Plastic And Composite Repair

Textbook

I-CAR®

Version: 13.2

PLA03-STMAN1-E

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Contents

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Introduction

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Obligations To The Customer And Liability

The collision repair industry has an obligation to correctly repair the customer's vehicle. Collision repairs must be performed using:

- recommended or tested procedures from vehicle makers, I-CAR, and other research and testing organizations.
- quality replacement parts and materials.
- repair processes and parts as written and agreed upon in the repair order. If items on the repair agreement are not consistent with the repair order, it can be considered fraud.

Performing proper collision repairs requires using parts and procedures that keep remaining warranties intact.

Collision repairs must restore:

- safety.
- structural integrity.
- durability.
- performance.
- fit.
- finish.

Throughout the damage analysis and repair process the repairer and insurer must:

- communicate with each other.
- maintain constant communication with the customer.
- be in agreement with each other and the customer on how repairs will be performed.
- inform the customer of any changes in the repair plan from the original repair agreement, and explain the changes and why they have to be made.

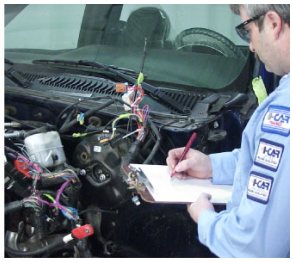
To reduce liability:

- make sure that all repairs are performed thoroughly, correctly and as listed in the damage report.
- follow proper procedures.
- have documentation of required repairs with detailed record keeping available for customers.

Technicians are considered the experts and are expected to be knowledgeable on how to perform a quality repair.

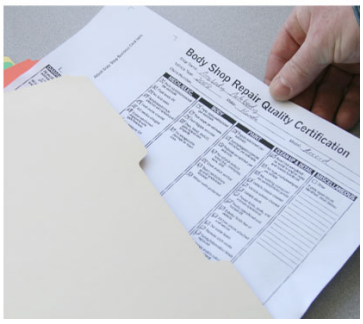
Liability insurance that covers the repair facility may not always cover all damages. For example:

- the policy may not cover faulty repairs, leaving liability responsibility completely on the facility.
- a shop owner may find that repair facility liability coverage may not cover the full amount awarded in a lawsuit. The shop owner would have to pay the difference.



It is difficult to reduce the risk of liability exposure. The part that the repairer can control is the chance of being found at fault. Chances can be minimized by:

- using recommended or tested procedures from the vehicle makers, I CAR, or other research and testing organizations.
- using quality replacement parts and materials that restore fit, finish, durability, and perform at least as well as the original.
- keeping thorough records.



Keeping thorough records includes more than recording the date, mileage, and pre-existing damage. Record keeping also includes:

- making sure all notes are legible.
- verifying the repairs that were made or not made.
- having the customer sign a waiver for repairs that they do not want performed. Repairers must determine their liability on not repairing safety systems such as restraint and anti-lock brake systems.
- keeping computer printouts or worksheets on file showing wheel alignment readings or vehicle dimensions before and after repairs.
- keeping scan tool printouts and records of computer codes for airbag, anti-lock brake, emission, and powertrain control module (PCM) systems.

- attaching the OEM or other tested procedure printout to the vehicle repair order.
- keeping receipts for all sublet work performed.

Refer to "Video: Topics Off Limits" in the presentation. This video identifies topics that should not be brought up in class.

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Module 1 - Plastic Identification And Repair Considerations

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Identifying Plastics

The learning objectives for this module include:

- identifying the type of plastic by its characteristics.
- determining the level of plastic identification that is required to perform the repair.
- identifying the different types of repair for plastics and fiber-reinforced plastic (FRP).

Refer to "Two-Sided Repair Part 1" in the presentation. This video shows how to perform the proper cleaning process for a two-sided repair.

Personal Safety

Hazards when working with plastics include:

- dust from sanding, cutting, or grinding.
- skin contact with cleaning solvents and plastic repair materials.
- vapors from cleaning solvents and plastic repair materials.
- static electricity. Plastic parts should be grounded before cleaning and refinishing and/or an antistatic cleaner should be used.

Personal Safety

The product-specific safety data sheet (SDS) identifies the personal safety equipment that is required during product use. Plastic repairs should be performed in a properly ventilated area. Safety equipment that should be used when repairing plastics includes:

- safety goggles or safety glasses.
- protective gloves.
- a dustless sanding system.
- proper respiratory protection.

Avoid skin contact with any type of adhesive.

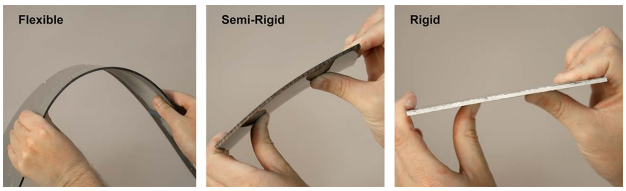
Always clean both sides of the part before beginning repairs.

Environmental Safety

Cleaners can contain VOCs and should be used and disposed of in accordance with all federal, state, and local regulations.

When prepping for a two-sided repair:

- always wash both sides with silicone-free soap and water to remove any water-soluble contaminants. This is a critical step and cannot be skipped or the result will be a poor repair.
- clean with the recommended cleaner or water-based cleaner. You must clean the repair area to remove any petroleum-based contaminants. This is the only time a solvent-based cleaner may be used, and only before abrading the repair area.

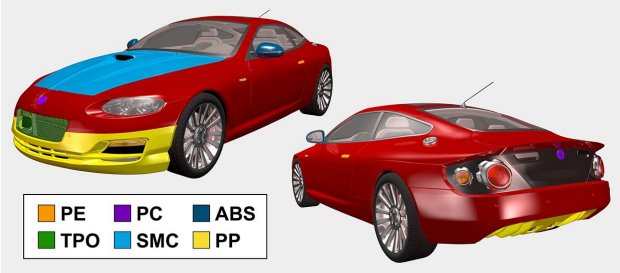


These are the three types of plastics.

Plastic parts can be:

- flexible, which are usually found on older vehicles but still has some limited use on new vehicles.
- semi-rigid. This is the most common plastic bumper cover type.
- rigid, which are usually used for hoods and fenders.

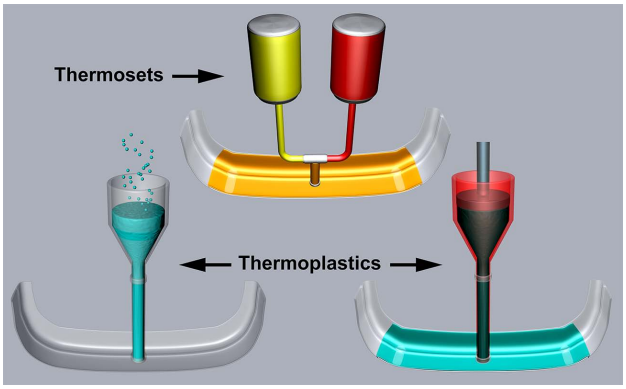
The adhesives, fillers, and repair method may rely on part flexibility.



Many different types of plastics and FRPs are used on today's vehicles.

Some common plastics include:

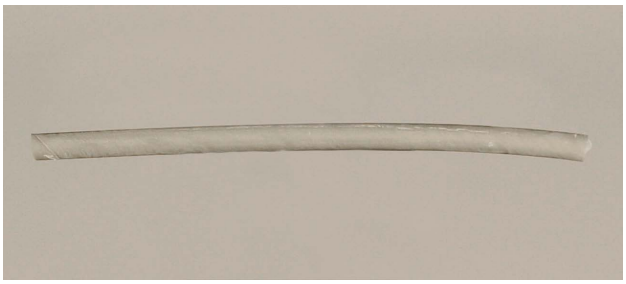
- polypropylene (PP), which is often used for bumper covers and is considered to be semirigid.
- thermoplastic polyolefin (TPO), which is also used for bumper covers and considered a semirigid part.
- acrylonitrile butadiene styrene (ABS), which is sometimes used for grilles and is a non-fiberreinforced rigid part.
- fiber-reinforced plastic (FRP), which are also called composites. Some examples of the different types of fiber-reinforced plastics are sheet-molded compound (SMC) and carbon fiber. FRP parts are usually considered a rigid part. These types of plastic have fiber strands that are inlaid into a plastic polymer to create the rigid part.



Thermoplastic and thermoset plastics are formed using two different methods.

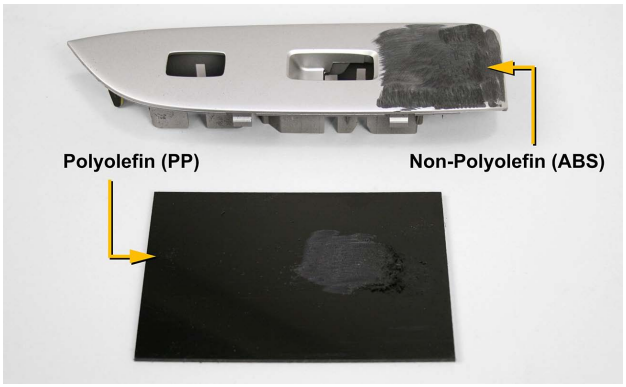
Plastics are generally classified as:

- thermoplastics, which are formed by injecting molten pellets into a mold. These are the most common types of plastic that can be melted and recycled. Both PP and TPO are thermoplastic.
- thermosets, which are formed by a two-part product, which takes on a permanent shape when formed. This type cannot be melted or recycled. An example of a thermoset plastic is polyurethane (PUR) bumper covers.



This RRIM cutaway has no visible fibers and is smooth on both sides.

Reinforced reaction injection molding (RRIM) can be repaired using plastic repair adhesives or by welding. An RRIM part is often made using PUR and is an exception for a thermoset in that it can be repaired using an adhesion weld. It contains microfibers that are so small it may be difficult to see them. RRIM is used for fascias, exterior trim, and body panels.

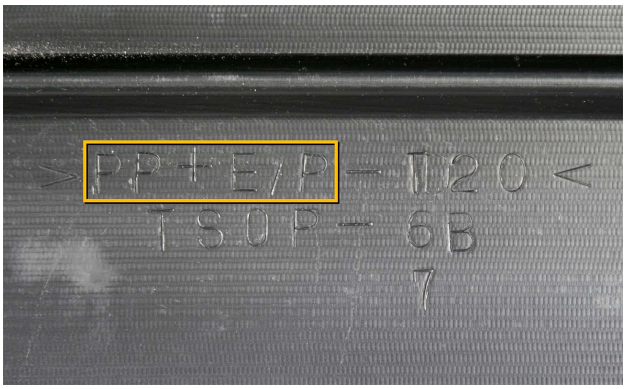


A polyolefin part smears when sanded, but a non-polyolefin will powder when sanded.

