



*Footwear adhesives are produced using advanced machines such as this mixer which processes both solvent and water-based products.*

CREDIT: CASWELL & COMPANY

## *Footwear Fundamentals*

# STICKING TOGETHER

**A**n adhesive is a substance used to bond two opposing surfaces together and to then resist them from being separated. The ability to do this is determined by its strength, the nature of the two surfaces involved and the manner by which it is applied. Adhesives are all solutions at some stage and the solvents used to produce them have a direct bearing on the speed and manner in which they set. Choosing the right adhesive is therefore important.

In the days before modern polymers, the choice was between starch-based pastes, latexes and rubber cements. Pastes were used in upper assembly and for attaching backers. They were cheap and easy to make but tended to be hard and rigid; they also reacted badly to moisture. Latexes were a major step forward as they were flexible and, as they could be used either wet with a single coat or dry with two, they proved suitable for a wide range of applications throughout the shoemaking process.

Rubber solutions offered the same flexibility and even greater bond strength. A variety of solvents were used to dissolve virgin or crepe rubber and produce different drying times. Carbon tetrachloride, trichloroethylene, carbon disulphide, petroleum ether and benzol produced fast-drying solutions, while toluol, naptha and xylol were slower.

Unfortunately, all are either highly inflammable or emit toxic fumes and only petroleum spirits with low N Hexane levels are now used together with efficient extraction systems.

The invention of modern polymers, beginning with neoprene in the 1940s, created a revolution in adhesive technology that has made it possible to develop new constructions, create ever-increasing levels of physical performance, improve operator safety and create the modern footwear industry. So, what adhesives are now available and what should they be used for? The simplest thing, perhaps, is to break the shoemaking process down into its various stages and list the adhesives that are available for the various processes taking place.

### UPPER CLOSING

Adhesives are primarily used in this department in the application of backers, for topline folding or binding and for sub-assembly work prior to stitching. Special variants are also used for seam sealing on specialist footwear.

Those used for backers vary with the materials involved. Latex is clean and easy to use where leather to leather surfaces are involved. It is also flexible and, if evenly applied with a spray system, will not cause wrinkling of the upper



*Nitrile rubber solution being hand applied to seal the seams of military flying boots.*

CREDIT: HAYNES & CANN

leather later on. Where woven backers are concerned, most now come pre-coated with a hot melt adhesive and are applied under a heated press. The key factor here is the type of coating. An all-over coat will create a much stiffer upper section than a powder or dot coat where less adhesive is present. In all instances, however, it is a very quick and easy system to use.

Some traditional manufacturers still prefer a liquid adhesive for both woven cloth and non-woven synthetic backers. In this instance, a rubber solution is often the best answer as, unlike latex, less of it is soaked up into the material itself and so a more even overall bond can be achieved. Whichever type of adhesive is used, it is best to use as little as possible commensurate with obtaining a satisfactory bond and to ensure it is applied as evenly as possible.

For topline folding and turning rolled or French bindings, polyamide hot melt is now in almost universal use. Fed into the folding/turning foot of the machine, it sets almost instantly to produce a clean, strong and flexible bond at a fast throughput speed. Except for micro-factory production or hand made shoes, there is nothing to beat it.

In sub-assembly work, or 'fitting' as it used to be called, the adhesive will again vary with the materials or components involved. For leather to leather, leather to fabric or fabric to fabric, either latex or rubber solution can be used if applied sparingly. Latex can be used to form a fast one coat 'wet stick', rubber solution a less time sensitive two surface coat 'dry stick'. In either case, care has to be taken to keep surplus adhesive from the surface of the upper where it is likely to show or cause stains. This is particularly important with suede and nubuck where a shoe is easily ruined as there is no way to clean it without leaving a mark.

