SMT OnLine

Choosing Carrier and Cover Tape for Tape-and-Reel

Tape-and-reel component packaging can determine the speed and operation effectiveness of pick-and-place feeders and equipment. Curtis Maynes, 3M Electronic Solutions Division, explains the types of carrier and cover tapes, how they affect pick-and-place operation, and what is available on the market for better feeder speed, higher accuracy with miniaturized components, and ESD protection.

Choosing carrier and cover tapes for tape-and-reel packaging is often an afterthought. Electronic component manufacturers may not view feeder packaging as adding value to their product. Carrier and cover tape are considered as pure cost, so the cheaper, the better. However, proper carrier and cover tape selection will minimize part migration, flipping and sticking during transportation, and mis-picks during the pick-and-place process, preventing product and productivity losses during SMT assembly. Carrier and cover tapes can also protect sensitive devices against damage due to electrostatic discharge (ESD). Putting some thought into choosing the right carrier and cover tapes can help manufacturers balance the need for product quality with the desire to control cost.

Industry standards offer guidelines for carrier and cover tape, but whether a product meets the minimum standards is only the beginning. With the various choices available on the market, manufacturers must consider many factors when choosing tapes that provide the right level of performance for the application without over-spending. Too little performance and you risk lowered product quality and unhappy customers when their production lines slow down, dealing with mis-picks or component damage. Too high performance and you may waste money on more than you need.

Choosing a Carrier Tape

Carrier tapes generally come in three standard materials: paper, embossed polystyrene plastic, and embossed polycarbonate plastic. Paper is the least expensive and offers basic component protection. Embossed polystyrene is more expensive but provides a superior level of component protection to paper. Polycarbonate offers the best protection as well as the highest price tag.

For small, passive components, such as chip resistors and capacitors, a paper carrier tape is common. These components are typically rugged and do not require a high level of protection from physical bumping during transport. The component fits into a rectangular hole punched out of the paper tape. An inexpensive rice paper tape is attached to one side of the paper tape and acts as a bottom for the cavities. Paper carriers work well for passive components up to approximately 0.9 mm in thickness. Beyond the 0.9 mm threshold, paper carrier tapes may be too thick and stiff, resulting in tough handling and errors when feeding into the SMT assembly equipment. In addition, paper carrier tapes are only capable of protecting sensitive devices from ESD when used in a moist environment.

Larger devices and those that require ESD protection are better served by a plastic carrier tape with embossed pockets. Plastic carrier tapes are constructed from a variety of polymers, but polystyrene and polycarbonate are the most common.

Polystyrene, the next level up from paper, can deliver a sufficient amount of protection and support at a cost-effective price for many components. A deeper, more rigid pocket than is possible with paper makes polystyrene carrier tape a good choice for some thicker components. Moreover, polystyrene carrier tapes are available in dissipative and conductive versions to protect ESD-sensitive parts.

While polystyrene is a good solution for a large number of component packing applications, it does have some drawbacks. Chief of these is its susceptibility to warping and bending. In particular, a phenomenon called camber is found in polystyrene carrier tapes. Camber occurs when the carrier tape curves in the X/Y plane, increasing the risk of rough feeding into SMT equipment and errors during the pick-and-place operation. Industry standards such as EIA-481 and IEC 60286-3 dictate a maximum allowable camber of 1 mm over a 250-mm section of tape. Polystyrene tapes can exhibit a higher degree of camber than tapes produced from engineered plastics.

Despite this dropback, polystyrene offers a suitable, cost-effective solution for larger parts. Because the pick-and-place operation moves more slowly for larger components, pocket placement accuracy isn't as critical as it is for smaller parts, and a little warping is less likely to cause an error.