Plastics can be grouped into families of:

- non-polyolefins. These usually turn powdery with a dual action (DA) sander and typically do not require an adhesion promoter for repair adhesives or topcoats. However most product makers typically do not have a problem with adhesion promoter being applied on a nonpolyolefin if it cannot be identified.
- polyolefins. These usually smear or are greasy when ground at high speed with a grinder. Also, they typically require an adhesion promoter before any plastic repair adhesives or topcoats can be applied.

Some examples of a polyolefin plastic are PP and TPO. An example of a non-polyolefin plastic is ABS.

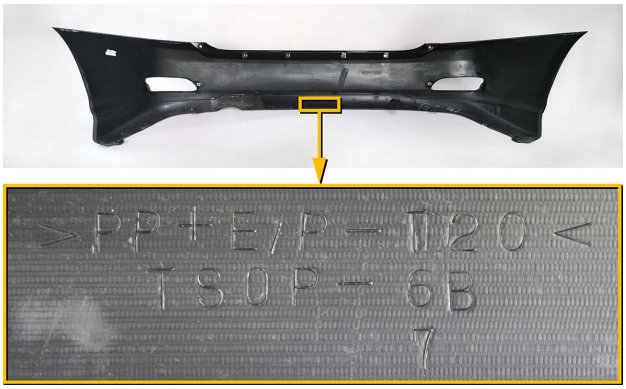


ISO codes are a standard letter code for the blend of plastic that the part is made of.

The International Organization for Standardization (ISO) code is a standard set of letter codes that identify the type and blends of plastic.

Due to the fact that ISO is an international organization, it was decided to use the "ISO" acronym. So no matter what language it was translated to, it would be the same acronym in every country.

The use of ISO codes is not consistent. They are not always on the plastic part. Different blends will have a combination code. For example, the codes PP, PE, and TPO may all be on the same part.



ISO codes are found on the backside of the part.

An ISO code, if placed on a plastic part, is molded into the backside in an unseen area. However, this may require that the part be removed in order to locate the code.

Repair Considerations

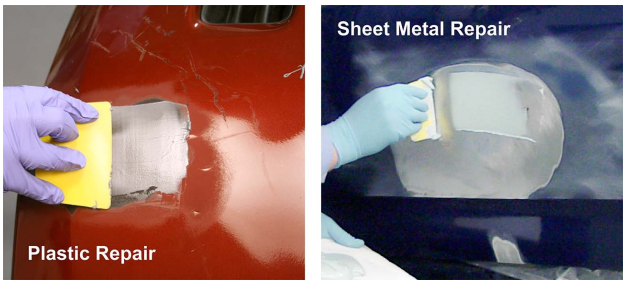
Sheet metal and plastic parts may be repaired using similar techniques.

Some of the similarities with sheet metal and plastic regarding repair prep and repairs include:

- proper cleaning. This is one of the most important steps of any repair process and should NEVER be skipped.
- appropriate sanding grits. If the sanding grit is too coarse, the scratches will be difficult to remove. Sandpaper grit that is

too fine may lead to adhesion problems.
- proper cure times must be observed. If cure times are not followed, it may lead to peeling and delaminating of the product.
- the need for featheredging. If there is not a good featheredge when sanding, it will lead to a bullseye that will show up in the finish.
- the need for a primer coat. You would not apply a basecoat over a bare metal part and this also applies to plastics.

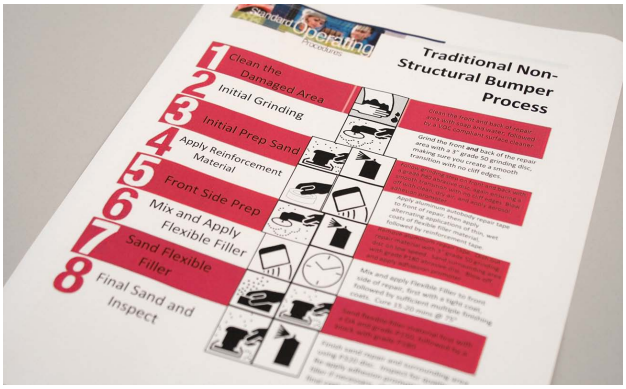
Regarding straightening, the “first in, last out” and “last in, first out” rules apply to plastics exactly like when repairing sheet metal.



Sheet metal and plastic parts use different repair materials. Plastic filler material (left) may require adhesion promoters while metal fillers (right) will not require adhesion promoters.

Some of the differences when repairing sheet metal versus repairing plastic include:

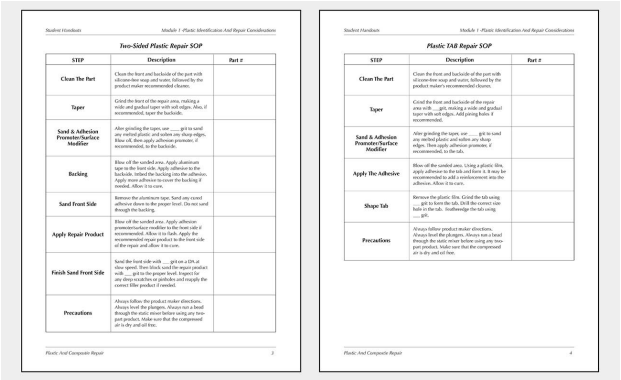
- plastic usually requires an adhesion promoter. When using an adhesion promoter, always check the product maker recommendations.
- different materials are used. The repair materials used for metal parts are not designed for plastic parts. Metal repair material is not going to adhere properly to plastic.
- more identification (ID) is required for plastics than sheet metal. With so many blends available, it is nearly impossible to know the exact blend of plastic.
- plastic is more heat sensitive when sanding with a DA sander, which can lead to delamination of the plastic repair adhesives.



SOPs are helpful in creating a consistent and quality repair.

Standard operating procedures (SOPs) help to:

- create a consistent and quality repair. That will lead to less comebacks and higher customer satisfaction.
- eliminate confusion on which materials to use.
- prevent delays in cycle time. That can cause a bottleneck in the flow of repairs.



Two-Sided Plastic Repair SOP

STEP	Description	Part #
Clean The Part	Clean the front and backside of the part with silicone-free soap and water, followed by the product maker recommended cleaner.	
Taper	Grind the front of the repair area, making a wide and gradual taper with soft edges. Also, if recommended, taper the backside.	
Sand & Adhesion Promoter/Surface Modifier	After grinding the taper, use ____ grit to sand any melted plastic and soften any sharp edges. Blow off, then apply adhesion promoter, if recommended, to the backside.	
Backing	Blow off the sanded area. Apply aluminum tape to the front side. Apply adhesive to the backside. Infuse the backing into the adhesive. Trim the aluminum tape to cover the backing if needed. Allow it to cure.	
Sand Front Side	Remove the aluminum tape. Sand any cured adhesive down to the proper level. Do not sand through the backing.	
Apply Repair Product	Blow off the sanded area. Apply adhesion promoter/surface modifier to the front side if recommended. Allow it to flash. Apply the recommended repair product to the front side of the repair and allow it to cure.	
Finish Sand Front Side	Sand the front side with ___ grit on a DA at slow speed. Then block sand the repair product with ___ grit to the proper level. Inspect for any deep scratches or pinholes and reapply the correct filler product if needed.	
Precautions	Always follow the product maker directions. Always wear the proper safety gear. Always run a bead through the static mixer before using any two-part product. Make sure that the compressed air is dry and oil free.	

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Plastic TAB Repair SOP

STEP	Description	Part #
Clean The Part	Clean the front and backside of the part with oil-none-free soap and water, followed by the product maker's recommended cleaner.	
Taper	Grind the front and backside of the repair area with ___ grit, making a wide and gradual taper with soft edges. Add prying holes if recommended.	
Sand & Adhesion Promoter/Surface Modifier	After grinding the taper, use ____ grit to sand any melted plastic and soften any sharp edges. Then apply adhesion promoter, if recommended, to the tab.	
Apply The Adhesive	Blow off the sanded area. Using a plastic film, apply adhesive to the tab and form it. It may be recommended to add a reinforcement into the adhesive. Allow it to cure.	
Shape Tab	Remove the plastic film. Grind the tab using ___ grit to form the tab. Drill the correct size hole in the tab. Featheredge the tab using ____ grit.	
Precautions	Always follow product maker directions. Always heed the plungers. Always run a bead through the static mixer before using any two-part product. Make sure that the compressed air is dry and oil free.	

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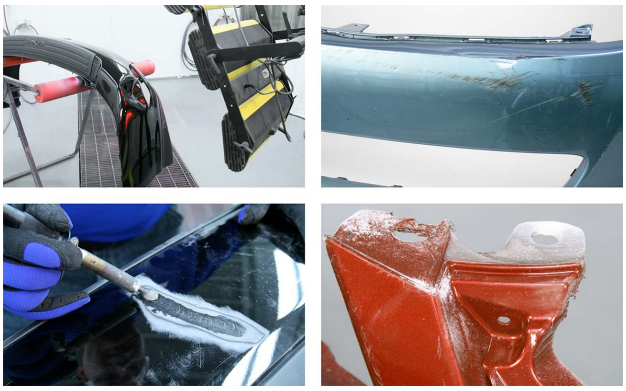
Refer to Module 1, “Demonstration: Example Of SOP” in the presentation for an example of a SOP.

Definitions



Types of repairs on plastics includes heating to reshape (top left), plastic welding (bottom left), one-sided repairs (top right), and two-sided repairs (bottom right).

One type of repair done on plastic parts that are dented or twisted is reshaping with heat. With the exception of FRP, this can be done on most plastics. Whenever doing plastic repairs, reshaping should be done before all other plastic repairs.

Other types of repairs done with plastics and fiber-reinforced plastics include:

- one-sided repairs.
- two-sided repairs.
- tab repair.

All these repairs can be done with plastic welding or by using a plastic repair adhesive.

An infrared heater may be used to heat and reshape plastic parts.

Heating and reshaping:

- reforms distortion. Part of the reason this can be done is that some plastic parts have a memory, and like to return to their original shape.
- process can be done by using an infrared lamp or heat gun. Another way to heat and reshape a plastic part is to submerge the part in a hot water tank. This is done primarily at a bumper recycler facility and is not common in a collision repair facility.
- cannot be done on fiber-reinforced parts because they are a thermoset plastic. The exceptions to this rule are polyurethane (PUR) and reinforced reaction injected molding (RRIM) parts.
- has to be done before plastic repair adhesives or weld repairs

are started. If this step is not done first, when the part is refinished and heated by the sun, the repair may show through. For example, the damaged area that was low may become a high spot and show a halo. It may even crack the filler or paint.

