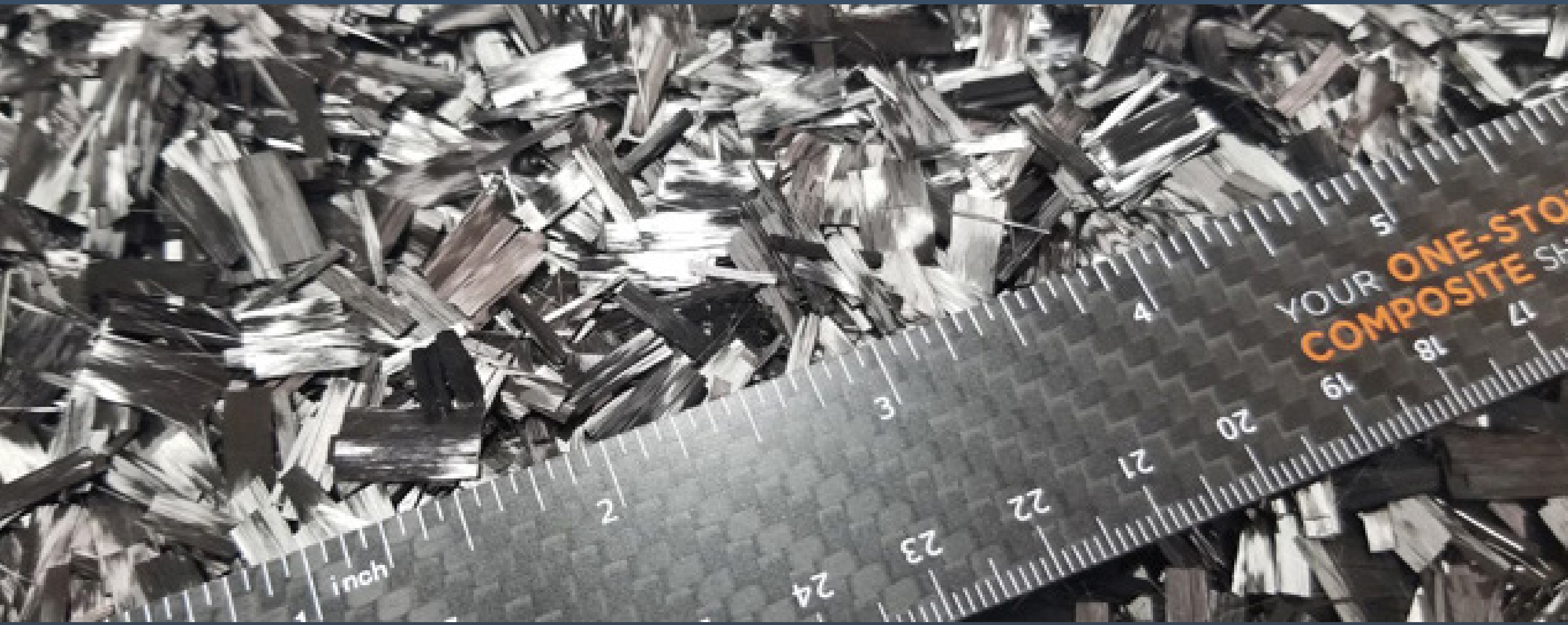
COMPOSITE ENVISIONS KNOWLEDGE HUB
PRACTICAL AND INSIGHTFUL COMPOSITES INFORMATION



RESIN ADDITIVES

COMPOSITE ENVISIONS

INTRODUCTION

Resins are a unique tool for the composite industry in how they bring other materials together, the glue of composites. Which makes the additives that go into them that much more interesting, because the resins additives that go into the resins solve an endless number of problems in the world today. Additives are commonly used to modify resin systems for thickening purposes and enhancing mechanical, thermal, or even electrical properties. Some additives change the mechanical properties of a resin enhancing its ability to suit tasks such as secondary bonding, vertical application, gap filling, blister repair, fileting, fairing, or injecting. Many of these additives work by manipulating the viscosity of a general laminating resin while some add ranging degrees of reinforcement to the resin for structural application. Basically, like using the additive properties as a composite within the resin itself as short reinforcement. Additive characteristics can be engineered to provide better overall parts dependent on the need.

In most composite applications, viscosity of a resin is manipulated or determined by the ratio of resin to a particular filler placed into a mixture. Less filler and more epoxy will yield a lower “runnier” viscosity product. However, as additional filler is added, the epoxy will become thicker, such as seen by certain thixotropic pastes. All of this is dependent on the additive and the resin used. The importance of mixing these additives is not necessarily a perfect ratio mixture but to achieve a particular viscosity or thickness for a needed job or application. Many products available are simply predetermined mixtures of various types of additives marketed for a specific job. However, it can be much cheaper and more feasible to make some of these products rather than buy them outright.

