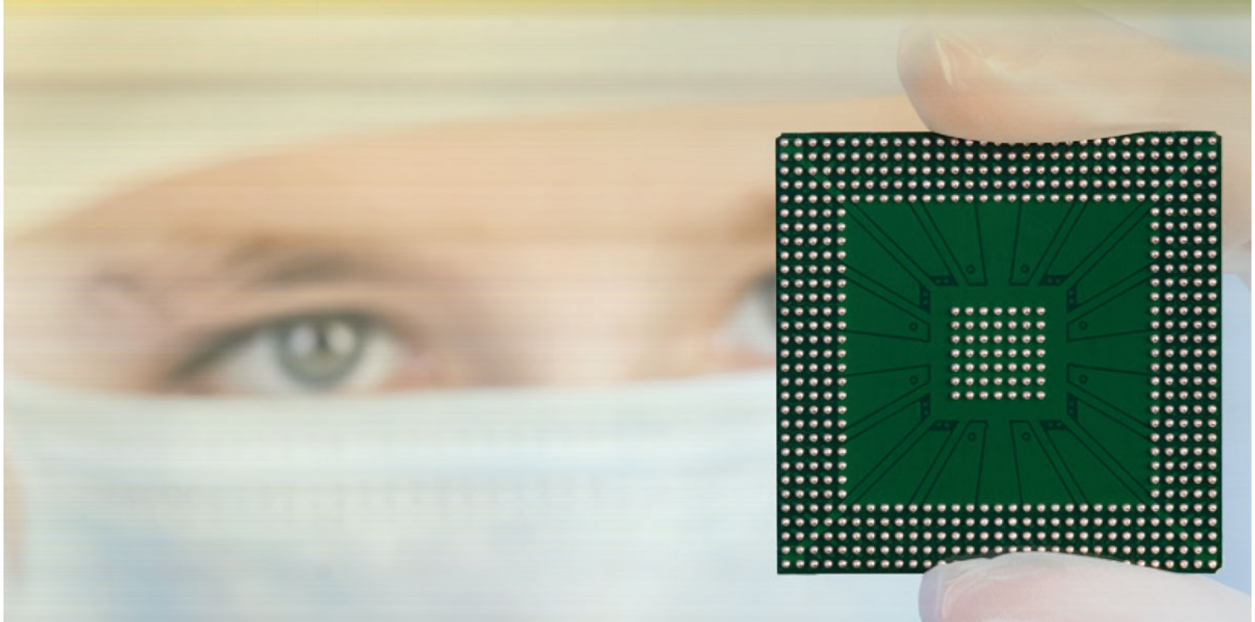

What **Fine-Pitch BGAs** Mean for **Fabrication**

Time and Frequency Domain

Making Flex Stiffer

Vapor Degreasing

I NEED A STIFFER FLEX CIRCUIT. WHAT DO I DO?

Published: 20 March 2020
by Mark Finstad

Material choices are often based on the planned assembly.

Many different materials are used to rigidize flexible circuits. Likewise, the reasons for stiffening an area on a flex board are many. The "best" stiffener material is tied to exactly why you are stiffening your flex circuit.

Rigidized SMT or through-hole component areas. Providing a rigid, stable surface for mounting components is probably the most common reason for stiffening an area on a flexible circuit. If components are mounted on a flex, which is then bent in that area, there is a very good chance the solder joints or solder pads will be damaged. The industry standard is to rigidize any area on a flex that has soldered components. If components are all SMT, install the stiffener on the side opposite the components. If through-hole components or connectors are used, mount the stiffener on the same side as the components. If components are on both sides, rigid-flex construction is probably needed, but that is a topic for a future column. By far the most common (and least expensive) stiffener material is epoxy-glass laminate (FR-4). This inexpensive sheet material comes in a range of thicknesses and is machined to size and shape by the flex circuit manufacturer. The machined stiffeners are then applied with either a pressure-sensitive or thermosetting adhesive (see below). Another material for stiffening a component area is 0.003" to 0.005" polyimide film. This material is common and cost-effective, since these stiffeners can often be added in panel form. This option is typically specified when overall thickness is a concern. The material is a bit more expensive than FR-4 but offers significant time savings during stiffener mounting. This material will not provide the same level of stiffness as a thicker FR-4 stiffener, so operators must exercise care in handing and forming during installation.