Refer to "Video: Reshaping Plastic Using Heat" in the presentation. This video shows the steps necessary to heat and reshape a dented bumper cover.

Environmental Safety

Cleaners can contain VOCs and should be used and disposed of in accordance with all federal, state, and local regulations.

The scratches in this bumper cover will require one-sided repairs.

Cosmetic or one-sided repairs:

- primarily include scratches or gouges. This type of damage may not require a filler.
- are for damage that does not go through to the backside of the part.
- are sometimes done in multiple areas on the same part.

This part is cracked through to the backside and requires a two-sided repair.

Two-sided repairs:

- include cracks, tears, or punctures that go through to the backside.
- require a filler on the front side.
- require a backing material on the backside.
- may need a hole drilled at the ends of the crack or tear.

Broken-mounting tabs can be recreated if a portion is missing.

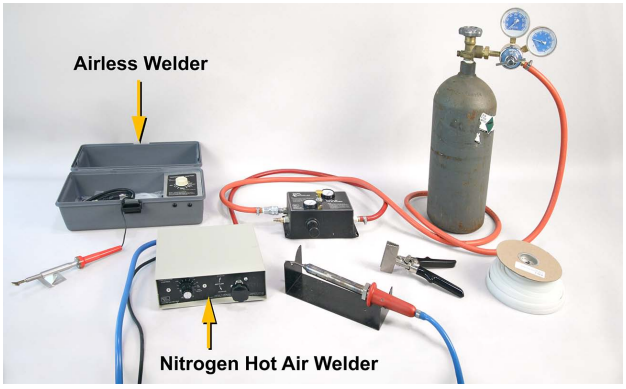
With mounting tab repairs:

- a two-sided repair is necessary in most cases.
- missing or torn, tabs can be recreated or repaired.
- the repair may be done along with other repairs.

Pinning is most commonly used for tab repairs.

Pinning the repair:

- involves drilling holes along the edge of the repair in the taper area. The first hole should be started about ¼" from the edge, with the remaining holes drilled around the perimeter of the repair taper with even spacing between each hole. This allows the plastic repair adhesive to form rivet-like pins in the part, which is another form of bonding.
- allows the product to adhere to itself, which provides the strongest bond.
- can be used on tab repairs and two-sided repairs, but care must be taken not to drill too many holes as this may weaken the repair.
- adds to overall repair strength. Some product makers, such as 3M, Crest, and SEM recommend pinning. Other product makers do not have recommendations on this process.



The two types of plastic welders are airless and nitrogen / hot air welders.

Plastic welding can be used to repair cuts, gouges, and tears. There are several types of plastic welding equipment, including airless and hot air. For some of the welding methods, a welding rod is needed for use as a filler. With two-

sided repairs, a screen on the backside is recommended.

Module Wrap Up

Topics discussed in this module included:

- plastic identification by its characteristics.
- plastic identification that is required to perform the repair.
- identifying the different types of repair for plastics and fiber-reinforced plastic (FRP).

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Module 2 - Adhesive Bumper Repair

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Adhesive Repair Definitions

Learning objectives for this module include:

- identifying the correct adhesive to use.
- identifying when to use adhesion promoter.
- preparing plastics for adhesive repair.
- performing one-sided and two-sided adhesive repairs.
- performing a mounting tab repair.
- identifying plastic refinishing considerations.

Adhesives may be used to repair the front and backside of the repair.

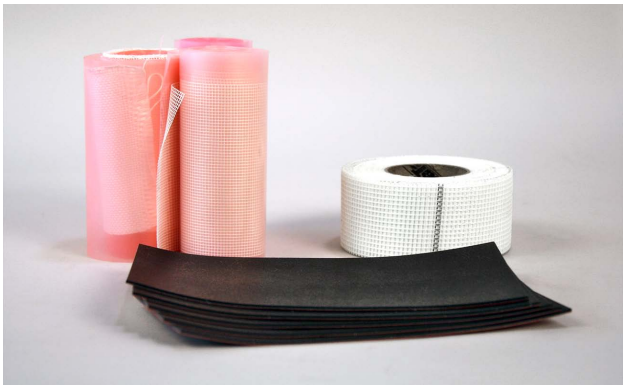
Personal Safety

Avoid skin contact with any type of adhesive. If using a cyanoacrylate, it is advisable to have the de-bonding solution available in case of accidental contact.

Adhesives used for plastic repair:

- are two-part materials.
- include epoxies, urethanes, or acrylics.
- may be the same for both the backside and front side repairs.
- typically cure by “exothermal” chemical reaction. This curing process creates heat. The hotter the product gets, the faster it will cure. When using these adhesives, the ambient temperature will affect the work time of the product. If the product is designed to work at 75°F and the temperature of the product is 55°F, the work time will usually about double. If the product temperature is 95°F, then the work time will be cut in about half. Also, the thicker the product is applied, the more heat it will build up and the faster it will cure. However, no matter how thick the product is applied, sand times still need to be observed because the product still needs time to adhesively bond to the part.

Cyanoacrylates (super glue) may be used as a two-part product with an accelerator or as a one-part product without the accelerator. A cyanoacrylate is used to hold the edges of a tear together while repairs are made with an epoxy, urethane, or acrylic. A cyanoacrylate product does not have the strength to be used alone.



A backing material is required on two-sided repairs.

Backing (reinforcement) material:

- should be used on any two-sided repair, especially when it is in an area that can flex. It also helps add strength to the repair area when the plastic expands and contracts with the change in temperature.
- can be a wire mesh, a fiber mesh or tape, or an adhesive patch. It may also be recommended to use multiple layers of fiber mesh or tape.
- adds to overall repair strength. It is also sometimes recommended to apply the backing material in an "X" pattern to give the repair more strength.

An adhesive patch may be used as a backing for two-sided repairs.

An adhesive patch is:

- an alternative for the backside on two-sided repairs. One of the limitations of an adhesive patch is that the damage should not be larger than the repair patch. Another limitation is that adhesive patches may not be recommended to repair damage that extends to an edge.
- fast, with no cure time required. The patch is simply applied and pressed on.
- able to be used on curved areas. In order for the patch to conform to a curve, it may be necessary to apply some heat from a heat gun to make it more pliable.
- not for the front side, as it will remain visible. The front side needs to be repaired using plastic repair adhesives or fillers.

One precaution when using an adhesive patch is that some product makers have a different adhesion promoter for the adhesive patch than for the regular repair

material. Always follow product maker guidelines.

Refer to Module 2, "Demonstration: Adhesive Patch" in the presentation to see an example of an adhesive patch.

Fillers are used only on the front side of the repair.

Fillers used for plastic repairs:

- are one-part or two-part. One-part materials are not very common, but with one-part materials, pay close attention to the cure time as the filler may shrink more after sanding.
- are either acrylic, epoxy, polyester, or urethane. Do not use metal body fillers or metal polyester glazes on plastics, as they were not designed for use on plastic parts. They also lack the correct flexibility needed on plastics. Flexible plastic polyester fillers are used only to fill minor scratches or gouges on plastics. Also, some product makers warn against using flexible plastic polyester glazes over their materials because they are not compatible with the chemical makeup.
- have good sanding characteristics. While some of the product makers have a separate two-part filler for the front side, others use the same plastic repair adhesive on the backside.

The companies that use the same product front to back are Crest, Fusor, Kent, IES, Ashland Inc. (PLIOGRIP), and SEM. Fusor, IES, and Ashland Inc. (PLIOGRIP) also have a separate product for applying a glaze coat over the repair area. 3M has a separate product for front side repairs.

There are a variety of applicator guns used to dispense repair adhesive.

Plastic repair adhesive mixing options include:

- dual mixing tubes with a manual applicator gun. A pneumatic applicator gun is also available.
- caulk gun cartridges that, with an adapter, can be used in a traditional caulk gun.
- A and B hand mixing tubes that need to be mixed thoroughly.


Dual cartridge tubes must always be leveled before use.

When using a dual cartridge product, always:

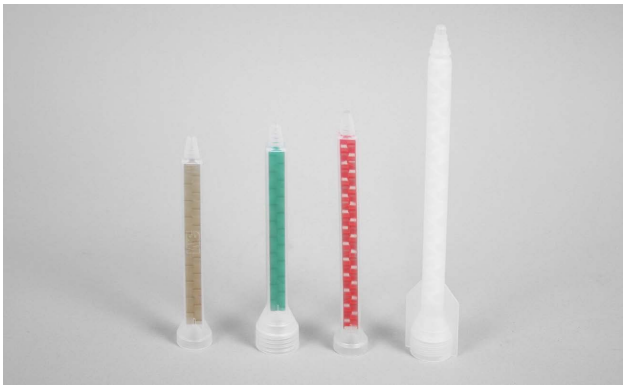
- level plungers before each use. To level plungers, place the cartridge into the applicator gun, remove the cap, and dispense product until both sides of the cartridge are dispensing evenly.
- install the static mixer and dispense a bead of product through the static mixer before application of the product. The length of bead does vary between product makers, so always check product maker recommendations.

A mixing board is used to dispense product while leveling the plungers.

Why is it necessary to level the plungers before each use?


Running out a bead of repair product will ensure the product is properly mixed before use.

Leveling the plungers allows the product to be mixed evenly. If plungers are not leveled it may cause the two-part product to mix unevenly causing the product to cure improperly. If the static mixer is installed before plungers are leveled, the product still may not mix properly no matter how much product is pushed through. All of the product makers recommend this step.

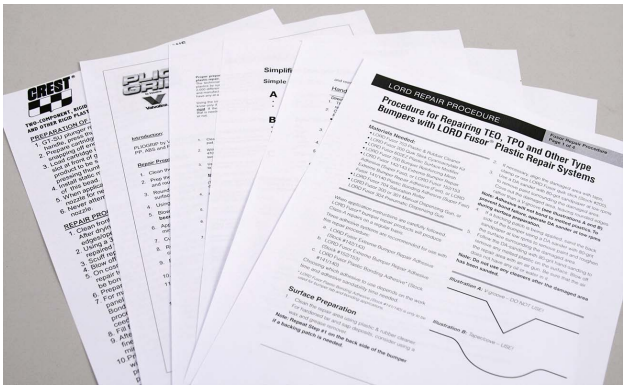


Static mixing tips vary in length and mixing ratio.

Some product makers require their product be mixed using a static mixing tip. A static mixing tip:

- mixes the product uniformly without causing air bubbles.
- wastes very little of the product. In some cases, only about a teaspoon is left in the static mixer. While it may look like there is more waste, this it is not the case. The mixing channels take up most of the space in the static mixer. It is also important to note that the static mixers are not interchangeable between product lines, as the length and mix ratio of the static mixer may vary.