For tiny, fragile components, polycarbonate carrier tape offers the highest level of protection and lowest risk of mis-pick. The smaller the component, the narrower the carrier tape, the more components per square inch held by the carrier tape, and the faster the carrier tape moves through the assembly equipment. Pocket shape and dimensional integrity of the tape become more important as part size is reduced. Polycarbonate tends to hold its shape better than other plastics, so it feeds more smoothly into board production equipment and the pockets line up better for the nozzle pick operation of pick-and-place. Polycarbonate carrier tapes are also made in dissipative and conductive versions to protect against ESD damage.

The smaller the device, the more important carrier tape dimensional tolerances become in ensuring proper feeding and pick-and-place. Standard dimensional tolerances for carrier tape pocket dimensions are 100 µm deviation from target. However, as component sizes drop, the dimensional tolerance of the pocket can become more important. Larger tolerances for a small component could lead to excessive part rotation or tilt within the pocket. Smaller, more complex components may require tighter tolerances down to the 50 µm level. Finally, new and emerging component packages such as 0603 leadless wafer level chip scale packaging (WLSCSP) may call out 30 µm tolerance for the pocket dimensions.

For 30-µm tolerances, high-precision polycarbonate carrier tape* is required. Unique tooling and precision processing technology enables form sizes as low as to 0603 (0201) for high-precision tapes. Tape pocket-hole-forming down to 0.20 mm will restrict movement and tilting to allow component placement into pocket cavities accurately during component insertion applications.

It is also wise to choose carrier tape suppliers that offer design and technical support. As components shrink, carrier tape design becomes more complex. Some carrier tape pockets (0402 outlines and below) are now so tiny they're almost impossible to distinguish with the naked eye. Smaller components cause smaller cavities and tighter pitch between pockets — dimensions that must be accurate to maintain accurate feeding during pick-and-place.

An animated computer model demonstrating how a component will fit within a pocket design enables fine tuning of the carrier tape for best performance. The level of technical service available near your factory should also be considered when choosing a supplier.

Choosing a Cover Tape

Choosing the right carrier tape for your device is only half the battle. Selecting the proper cover tape is also important to protect components, minimize product loss, and ensure a smooth ride through the

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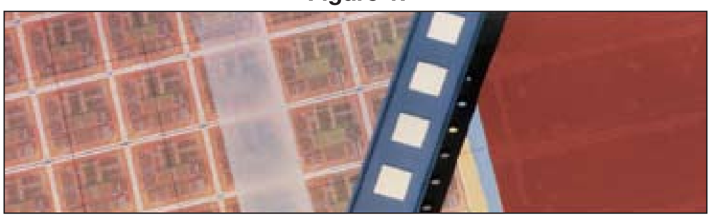
pick-and-place process.

Heat-activated adhesive (HAA) cover tapes are the most widely used in the electronic component industry. Historically, they have been the least expensive and most readily available cover tapes on the market and work well in many cases. In the taping process, a heated sealing shoe presses the tape onto the edges of the carrier tape on both sides of each device, sealing the cover tape to the carrier tape while leaving the component free from active adhesive. In the HAA taping process, time, heat, and pressure must be carefully controlled to achieve optimum adhesion.

Most component manufacturers are familiar with and comfortable using HAA cover tape. However, compared to some newer technologies, HAA tape may not be the optimal choice for certain applications. The HAA taping process is relatively slow. While that's not generally a problem for bigger components, smaller components and more devices per inch of carrier tape can markedly slow the production line. Moreover, HAA cover tape peel force is relatively inconsistent compared to more advanced cover tapes (Figure 1). The peel force's deep lows and high peaks can result in a relatively inconsistent de-taping force at the SMT assembly plant, potentially causing devices to pop out of their carrier tape pockets — known as trampolining — and

Figure 1.

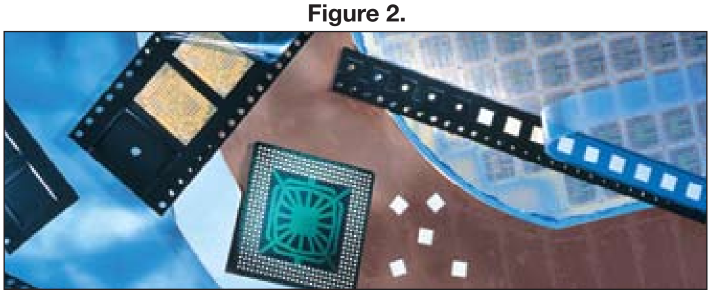


slowing down production. HAA cover tape's adhesive can also be affected by time, temperature, and humidity.

