

Many shoemaking operations involve the use of adhesives of which there is wide range, including latex, polychloroprenes (solvent- and water-based—the latter referred to as polychloroprene dispersions or PCPDs), polyurethanes (one and two component solvent-based and water-based dispersions or PUDs), hot melts (polyester, polyamide and EVA), pressure sensitive adhesives, cyanoacrylates, solvent wipes, primers and other surface treatments. Such a bewildering number of possibilities, in fact, that they cannot be adequately covered in one article. The use of adhesives in footwear will therefore be broken down into three areas: sole bonding, upper lasting and ancillary bonding operations. This first article deals with sole bonding with the other two areas following in future issues of *World Footwear*.

Adhesives in footwear — Part 1

Sole Bonding

The first adhesives with the ability to successfully join a sole to the upper entirely on their own were based on nitrile or polychloroprene rubbers, dissolved in solvents, and were in use by the late 1940s. The real growth of the stuck-on construction occurred between 1950 and 1965 when it was discovered that polychloroprene adhesives could be heat reactivated days or even weeks after application before bonding with short press times. This provided a high degree of flexibility as sole units could be prepared in advance and stored ready for use.

While polychloroprene adhesives worked well with existing vulcanised rubber unit soles, they were not compatible with the PVC sole units introduced in the mid-1960s as they were susceptible to softening by plasticisers. However, solvent-based PU adhesives soon became available which were found to provide excellent adhesion to PVC and resistance to grease and plasticisers.

Although PU adhesives provided a good bond between PVC and leather, there were consistency problems in regard to vulcanised and thermoplastic rubber (TPR) sole units. A major step in overcoming this was the development of the surface chlorination or 'halogenation' process which enabled standard PU adhesives to be used on these materials. Halogenation and specialist primers for other solings such as EVA and nylon are now widely used in conjunction with PU adhesives.

The ability to use a common adhesive type on a wide range of materials, subject to correct surface pre-treatment, proved attractive to shoemakers and, by the end of the 1970s, PU had become the main sole attaching adhesive in the developed world. Polychloroprenes are still used, however, when their good working properties will be of value.

During the late 1970s, acrylic modified PUs and PCPDs were developed for bonding thermoplastic rubber. Modified PUs are now often used after halogenation for added security, while modified PCPDs are widely used in Asia for sports and casual footwear.

SOLVENT-BASED ADHESIVES

A solvent-based adhesive is a true solution in which individual molecules of polymer are separated from each other and are freely mobile. Unless fillers, dyes or pigments are present, the solution is essentially clear. After application, as the adhesive dries and loses solvent, the molecules come together and coalesce to form a coherent solid film.

These products have served shoemakers well, as they can wet and coat a wide variety of both rough and smooth footwear material surfaces. After drying, the adhesive films can be heat reactivated and fused under a brief application of pressure to give a bond with good initial green strength and satisfactory final bond strength, providing the material surfaces have been correctly prepared.

Solvent-based PU adhesive is made by dissolving linear polyester-based thermoplastic PU polymers in solvents such as methyl ethyl ketone, acetone and ethyl acetate to provide a solids content of 15-20%. Chlorinated rubber and resins may be added to improve heat resistance or tack. It can also fall into one of three types:

- One-part with no free isocyanate present
- Pre-reacted or premixed and containing an isocyanate that reacts very slowly before application to provide a shelf life of several months
- Two-part where a small proportion of an isocyanate curing agent is mixed in by the user just before use (these have a pot life of only a few hours and a short open time)

The isocyanate again improves heat resistance and increases overall adhesive strength. It works by reacting and cross-linking the linear thermoplastic PU polymer.

Solvent-based polychloroprene adhesive is produced by dissolving polychloroprene rubbers such as Neoprene and Baypren in solvents such as toluene, petroleum and MEK to give a solids content of 20-25%. Essential additives are acid acceptors such as zinc or magnesium oxide and resins to impart tack, with the metal oxide and tackifying resin usually reacted together

Film of dry adhesive on a sole unit


before addition. Polychloroprene adhesives can be used in two-part form by adding isocyanate to improve heat and grease resistance.