Refer to Module 2, “Demonstration: Video: Static Mixing Tip” in the presentation for an example of a static mixing tip.



It is important to always follow product maker instructions.

Precautions to take when using plastic repair adhesives include:

- never intermix different plastic repair systems, as this may lead to compatibility issues.
- always follow product maker instructions. Failure to do so will lead to repair failure.
- choose the product with the same flexibility as the part being repaired.

For example, do not use a rigid repair product on a semi-rigid part because the semi-rigid part needs to be somewhat flexible.

Adhesion promoters are used to form a chemical bond to the plastic part.

Adhesion promoters or surface modifiers are:

- applied after the surface has been sanded with a DA sander, but before any plastic repair adhesives are applied. Caution must be used to avoid melting the plastic, as repair materials will not stick to melted plastic or plastic that has not been sanded.
- used to form a chemical bond to plastic. In simple terms, adhesion promoters give the repair material something to stick to when the plastic is a poor adhesion plastic like TPO or PP. Most product makers say that when not sure if the plastic will need adhesion promoter, use it and it will not have any adverse affects.
- not required by all product makers. Some materials have adhesion promoters built into the product, so no additional adhesion promoter is necessary. The repair area must still be cleaned and sanded with a DA sander.

Never use a paint maker's adhesion promoter instead of a product maker's adhesion promoter as they are made to create adhesion for different materials.

Flame treatment is another option to promote adhesion. It is not widely used or recommended by product makers. This is accomplished by passing a butane or propane (not oxyacetylene) flame over the repair area. The difficulty in using flame treatment is that the distance to the plastic and travel speed will affect the level of heat being applied. If too much heat is applied and the plastic melts, it will actually cause poor adhesion. If not enough heat is applied, it will not provide the proper adhesion promotion.

Crest recommends flame treatment but also has an adhesion promoter.

Personal Safety

Hazards when working with adhesion promoter/surface modifier include:

- skin contact with cleaning solvents and plastic repair materials.
- vapors from cleaning solvents and plastic repair materials.
- static electricity. Plastic parts should be grounded before cleaning and refinishing and / or a antistatic cleaner should be used.

The product-specific SDS identifies the personal safety equipment that is required during product use. Plastic repairs should be performed in a properly ventilated

area. Safety equipment that should be used when repairing plastics includes:

- safety goggles or safety glasses.
- protective gloves.
- proper respiratory protection.

Two-Sided Repair

Honda CR-V

The bumper cover on this Honda CRV is a semi-rigid plastic.

The level of plastic identification required when repairing with plastic repair adhesives is not as critical as it once was. Many of the product makers have a product that can be used for all plastics, with the exception of fiber-reinforced plastics. This greatly reduces the need to identify the exact type of plastic.

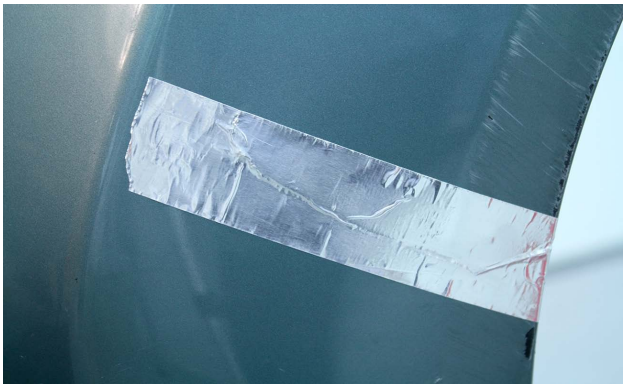
To choose the right repair material, some product makers only require that the technician determine if the part is flexible, semi-rigid, or rigid. Most late model bumpers are considered to be a semi-rigid part, which reduces the need to identify the plastic type even further.

If the plastic becomes overheated from sanding, the plastic repair adhesive may lift.

When making a two-sided plastic repair, be careful to:

- not overheat the plastic when sanding or grinding. If the plastic does get overheated and starts to melt, it will cause poor adhesion for the plastic repair adhesive. The way to avoid that problem is to use the DA sander at slow speed or sand by hand.
- make sure there is no paint in the repair area, including any paint overspray on the backside of the repair. The plastic repair adhesives are designed to stick to plastic, not paint. Also, paint overspray forms a weak bond to the part making it a major problem for good adhesion.

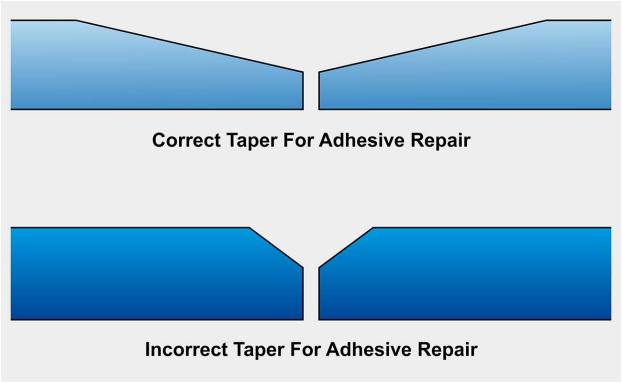
Refer to “Video: Two-Sided Repair Part 2” in the presentation. This video shows how to perform a proper two-sided repair using plastic repair adhesives with a backing material.



A tear may be held together by applying aluminum tape to the front side of the repair.

Any heating and reshaping should be done before beginning a two-sided repair. When starting a two-sided repair:

- remove any broken or loose pieces to provide an even surface for the repair. If this is not done, the part may not have the proper alignment.
- temporarily align the front side of the repair and hold it together with aluminum tape, body tape, or cyanoacrylate. It is important to align the pieces and hold them together so that after the backside repair is complete, everything is in proper alignment.



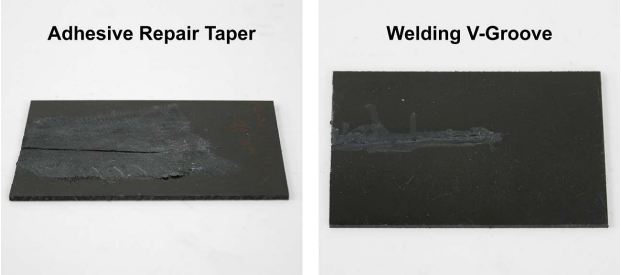
A repair taper should be wide and gradual with soft edges.

On the backside repair taper:

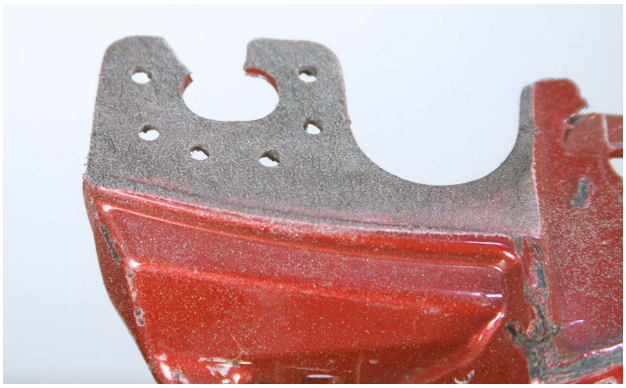
- use 40 grit on a grinder to dish out the repair area. This step is used to get the general repair taper with soft edges. Care must be taken to not remove too much of the material.
- use a DA at slow speed with P80 grit to remove deep scratches. Any melted plastic from the grinding procedure must be sanded until there is no shiny plastic left. Once this step is done, the plastic should have a fuzzy or hairy looking appearance.

Some product makers do not require a backside repair taper and only require the backside to be sanded using P80 grit.

It is also recommended to clean the area with the appropriate cleaner before any sanding can be done. Do not use a solvent once the plastic surface has been abraded. If a solvent is applied to the abraded plastic, it may absorb into the plastic, causing the solvent to be released in the bake cycle of the paint process. This could cause the plastic repair adhesive to blister and the repair to fail. This may also occur once the repair is exposed to the sun.



Refer to Module 2, "Demonstration: Incorrect / Correct Taper" to see an example of an incorrect and correct repair taper.



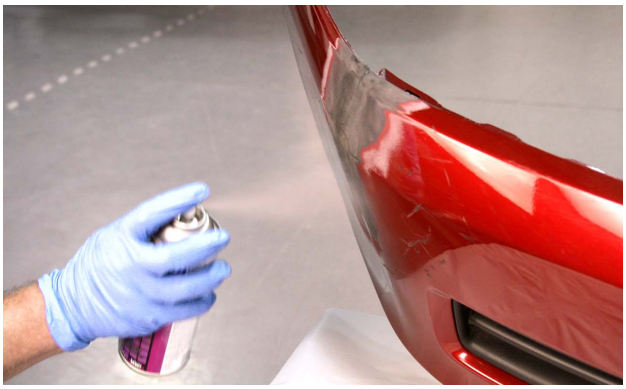
This tab has 1/8" pinning holes that will provide strength for the repair.

Pinning may be used for added strength. This is a recommendation by Crest for a two-sided repair. Most other product makers use pinning only for tab repair.

When using pinning on a two-sided repair:

- drill 1/8" holes about 1/4 - 1/2" apart. It is a good idea to drill holes in a pattern instead of erratically drilling the holes, This ensures that not too much of the plastic is removed from the repair area, unnecessarily weakening the part.
- it is recommended to stay 1/4 - 1/2" away from the edge. This allows for a full hole and not just a partial hole when the repair taper is completed.
- it may be recommended to drill a small hole at each end of the crack in order to prevent the crack from continuing further.

Make sure that all pinning holes are within the repair taper.

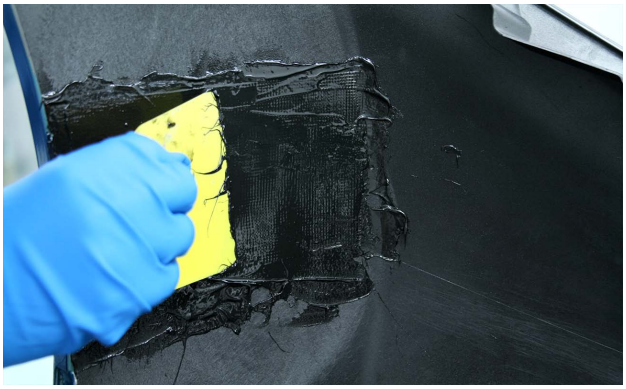


Most adhesion promoter / surface modifiers should be applied in a light mist coat.

