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Reactive Hot-Melt Adhesives for Electronic Applications

Design is all about tradeoffs. The designer has to balance everything from cost and cosmetics to performance and durability and come up with an end result that can survive and thrive in today's competitive markets. Virtually every aspect of the finished product can be critical to its success, making the design process a high-stakes game of multidimensional chess. And the critical factors aren't just those inherent in the end product itself; they also include aspects of manufacturability: the materials and processes used to turn the design into an attractive, durable, functional, affordable physical product you can take to market.

As devices become ever more complex, the connections that join a handful of components into finished products can have a huge impact on the speed, cost, and efficiency of their manufacturing processes as well as the quality and performance of the end products. The ways in which those connections are made are a key aspect of the product's design, and today more and more of those connections are made using adhesives.

The Right Adhesive for the Job

A walk down the adhesives aisle of any hardware store suggests just how complex the choices can be. There are general purpose adhesives as well as specific products for wood, plastic, metal, paper, and fabric. The adhesives for plastic alone can be very resin-specific and take up yards of shelf space. There are one-part and two-part products and ones that reach working strength in seconds, minutes, or hours. They can be applied from tubes, cans, syringes, or guns, and these are just the products available to consumers. Manufacturers have many more choices, and those choices, played out over tens or hundreds of thousands of uses, are more critical to the cost and quality of the end result than anything a consumer is likely to use.

Performance Properties

As today's electronics get smaller and denser they rely less on yesterday's screws and bolts and more on high-tech industrial adhesives. And the performance of those adhesives is measured in many dimensions. Take for example the glass touchscreen of a cellphone. The touchscreen itself is, by design, resilient enough to handle the rough-and-tumble of carrying, handling, and occasional mishandling to which it will be subjected. The connection of the screen to the body of the phone has to be just as tough. Bond strength varies from adhesive to adhesive, but an individual adhesive's bond strength varies depending on the substrates to which it is bonding. Since many bonds are between unlike materials it is important to know how well the adhesive works with both. You may not need to use the adhesive with the highest bond strength for your materials, but it is important to know that the bond will be sufficient for your needs.

"Wet out," the degree to which an adhesive flows and covers a surface to maximize the contact area and the adhesion to the bonding surface, is a primary determinant of the strength of its bonds. Technically, effective wet out occurs when the surface energy of the adhesive

is as low or lower than the surface energy of the substrate. This is why an adhesive's bond strength varies depending on the substrate. For example, the bond strength of a particular adhesive, measured in MPa (MegaPascals or million newtons per square meter), may be over twice as high with polycarbonate as with glass.

Finally there are all the same characteristics you would look for in a plastic resin. While devices like mobile phones do tend to have a relatively short product life, you will want an adhesive with the durability to last the life of the device. It will have to stand up to extremes of temperature, not just the heat of a summer day, but the extreme heat of a car left out in the sun on a summer day. The same is true for the extreme cold of a night out in the car in mid-winter, the UV exposure of a day at the beach, or the humidity of a muggy day in July. And while few electronic devices are likely to get dipped in gasoline or acetone, they may well be exposed to any number of chemicals — perfume, suntan lotion, sweat, and more — both individually or in combination. And then there are the cycles, hot and cold, humid and dry, that can wear down the resistance of a poorly chosen adhesive.

Process Properties

The characteristics of an adhesive can have a tremendous impact on the efficiency of a manufacturing operation. The more "coddling" an adhesive requires, the higher your labor costs. And while the ideal adhesive should allow enough time for necessary handling, any avoidable wait time for setup and cure will significantly reduce the throughput of your entire operation.

- As screens get larger and move closer to the edges of the device face, the adhesive used to adhere the screen to the phone body will have to be laid down in a thinner, more precise line. This will affect aspects of the adhesive itself such as viscosity along with the type of application equipment used.
- Some materials are heated for application. Others can be destabilized by heat. Some, hybrid materials must be heated but can also be destabilized by too much heat. It is critical to understand the nature of the material and how it is applied to achieve good adhesion through proper heating without overheating and reducing the "pot life" of the material.
- Open time, the time after adhesive application during which parts can be put together and positioned while still being able to achieve full bond strength, helps determine the efficiency of your assembly operation. Achievable bond strength can drop sharply after rated open time has elapsed.
- Wet out of the adhesive helps determine its appropriateness for the assembly. As described earlier, the adhesive's ability to bond to the substrates being used is important, but the amount of pressure that can be applied to a component like a touchscreen — low in this case — requires better wet out than would be required if more pressure could be applied.
- Green strength, the immediate grip of an adhesive after application, determines how an assembly can be handled to keep the assembly process moving. In the case of electronic devices superior green strength is desirable.
- Clamp time can be the biggest bottleneck in this kind of electronic assembly. Typically it can take hours, tying up space and equipment. A faster curing adhesive with a shorter clamp time would free up those resources and significantly improve throughput.
- Finally, can you rely on the provider to support your application and help troubleshoot any issues that may arise. Nobody knows you application better than you do, but there are times when you'll need adhesive expertise to ensure that you are getting the performance you need.

Reactive Hot Melt

Most consumers are familiar with hot melt glue guns. They don't provide the strongest of bonds, but they do provide a quick clean bond and are easy to use. They're also probably familiar with the one-part, moisture activated glues that take longer to cure but provide the superior strength usually alluded to in their product names. Reactive hot melt adhesives are hybrids that combine the best of both adhesive types in a single product. Essentially, they combine the characteristics of a thermoplastic, which softens with heat and re-solidifies when cooled, and a thermoset, which cures to form a creep-resistant, cross-linked matrix that not only does not soften with heat but can withstand heat better than most thermoplastics. Traditionally they have been complicated to use and messy to apply. This need no longer be the case.

Reactive hot melts are heated for application, allow a short open time as they cool, deliver good immediate green strength, and then are clamped to allow the cure that gives them their superior bond strength. Specialized equipment for application can help provide clean, accurate application, eliminate stringing and mess, and provide the necessary heat for application without overheating the adhesive reservoir and potentially destabilizing the material. Final cure to full bond strength usually takes place after clamping is removed. Clearly these are the ideal adhesives for electronic assembly. The challenge lies in fine tuning your selection to best meet your requirements.

H.B. Fuller EH9641 Reactive Hot Melt Adhesive

- 100 percent solid
- Dispenses like a hot melt, cures to form a strong cross-linked network
- Low application temperature (110-125°C)
- Optimum adhesion to glass, aluminum, stainless steel, engineered plastic, and more
- Open time of 2.5 minutes
- High green strength allows immediate handling
- Hardness, Shore D: 35
- Elongation at break (%): 850
- Lap shear strength at 24 hours, PC-PC: 8.27 MPa

A Checklist for Reactive Hot Melts

In evaluating RHMs for your application, consider the following:

- ☐ Ensure that the product is right for your substrates. The supplier should be able to provide data on bond strength with various materials.
- ☐ Consider the environmental requirements of your application. Will the device have to withstand heat and/or cold? Will it be exposed to moisture or chemicals?
- ☐ How is the adhesive applied? Can you get a thin enough line for both the performance and the cosmetics you need?
- ☐ Can heating of the adhesive be controlled to allow effective application without reducing pot life of the material?
- ☐ Will the adhesive wet out sufficiently under the pressure you can safely apply to components like a touchscreen?
- ☐ Will the adhesive give you sufficient open time for assembly of intricate geometries while still providing the bond strength you need?
- ☐ Will it give you sufficient green strength to keep your assembly operation moving after the parts have been assembled?
- ☐ How short a clamp time can you plan on and still have adequate cure?