What you need to know before selecting high tech adhesives

Choosing the best adhesive for a specific application can be complex. There are many variables to be considered and numerous types of chemistries with different capabilities. An understanding of the following parameters will help to narrow the choices. Selecting the correct adhesive will reduce the number of products to be evaluated and increase the likelihood of success.

1. Substrates: Knowing the materials to be bonded is very important. Certain adhesives may adhere better to ceramic or glass. "Metal" and "Plastic" are generic terms which encompass many different types of materials so knowing the exact substrate is essential for determining the correct adhesive. For example, ABS and Teflon are both plastics but Teflon requires an acid etch to achieve a bond where ABS can usually be bonded with just an alcohol cleaning.

2. Cleanliness of the parts: Most adhesives require that the substrates be prepared properly. Whether it's just a simple cleaning, or the ability to do more complex operations (such as abrasion, chemical etch or plasma treatment) will all come to play in selecting an adhesive.

3. Viscosity: The viscosity must be considered. Low viscosity (thin) products are best for thin bonds or for applications requiring wicking. Thixotropic materials (won't run) are best for use in vertical applications.

4. Thermal cure vs UV cure: UV cure adhesives are usually one part and can be cured quickly. They must be exposed to UV light to cure so at least one of the substrates must allow transmission of UV. Thermal cure materials can be cured at room temperature and/or with heat. Heat cured, thermal adhesives can require high temperatures which might be detrimental to components but, in general, they will cure faster with higher properties.

5. **Working life:** Determine how much work life is desired. Remember that working life (time before the material gels) is generally related to cure time. For thermal cure materials, the longer the working life usually means a longer cure time (at room temperature). Single part UV cured materials can be cured quickly and the working life doesn't apply.

6. **Configuration:** The dimensions of the parts and how they fit together are very important to determining the best material. Larger parts and thicker bond gaps may require a slower cure to reduce shrinkage. Certain adhesives are designed to work best with thinner gaps.

7. **Required Performance:** Some factors that should be understood before selecting an adhesive:

   - Does the adhesive need to form a structural bond?
     Ideally, a structural bonding material will create a finished part that is as strong as the substrates. As stated earlier, knowledge of the composition of the substrates helps to decide the best adhesive and preparation to accomplish an ultimate bond. Also, understanding the configuration of the parts to be bonded will determine the types of adhesives for use. With most adhesives the larger the surface area of the mated parts the stronger the bond.

     The bond gap is also critical. Various adhesive chemistries work best with certain gaps. In general, cyanoacrylates and anaerobics need the thinnest bond line where epoxies and urethanes are better with thicker gaps. Every chemistry can vary dependent upon how they were formulated but these are general rules.

   - How much mechanical stress will be on the bond during use?
     This may seem obvious but the forces on the adhesive joint and the direction of those forces have a major impact on the adhesive to be used. Some chemistries may have excellent tensile strength (strength in a horizontal direction) and very little shear strength (strength in a vertical direction). Other considerations would be if there are any compressive forces or torsion on the joint. Adhesives may be formulated to be more flexible or with fillers to compensate for these stresses.

- Will any stresses be consistent or intermittent?
  Some adhesives can take extreme stresses for very short periods but not withstand the stress over longer periods. Others may hold up to long consistent stress as long as it is not brought on suddenly.

  Other types of stress may also be of concern. For example, autoclaving is a standard practice in many industries. Many adhesives cannot withstand autoclaving. It is important to consider all stresses when selecting adhesives.

- What are the temperature requirements during processing and use?
  This can be an extremely important parameter. Materials with low temperature cures may not withstand high temperatures during use. Adhesives designed for high temperature uses might only cure with heat so the adhesive will have to be exposed to dry heat (an oven or a heat element).

  The exposure temperatures during use are critical. Also consider if the parts with be temperature cycled. Many materials that will withstand high temperatures will crack when cycled to low temperatures and low temperature materials might lose their strength at high temperatures.

