Repairing Plastic Telecomm's Parts

(John Paskulich)

Quick Review

Plastics are polymers - large molecules made up of long chains, of smaller molecules called monomers. Polymers can exist naturally (e.g. Gutta percha) or be created synthetically (e.g. Nylon).

There are two main families of plastics: ***Thermoplastic*** - once moulded into shape they will soften or melt with the application of heat before burning e.g. ABS plastic. ***Thermosetting*** - once moulded into shape they will not soften or melt with the application of heat before burning e.g. Bakelite.

History

19th Century plastics

Cellulose nitrate (Celluloid etc), Gutta percha, Rubber (latex), Hard rubber (Ebonite etc).

Early 20th C (up to about 1930)

Casein plastic, Phenol-formaldehyde (Bakelite, Catalin etc.), Urea-formaldehyde.

Mid 20th C (prior to WW2 on):

Acrylics, ABS (Acrylonitrile-butadiene-styrene), Alkyds, Cellulose acetate (Tenite etc.), Melamine formaldehyde, Nylon (a Polyamide), Polycarbonate, Polystyrene, Polyvinyl Chloride (PVC).

Later 20th C:

Polyolefins: High-Density Polyethylene***(HDPE)*** - examples of applications are "polythene" pipes and plastic building materials. Low-Density Polyethylene ***(LDPE)*** - examples include. plastic bags, soft bottles etc. Polypropylene ***(PP)*** usually white in colour and used for packaging, labelling etc.
Others: Polyethylene terephthalate ***(PETE or PET)*** - broad uses - clothing fibres through bottles to engineering resins. Polylactides ***(bioplastic)*** – wide range of uses from medical implants through to 3D printer filament.

Identifying plastics

It is difficult to identify many plastics in the field. A few tricks: Polyolefins float - most others sink. If you burn a sample of an unknown plastic (SAFELY) its unique flame characteristics and odour may help identify it. Modern plastic items carry a recycling code (inside a small triangle) describing the type as well. One example of a typical website with this information, and also some repair advice, is; https://www.polyvance.com/identify.php .

Researching an item's history may also offer some clues.

Item known to be made in 19th C or very early 20th C (pre-WW1):
Black/brown colour - Most likely hard rubber (Ebonite). Coloured could be "Celluloid" (cellulose nitrate) or a casein plastic. Although very early items (from mid 19th C) could be gutta percha (may range from very dark brown through to coloured). There are numerous articles on the internet on these early plastics.

Item known to be of mid 20th C manufacture (post-WW1 to 1950s):
Black/brown colour - most likely Bakelite. Bakelite is usually considered to be phenol-formaldehyde containing dark fillers/reinforcing (sometimes asbestos) Although cellulose acetate (e.g. "Tenite") was popular in the USA and it could be coloured black as well.
Coloured items could also be "Catalin" (phenol formaldehyde - related to Bakelite but without dark fillers), urea formaldehyde, acrylics and even nylon.

The Baking Soda Test - Bakelite and Catalin:
- Dip a moist cotton swab into baking soda and rub it into an inconspicuous (and clean) test spot on the item. If the cotton swab shows a yellowish mark, it is a positive test of phenol formaldehydes.

From the 2nd half of the 20th C
Numerous new plastics were developed from the second half of the 20th C. Go to sources like https://www.polyvance.com/identify.php for more information.

Glues

The words "glue", "adhesive" and "cement" are synonymous in this context. The theory of adhesives is complex but, In very general terms, the two common forms of bonding are mechanical or chemical.

Mechanical bonding means the liquid glue molecules "flow" into microscopic crevices in the surfaces and when hardened ""hook" in and hang on". An analogy is stitches holding fabric together. Examples of glues using this principle include Cyanoacrylate (e.g. "Superglue") and epoxy resins (e.g. "Araldite").

Chemical bonding means the glue molecules alter the surface material to create a new bond at the surfaces. Solvent cements are generally in this category. They often contain acetone or a related chemical, Methyl Ethyl Ketone (MEK).