For smaller devices, a pressure-sensitive adhesive (PSA) cover tape may offer a better alternative to HAA tape. As the name implies, PSA tape adheres when pressure is applied; heat is not required to activate the

bond. PSA tapes are designed to provide a smoother peel force (Figure 2), minimizing trampolining and increasing production speed regularity. PSA adhesive are also less affected by time and weather conditions. Moreover, because heat is not required, PSA cuts down on energy costs at the component packing stage. The drawback to PSA tapes is that they leave a residue that can build up in SMT feed-

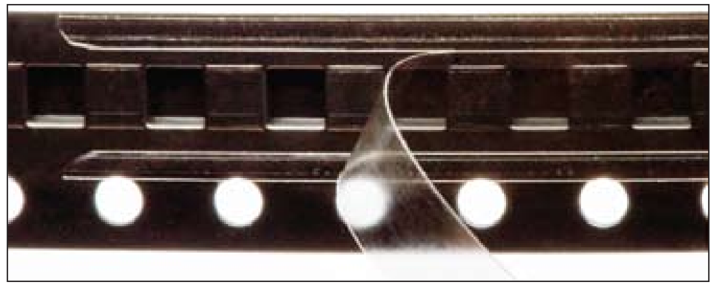
Figure 2.



ers over time. This can be mitigated through regular placement equipment cleaning and minor retrofits, which tape suppliers should be able to suggest.

Universal cover tape offers the smoothest peel force (Figure 3) of any available cover tape type. Like PSA tapes, universal tapes adhere to the edges of the carrier tape when pressure is applied. HAA and PSA cover tapes depend on adhesive to seal securely enough to keep components in place during transport, but also to release easily during production. This requires a delicate balance between bond strength and peel force, a "Goldilocks" dilemma where the porridge needs to be "just right." With universal tape, the adhesive never actually peels away from the carrier tape. Instead, the middle section is de-

Figure 3. Black and clear universal cover tapes



signed to effortlessly tear away from the carrier tape, leaving the outside edges of the bonded cover tape adhered to the carrier tape. This provides a highly consistent peel force, minimizing trampolining, slowed component feeding, and other issues.

The universal cover tape can be used with almost any carrier tape on the market: paper, polystyrene, or polycarbonate. Because of its flexibility in terms of applications, component manufacturers using universal cover tape do not have to stock multiple carrier tapes, trimming inventory and expenses. UCT also eliminates errors or defective packaging when un-matched cover and carrier tapes are used for an application. When compatibility issues occur (i.e. the cover tape is not sticking properly to the carrier tape), manufacturers are often stuck with two companies pointing the finger at one another. Universal tapes work with almost any carrier tape, and the adhesion/removal of the tape is controlled almost purely by the cover tape. The universal tape is available in non-conductive and static-dissipative versions as well.

Conclusion

In choosing carrier and cover tapes for tape-and-reel packaging, electronic component manufacturers must balance performance with cost-effectiveness. In selecting a carrier tape, manufacturers must weight the benefits and drawbacks of paper, polystyrene, and polycarbonate products for the component size and sensitivities that must be accommodated.

Cover tapes are available with heat- and pressure-activated adhesives. A third alternative, universal cover tape, works well in a variety of applications with virtually any carrier tape.

Finally, manufacturers should weigh design capability, global reach, and technical service support when choosing a carrier and cover tape supplier. Technical support should be available to tape purchasers as well as end users in SMT assembly.

* 3M Ultra Precision Carrier (UPC) Tape.
** 3M Universal Cover Tape (UCT).

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