The alternatives are hot melt or double-sided tapes. Hot melt is increasingly used in the form of a hand-held gun which extrudes a controlled amount of molten adhesive on to one surface to which the second is immediately applied. It is a good system for 'spotting' small components such as trims

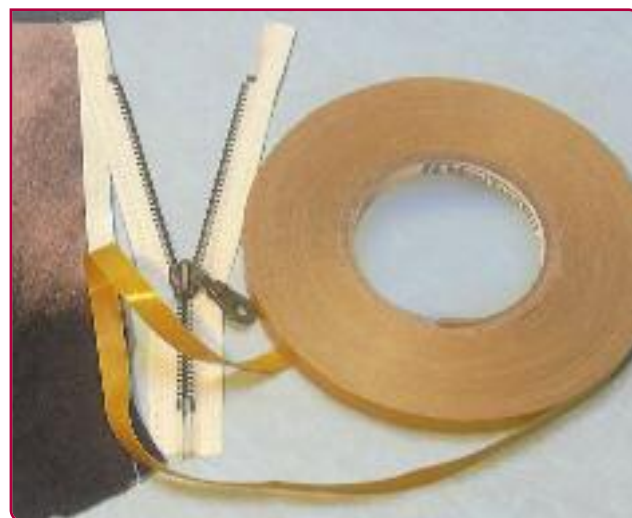
or eyelet stays. It is less successful with larger components where two hands are needed to align them. Double-sided tape, on the other hand, can be used to temporarily attach most types of upper component. It is clean, easy to use and, if incorrectly applied, can be removed and replaced without damaging the upper. It is particularly useful for locating long zippers in high leg boots to prevent distortion during the stitching of what is often a long and difficult seam. With a liquid adhesive, there is always a risk of excess adhesive jamming the zipper slider.

## LASTING AND MAKING

Modern combination lasting machines all use either hot melt adhesive or a combination of hot melt and tacks at the waist and seat. Polyamide-based adhesive is strong and flexible, and can be used throughout the shoe. The polyester-based type is however more commonly used for lasting the toe where there is no flexing of the shoe in wear as it is considerably cheaper. Both types are supplied as a reel of narrow rod that is fed into the machine's melting system immediately prior to being injected through a shaped foot or adjustable cement tracers on to the lasting margin of the insole immediately prior to the upper being wiped over and pressed down as the adhesive strikes off.

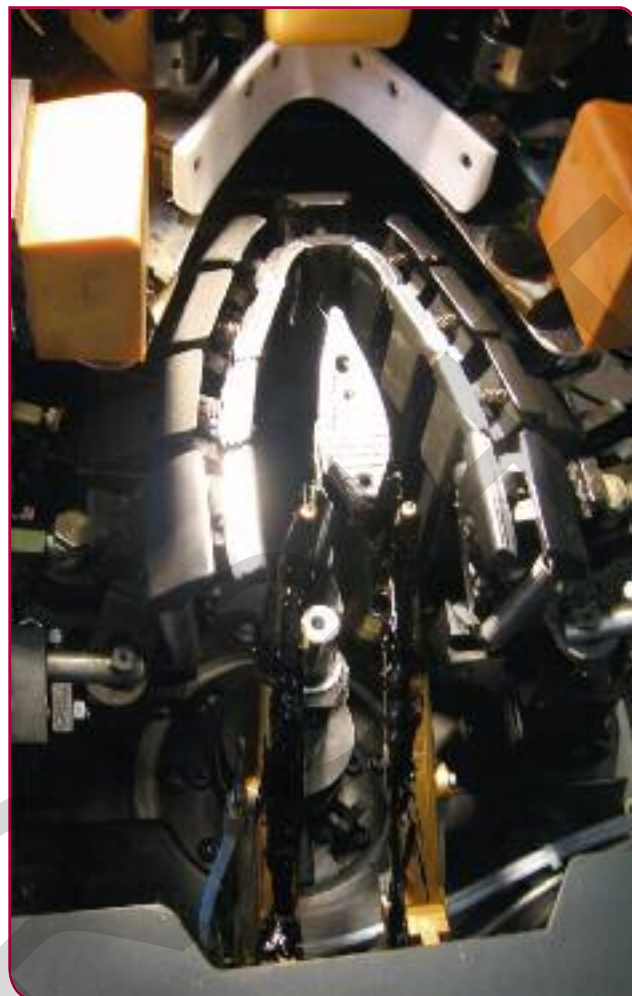
Granulated adhesive was used on the early machines but was found to degenerate in the melting pot. With rod adhesive, only the exact amount needed is fed into the melt system with each wiping-in cycle. Polyamide hot melts are nevertheless used in granulated form for attaching small bottoming components such as bottom filler, heel blocks in direct injection soling and some types of shank.