To make things simple, there are a few various viscosities that can achieved to complete a task at hand. Getting the proper consistency, thickness, or viscosity for a job will make it much easier to apply and achieve optimal bonding performance to various substrates. To make thigs easier to reference, well use comparable product consistencies to describe the viscosity.

Ranch Dressing to Honey Consistency: Achieved in buying a thicker resin or by minimal amount of additive such as Fumed Silica or Microbeads. This consistency achieves an easier rolling ability with application to laminating or to small fill holes.

Ketchup Consistency: Slightly thicker for use in bonding flat, horizontal, or like (close) mating surfaces together. Also used in application to fill holes and great for when needing to inject into specific locations using a syringe.

Plaster Consistency: Much thicker in application for bonding to vertical surfaces, like that of a thixotropic resin. This consistency is best utilized for repairs to composite surfaces along vertical walls where a thinner consistency would simply run out. This is also an option for bonding where a minimal surface gap is evident and for bonding various hardware into place and works well with gap filling

Peanut Butter Consistency: With more thickener added, this consistency will hold to vertical surfaces and is widely used for a filling and fairing compound. This consistency is also highly regarded in its ability to achieve bonds to uneven mating surfaces and works well with gap filling.

While many of the selectable additives available may achieve a desired viscosity when mixed with a resin, certain types of additives and even mixtures of multiple additives can be used for optimal performance. The performance of these additives is determined by their size and molecular makeup. From microns, nanometers, millimeters, and beyond, the end uses are fillers or additives are nearly endless.

FILLERS

Fumed Silica (aka Cabosil) is an extremely versatile thickening agent / additive for epoxy resin systems. Because of its highly hydrophilic nature and easily dissolving, it is used in products worldwide ranging from composites, paints, water and even the food industry. Fumed Silica is finer than dust, a nanometer scale size material. Silica's low density material packs in high strength while providing quick thickening properties. Fumed Silica is a small particulate substance and may be harmful if inhaled. It is strongly advised to wear a mask when working with this material or to have adequate exhaust ventilation.

Advantages: Extremely versatile in use, can be used as single additive or with other material mixtures as a thickening agent at all above consistencies. Very quick filling agent with great thixotropic properties at the right consistencies.

Disadvantage: As an additive, it may make sanding more difficult. Best used as a thickening agent along with other additive mixtures.

Glass / Plastic Microspheres are widely mixed with epoxy to provide light faring compounds. These microspheres are hollow with small air voids, making it an ideal light weight filler and fairing additive. This additive is larger in size compared to that of Fumed Silica but does not thicken to the same extent as Fumed Silica.

Advantages: Easy sanding ability & lightweight, ideal for fairing

Disadvantage: When used alone with epoxy, material does not cling well to vertical surfaces.

For vertical surface fairing, mix Microspheres with Resin at ~1:1, add a small amount fumed silica to thicken mixture until it will hold onto vertical surface. (Think plaster consistency) This method will still provide an easy surface to sand.

RESIN REINFORCEMENT

Carbon Fiber Nanotubes used as a resin additive are relatively new to composites considering other products. Carbon nanotubes are very small, known best for being one of the strongest materials known to man being the cylindrical version of graphene. When mixed in light volumes with epoxy (4-6% by volume), it can create reinforced resins great for castings and surface coats. The long thin carbon tubes make for a good surface coat additive because the nanotubes transfer energy better to the reinforcement than resin alone. There is still much to be learned from this unique material's characteristics going into final use products.

Advantage: Surface abrasion, added durability to castings and surface coats, better energy transfer leading to tougher composite laminates

Disadvantage: Challenging to work with in traditional composite laminating

Glass Microfibers are made from the "left-overs" of producing fabrics or other various fiberglass materials. Instead of the scrap fiberglass being thrown away, it is finely chopped to various sizes for use as needed. Being left over does not make it use any less valuable, fiberglass microfibers offer stronger mechanical bonding than that of the resin alone, fumed silica, or microsphere additives. "Glass microfibers" are finely chopped to a micrometer sizing of ~2 micrometers in diameter, basically the smallest glass sizing that will offer any substantial strength as a resin additive. Glass microfibers great resin additives for general hole filling, surface repairs and for secondary bonding with well-prepared like mating surface bonds.

Advantages: Offers higher mechanical properties over products such as wood filler, Fumed Silica, or microspheres.

Disadvantages: More difficult to work with as consistency is comparable to a runny jelly, some experience helps with processing this material.

Milled Carbon Fiber (MCF) is produced similarly to that of glass microfibers and is between 80-100 micrometers in length. When used even in small mixtures (~5%) in resin it adds a substantial increase to a resin's mechanical properties. Because of CF's low thermal expansion there is an evident increase the thermal properties of a given resin. MCFs can also be engineered to manipulate a surface's electrical conductivities. It is used commonly in increasing various plastic properties, and in enhancing thermal properties of tools and molds. MCFs are also used in the same manner for general hole repairs, surface defects, and secondary bonding. Note: When mixed, the color of the resin will become a darker shade which may affect a desired surface finish.