WATER-BASED ADHESIVES

From the late 1980s, environmental pressure plus increasing legislation restricting the release of solvent vapours into the atmosphere and health and safety hazards—especially control of flammability and toxicity—have led to the development of water-based adhesives. These now compete with solvent-based adhesives in all markets.

Water-based adhesives are synthesised by dispersing polymers in water to form a latex or emulsion, defined as 'a stable colloidal dispersion of polymer particles in an aqueous medium'. Particles, each comprising thousands of individual molecules but still exceedingly small (0.01-0.1 microns), are kept in suspension by the action of stabilisers. The dispersion is usually milk white in appearance as the polymer particles reflect light.

After application as a coating, dispersions dry by losing water, the polymer particles being forced closer together until they coalesce into a film. Chemicals or traces of solvent are often included in the formulation to act as coalescing aids. One of the constraints of water-based adhesives is that they need to be stored at above 5°C to avoid freezing, which would lead to

irreversible coagulation of the polymers into large lumps and making the adhesive unusable.

Although the solids content of PUD adhesives is normally around 35-50%, viscosity is significantly lower than the 15-20% of solvent-based as it consists of agglomerated molecules rather than individual molecules in solution. PUDs can be used as made or mixed with latexes of other polymers such as natural rubber, polychloroprene or PVA. There is also a range of isocyanate curing agents compatible with the PUD adhesives, enabling two-part systems to be offered to improve thermal stability and bond strength.

Polychloroprene dispersions are also well established, enabling adhesives for many purposes to be formulated. Like their solvent-based counterparts, they usually need the addition of a compatible tackifying resin. They are used in shoemaking for temporary sole attachment in welted footwear and other ancillary operations.

HOT MELT ADHESIVES

The main limitation of conventional hot melts as used for lasting is relatively high viscosity and subsequent poor wetting and penetration of leather and other fibrous materials. It is not feasible to use conventional PU polymers in hot melt form. In recent years developments in reactive PU hot melts have overcome this by applying a partially cured polymer as a low viscosity melt. The adhesive then further cures by heat or moisture before either direct bonding or heat reactivation. Final cure takes place after bonding. The key is to produce the optimum balance between wetting, tack, green strength and final bond strength. Although hot melts have the advantage of 100% solids content, making adequate adhesive coatings easy to achieve, they do require special application equipment.

PROPERTIES OF ADHESIVES

Soling adhesives have to meet a demanding specification to ensure they can be handled without problems in the shoe factory and perform satisfactorily in wear. There are several key properties, most of which are common to all adhesives.

Tack — the dry, coalesced films on both surfaces have a dry feel and only become 'tacky' (sticky) when heat reactivated. Reactivation life is the time during which the dry adhesive film is capable of reactivation to produce a satisfactory bond. With ➤

Flash reactivation


WORLDFOOTWEAR

one-part adhesives this may be days or even weeks, especially if a surface reactivated after a long storage time is combined with one that is relatively fresh. For example, a storage time of one week on a sole may be acceptable in conjunction with one hour open time on an upper. Two-part adhesives have a heat reactivation life of only a few hours depending on the age of the mixed adhesive when applied. Once the two films have been reactivated, tackiness is measured by the ability of the two to form a bond immediately on contact with each other.

The first requirement is to have what is called good 'spotting tack'. The toe is usually positioned or 'spotted' first, so the initial tack must be sufficient to allow the toe to remain bonded while the waist and heel are similarly attached after bending and possibly stretching the sole. The assembly needs to remain bonded until it is placed in the sole press and consolidated under full pressure.

Toe spotting



Bond Strength — green strength is the initial strength of the sole bond immediately on release from the press and must be sufficient to prevent the sole from springing away from the upper following a pressing time usually as short as 10-15 seconds. Bond strength then gradually increases through cooling, crystallising and curing of the adhesive layer up to a maximum with one-part adhesives within one or two days. Two-part or reactive systems may require several days for complete curing.

