

Description and Operation

General

The proportion of plastics used in vehicle construction continues to rise. Up to now damaged plastic components often had to be replaced. These days, plastic repairs are becoming more and more widely accepted because of the increasing cost of spare parts.

NOTE: Plastic adhesives are chemical products and are subject to the safety instructions of the manufacturer. In repair work, the material properties of plastics are highly significant. There are two main groups:

- Thermoplastics.
- Thermosets.

NOTE: Elastomers make up a third group of plastics. These are not mentioned below because they have no plastics repair applications.

Thermoplastics

Heat causes thermoplastics (also called TP polymers) to transform from the solid state into the thermoelastic state and then into the thermoplastic state. When thermoplastics are cooled, they return to solid state.

Brief description	Plastic
ABS	Acrylonitrile butadiene styrene copolymer
PA	Polyamide
PC	Polycarbonate
PP	Polypropylene
PP/EPDM	Polypropylene/ethylene propylene diene copolymer
PC/PBT	Polycarbonate/polybutylene terephthalate
Hard PVC / soft PVC	Polyvinylchloride

Thermosets

Thermosets (also called TS polymers) are much harder and more brittle than thermoplastics. Their strength remains largely unchanged when they are heated. Thermosets are destroyed when heated above the critical temperature. Also, the original state will no longer be restored on cooling.

Brief description	Plastic
GRP	Glass reinforced plastic
PUR	Close-meshed cross-linked polyurethane
PUR	Wide-meshed cross-linked polyurethane

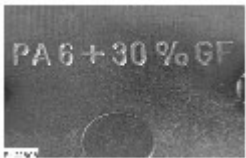
Plastic identification

Normally the appropriate identifier is marked on the plastic components used in vehicle construction.

The capital letter sequences used for this are standardized in DIN EN ISO 1043-1 and DIN ISO 1629 (for rubber) and can be looked up in the tables which they contain. In addition the string of characters provides information about the exact mixture ratio and the proportion of certain fillers.

Examples of the identification of plastics





NOTE: The identification of the type of plastic is necessary for the plastic welding process in order to determine the correct welding rod (welding material) to use.
If an identifier is missing or cannot be made out, the following easy to perform tests will help:

Visual Inspection

Visual inspections mainly serve to identify PUR and GRP materials. Thermoplastic components are often painted and are therefore difficult to identify.

Identification characteristics:

- When PUR cracks or similar damage occurs, pores of foam can be seen.
- GRP can be recognized by the glass fiber structure on the inside.

Mechanical test:

The plastic group can be determined by a sound test:

- Degree of hardness - the higher-pitched the sound, the harder the plastic.
- Elasticity - the more muffled the sound, the higher the elasticity of the plastic.

Sanding test

In this a place is chosen which will not be visible later, and the finger belt sander is used to sand the plastic.

The plastic group can be determined using the pattern of the dust:

- Thermosets produce a white dust.
- Thermoplastics smear and do not produce dust.

Float test in water:

Take a small piece of plastic from the component to be repaired and test whether it floats on water (PP-EPDM, HD-PE, PP) or sinks (PVC/U, PVC/P, ABC, PC).

Nature of the surface

The surface of plastics can be categorized as rigid (PVC-U, PVC-P) and waxy (PP/EPDM, HD/PE, PP).

Adherence test using welding rod

Heat a welding rod that is identified with the type of material and the plastic component using the hot air gun. Press the welding rod onto the plastic component to be welded. When the welding rod cools down, if it remains stuck to the component or can only be removed with great difficulty, then it can be assumed that the two are made of the same plastic. When pulling away from PP/EPDM, HD/PE and PP, this can lead to strings.

 NOTICE: Danger of poisoning! When burned, most plastics release vapors harmful to health. Ventilate the room well and use respiratory protection. Where possible work using an extraction system.

Burning test

Every plastic has a characteristic behavior and smell when burned. Using a knife, cut off a small piece from the component to be repaired, remove any dirt and paint residues and set light to the small chip. Now observe the burning behavior. Compare the color, type and smell of the smoke with the results from the following table.