When using an adhesion promoter:

- use a mist coat. If a heavy coat is applied, it may cause adhesion problems. The adhesion promoter should make the plastic look dull and not glossy. The exception to this rule is when the product maker's adhesion promoter is applied with a spray gun or a dauber.
- follow the product maker instructions for flash times. If the adhesion promoter has product applied over it too soon, there will be adhesion problems.
- make sure the adhesion promoter is for the plastic repair adhesive that is being used. Do not use a paint manufacturer's plastic adhesion promoter before applying plastic repair adhesive materials, as they might not be compatible for this step. Also do not intermix an adhesion promoter from another plastic repair system, as some are made for urethane materials while others are made for epoxy materials.

There are some product makers that do not have an adhesion promoter.



The adhesive should be applied using firm pressure.

When applying plastic repair adhesives:

- make sure to use firm pressure to prevent any air pockets from forming. This should be a thin skim coat to ensure that the repair material fully adheres to the plastic part.
- make sure to check the work time of the product. Work time varies depending on the type of product and temperature. Some materials have a work time that is only seconds long.
- the longer that the adhesive can cure, the better the bond will be. The reason for this is that with most adhesives, the chemical bond increases over time. Once they can be sanded, most of the curing is done. However, most continue to cure after the sanding window for about 24 hours. This is the time it takes for the product to achieve its full bonding strength. It is also okay to topcoat because most two-part materials are an exothermic cure, so there is no real shrinkage after the mixed product cools.

It is also important to keep the mixing tip submerged in the plastic repair adhesive while dispensing the product to avoid putting air into the product, which will create pinholes.

One-Sided Repair

After grinding the front side repair taper the area should be sanded to remove any deep scratches or gouges.

If performing a one-sided repair, this is the step that the repair would start at after properly cleaning the part. When preparing the front side (one-sided):

- taper the front side and remove any deep scratches or gouges. If a backside repair was done, it is okay to grind with a grinder into the backing when making the repair taper. However, avoid grinding through the backing.
- clean and apply the product maker recommended adhesion promoter, if required. Do not use a solvent-based cleaner on any abraded plastic surface.

Apply a skim coat with firm pressure and overfill the repair area to allow for sanding of the plastic repair product.

When applying filler to the front side:

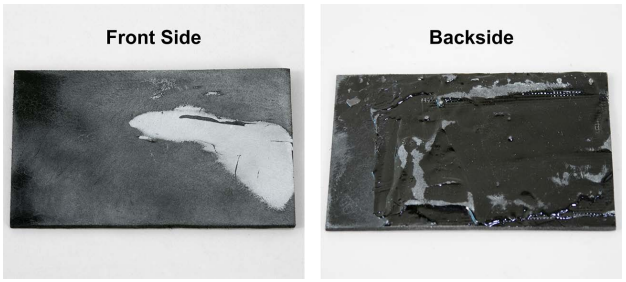
- sand any product that may have seeped from the backside. Any product that is shiny will have poor adhesion and therefore, must be sanded.
- apply a skim coat with firm pressure, making sure there is proper coverage and adhesion. Overfill the product slightly to allow for sanding.

Use caution when using flexible polyester fillers for plastic, as they were designed for application over pinholes and minor scratches. They should not be more than 1/16" thick once sanded. Flexible polyester fillers typically tend to loose flexibility after about 48 hours and, if applied too thick, it may crack if flexed.

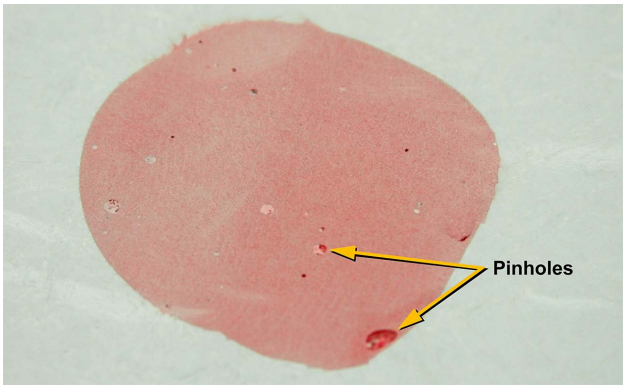
Sanding should be done with a DA sander at slow speed to prevent overheating.

When sanding the front side:

- check sand times for the product. Do not try to sand the product before it is properly cured.
- use a DA sander at a slow speed to prevent overheating. It is also recommended to keep the DA sander moving and not stay on one spot. Start with P80 grit and progress to P220 grit to featheredge the repair area. Changing the sandpaper often will help prevent overheating.
- block sand so the repair is level. This is done to create a straight and level surface after the repair product has been initially sanded with a DA sander.
- overheating can cause the product to peel or lift. Be careful not to overheat the repair area when block sanding.

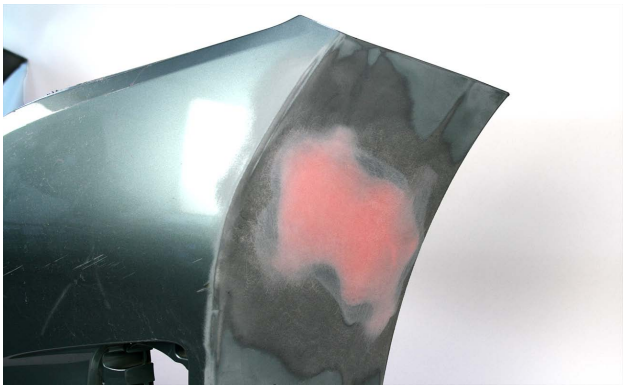


Refer to Module 2, " Demonstration: Two-Sided Repair" to see an example of a two-sided repair.



Apply a glaze coat over any pinholes.

When the repair is completed, clean the repair area with a blowgun or a vacuum to check for any pinholes or deep scratches that needs to be filled. If any pinholes or deep scratches are found, reapply a glaze coat of the plastic repair adhesive or filler, depending on product maker recommendations.



The repaired surface should be smooth after sanding.

When the part is ready for primer, it is a good idea to remove the fuzzy plastic residue created from the sanding procedures. One-way to do this is by block sanding the fuzzy plastic with P320 grit. Next, blow off or wipe the area with a dry rag. Then vacuum the area and check again for any pinholes or deep scratches that need to be filled.

If the vehicle is equipped with adaptive cruise control or parallel park assist system, no repair can be done in front of a sensor if it impedes the sensors ability to function. Typically the only repair that can be done is refinishing and that can only be done once because excessive film thickness can affect the sensors. Check with the OEM before painting any parts that have these systems.

Another consideration is if there is any paint cracking (spider webbing). This requires the finish to be sanded with a DA sander until all the cracking is removed. If this is not done, the cracking will show up again after refinishing.

Tab Repair

This partially-torn tab is repairable.

When performing tab repairs:

- multiple tabs can be repaired at the same time. It is important to check the cure time of the product. If not enough time is given for each tab, the plastic repair adhesive may harden before the tab can be shaped.
- most tabs will only be partially torn out. Typically this happens on the thinnest part of the tab.
- complex tab shapes can be recreated. One of the ways to do this is by tracing the outline of a good existing tab onto a piece of plastic film and then transferring the outline to the new adhesive tab.

Refer to “Bumper Cover Tab Repair” in the presentation. This video shows how to make a pinning tab repair on a bumper cover using plastic repair adhesive.

The finish is being removed from the repair taper area.

Environmental Safety

Cleaners can contain VOCs and should be used and disposed of in accordance with all federal, state, and local regulations.

In order to prepare a tab for repair, the:

- part must be cleaned on both sides with soap and water and with the appropriate cleaner. Any contaminants left on the part may cause adhesion failure.
- finish must be removed from the repair area. If it is not removed, it may lead to an adhesion failure, especially with the overspray on the backside of the part.

1/8" pinning holes are being made to help anchor a replacement tab.

When a tab is missing or torn, pinning is sometimes recommended to increase repair strength and durability. This process is another way to anchor the tab to the part.

The repair area must have a taper that is gradual and not a sharp line. This is so that the product has more surface area to be applied to and is able to expand and contract.

It is also important to measure a good existing tab to ensure correct appearance and position of the repaired tab.

Refer to Module 2, "Demonstration: Tab Repair" to see an example of a tab repair.

Any broken or loose plastic should be removed prior to applying an adhesive.

When starting a tab repair:

- remove any loose or broken plastic from the repair area to ensure the integrity of the tab.
- taper the front and backside of the repair area so that the plastic repair adhesive has enough area to adhere to the plastic.
- drill the pinning holes, if recommended.
- add backings for strength, if recommended by the product maker.

A plastic film may be used to form new tab.

When applying plastic repair adhesive to a tab repair:

- clean the area with a blowgun using low PSI and clean, oil-free air.
- cut a piece of plastic film to size. This will be used to push product into the pinning holes and onto the part. It will also be used to achieve the approximate thickness and shape of the tab.
- apply an adhesion promoter, if recommended by the product maker.
- apply adhesive to the part, using the plastic film to form the tab. Before applying any adhesive, make sure to have all necessary plastic repair materials and tools ready. Because most of these materials use an exothermal cure process, hotter shop temperatures and thicker adhesive will decrease cure time, giving you less work time.

A grinder is used to shape the new mounting tab.

To shape the new mounting tab:

- use a grinder with a 50 grit disc at low to medium speed to shape the tab. Grit sizes will vary but a coarse grit should be used to keep heat down and to speed up the process.
- featheredge the area that may be seen with P80 - P180 grit to ensure that the edge of the repair remains hidden following the repair.
- drill the correct size hole in the new tab. A die grinder may also be used to shape a hole to match the original shape.
- fill any pinholes or deep scratches with the correct product. Some product makers do not recommend polyester fillers be used over their product.

Module Wrap Up

Topics discussed in this module included:

- one-sided and two-sided adhesive repairs.
- making a mounting tab repair.
- refinishing plastic considerations.

Module 3 - Fiber Reinforced Plastic (FRP) Repair

I-CAR®

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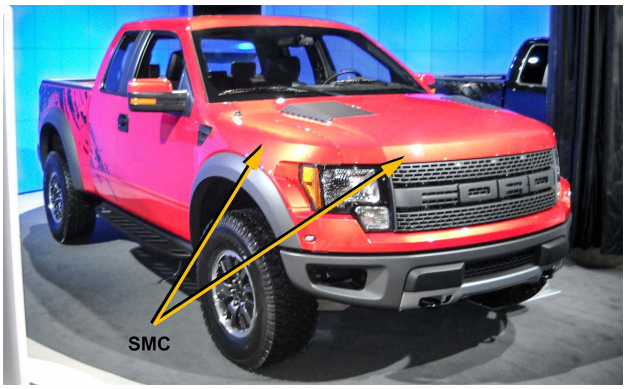
FRP Definitions

The learning objectives for this module include:

- identify some of the fiber reinforced plastics (FRP) used on vehicles today.
- identifying the correct repair method to repair FRP.
- performing proper preparation of FRP.
- performing one-sided and two-sided FRP repairs.
- identifying refinishing considerations for FRP.

