Flexible Conductive Adhesives for Thin Film Solar Cells and Flexible (In-Mold) Electronic Wearables

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When it comes to electronics, characteristics like bendability, flexibility, foldability and wearability become increasingly important. To produce functioning devices with those characteristics it is necessary that all device parts are flexible or bendable. Usually, the electronic parts, especially those mounted on PCBs or flexible PCBs, are connected by soldering. But solder materials are very rigid and inflexible. In addition, soldering temperatures of 600° to 700°F (316° - 371°C) are an increasing challenge for heat-sensitive modern electronic devices. Therefore, soldering to create conductive connections between the separate electronic parts is not an option for modern flexible electronic devices.

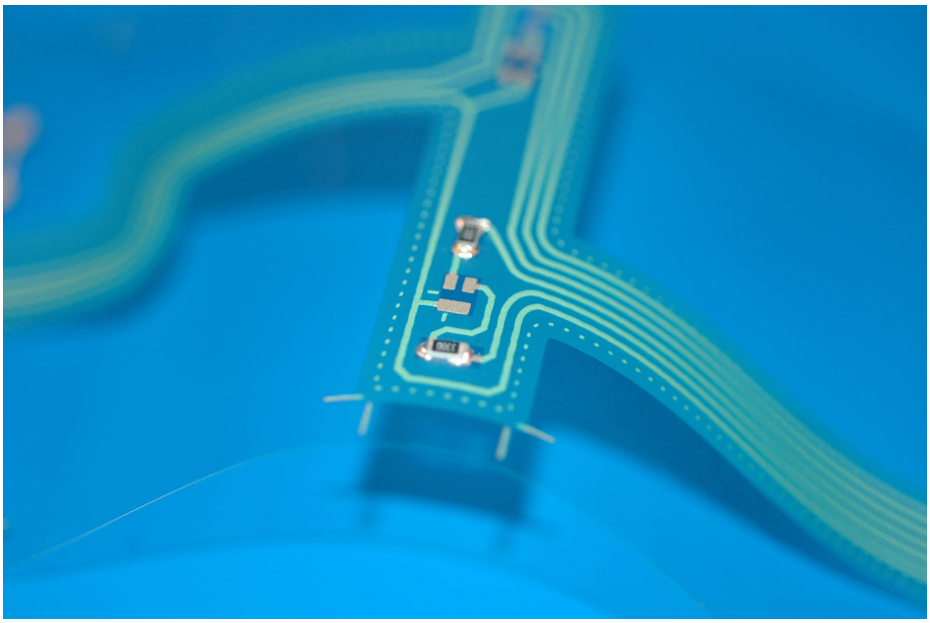


Fig. 1: Bonding and creating an electrical connection in one step: Small chips are fixed to flexible tracks with a conductive connection.

Conventional conductive adhesives were invented for this purpose, which already makes it possible to bond two electronic components on circuit boards without a major temperature stress. But these conventional adhesives must be applied on a hard surface, to create a high conductivity. For softer more flexible surfaces, like thin film solar cells, in-mold electronics or electronic wearables and flexible electronics in common, other ways of contacting need to be in place. For these applications a high flexibility of the whole device is often required. Epoxy-based flexible conductive adhesives are a smart alternative to bond and electrically connect components on flexible circuits in one single step. These new flexible conductive adhesives are as flexible as the materials

they are applied on, and cure at low temperatures. These conductive epoxy adhesives are the perfect solution to flexibly connect modern electronic applications.

The latest generation of electrically conductive adhesive systems are specially designed to meet the high requirements of the flexible electronic devices sector. These adhesives are particularly suitable for bonding with temperature-sensitive films or flexible PCB materials. They possess high peel strength and extreme vibration resistance. Flexible conductive adhesives allow component attachment with minimal temperature stress.

These features result from the high flexibility of the adhesive systems themselves. Even with a silver content of 80 % and more, these adhesives show a significantly higher strain compared to brittle conventional adhesives. As shown in Fig. 2, typical tensile test results indicate that flexible conductive adhesives (here in orange) are minimally stressed, when strain is applied. In comparison, the brittle conventional conductive adhesives (blue graph) become severely stressed as more strain is added. The new adhesives can withstand vibration and bending loads without breaking.