Short description	Plastic recognition using a burning test
ABS	Blackish smoke, the material drips like a candle when burning and smells like wax.
PA	No smoke, draws filaments, smells like burnt horn.
PC	Yellowish, sooty smoke. Smells sweetish.
PP	No smoke, the material drips like a candle when burning and smells like burnt oil.
PP/EDM	No smoke, the material drips like a candle when burning and smells like burnt oil.
PC/PBT	Hard and shiny, burns yellow, fluffy soot.
Hard PVC / soft PVC	Blackish smoke and acrid smell.

Safety instructions

In addition to the general safety instructions, the relevant regulations and accident prevention legislation must be observed.

NOTE: Without exception, before starting work you must read the safety and warning instructions in the chapter "Safety Instructions". In addition, pay attention to the warning instructions of the particular equipment manufacturer.

Information sheets, safety notices and guidelines for the processing of adhesives containing isocyanate, polyester resin, adhesives, solvent and thinners provide more details on their use.

The following instructions must always be followed:

- Polyester resin, adhesive, solvents and thinners are inflammable and must not be used near naked fire or flames.
- Sawing and grinding operations must only be carried out in rooms equipped with extraction systems.
- If no rooms with extraction systems are available, only use tools with extraction equipment.
- Protective equipment such as gloves, protective goggles, aprons and breathing masks are essential.

Because of the various compositions of plastics, repair work to plastic parts involves a variety of repair methods.

The following methods are used:

- Thermoplastic straightening.
- Plastic welding.
- Plastic adhesive bonding.
- Plastic lamination techniques.

Thermoplastic straightening

Damage to thermoplastics can be rectified by heating using the hot air gun (temperature about 100°C) while the deformation is pressed out until the shape is regained.

Plastic welding

Splits formed in plastic bumpers are typical possible plastic repairs.

NOTE: Do not carry out plastic welding in the area of fixed foam backing. The foam backing will usually be destroyed and the function of the component is then no longer guaranteed.

If repair using adhesive methods is not possible because of unfavorable conditions at the rear of the repair location, plastic welding is a possible repair process.

There are two methods of welding: hot air draw welding and hot air fanning welding.

Plastic welding set



Item	Description
1	Various welding rods
2	Scraper (heart-shaped)
3	Hot air blower (approx. 1500 W)
4	Clamps
5	Welding nozzles

In addition to the components listed, plastic welding requires tools already found in the workshop such as scrapers, sanders, face cutters etc.

As with all other welding processes, only certain material combinations can be joined together using plastic welding.

NOTE: Basic and in-depth training is offered on the following topics. You will find an overview of the complete range listed in the Training brochure published by the Ford Service Organization.

NOTE: The manufacturer's data must be taken into account when choosing welding materials and the correct temperature setting of the hot air gun.

Repair sequence during plastic welding:

- To prepare the location for welding, remove paint residues and sand the weld area.

- If parts of the material have been pushed in by an impact, the damaged area can be brought back to shape by heating.
- Drill out the ends of the split to stop it spreading further. Machine the location of the weld into a 90° V-shaped groove, to accept the welding rod.
- Lay the welding rod in the groove.
- Perform the welding. Hot air draw welding or hot air fanning welding.
- Rework the weld seam. After cooling, sand the raised weld seam.
- Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface and paint it.

Despite good preparation and the correct choice of welding materials, weld faults may occur.

The following points must be noted when welding plastic:

- Weld together like with like:
 - With very few exceptions, only the same materials can be welded together, e.g. PP with PP.
- Correct temperature:
 - The correct choice of temperature is important for the success of the repair. The plastic must be warmed until it plasticizes (dough-like, soft).

Guideline values for welding temperature:

Brief description	Plastic	Temperature
ABS	Acrylonitrile butadiene styrene copolymer	360°
PA	Polyamide	400°
PC	Polycarbonate	370°
PP	Polypropylene	280°
PP/EPDM	Polypropylene/ethylene propylene diene copolymer	280°
PUR	Polyurethane	300°
Hard PVC	Polyvinylchloride	340°
Soft PVC	Polyvinylchloride	370°

- Even pressure:
 - When rod welding, the pressure is applied by pressing on the welding rod.
- Steady speed:
 - To achieve a good weld, care must be taken that the working speed is steady.