For thermosetting plastic (e.g. Bakelite) repairs, the best glues are generally Cyanoacrylate (CA) and epoxy resins. Solvent cements, which facilitate a chemical

bond are ideal for many thermoplastics like acrylics, ABS, polystyrenes etc. A good description can be found at: https://en.wikipedia.org/wiki/Solvent_bonding

NOTE: Avoid using these common adhesives with PVC pipe or the *Polyolefins* (i.e. polyethylene or polypropylene plastics). These plastics use specialised versions of solvent glues and may include an additional primer stage.

Hard Plastic repair (Bakelite/Ebonite etc)

Cyanoacrylate (CA)

Liquid CA glue is made of repeating monomers of Cyanoacrylate – ions made of carbon, oxygen, hydrogen, and nitrogen. Exposure to negatively charged ions (anions) initiates a chain reaction where all the separated Cyanoacrylate ions (monomers) link together into long chains, called polymers. The CA glue can solidify rapidly when exposed to negatively charged hydroxyl ions (OH-) found in water. CA glue accelerators containing chemicals that speed up the anionic polymerisation process are also available. CA glues can also be temporarily “debonded” with acetones.

As described, CA glue e.g. “Superglue”, relies on the presence of hydroxyl ions (found in water) to cure, so this is why it bonds moist human skin almost immediately. In dry conditions, it may be necessary to dampen a surface to start the reaction. Alternatively, spray-on accelerators can be used to speed up the cure time.

Sodium bicarbonate (baking soda), combined with CA glue, not only accelerates the cure but results in a cement that both bonds and fills voids. It can be sanded etc. It cures almost immediately, requiring a technique of repeatedly dusting the bicarbonate powder over droplets of the glue to build up a void. It is white in colour and may require painting to match.

CA glue, coloured with carbon dust (scrapings of pencil “lead”, activated charcoal powder etc.), can hide minor chips on black Bakelite. Place a suitable amount of fine carbon dust in a small disposable container, apply some drops of CA glue, mix quickly with a small stick and daub the resulting paste onto the work piece until filled. The mixture has a very short work time – may harden within seconds in a humid environment. Soon after setting, the surface can be sanded with various grades of abrasive paper and ultimately 0000 steel wool. The filler is quite hard, retains its “blackness” and takes a polish. Application can be repeated to fix any blemishes. A similar process for a white finish can be achieved using talcum powder.

CA glue reacts immediately with eyes and skin so protective glasses and latex gloves are imperative, as is workplace ventilation. Beware that some heat is given off by reactions. CA glue is suitable for minor repairs where minimal stresses exist on the

item in service. Epoxy resin glues, fillers, or extra support will be required for larger jobs, or where the item is under some mechanical stress.

Epoxies

Epoxies are a class of polymer and prepolymer compounds containing epoxide groups formed by combining two substances – resin and hardener.

When combined, the epoxide groups in the resin get interlinked with the chemical units of the hardener – resulting in an extremely strong bond. The resin also contains hydroxyl groups, which have the capacity to bond with other materials. When applied on a surface, the hydroxyl groups in the resin tend to bond with the chemical units of the material and form a very strong bond.

Two-part, mouldable, epoxy putty is a useful repair product. It comprises resin and hardener each mixed with a filler such as talc. Particularly suitable for filling holes in hard plastics such as Bakelite, it can be drilled sanded etc. One local product is Selleys “Knead-it” but it only comes in a light colour so may need painting. Another product called “Milliput” is available online. It is similar to “Knead-it” but is available in black and several other colours. From experience, the finished black is a bit dull but touching up with a black spirit pen often works wonders.

Two-part, epoxy casting resins and glues are translucent. To colour them, commercial pigments are available but artists’ acrylic paint also works well. Only a very small amount is needed for a strong colour and too much may weaken the adhesion. Around 5% by volume is a typical recommendation. For black, the abovementioned carbon dust also works well.

By their nature, epoxy resins are “runny”, so will need to be contained until cured. Depending on the required outcome, the containment can be as simple as a dam of children’s “plasticine” or more sophisticated barriers, only limited by imagination. When cured, any rough epoxy surfaces can be sanded and polished similarly to that describe previously with CA.