- What optical properties (if any) are important?
  Optical properties may be important for certain applications. If light transmission is important, we must know the wavelength being transmitted and the duration. You may also want to consider the refractive index are the substrates. Certain chemistries will not remain clear over long exposure to UV radiation.

- Does the cosmetic appearance matter?
  Some adhesive chemistries can be easily colored but others cannot. Some chemistries will have lot to lot variations so the final appearance can change. In applications requiring specific colors (especially for consumer products) it may be necessary to ensure that lots can be color matched.

These are some of the more important issues although for any specific applications there can be other considerations before selecting the right candidate. It is not often feasible to know all the required parameters before choosing but it is important to have as much information as possible to make an educated decision.

8. Considerations for application

When evaluating adhesives and potting materials, it also important not only to make sure it works on a performance level but also on a production level. How will material be applied? It is a common occurrence that engineers or project managers approve a product that works perfectly for the application only to find out later that processing it on the production floor is either inefficient and wasteful or just not possible. Considering dispensing, mixing, applying concepts early can save a lot of time and money down the line and avoid production or launch delays.

Mix Ratio:

One of the biggest issues facing production lines while using 2 part polymer systems are the mix ratios. Mix ratios vary from product to product and unfortunately not as simple as 1:1 by weight and volume. Some mix ratios are also less critical allowing for higher degrees of tolerance. Alternatively, slight changes in a mix can result in changes in the physical characteristics of the product. For instance, polyamide based epoxy systems are very forgiving in mix ratios. If the product calls for a 100:80 mix ratio by weight and the actually mix ratio is off by even 10%, the finished polymer and the characteristics are not drastically different nor should it affect its performance. A tin catalyzed silicone is very vulnerable to changes in mix ratio. A 10% increase in catalyst can accelerate the polymerization process and decrease work life not allowing operators enough time to pot or encapsulate the part leading to waste material.

Amine and imidazole cured epoxies, (as well as many urethane systems) with an incorrect ratio, will result in a finished adhesive with diminished properties. If a ratio specific material is the best choice, ensure that manufacturing processes are set up accordingly to produce the best and consistent results.

While uneven mix ratios should not deter one from choosing a product, many prefer even ratios to reduce risk of mistakes. There are several options for high efficiency application of adhesive systems. Many products that have even volumetric mix ratios (1:1. 2:1, 4:1) are also available in dual barrel cartridges. These types of cartridges come different sizes and are convenient because there is no risk of weighing and/or mixing mistakes. These dual barrel cartridges can be dispensed via applicator guns which can operated either manually (like a caulking gun) or pneumatically for higher efficiency.

Conclusion:

While evaluating and ultimately choosing an adhesive or encapsulating compound can be an exhausting effort, it can be made easier by considering some of the elements discussed in this article. The more information you have on the application helps to tremendously eliminate a majority of options and makes it easier in filtering the variety of products available.

Contacting the experts is also a major step in choosing the right product. Adhesive suppliers tend to have a vast amount of knowledge to know only their products but where they are used. At Epoxyset, we encourage you to speak with our technical team to assist in choosing the best adhesive for your application.

Ultimately, evaluating adhesives comes down to choosing one (or a few) and testing them in your application before deciding. **There is no substitute for sampling and evaluating a product.** Testing often reveals previously unconsidered parameters.

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GRAPHICS:

Substrates - Understanding the substrate to be bonded is essential in choosing the appropriate adhesive and proper surface treatment

Packaging – Many materials can be supplied with various packaging options for ease of use and manufacturing convenience. Cartridge packaging may also eliminate errors in mix ratio.

Thermal – Thermal cured materials may be room temperature or heat cured. Heat cured systems can be cured faster and result in better properties but high temperatures may damage components.

Delicate – Delicate components require choosing an adhesive that will yield high performance as well as prevent stress.