Ford F-150 SVT Raptor

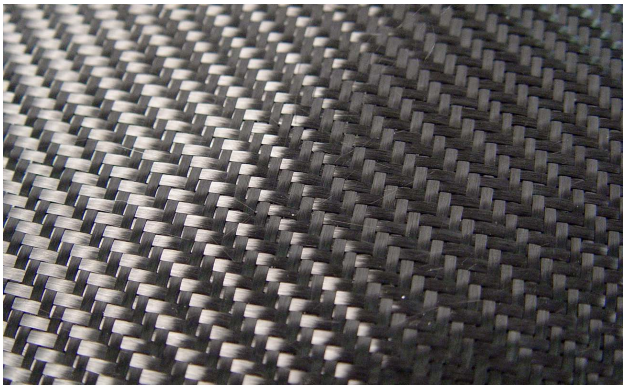


SMC parts are used on the hood and fender of this Ford F-150 SVT Raptor.

One type of FRP is called sheet-molded compound (SMC) which:

- is smooth on both sides with no visible fibers unless the part is cracked.
- may require finish sanding both sides.
- cannot be repaired using fiberglass repair materials or plastic welding. The reason fiberglass repair materials cannot be used is that fillers and mold release agents in SMC cause adhesion problems with fiberglass repair materials. SMC cannot be welded because it is a thermoset. Also, adhesion promoters and pinning are not used for any FRP repairs.

SMC is used in multiple locations on a vehicle primarily for weight reduction and the ability to be molded into complex shapes.



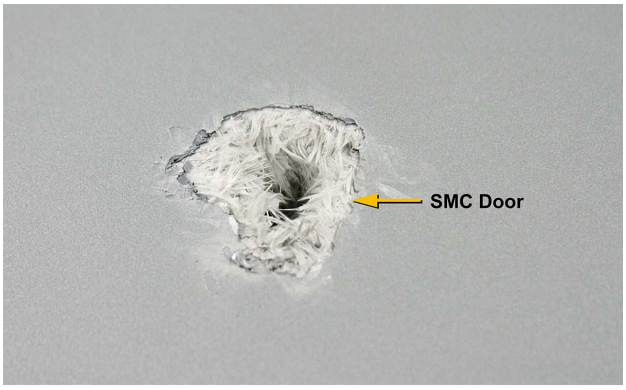
Carbon fiber has a woven-matt appearance.

Carbon fiber has:

- no widespread use yet. Most carbon fiber use is limited to high-end vehicles or aftermarket accessories.
- few recommendations on repair. Some product makers say that it can be repaired using SMC products, but there has not been a large demand for a separate repair product.

Raw carbon fiber itself is not a plastic. It is a type of woven, or unidirectional, fiber cloth that is imbedded within a resin or a plastic. The resin or plastic that is used can be made of many different materials. Some examples include epoxy, vinyl ester, polyester, and nylon. There are also several different types of carbon fiber finishes. The first is called tooled face. This means that the carbon fiber weave is exposed but has a smooth and shiny or clear-coated surface. Another finish is called a bag surface. This has a dull rough looking surface. The third finish type is a painted surface.

FRP Repair



FRP panels will not dent but may be punctured.

An FRP:

- does not dent or crush but will crack when struck with enough force.
- must be checked for secondary damage in the form of cracking outside of the direct impact area, usually at mounting points. Make sure to inspect backside of the part for any microcracking.

Refer to "Video: Sheet Molded Compound (SMC) Repair" in the presentation. This video shows a two-sided repair on an SMC door.

Personal Safety

Hazards when working with composites include:

- dust from sanding, cutting, or grinding.
- skin contact with cleaning solvents and composites repair materials.
- vapors from cleaning solvents and composites repair materials.

Personal Safety

The product-specific SDS identifies the personal safety equipment that is required during product use. Composite repairs should be performed in a properly ventilated area. Safety equipment that should be used when repairing composites includes:

- safety goggles or safety glasses.
- protective gloves.
- a dustless sanding system.
- proper respiratory protection.

Avoid skin contact with any type of adhesive.

Environmental Safety

Cleaners can contain VOCs and should be used and disposed of in accordance with all federal, state, and local regulations.

The backing material can be a fiberglass cloth (left) or a scrap piece of the same material (right).

An FRP backing:

- can be a scrap piece of the same material.
- can be made of a fiberglass cloth or a backing tape.
- is needed on any two-sided FRP repair.
- must overlap the damaged area. The amount of backing overlap varies by product maker. A good general recommendation is a 3/4 - 2" overlap on all sides of the damage.

Damaged SMC parts should be cleaned before making any repairs.

Prepping FRP for a two-sided repair requires:

- washing the area with soap and water.
- taping off any exposed fibers before using wax and grease remover. If the fibers are not taped off, the fibers can wick the solvents and trap them under repair materials, which can lead to delamination.

All damaged fibers should be removed.

To start a two-sided repair:

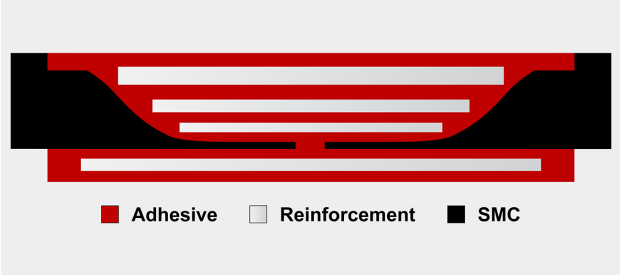
- remove any loose or damaged fibers with an air saw or die grinder.
- taper the front side of the repair.
- sand and / or taper the backside of the repair, if recommended. Start by using a grinder with 40 grit. Then sand with a DA sander and P80 grit.
- clean the area with a dry cloth, a vacuum, or clean, oil-free compressed air.

The backing should be pressed into the composite repair adhesive.

To apply the FRP backing:

- apply aluminum tape or plastic film on the front side to prevent the repair material from falling through the front of the repair area.
- apply a layer of composite repair adhesive onto the repair area in a pool, keeping the static tip submerged in product. Spread the product using firm pressure to ensure the composite repair adhesive is applied tightly.
- press the backing material into the composite repair adhesive, making sure to use firm pressure.
- put another layer of composite repair adhesive over the backing and cover it, making sure to cover all edges with adhesive.

Some product makers have special instructions for their composite repair adhesive. For example, Fusor and Ashland Inc. (PLIOGRIP) have some composite repair adhesives that need to be heated in order to cure.



Alternating the composite repair adhesive and backing material make the pyramid patch.

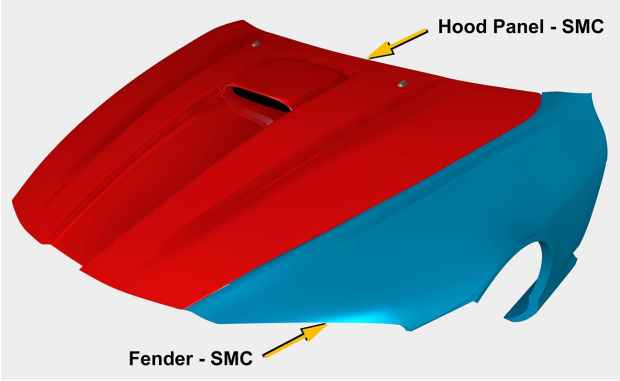
An alternative repair method is a pyramid patch, which is a patch built up with alternate layers of the repair product and a fiber cloth or mesh. To make a pyramid patch:

1. Clean and taper the backside and front side of the repair area. Clean the repair area with a vacuum.
2. Place aluminum tape onto the front side and apply the composite repair adhesive to the backside and to the backing, making sure to cover the entire backing patch. Allow this layer to cure.
3. Sand the front side where the composite repair adhesive is

exposed, and clean the area with a vacuum.

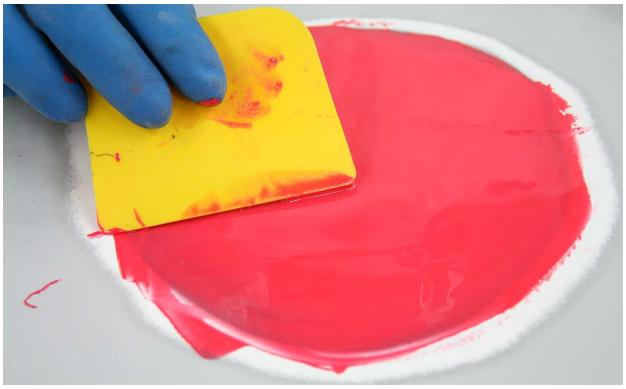
4. Apply another layer of composite repair adhesive, followed by more cloth or mesh, and then another layer of composite repair adhesive. Continue to add layers in this manner increasing the size of the backing with each layer until the desired thickness is reached.
5. Allow the patch to cure and sand it level.

Some vehicle makers, like GM, recommend the pyramid patch.



A backing material must be used even if the backside of the repair is seen.

When applying a backing that is exposed, there still must be backing material used to ensure repair strength and stability. The backing material must be below the final level of the repair. Otherwise, the backing material may be visible and the repair would have to be redone.

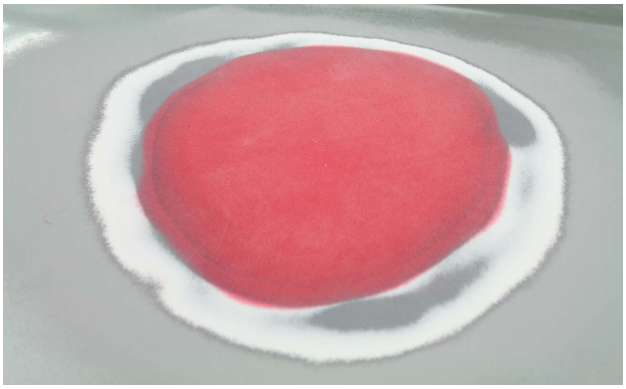


The composite repair material should be filled slightly higher than the part surface to allow for sanding.

When performing a front side repair:

- remove the plastic film or tape.
- sand any exposed repair material that came through from the backside.
- clean the area. Do not use solvents because the fibers are still exposed and can wick the solvents into the FRP.
- overfill the repair material to allow for sanding. The material used for the front side repair may be different than the material used for the backside repair.

