

Overcoming the Challenges of Bonding Composite Materials

Composites are two or more materials with very different physical or chemical properties combined in such a way to give properties superior to those of the constituent elements. Many types of plastics can be reinforced often with fibres and this combination can produce some of the strongest materials for their weight that technology has ever developed...and the most versatile.

Composite materials provide a host of benefits such as:

- Lightweight
- High strength
- Corrosion resistant
- High strength-to-weight ratio
- High impact strength
- Thermal & electrical insulator
- Radar transparent
- Non-magnetic
- Low maintenance
- Long-term durability
- Dimensional stability



It is for these benefits and its versatility that composites are so widely used enabling the manufacture of remarkable products with exceptional capabilities. Used in industries from automotive, aerospace, defence, electronics and construction to wind energy, sports and consumer goods and the marine industry; the composites materials market has seen unprecedented growth. Between 2015 and 2016, the sector's value grew from 78 billion dollars to 82 billion dollars and is forecasted growth of 5% a year to reach a value of 103 billion dollars by 2021 (Ref. JEC Group Global Composites Market Report Mar 2017)

Plastics and structural composites allow for greater design freedom and can improve a product's aesthetics and environmental resistance as well as increase its strength-to-weight ratio and often result in lower manufacturing costs. They are increasingly being used to make components particularly where light weighting is targeted to help reduce emissions such as in the automotive and aerospace industries. However, the bonding difficulties associated with these materials can cause a real headache for manufacturers.

Traditional mechanical fasteners have the disadvantage of adding weight, and lighter composite materials will often incur damage when subjected to welding or through-part fastening techniques and can often be excessive in terms of the bonding strength actually required; so engineers have been turning to adhesives and tapes to join these substrates together.

Technological advances mean that adhesives and tapes are able to meet the same strength requirements as traditional rivets or mechanical attachments, while offering many advantages such as providing a reliable seal, preventing galvanic corrosion between dissimilar metals and offering an aesthetically pleasing appearance without costly finishing work.

The difficulty is with such a range of properties in the composite itself and the other substrates to be bonded - how do you choose the right adhesive?

One of the first things to consider is what materials are in the composite and choose an adhesive that will bond both. From there the joint type, joint function, in-service conditions and the manufacturing process must all be considered.

By defining a few key performance or manufacturing requirements, this will quickly deselect most potential adhesive types.

- Bond line thickness or gap filling ability?
- Maximum or minimum continuous temperature performance?
- Mechanical performance required e.g. shear strength, extension?
- Required open time before cure?
- Cure speed?
- Tolerant of contaminated surfaces?
- Required form of adhesive e.g. film, paste, liquid, one part?
- Special property required e.g. electrical, thermal, optical?
- Specific approval required e.g. fire rating, Mil spec., FDA, medical?
- Acceptable for site health & safety policies?
- Maximum allowed cost?

Cyanoacrylates, Epoxy Adhesives, Polyurethane Adhesives, Structural Acrylic Adhesives and UV Cure Adhesives all bond well to composites. The following reviews a few of the various adhesive types.

Methacrylates

Also known as toughened acrylics are probably the best known adhesive for bonding composites. Both surface activated structural acrylic adhesives and 1:1 mix structural acrylic adhesives are used in composite bonding as they provide very high strength bonds with high peel strength and are fast curing. Some also have gap filling properties. Techsil offer the Penloc® GTi range from Panacol and the Plexus™ range from ITW.

Epoxy Adhesives

Epoxy adhesives can be used to join most materials. Epoxies have good strength, do not produce volatiles during curing and have low shrinkage. However, they can have low peel strength and flexibility and are brittle. Epoxy adhesives are available in one and two-part forms and produce extremely strong durable bonds with most materials. Modified epoxy adhesives are formulated to provide flexibility and provide shock absorbing properties between the composite pieces that have been bonded.

Polyurethane Adhesives

They provide strong impact resistant joints and have better low temperature strength than any other adhesive. Polyurethanes are useful for bonding glass fibre reinforced plastics (GRP). The fast cure usually necessitates applying the adhesives by machine. They are often used with primers

Cyanoacrylates

Cyanoacrylate adhesives cure through reaction with moisture held on the surface to be bonded. They need close fitting joints and usually solidify in seconds. Cyanoacrylate adhesives are ideal for creating strong bonds very quickly in applications that don't require high impact or peel resistance – can also be used in place of clamps or jigs to hold the assembly in place while a longer curing two part adhesive is bonding composites.

UV-Cure Adhesives

UV curable adhesives are used to bond composite to clear glass or plastic and are also used to coat composites.

Silicones

Silicones are not very strong adhesives but are known for their flexibility and high temperature resistance. They are available in one or two part forms. The latter function like two part epoxies, the former like single part polyurethanes.

Tapes

All forms are based on a backing material, such as cellulose, polyester or PVC, which has been coated with a pressure sensitive adhesive a tacky, semi-solid polymer, either acrylic, polyurethane or rubber. In many cases, double coated thin or foam tapes can be used for no mess, instant bonding with excellent aesthetic results.

Hybrid Adhesives

An exciting recent development is the formulation of LOCTITE®'s range of unique hybrid structural adhesives which combine the qualities of different adhesives to achieve bond strength, speed and durability providing improved performance on a variety of substrates (including composites) and the versatility to solve many more design and assembly challenges.



Selection of an adhesive for a particular application may at first appear daunting but it need not be. As a distributor of adhesives and tapes Techsil can advise on and supply a wide range of engineering adhesives, sealants and tapes that are compatible with many composites.

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