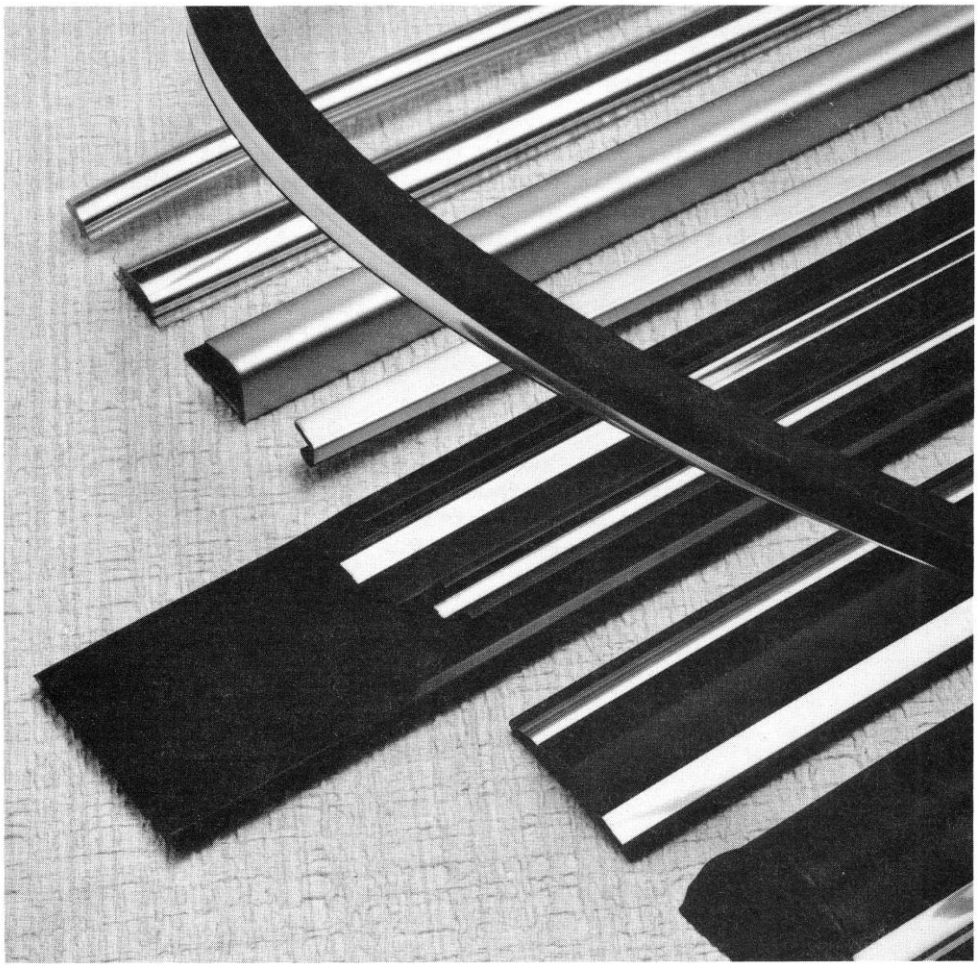
METALON LAMINATES FOR PVC EXTRUSIONS

Metalon vinyl-based laminates are specially designed for bonding to PVC extrusions by heat and pressure, to give to the finished profile a decorative surface finish, metallic or coloured, smooth or embossed, which cannot be achieved with normal extrusion compounds alone.

The finished extrusions, trimmed with Metalon, are used extensively in the automotive industry world-wide as internal trims, body-side mouldings, windscreen surrounds and accent lines on bumpers. The imaginative combination of Metalon with either flexible or rigid extrusions has also produced a wide range of applications for other products, such as furniture, footwear and travel goods. New possibilities for using Metalon faced PVC extrusions continue to be found as extrusion companies become aware of the potential of this versatile laminate.



The purpose of this guide is to give general technical information to customers wishing to apply Metalon to PVC extrusions. As there are a wide variety of process methods and materials, however, these notes should be regarded purely as a general introduction. Individual customer requirements and profile design will greatly influence the finer details of the production methods used.

