Flexible Circuit, Rigid Flex and Printed Circuit Boards

Design Tips for Flexible Circuits 01.11

Material choices for your flexible circuits

Material Choices: Advantages & Disadvantages

When a flex circuit is decided on as a solution for your product or application that is not where the decisions end. There are many reasons to consider the materials used for your flexible circuits. Some of those reasons include cost, impedance controlled signals, flexibility, overall thickness requirements, component assembly and many more.

It's not always clear when materials should be considered, but we'll try to identify some of the scenarios and help clarify some of the choices and the reasons for those choices.

Most commonly used Materials

The two most common materials used in today's flexible circuit industry are polyester and polyimide. We will keep this discussion general as it is intended to support the reader as a guideline and not as a technical investigation. Polyester is considered to be the most economical and is used extensively for cables because of that. Polyimide is typically used in applications that require components to be soldered to the flex circuit because it can handle the higher temperatures much better than polyester can. There are processes that allow component attachment to polyester circuits, but they are typically conductive adhesives that are used typically in the membrane switch industry. Polyimide, however, allows any shape, size and component arrangement you can imagine. All components can be soldered to polyimide circuits using industry standard techniques/process.

Polyester vs. Polyimide

Description	Column1	Material 1	Column2	Material 2
		Polyester		**Polyimide**
Cost		Typically less expensive		Higher cost
Temperature		-45 C - 100 C		-55 C - 200 C
Component Attachment		Conductive Adhesives & Inks		Typically used solder methods
Typical uses		Membrane Switches, Dynamic Cables, Static Cables		Any circuit shape and configuration for all industries

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Cost

Cost is a common reason to consider flex circuit materials. If the product will be built in high volumes then cost certainly will be a high priority. Also, if the product will be used in cost sensitive industries such as automotive or consumer products cost will be a high priority.

For any products where cost is a priority the best decision is to use the most widely used materials to take advantage of economies of scale. In the flex circuit industry the most widely used materials are 1.0 mil thick polyimide with 1 oz copper. The copper material is typically bonded to the polyimide with 1.0 mil thick adhesive. This material is by far the most widely used and therefore the least expensive and easiest to procure for typical flexible circuits. Most flex circuit fabricators stock this material in the highest numbers which results in no lead time concerns. Also it is available in single and double sided constructions. The two most common constructions used for flexible circuits.

Impedance Control

For impedance controlled designs the materials 'must be' considered as they play an integral part of the formula for impedance. The dielectric constant for polyimide materials may be considered constant for all intents and purposes. The thickness of the polyimide, however, coupled with signal trace width allow many options to unveil themselves. Once the value of the impedance is set and the type of requirement either single ended or differential for example, the next step is to choose a combination of dielectric thickness and trace width that allow for the proper value. The choices made at this point can have a big impact on cost and availability of materials. If materials that are not standard are necessary or chosen, the lead time will undoubtedly be affected as well as a higher cost for the lesser used material.

It's a good idea to consult with your fabrication partner at this point to either design around material they already stock or design for the lower cost solution. A few minutes spent with your supply partner at this stage of the product development will be well worth it in the long run.

Flexibility

This section is sure to cause some head scratching. First of all there are two common types of flexibility to consider. The first is dynamic flexibility - a circuit that is in motion and one time flexibility or so called flex to fit. The common opinion is that the thinner the materials, the more flexible the circuit. It makes sense on the surface, but sometimes the cost difference doesn't surpass the gain in flexibility. For instance if you have a design with few signal traces and more copper etched away than remains the flexibility will be determined by the polyimide itself. And in this case the thicker albeit more standard materials may be the better choice as the flexibility gained by going to thinner material is negligible, but the cost may be much higher. Another example may be a dynamic flex circuit that you would want "as flexible as possible". A dynamic flex may actually be more robust with the thicker 1 oz copper than going to ½ oz copper materials.

With all of the possible scenarios that exist for this discussion it is another good opportunity to solicit suggestions from your supply partner. Those few minutes on the phone discussing the application and possible solutions will be time well spent.

Thickness Requirements

Sometimes the application simply requires the thinnest circuit available. Sometimes the application requires a specific thickness for the circuit as it doubles as a spacer or for some other reasons. When faced with these or similar situations the material choices are reduced, but discussion is valuable. You may find that the specific thickness requirements will put you into a situation that increases typical price and lead-time, but generally, you'll want the best price and lead time. Your supply partner will be able to help you choose the best solutions for your application with the least amount of inconvenience in this situation. After all, the ultimate goal is to design the product for high quality and robustness and this can be done more easily when all of the options are spelled out clearly.

Component Assembly

When your flex circuit requires component assembly via traditional soldering methods, you'll most likely use polyimide material as discussed above. However if the circuit you've designed utilizes crimp on connectors or conductive adhesive attached LEDs , R's & C's for instance on Membrane Switches you'll most likely use polyester material. Both materials hold up well in common practices and the assembly methods decided upon generally dictate the material choice.

Ambient Application Temperature

As seen in the chart above any high temperature applications will require polyimide materials at worst. There are higher temp materials such as Teflon that can be used for the highest temperature applications, but in general polyimide will be the most widely used in practice.

Conclusions

So from the discussion above you can see that most decisions will fall generally into two categories, polyester and polyimide. After that the cost, design, flexibility, temperature and assembly requirements will all play a part in your material choices. It's not terribly complicated as you've seen so go ahead and design your circuits with confidence. Then consult your supply partner for the best and most economical material choices available for your new design.