Some product makers have different materials for front side and backside repairs for example, Kent and Ashland Inc. (PLIOGRIP).



The repair area is sanded smooth with progressive grits, making sure to featheredge the repair.

Once the repair material has cured, begin by sanding with a DA sander. Typically progress from P80 to P220 grit with a DA sander to featheredge the repair area, and then with a block sander to featheredge and ensure even panel lines. Once the repair area has been block sanded, clean the area with a dry cloth or a vacuum. Check the area for pinholes and apply a glaze coat of the appropriate product if needed.

Carbon Fiber

Lexus LFA Roadster

Many body panels on the Lexus LFA are made of carbon fiber likethe hood for example.

Some challenges with a carbon fiber repair include that the material:

- may not be able to be repaired if the damage extends to an edge. This recommendation comes from GM on the ZR1 / Z06 Chevrolet Corvette fender repair procedures.
- cannot be duplicated if exposed carbon fiber weave is cracked. There is no way to recreate the exact weave pattern of a tool-faced surface.
- cannot be buffed if damage goes through the clearcoat on tooled-faced surfaces.

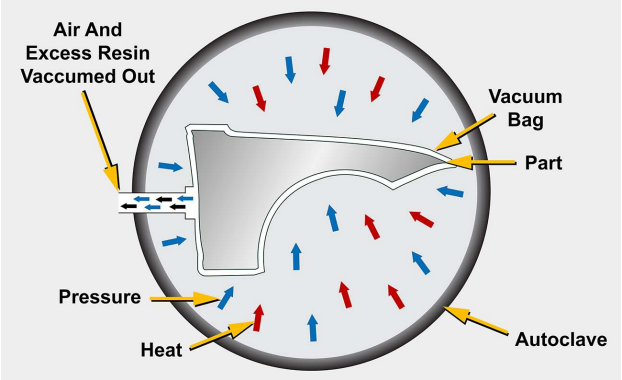
Chevrolet Corvette ZR1 Hood

One of the reasons that carbon fiber is used is that it is lightweight.

The reasons why carbon fiber is being used is that it:

- is lightweight. Carbon fiber is lighter than both steel and aluminum, which helps with the corporate average fuel economy (CAFÉ) standards by reducing overall vehicle weight.
- has high impact strength and is stronger than steel. It is also

resistant to weather conditions such as hail.
- has a unique appearance.
- can be formed into more complex shapes than metal and SMC parts due to the thin but strong carbon fiber reinforcement.



Carbon fiber parts are typically produced in an autoclave.

In the carbon fiber manufacturing process:

- the resin can be made up of many different types of resin that may include an epoxy, vinyl ester, polyester, or nylon.
- the resin and carbon fiber are cured in an autoclave with high heat (300°F) and pressure at 100 psi. An autoclave is kind of like a pressurized oven that can be used to create a carbon fiber part. The parts can also be made without the use of an autoclave, but most of the vehicle makers use the autoclave to produce their parts.

The following websites all contain general information on carbon fiber, such as how it is made, applications of use, and how strong it is. Go to www.compositesworld.com, do a search for "carbon fiber," or go to www.dragonplate.com, and click on the word "Technical."

Mercedes-Benz SLR McLaren

Most of the body panels on the Mercedes-Benz SLR McLaren are made of carbon fiber.

Downfalls with carbon fiber is that:

- it is expensive to manufacture. The raw carbon fiber is much more expensive than steel or aluminum.
- it is not mass-produced yet. Most carbon fiber parts are made by hand with little automation. So the quantities necessary for a mass-produced vehicle are limited.
- the carbon fiber dust can short circuit electric tools because it is a conductive material. The dust is also very hazardous to breathe, so the appropriate particulate respirator should be used.
- the raw or exposed carbon fiber can cause galvanic corrosion when it comes into contact with metal. But once it has

been imbedded in the resin, it eliminates the galvanic corrosion problem.

Chevrolet Corvette ZR1

An exposed-weave carbon fiber body panel is used for the roof panel on the Corvette ZR1.

Carbon fiber is used for many different applications including:

- body panels such as hoods, fenders, and roofs. An example of a vehicle with carbon fiber body panels is the 2011 ZR1 Chevrolet Corvette, which has a carbon fiber hood, roof, and fenders. The 2011 Lexus LFA and the 2009 Mercedes-Benz SLR McLaren have a full carbon fiber body.
- interior / exterior trim, such as rocker panel moldings and instrument cluster bezels. Some examples include the 2008 Audi RS4 and the 2011 ZR1 Chevrolet Corvette. There are also a wide variety of aftermarket trim pieces.
- radiator core supports. An example of this can be found on the 2009 Nissan GTR.
- pillars on the 2006 Aston Martin V12 Vanquish and rail parts on the 2011 Lexus LFA.
- powertrain parts, such as the driveshaft. Some of the reasons that carbon fiber driveshafts are used are that the shaft is lighter, stronger, can put out more torque, and if the shaft does come off the yoke, it will broom out (spread out like the bristles of a broom) unlike steel driveshafts that can shatter. One of the first places that carbon fiber driveshafts were used was in racing cars, for safety reasons and weight savings. The 2010 Mitsubishi Montero, 2010 Nissan 370Z, and 2010 Mazda RX-8 all have carbon fiber driveshafts that weigh 40 – 50% less than comparable two-piece steel designs.

Minor scratches in an exposed-weave carbon fiber body panel may be removed by buffing the area.

When repairing carbon fiber, it is important to inspect the rest of the part for secondary damage. Just like when repairing fiberglass or SMC, carbon fiber repair possibilities include:

- repairing using SMC repair material and methods. It may be recommended to use a pyramid patch.
- buffing the tool-faced surface.

Personal Safety

When working with carbon fiber, leather gloves should be worn because the fibers are very sharp. Carbon fiber dust is a conductive material and can short circuit electric tools. A NIOSH P100 combination respirator should be worn to prevent fibers from getting into the lungs and to prevent any gases from entering the lungs from grinding or cutting of carbon fiber parts.

Module Wrap Up

Topics covered in this module included:

- some of the FRP used on vehicles today.
- the correct repair method to repair FRP.
- proper preparation of FRP.
- one-sided and two-sided FRP repairs.
- FRP refinishing considerations.

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Module 4 - Plastic Welding Repairs

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Plastic Welding Process

The learning objectives for this module include:

- identifying the types of plastic welds in automotive applications.
- identifying differences between a fusion weld and an adhesion weld.
- identifying welding equipment.
- explaining how a rod adhesion test is done.
- explaining how airless welds are made.
- explaining how hot air welds are made.

This repair was made with hot air welding equipment.

For the plastic welding process:

- hot air or airless equipment is available.
- materials include a welding rod or universal-type ribbon, backing materials, and metal tape. A front side plastic repair adhesive or filler may be needed to finish the front side.
- equipment cleaning is required. This includes the welding tips for airless and hot air welding.

Plastic welding requires the use of specific techniques to performa quality weld.

The use of plastic welding:

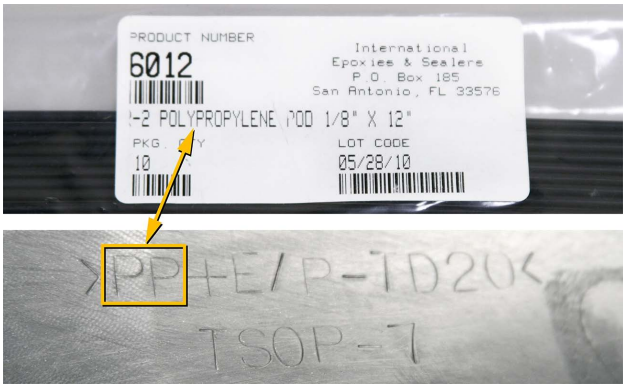
- requires more practice than adhesives for a strong and quality repair. But once the method has been mastered, it can produce high quality repairs.
- requires proper preparation and technique, not all that different than an adhesive repair.

Several plastic welding rods are available.

Plastic welding rods:

- are usually made of a pure plastic like PP, ABS, or TPO. Therefore, they may not match a specific blend of plastic base material.
- are available in different diameters and shapes. Some are round rods and others are a flat ribbon. There is also a universal ribbon available that bonds most plastics. If a specific filler rod will work on that part, it should be used.

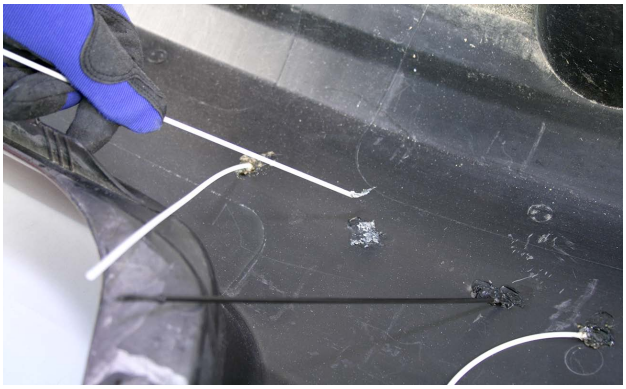
Plastic ID For Welding



Plastic welding rod codes may be matched to the ISO code on the part.

The need for plastic identification is:

- more important for plastic welding than it is when using adhesives.
- primarily used to determine which rod will match the plastic part.
- helpful to know how the plastic will melt because different plastics will melt at different temperatures.



A rod adhesion test may be used if the ISO code is not available.

A rod adhesion test is available if an ISO code cannot be found or is not available. To perform a rod adhesion test, clean and scuff a hidden area of the part to be repaired. Next, melt a rod on the part, allow it to cool, and try to pull it off. Try the other rods at different locations. Determine which rod sticks best. If none of the rods stick well, there is also a universal ribbon that may be an option.

Personal Safety

Hazards when working with plastic include:

- dust from sanding, cutting, or grinding.
- skin contact with cleaning solvents and plastic repair materials.
- vapors from cleaning solvents and plastic repair materials.
- vapors from melting plastics.
- hot welding tips.

Personal Safety

The product-specific SDS identifies the personal safety equipment that is required during product use. Plastic repairs should

be performed in a properly ventilated area. Safety equipment that should be used when repairing plastics includes:

- safety goggles or safety glasses.
- protective gloves.
- a dustless sanding system.
- proper respiratory protection.

Avoid skin contact with any type of adhesive.

This float test shows that the piece of plastic is likely to be a polyolefin.

A float test can help determine the type of plastic, however it may not be fully conclusive. Float tests can be used in conjunction with other tests. To perform a float test:

- cut a sliver of plastic off of a hidden area.
- drop the sliver into a cup of water.