INTRODUCTION

The precision-calendered PVC substrate of Metalon provides a firm cushion between the bright metallic or coloured surface and the extruded section. This makes it possible to obtain a smooth bright surface finish on an otherwise indifferent PVC extrusion. Major defects in the extrudate will still show through, but should be reduced in severity.

To achieve the bond, Metalon tape, in the appropriate width, is heat welded to the extruded PVC during processing, using residual heat in the PVC as it leaves the extruder. PVC in this hot plastic state is very tacky and will, therefore, stick to the PVC backing the Metalon laminate if this is pressed firmly on to the extrudate within a very short distance of the die head. On a section of simple design, where the adhesion between Metalon and extrusion is not critical, the bond achieved in this way will probably be adequate, but its strength is considerably increased if the PVC supporting the Metalon tape is heated prior to contact with the extrudate.

Where die design allows the Metalon tape can be inserted direct into the extrusion die head rather than the tape being laid onto the extrudate, although this method is generally more complicated and needs greater attention to tension and stress control.

After being heated ready for bonding, the Metalon tape is fed through one or more guides to shape it to the required form. It is then firmly rolled on to the hot extrudate by power-driven rollers profiled to make accurate contact with the section.

The profile, with the Metalon tape laminated to it, is then drawn through a water-cooling bath by a winch or haul-off located at the end of the bath. It can then be reeled or cut to length, inspected and packed.

The above description indicates how a PVC extrusion may have Metalon bonded to its surface. Process methods will differ greatly where the Metalon is encapsulated or where it is being laminated to an extrusion made from rigid PVC.

EXTRUSION MACHINE AND PVC COMPOUND

The extruder should preferably be of modern design and of the standard generally used for high-quality PVC work. As precision extrusion is involved, accurate temperature control is essential. Good design of the head and die are of great importance to dimensional stability, rate of output and continuity of running. When the final design of the profile has been arrived at, the finished die should be made with perfectly blended changes of cross section and shallow approach angles. Regular inspection and careful maintenance of the die will also help prevent turbulence defects and die lines.

For simple non-encapsulated sections, general-purpose compounds are usually quite satisfactory. They should be consistent in both quality and rheological properties to ensure conversion into a uniform melt. Surging must be avoided. Dimensional control of the finished extrusion will highlight any problems in this area.

It is best to avoid heavily filled compounds, as these tend to be dry at extrusion temperatures and give inferior bonds to the Metalon backing.

Care should also be taken to use good quality plasticisers in the compound to be extruded, especially avoiding those containing a C_6 fraction. Soft compounds containing more than a very small proportion of a volatile plasticiser, such as DBP, may occasionally give problems. Small vapour bubbles might form under the Metalon tape and these may not develop and appear until a day or two after extrusion. Where a rigid grade of Metalon is being used, plasticisers containing low molecular weight fractions have been known to migrate into the rigid PVC substrate and consequently induce stress cracking during storage of the profile.

Great care is also needed when Metalon is being used in conjunction with very soft compounds, as the finished profiles are easily stretched in use and the bond between Metalon and extrudate may be ruptured.

DISPENSING THE METALON TAPE

The reel of Metalon tape being used should ideally be placed on a horizontal - not a vertical - turntable, as this will considerably reduce variations in the torque needed to unwind the reel. If the Metalon is in a vertical position the continual reduction in mass as the reel is consumed, together with the inevitable slight eccentricity of the reel, will cause variations, which will make it more difficult to maintain a uniform tension at the next stage of the process.

When the reel of tape is nearly exhausted, another should be placed on a second reel holder or turntable. The expiring reel can then be unwound completely and the tail end joined to the lead end of the new reel. A butt joint, using a suitable heat-resistant adhesive tape on both sides of the Metalon tape, is usually satisfactory and gives least risk of fouling the guides. Several metres of profile on both sides of such a joint will have to be discarded, as it will have been produced under conditions of uncertain tension in the Metalon tape.

Where we have supplied a very narrow Metalon tape (3mm wide for example) with two tapes on one common core, then the top reel can be unwound when it is almost used up and be attached to the bottom reel.