To overcome “runniness”, epoxy resins/glues can be thickened into a paste with additives. The recommended material is “fumed silica” powder e.g. “Cab-O-sil”. BEWARE - silica dust is implicated in lung disease so ensure good ventilation and use proper breathing protection. Talcum powder also seems to work quite well as a thickener.

Always consider using mechanical support for the glue. A simple, glued, butt joint is inherently weak. This writer likes to add extra supports such as metal pins or stitches across joints (or epoxy/fibreglass reinforcing behind a joint). Analogous to woodworking where dowels or biscuits are used for the same reason. The metal pins are epoxy glued into matching holes drilled in the edges and, similarly, the stitches glued in grooves cut with a rotary tool and later disguised with coloured resin. The metal should be corrosion-resistant such as stainless steel or copper wire. The item

edge must be thick enough to use pins or stitches, if not, resort to epoxy/fiberglass reinforcing behind the joint.

Cleaning Bakelite

Bakelite surfaces, that are grubby but in good condition, can be cleaned with methylated spirits and a rag and then followed up with a suitable polish like “Polishing Paste No. 5”. Other slightly abrasive polishes like “Brasso” and automotive cutting compounds have also been successful.

With dry, grey, degraded surfaces, this writer has had some success spraying the surface with WD40 (or equiv.) and briskly polishing with 0000 steel wool. This removes grime and some of the degradation and if it is not too bad, a reasonable finish achieved. On a really badly degraded surface, application and rubbing in of black shoe polish may improve appearance but, once the surface is worn down to the filler, it cannot be properly restored. Sometimes painting may be the only option.

ABS plastic repair

ABS plastic glue

The solvent acetone dissolves ABS plastic (and related styrenes). It is an effective ABS solvent cement that chemically bonds the surfaces.

Liberally apply acetone with a cotton bud or similar to both edges to be joined and then push and hold them together until set. Leave the joint alone (at least overnight) to allow the acetone to evaporate fully and harden properly. Later, any raised “glue” lines can be sanded out and polished to give an unobtrusive result.

A "slurry" of ABS glue/filler can be made with scraps of ABS (e.g. Lego blocks?) dissolved in acetone in a sealed ***glass*** jar with a ***metal*** lid. It is slow to dissolve fully but will remain liquid if kept sealed and occasionally refreshed with acetone. Paint the slurry over the inside of a repaired surface to build up strengthening layers. Similarly, it can be used as a filler. Since the acetone partly melds the dissolved ABS into the surface before it evaporates (i.e. chemical bond), the joint is ultimately very strong.

Discoloured ABS plastic

Collectable ABS artefacts like telephones from the 1960s, computer cases etc. are prone to unsightly “browning” of the surface through prolonged UV light exposure (sunlight etc.) and sometimes nicknamed “sunburn”. It was thought that this discolouration was due to the flame retardant bromines added to the ABS but is more likely due to chemical changes in the ABS surface molecules. Several methods of reversing this damage appeared over the years. These included aggressive sanding of the surface to get down to unblemished plastic and a similar process but using a solution of acetone and methylated spirit with steel wool or rags to wipe away the degraded surface. Generally followed up with a mildly abrasive plastic polish.

In recent years, another process has arisen. Called “Retrobrite”, it uses a hydrogen peroxide solution plus UV light to bleach away the discolouration. A brief description appears at: https://en.wikipedia.org/wiki/Retrobright. Variations of this process have popped up since and these have all been enthusiastically adopted by “restorers”. All are well documented on-line.

Some words of warning. There is anecdotal evidence that this process is not suitable for coloured items. In one case known to this writer, it not only removed the “sunburn” but also the colour! There are some suggestions that the surface is weakened by the process and also that it is only a temporary fix and the “browning” will eventually reappear. The best advice this writer can offer is, where possible, obtain ABS collectables that are undamaged in the first place and store them away from damaging UV.

Final recommendation on repairing your valued artefacts: ALWAYS PRACTICE ON VALUELESS ITEMS FIRST.