Advantage: Additive results in better material properties than that of Glass Microfibers for stability, toughness, modulus, and strength. Can be used for additional enhancement of thermal & electrical properties in the resin.

Disadvantage: May be difficult to work with in higher mixt ratios, research proper mix ratios before use to ensure desired resin properties are reached for the task at hand.

CHOPPED MATERIALS

Chopped Fiberglass is much longer in length than milled down versions of resin reinforcement. This is one of the reasons why it offers a substantial increase in material properties when used as a resin additive. Offered in different lengths, usually ranging from [illegible]” to an inch, Chopped Fiberglass additive works to increase compressive and tensile strengths in resins. This application works great with filling larger holes and secondary bonding but is also used to add reinforcement in hard to laminate areas of a part. General Mix Ratio starts with ~1 part Chopped fiberglass to 15 parts resin, and not to forget, Fumed Silica may be added to mixtures to promote the handling features of the resin.

Advantage: Inexpensive solution offering high tensile and compressive strength to a vast number of composite applications. Will not change electrical conductivity properties as carbon products may. Various colors of the fiberglass may be used to match a needed surface.

Disadvantage: Its wet hairball consistency makes it a little different than anything else one may work with on a regular basis. It can be a challenge but give it a few batches one can become effective in its use. May lead to create an uneven surface finish so additional work may need to be done to achieve a desired surface finish. Chopped FG not as strong as chopped carbon fibers.

Chopped Carbon Fiber in length of 3-10 millimeters can add a substantial amount of strength for bonding with little to no implication to weight. When used as a resin additive, it can create an adhesive that has the absolute highest strength characteristics of other additive choices, even comparable to welding practices. These chopped carbon fibers compliment what carbon fiber is best for, adding strength and stiffness. When used as a resin additive, its just it is applied in more liquid form. It is relatively cheap as it can be mixed in small ratios so get the desired effect. Using this as a resin additive goes further in application than general composite laminating or bonding. Chopped Carbon Fiber’s stiffness promotes itself as a good choice in concrete repair and compression molding in thermoplastics. It will also serve as a great gap or cavity filler depending on application.

Advantage: Strongest additive available for resins, vast number of final use applications, very versatile

Disadvantage: Challenge to work with as it its consistency is when mixed with the small carbon fibers is comparable to a furball being mixed with water, only stickier. Like Chopped Fiberglass its surface finish may leave a little to be desired.

CHEMICALLY ENHANCED ADDITIVE POWDERS

There is a seemingly endless number of chemical powders that can be added to epoxy that enhance or specialize the resin to promote needed characteristics of a final product. Additive Powders go far beyond just changing the color of a given resin. Features of resin additives can determine whether a given resin is electrically conductive or insulating. There are powder additives that change the thermal conductivities of epoxies. These powders ultimately offer inexpensive ways to engineer epoxies to the likening of needed properties. Several different powders can be mixed with resins to promote desired characteristics. Many of the additives also promote UV resistance. This small list of additives below scratches the surface of some other available additives and their uses when mixed with resins.

Copper (Cu) Powder: Additive to enhance an epoxy resin's thermal conductivity properties. On a molecular level, Copper powder has a high surface area making it ideal for dissipating heat. This may lead to the resin's ability to withstand higher temperatures.

Aluminum Nitride (AlN) Powder: Additive promoting electrical insulative properties and thermal conductivity enhancements

Silver (Ag) Powder: Additive promoting electrical conductivity

Graphite Powder: Additive promoting electrical conductivity and UV resistance

Aluminum (Al) Powder: Additive enhancing damage / abrasion resistance and UV resistance preventing breakdown or failure of resins

Boron Nitride (BN) Powder: When added to epoxy it can make a low friction surface that is cheap and moldable, comparable to HDPE plastic or Teflon

BEST PRACTICES

- Always pre-mix the epoxy. Have it completely mixed BEFORE applying any additive
- Mix slowly the additive slowly using a small amount at first working toward needed properties. Add less additive at first, it is easy to add and mix extra, not as easy to take back out.
- Most of the additives are easier to sand than to reapply, always make sure there is more than enough resin and additive mixed going onto or into a part / repair surface.
- Use of chalking tube for certain applications may make life easier when using thicker mixtures. A cheaper or quicker option to achieve easy application is through use of a

plastic sandwich bag, placing the thickened epoxy into the bag, cutting a slit at one of the corners, and applying the resin to the needed surface comparable to that of applying cake icing.
- Create a more visual appealing joint surface by using specific radii to achieve desired fillet. Examples of use include semi rigid cards or popsicle sticks (etc.) to achieve a specific desired radius.

Composite Envisions LLC
8450 Development Court
Wausau, WI 54401 USA
+1 715-842-0101
info@compositeenvisions.com
https://compositeenvisions.com/

COMPOSITE ENVISIONS