TENSION CONTROL

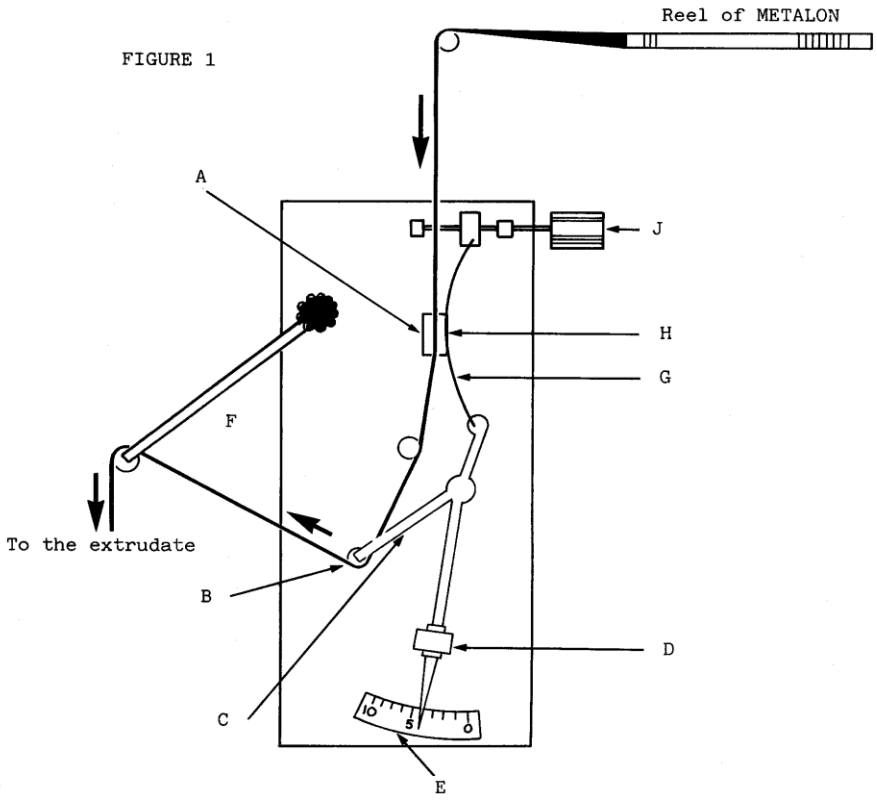
Throughout the bonding operation, the control of tension is very important. Not only is it vital to the process itself, but it also affects the quality of the finished profile, especially with regard to wrinkling and delamination of the top polyester film layer. The correct tension must, therefore, be set and maintained by a tension control system through which the Metalon tape passes on its way from the reel to the extrudate.

Insufficient tension in the tape impedes the shaping of it as it passes through the guides. Excessive tension is undesirable as it can result in dulling of the metallic layer and can create dull patches or milky stress marks. It may also lead to weakening and/or delamination of the clear polyester film from the surface of the metallising. Care must therefore be taken to avoid exceeding the stress limits of the particular tape being used especially laminates where Chromium metal is used in the structure. As these limits depend on temperature, tape width and profile design, they are best established by trials, but we suggest you aim for a maximum of 2 – 3% when using Aluminium metallised laminates and a maximum of 1 – 2% stretch when using Chromium metallised laminates.

Smooth profiles, which in service are required to negotiate radii in the principal plane of the Metalon, are best laminated with the tape under tension. The elastic stress thus imparted to the polyester film on the surface of the Metalon will enable it to accept compressive stress on the inner radius of a curve by elastic recovery, instead of deforming into a wrinkle, which it might otherwise do.

The tension required for any particular profile must, of course, be established by pre-production trials, but the exact amount needed will be a matter of grams per centimetre width, rather than kilograms per centimetre. We suggest that trial sections be produced under different tensions and then tested in the exact manner in which it is proposed to use them in service - or against an end-user specification.