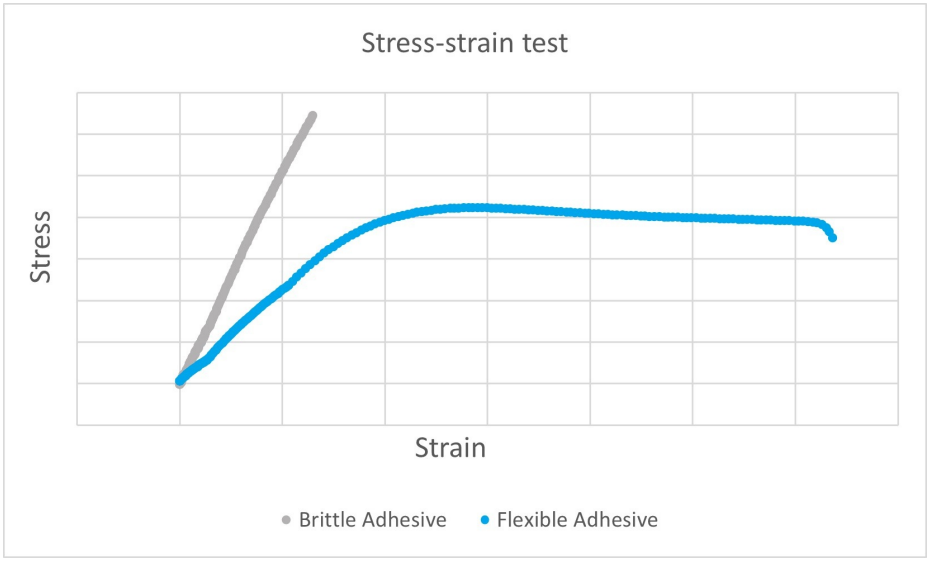
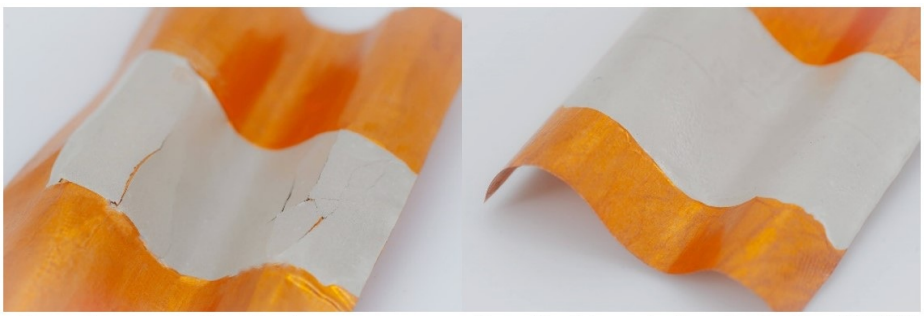


Fig 2.: Stress-strain diagram of brittle and flexible adhesive systems

The behavior of a traditional conductive adhesive and a flexible conductive adhesive film are shown on a bendable substrate in Fig. 3. The two different adhesives were applied on a thin bendable copper foil and subsequently bent in a manner that might be required in a real flexible electronic device. When the foils were bent, the conventional, more brittle adhesive shows clear signs of breakage. In comparison, the flexible adhesive adapts to the movement and shape of the copper foil and remains completely unimpaired.



Conventional conductive adhesive | Tested flexible conductive adhesive Elecolit® 3647

Fig 3.: Comparison of bent foils with brittle and flexible electrically conductive adhesives

Compared to other traditional conductive adhesives and solder, this new generation of flexible conductive adhesives provides additional important benefits. Flexible conductive adhesives show excellent adhesion to plastics, including polyimide, PC, PVC, ABS, and FR4 board. They can be applied in very thin layers and are lightweight. These flexible adhesives can be precisely dosed and applied quickly in high volumes for automated manufacturing, which makes them perfectly suitable for die attach applications and component assembly on flexible films and PCBs. A further advantage is the very easy handling and storage of these materials. These single-component adhesives can be dispensed, and cured within minutes at temperatures as low as 100°C. This makes it possible to bond semiconductors and create electrical connections at the same time. Furthermore, these flexible conductive adhesives only need to be cooled and not frozen during transport and are not classified as dangerous goods for transportation.