Other Properties — sole bonds must be resistant to heat as shoes

Figure 1: Typical treatment applications

Material	Treatment	Adhesive
Upper Material		
Grain Leather	Rough	PU or PC
Coated Leather	Rough or solvent wipe to remove coating	PU
PVC Coated Fabric	Rough or solvent wipe to remove finish only	PU
PU Coated Fabric	Rough to remove coating	PU
Textiles	None, lightly rough or use special primers	PU or PC
Sole Materials		
Leather	Rough to remove loose fibres	PU or PC
Resin Rubber	Rough or split/Halogenation primer	PC/PU
Vulcanised Rubber	Rough/Halogenation Primer	PC/PU
PVC	Thoroughly solvent wipe	PU
TPR	Halogenation	PU
PU	Rough or thoroughly solvent wipe	PU
TPU	Rough or thoroughly solvent wipe	PU
EVA	Special primer or UV light plus primer	PU

Sole pressing



can experience high temperature conditions during transport and storage, display in shop windows, warm climates, and heaters and hot conditions in the home or workplace. Sole attaching adhesives are therefore usually expected to be resistant to a temperature of 60°C and isocyanate cross-linkers need to be added if a particularly high temperature environment is predicted. Sole bonds must also resist repeated wetting and those with unsatisfactory coalescence are particularly prone to weakening by wetting. Soling adhesives generally show good ageing resistance with little or no fall off in bond strength through extended storage under normal conditions. Occasionally, however, chemicals from the upper or sole such as grease will migrate to the bond line and reduce strength.

SURFACE PRE-TREATMENTS

Effective surface pre-treatment is essential for good bonding and can be either mechanical (roughing or scouring) or chemical (solvent wiping and priming). Both types prepare the surface by removing contaminants, consolidating weak layers or enabling it to be more easily wetted by the adhesive. Chemical treatments can also modify the surface to give it greater affinity for the adhesive, while UV or gas plasma treatments are increasingly used to activate difficult surfaces. A list of typical treatment combinations is shown in *Figure 1*.

BONDING PROCESS

Adhesives can be applied by hand brush, pressure fed brush or roller or extruder machines. Special applicator heads for water-based or hot melt adhesives have been developed and computer control is on the increase. Water-based adhesives are more difficult to dry than solvent-based and this has led to the development of drying equipment with increased air movement and/or higher temperatures.

In much of the world, heat reactivation immediately prior to spotting and pressing continues to be the favoured sole bonding method. However, there is also a move back to using longer wavelength infra red energy for reactivation, with its low sensitivity to surface colour compared to flash heaters.

In Asia, adhesive coated soles and uppers are usually dried in successive warm air cabinets, followed by a reactivation stage giving a temperature sufficient for coalescence. The comparatively high amount of heat absorbed by the materials allows for a relatively long delay between heating and pressing. Indeed, the soles of sports and casual footwear, after spotting, are often pressed in successive operations dealing with sidewall, toe/seat and sole bottom, using simple presses in each case. In conventional shoemaking, the need to press the whole of the sole evenly in one operation has led to flat bed presses with self-levelling pad boxes or diaphragm presses which envelop the whole sole. 

FASHION & TECHNOLOGY SIGN YOUR PRODUCTS WITH QUALITY SEAMS



C.T. POINT Spa
BRAIDS - SEWING THREADS

S.S. 263, Km 26 - Zona Ind.le
66010 RAPINO (CH) - ITALY
TEL: 0039 087180851
FAX: 0039 087182607
www.ctpoint.it
E-mail: ctpoint@ctpoint.it

SALES:
TEL: 0871 80851
FAX: 0871 800290
E-mail: info@ctpoint.it



C.T. POINT manufactures and sells all over the world the widest range of sewing threads for shoes and leathersgoods. Guarantee of excellent performance, high resistance and outstanding aesthetical results. More than 100 colours and multi colours.

COMBI the only original braided waxed thread, created in 1975 for moccasins machine sewing, for special stitches (cross, square, comb, a.s.o.) and for Opanka box soles sewing.

SLAM waxed braids for hand sewing of moccasins, leathersgoods, suitcases, bags and similar.

PENNY twisted polyester sewing threads for shoes, leathersgoods, bags, luggage, upholstery furnishing and technical uses.

WEST waxed cord for American type moccasins hand sewing by one or two needles system.

BLAKE ready-to-use threads for soles sewing by Blake and Rapid machines, welts and randing.

LOGO silicon lubricated braided threads for decorative seams by usual sewing machines.

METAL metal plated threads for "fashion" highly decorative seams on shoes, bags and leathersgoods.