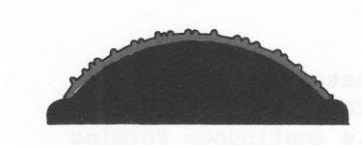
FIGURE 1



A proposed, simple tension-control device is shown above, although many variations and alternatives are possible. In this example, the Metalon tape is led between two spring-loaded felt pads (A) and (H), round the pulley (B), which is attached to the lever arm (C), to which, in turn, is attached the loaded pointer (D). The tension can then be read on the scale (E), which may be arbitrary or calibrated in grams. The tape then passes over the idler pulley (F) and down towards the extrudate. The loaded lever arm exerts a pressure upon the spring (G), which presses the moving pad (H) against the fixed pad (A). The pressure can be adjusted with screw (J). The required tension is obtained by using this screw and it is then maintained throughout the run by compensating adjustments to the spring tension caused by movements of the lever arm. This arm will only move if there are changes in tension and its movements will adjust the tension in the opposite sense, thus restoring equilibrium.

OBTAINING THE OPTIMUM BOND

Obtaining optimum and even bond across the width of the tape is critical to good performance. Where the bond is not perfect and the finished section is subject to stress, there is a risk that the Metalon tape will separate from the extrusion. This will cause unacceptable wrinkling of the tape as it lifts off the extrusion in the stress area.



Poor adhesion can also reveal itself in the formation of small blisters or bubbles on the surface of the Metalon, caused by areas of non-adhesion and the emergence of volatiles between the vinyl layers.

As already mentioned, pre-heating the PVC reverse side of the Metalon will assist the bonding of the two PVC surfaces. This can be achieved by passing the tape continuously in front of an infrared heater with the PVC side of the Metalon towards the heater. The optimum temperature to which it should be heated is the highest at which the next step of feeding the tape through the guides can be controlled. Temperatures of around 100^0C are usually ideal - above this the Metalon can curl excessively. Additionally a combination of too much heat and tension can affect the bond of the metallic deposit to the polyester film, resulting in dulling or even delamination.

A typical heater would be of slender design, about 20cm long and partially surrounded by a brightly polished reflector. It can be a simple radiant resistance heater of the type used in domestic electric fires, consisting of a single strand of resistance wire wound on to a ceramic core. 750 watts is usually adequate, but larger or smaller elements can be tried and the heating effect can be adjusted by varying the distance of the heater from the Metalon.

Silica tube type infrared heaters give a better performance, last longer and are also safer electrically, although they may need to be specially made.

When small heaters are used to reheat the edges of the Metalon tape, these need to be custom-made. Fine resistance wire wound on to a silica rod of about 3 or 4cm in length will make an adequate heater and, because of their low resistance, these small heaters should be supplied from a step-down transformer of around 24 volts.

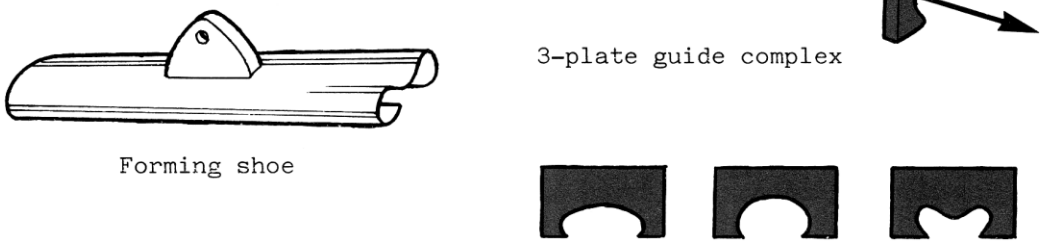
In the case of difficult profiles or unusual extrusion compounds, or where a sufficiently high heat input is not possible, some users employ a method of wiping the PVC reverse of Metalon with a solvent such as Iso-phorone to make the vinyl tacky. In this system the tape is usually passed over a solvent impregnated felt pad. Great care is needed when using this method to ensure that the laminate is exposed to the minimum of solvent, in order to avoid damage to the laminate structure. For this reason we cannot really recommend this method.

LAMINATION TO THE EXTRUDATE

After passing the heater, or the tension control stage, if no preheating is carried out, lamination to the hot extrudate can be achieved by leading the Metalon tape through pre-forming guides before it contacts the extrudate as it passes under the profiled rollers. The guides flex the tape to an appropriate shape and also control the angle at which the tape meets the extrudate.