Possible causes of weld faults:

- Deformation caused by overheating of the repair area or tensions in the material while welding the component.
- Plastic material too thin.
- Poor weld joint because the weld temperature was too low or the welding speed was too fast.
- Welding different materials together.
- Weld seam dropped because the split gap was too wide or the welding temperature was too high.

A good weld is recognized by a slightly raised, smooth and even weld bead on the surface of the component.

The weld bead must only be worked once it has fully cooled down.

Plastic adhesive bonding

Adhesive bonding of plastics has some advantages over welding methods:

- Within the group of thermoelastic plastics, all semi-rigid ancillary components (such as bumpers, front grilles, etc.) can be repaired without identification.
- A two-component polyurethane based adhesive is used for all thermoplastic parts.
- Reinforcement strips can be attached behind splits (split length up to max. 100mm) and openings to ensure the original strength properties.

Tools and equipment also familiar from paint repairs can be used in making adhesive repairs to thermoplastic components.

Angle grinders and belt sanders can be used to grind out scratches and splits. Orbital sanders with extractors are used for fine sanding.

The infrared heater is used to provide fast and certain drying throughout.

Plastic adhesive set



Item	Description
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1	2-component adhesive
2	Cartridge gun
3	Mixing tube

Apart from the components shown, other materials may be needed to bond plastics, depending on the repair position.

For large scale repairs, it may be necessary to insert reinforcement panel strips and reinforcement matting as fixing aids.

Repair sequence during plastic adhesive bonding:

NOTE: Follow the manufacturer's guidelines when using adhesives.

- Prepare the location of the bond. Remove paint residues and sand the area to be bonded. Drill out the ends of the split to stop it spreading further. Prepare the bond location into a V-shape and clean it with plastic cleaner.
- Apply the adhesive. The two-component adhesive is applied to the cleaned and primed repair location using a hand gun. Spread and smooth the adhesive using a flexible plastic spatula.
- Rework the bond location. After cooling, sand the raised adhesive. Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface. Apply paint.

GRP repairs

GRP material is hard and brittle in its strength properties. Because of these material properties, splits and openings often result in cases of serious damage.

The stability of GRP parts is impaired if the glass fiber reinforcement is cracked. The component must be replaced in cases of serious damage that affect the structure.

Minor damage (such as abrasion, splits up to 80mm, holes up to approx. 60mm diameter, etc.) can be repaired to a technically and visually perfect standard, provided that the damage does not occur in heavily used or hard-to-reach areas.

To ensure perfect repair results, observe the following points:

- The room temperature should be at least 15°C and the air should be as dry as possible.
- The repair location must be thoroughly dry and clean.
- Before the repair, the GRP part being repaired must be dried using an infrared heater or in a drying oven.
- In cases of large splits and fractures, the strength of the outer skin can be re-established by backing with a reinforcement material.

Tools and equipment from the paint shop can be used to carry out repairs to GRP parts. Angle grinders and belt sanders can be used to grind out scratches and splits. Orbital sanders with extractors are used for fine sanding.

GRP repair set



Item	Description
1	Polyester resin
2	Glass fiber mats
3	Hardener

Scissors, paintbrush and cleaning materials are other materials which will be needed to perform a GRP repair.

NOTE: Follow the manufacturer's instructions when using the repair materials.

The repair process for a GRP repair is as follows:

- Prepare the repair location. Remove paint residues and sand the repair area.
- Drill out the ends of the split to stop it spreading further.
- The repair location must be sanded by hand. If machine working is attempted, the resin will be heated so much that the surface structure will be changed. The result is inadequate adhesion.
- Perform the GRP repair. Apply polyester resin thinly to the repair location. Lay the glass fiber mat in place and apply polyester resin over it again.
- Rework the location of the repair. Sand away any polyester resin which stands proud after it has hardened.
- Clean the sanded repair surface using plastic cleaner. Apply plastic primer thinly to the repair surface and after it has dried apply the paint finish.