If it floats, it may be a polyolefin, but if it sinks, it may be a non-polyolefin. Also, any paint left on the sliver may lead to false readings. One of the problems with a float test is that blends can give false results.

This sanding test shows that the part is a polyolefin.

When performing the sanding test:

- a polyolefin may smear, melt, or appear greasy or waxy.
- a non-polyolefin usually creates a powdery dust when sanded.
- grind using high speed and a coarse grit like 40 grit.
- blends may give a false result.

Weld Equipment And Types Of Welds

This airless welding kit includes 110-volt power supply, a flat-bottomed welding shoe, and filler rods.

Airless welding equipment is usually run on 110-volt electrical power. In the airless welding kit, typically there is a flat-bottomed welding shoe without a melt tube. These can be used for smoothing and pressing in backing screen and can be used with a universal ribbon. The kit will

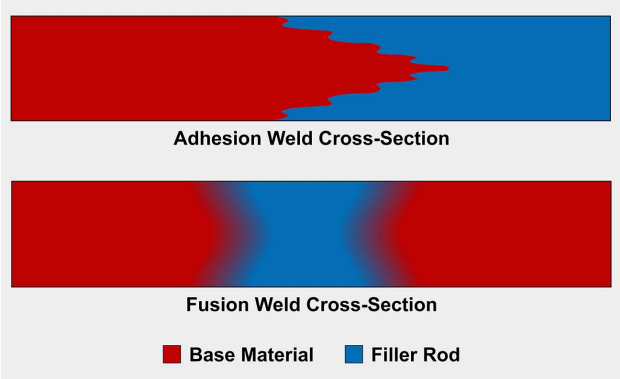
often contain a shoe with a melt tube to feed a filler rod through.

Nitrogen hot air welders use nitrogen as a shielding gas.

One type of hot air welder uses nitrogen to make a plastic weld. The difference between a nitrogen hot air welder and a regular hot air welder is that the former uses nitrogen as a shielding gas and compressed air. The latter uses regular compressed air. Both types of welders can only be used on thermoplastics.

This type of welder does not use a flat shoe or feeder tube-type tip. A V-groove is cut into the part and the rod is laid into the V-groove and the two are melted together. Whenever using this type of welder, it is important to have air flow over the element at all times no matter if it is preheating, welding, or cooling.

Thermoplastics, such as PP / TPO, which is used to make most bumper covers today, work very well with this type of welder.



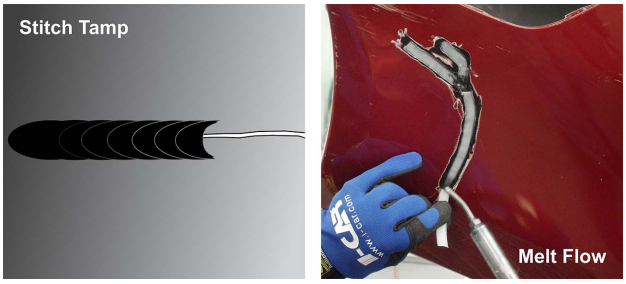
An adhesion weld adheres to the surface but a fusion weld blendsthe filler rod and the base plastic together.

A fusion weld is when the welding rod and plastic melt and mix together. This type of weld can only be done on thermoplastics. An adhesion weld is done on thermosets where the plastic base does not melt but the filler rod does. It is like an adhesive repair, only a filler rod is used instead of an adhesive. Melting a universal flat plastic ribbon onto the base plastic creates the adhesion weld. Some polyurethane parts do not melt.

Universal ribbon does not fuse with the melting base plastic. Equipment suppliers that make airless welding equipment have different names for universal ribbon. The ribbon for:

- IES is UNI-FLEX Fiber Ribbon Rod.
- Urethane Supply Company is Uni-Weld Fiber Flex.
- Pro Technology is called multi purpose welding wire. They have a second ribbon called universal welding ribbon.

A hot staple welder is being used to repair a plastic part.



Airless welders use the stitch tamp method, while hot air welders use the melt flow method.

It is important to know that a repair using a hot staple procedure needs to have the welded area finished with an appropriate plastic repair method.

A hot staple welder is used in conjunction with other plastic repair methods by melting a staple into the crack or tear to fuse them back together. After the staple cools, the wire not included in the repair is clipped off and the repair can be finished. Hot staple welding provides a flexible yet structural repair.

Hot staple welders typically have an adjustable heat control to manage the melt rate. There are four main staples used for plastic repair. "Z" style for straight panel repairs, "W" style for outside corners and tight curves, "S" style for curved surfaces, and a "V" style for inside corners.

Some of the most common welding techniques are:

- stitch tamp. To perform a stitch tamp, use an airless welder tip to mix a filler rod with base material, then tamp with a second pass. This technique can also be done with a flat shoe and without a filler rod. The stitch tamp method is commonly used on hard plastics such as ABS, but will also work well on PP and TPO.
- melt flow. To perform the melt flow technique, preheat the taper with a heat gun or hot air welder and melt the filler rod onto the melted plastic in the repair taper. Melt flow is sometimes necessary on thicker material with high melting temperature like polycarbonate (PC) and polyamide (PA).

Airless Welding Repair Procedure

When using an airless welder, the filler rod is blended into the base material.

When performing airless welds, a backing is needed on any two-sided repair. A V-groove can be used when using a filler rod in order to get better penetration. It is also critical to use a rod that is as close as possible to the base material in chemical makeup to ensure a strong fusion weld. When using a universal ribbon, it has properties that allow it to stick to multiple plastics and is mainly used for adhesion-type welds.

The welding shoe can be cleaned with P220 grit sandpaper while the tip is hot.

Cleaning the welding shoe avoids contaminating the weld with other plastics that may be on the shoe. It also helps ensure enough heat is generated to effectively perform the weld. If the welding shoe has a melt tube, it is also important to remove melted plastic from the melt tube. When cleaning the tip, use P220 grit sandpaper while the tip is hot, or a stainless steel wire brush. It is also important to keep the tip tightened to ensure proper heat transfer.

Refer to “Video: Airless Welding” in the presentation. This video shows how to make an airless plastic weld without using a welding rod.

Hot Air Welds

A nitrogen hot air welder can only be used on thermoplastic parts.

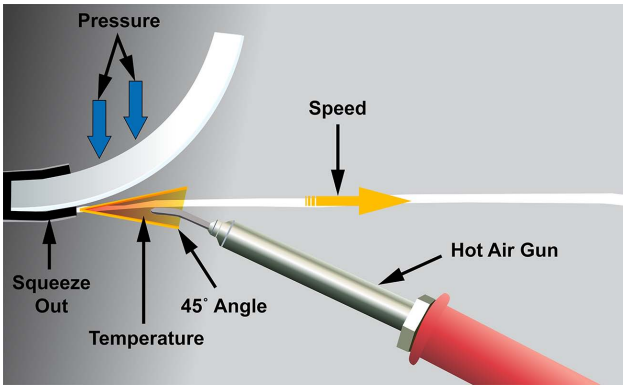
A nitrogen hot air welder uses compressed nitrogen gas to eliminate oxygen from the weld area. The nitrogen acts as a shielding gas and allows for a contaminate-free weld with less smoke, which creates a

stronger weld. This type of welder can also switch to compressed air so that when preheating or cooling down the heating element, it does not waste the nitrogen.

A hot air welder uses the same processes as the nitrogen hot air welder except that it runs exclusively on compressed air.

E-Z Weld Hot Air Welder is the name of Urethane Supply Company's (USC) hot air welding equipment, along with a nitrogen-air controller.

Refer to "Video: Nitrogen Hot Air Welding" in the presentation.This video shows a plastic weld being made with a nitrogen hot air welder.



TAPS is an acronym to remember all of the things to watch when making a hot air weld.

TAPS stand for:

- temperature, which must be at the correct setting to melt the part and the rod.
- angle, which should be about 45° to the part.
- pressure, which should be firm and constant.
- speed, which should allow for 4 - 6" of material to be welded per minute.

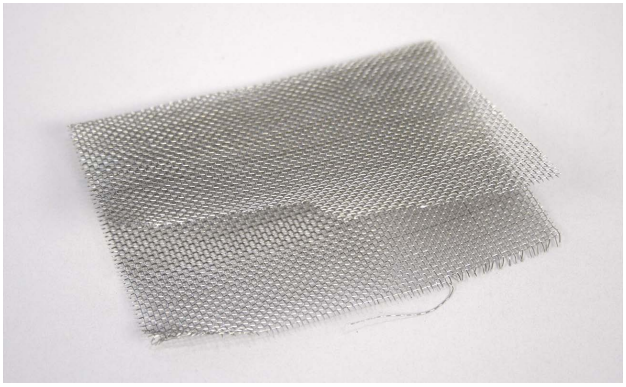
Weld Repairs

Before welding repairs begin the part should be cleaned with the appropriate cleaner.

Preparation for welding include:

- cleaning with soap and water.
- cleaning with recommended cleaner.
- wiping in one direction to help reduce static.

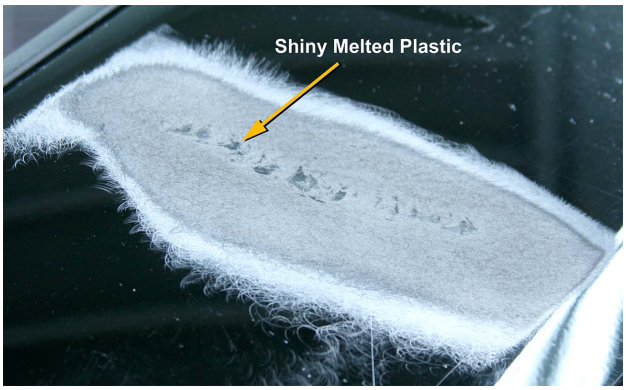
Refer to Module 4, "Demonstration: Plastic Weld" to see an example of a plastic weld.



A metal window screen may be used as a backing material.

When performing an airless weld, backing is needed to increase the strength of the repair especially in a flexible area. This backing can be made of regular metal window screen. Aluminum tape is then applied on the front side while making a weld on the backside to hold the pieces in alignment.

Also, if the vehicle is equipped with an adaptive cruise control or parallel park assist systems, no repair can be done in front of a sensor if it impedes the sensors ability to function.



Shiny or melted plastics may cause adhesion problems of repair fillers.

Some welding repair precautions are to never leave any shiny or melted plastic on the front side. This will cause poor adhesion of any filler or refinish material. It is also important to featheredge the repair area to eliminate any ringing of the repair area. With all plastics, never use a solvent on bare plastic.

Module Wrap Up

Learning objectives for this module include:

- welding equipment.
- rod adhesion test.
- how to make an airless weld.
- how to make a hot air weld.