In Goodyear welted shoes, the soles are temporarily attached to the welt prior to rough-rounding to shape ready for outsole stitching. The adhesive used needs a long open time and to be capable of forming a strong bond without the use of any heat activation. It will also often be used on damp 'wetted' leather soles, so a special formula has to be used to produce it. These are usually polychloroprene rubber dispersions with an additional compatible tackifier to provide



*Pre-taping a zipper ready prior to fitting*

CREDIT: IDEAL TAPE CO



*Many forepart lasters now have cement tracers to inject adhesive accurately on to the insole.*

CREDIT: CERIM SPA

the extra 'grab' that is needed for this operation.

Sole attaching is the most demanding application for adhesives in the whole shoemaking process. Because of the extreme stresses the bond between sole and upper must withstand during the life of the shoe, their physical properties need to be exceptional and their use in the factory strictly monitored and controlled, as faulty sole bonding leads to expensive customer complaints and a rapid loss of a factory's reputation. Because of this, a more detailed analysis is to be found in an article on page 20 of this issue of *World Footwear*.

## FINISHING

The final department a shoe passes through is that for finishing or shoe rooming as it still sometimes referred to. The main application here is for attaching a sock to cover the insole and also carry the manufacturer's or retailer's brand. For many, latex remains the preferred option as it can be formulated to have a degree of 'slip' coupled to a relatively slow drying time which enables the sock to be slid into position before it begins to set. A fast drying time will not allow for the fine adjustment needed to ensure the sock sits accurately in the bottom of the shoe. It is, after all, not just functional in covering any tack ends or insole tack holes, but

an essential part of the overall presentation of the finished shoe and one which plays an important part in reflecting the image and quality of the manufacturer or brand.

## CYANOACRYLATES

One other category of adhesive to consider is cyanoacrylate or 'super glue' as it is often called. This works by a process called polymerisation which occurs when a single chemical known as a monomer is converted into a chain by reacting with other monomer units. In a cyanoacrylate, this reaction can be triggered by moisture and is why it was first used in the Vietnam War to close battle-wounds in the field.

A key feature is that the smaller the amount of adhesive applied, the faster and better it bonds. This is due to the surface to volume ratio and, in this regard, it is rather like paint; if you apply too much it takes longer to dry and does not harden properly. It is also why it comes in small squeezable bottles or tubes with a fine nozzle applicator. Similarly, a drop placed on a smooth surface will remain liquid for a considerable length of time. Applied between two substrates and put under pressure to form a thin layer, it immediately forms a bond.

Although at first glance cyanoacrylates would seem to be ideal for sub-assembly operations where speed is of the essence, there are two drawbacks. One is that they tend to be brittle when cured and so cannot be used where flexing is likely to occur. The other is that the acidic nature of leather inhibits polymerisation. Specialist products are now becoming more readily available that would appear to have overcome this. The best bonds, however, are actually achieved between leather and a totally different material such as plastic, wood or metal. This would suggest a potential use in assembling shoe trims.

## HEALTH AND THE ENVIRONMENT

The last twenty years or so have seen ever more stringent regulations to restrict the use of toxic substances in the workplace for both health and safety reasons and concerns over their effect on the environment. This caused a second revolution in footwear adhesive technology as suppliers sought to replace solvent-based products with water-based alternatives. To begin with, it proved difficult to achieve the same degree of bond strength and this, coupled to slower drying times, made many shoe manufacturers reluctant to change.

Answers were of course found. New and more advanced polymers were developed which eventually produced even better bonds than the old solvent-based adhesives. New tunnel drying and activation systems solved the production problems in shoe factories so that, now, solvent-based adhesives and primers are only used where there is no available alternative. Shoes produced using today's generation of footwear adhesives are better than ever before, factory conditions have improved immeasurably and the environment is protected. 🌱