ZIF (zero-insertion force) connector applications. ZIF connectors are an easy, reliable and inexpensive termination option. But these connectors have very specific thickness requirements for the flex to ensure it will seat securely in the connector. The typical thickness requirement for the insertion zone of the flex is ~0.011" to 0.013". Since most single- and double-sided flex circuits fall short of the ZIF thickness requirements (especially since the top cover is removed over the fingers), a stiffener is added to increase the thickness of the area inserted into the ZIF connector. ZIF stiffeners are usually less than 0.005" in thickness, so polyimide is the preferred material choice for these applications. Virtually all thickness options of polyimide film are supplied to the fabricator with pre-clad thermosetting adhesive, making it the typical bonding adhesive choice.

Heat sink stiffeners. It is more and more common to see high-power LEDs mounted on flex. Due to the heat generated by the LEDs during operation, it is sometimes necessary to provide a heat sink stiffener. Aluminum is the most common heat sink material due to its low thermal resistance and relatively low cost. Aluminum stiffeners are typically punched out of sheets, then bonded with either pressure-sensitive or thermosetting adhesive. Stainless steel is occasionally used as a heat sink material but is typically more expensive than aluminum.

Mechanical rigidity of specific non-component area. Mechanical stiffeners are often necessary for a variety of reasons, including:

- To provide abrasion protection.
- To force a natural bend into a specific area.
- To add mounting holes that can accept screws or other hardware.

The material type used for these applications is driven by which of the aforementioned items is desired. Usually FR-4 is the first choice to evaluate due to its low cost and ease of installation. It can be machined to virtually any size and shape, and can also be drilled and tapped to accept hardware such as screws, small bolts, and press-fit hardware. Polyimide stiffeners are widely used for abrasion protection, and to force a bend into a specific area. Its thinness makes polyimide film typically a poor choice to use in conjunction with screws and other metallic mounting hardware.

FIGURE 1. **Aluminum stiffeners can be a great way to both stiffen the flex and dissipate heat from LEDs.**

While stiffeners could technically be bonded with virtually any type of adhesive, only three are used regularly: thermosetting epoxy film, thermosetting acrylic film, and pressure-sensitive adhesive. Thermosetting epoxy and acrylic are virtually identical in most respects regarding processing and finished properties. Both types require high-pressure and high-temperature lamination for adhesion and curing. This results in a superior bond between the flex and any mechanical stiffener added, but is also more expensive due to the added lamination step. Pressure-sensitive adhesive (PSA), as the name implies, only requires some pressure between the flex and stiffener in order to bond. A *lot* of PSA options are available; it is imperative to choose one that will bond well to both the flex and stiffener material. Most PSAs are applied by hand and require only finger pressure to create an acceptable bond. A very quick low-temp “kiss” press operation can reduce some of the bubbles and provide increased bond strength.

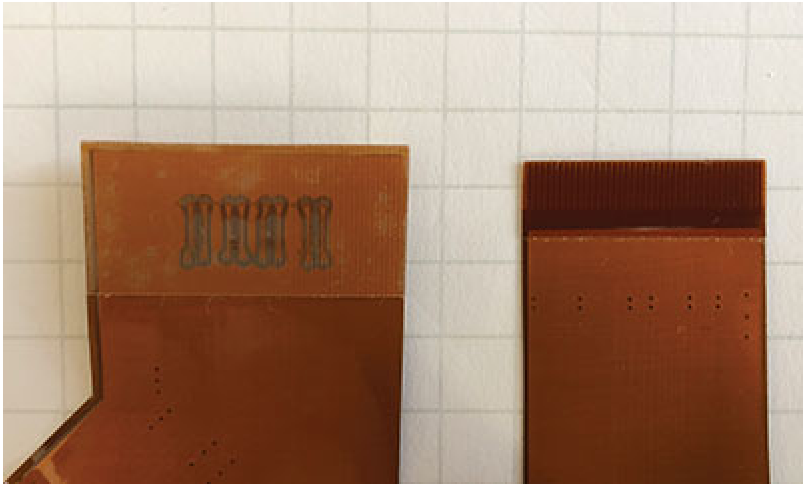

FIGURE 2. **FR-4 (left) and polyimide (right) make up the lion's share of stiffener used today.**

This brings up another important point. Per IPC-6013, stiffeners are for mechanical support only, and void-free lamination is *not* required. Bubbles and small voids are almost always evident with PSA-bonded stiffeners, and bubbles are also common to a lesser degree with thermoset adhesive bonded stiffeners.

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