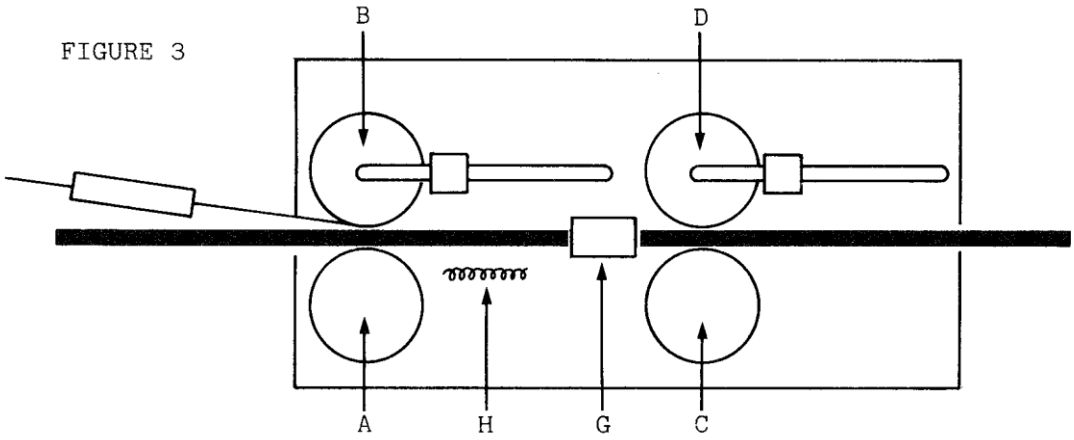
The guide system may consist of a series of plates, which lead the Metalon progressively from its original flat form to the profile at the top of the section. Alternatively a single continuous forming shoe may be used, although this is more difficult to produce. Whichever method is used, the guides should be kept as low in weight and surface area as is possible so that they do not absorb too much heat from the Metalon. The number of plates or the complexity of the forming shoe will depend upon the profile required.

FIGURE 2



A typical roller system is shown in Fig.3. This features a powered roller ‘A’, with its complementary floating weighted roller ‘B’. For simple profiles this is all that is required, but where the complexity of the sections demands it, additional heaters ‘H’ and rollers ‘C’ and ‘D’ can be used. Loading of the upper rollers is by a weight ‘E’ of about 450 grams, which can slide along a notched and indexed arm. An additional guide ‘G’ is shown, which would be needed where there is a wrap-around of the Metalon tape. This guide could be made in two halves from solid brass. The rollers can be manufactured in brass or preferably stainless steel. They should be hollowed out to reduce their heat retention capacity.

FIGURE 3



The guides and rollers soon reach a high equilibrium temperature whilst the first running adjustments are being made and, as a consequence there is no need to make special provision for heating them. In practice they receive a considerable amount of stray radiation from the infrared heater.

Since part of the heat required for bonding the Metalon tape to the extrudate is supplied by the extrudate itself, it is essential that lamination takes place as close as possible to the die head. If the first pair of rollers is about l0cm from the die head, this should leave room for feeding the Metalon tape through when starting up. For the same reason - heat conservation - the pre-heater should be as close as possible to the point of lamination, ideally only a few centimetres directly above the die. From the handling point of view, it is also desirable to keep the path of the heated Metalon as short as possible.

If the profile over which the Metalon is to be applied is very complex (for example: with deep curves or a wrap around underneath) it may well be necessary to apply the tape in stages. The first roller smoothes the Metalon on to the top and sides or into a surface recess. An additional guide plate may be needed to further shape the Metalon before a second roller presses it into its final position. Small additional heaters may also be necessary immediately before the second roller to reheat the PVC reverse of the tape and the extrudate to ensure the optimum bond.

The pressure applied to rollers should be little more than the minimum necessary to achieve a good bond. It will, of course, vary from one profile to another. Excessive pressure will cause variations in the dimensions of the profile, which may tend to become so thick in front of the roller that in fact the roller is lifted.

COOLING AND HAUL-OFF

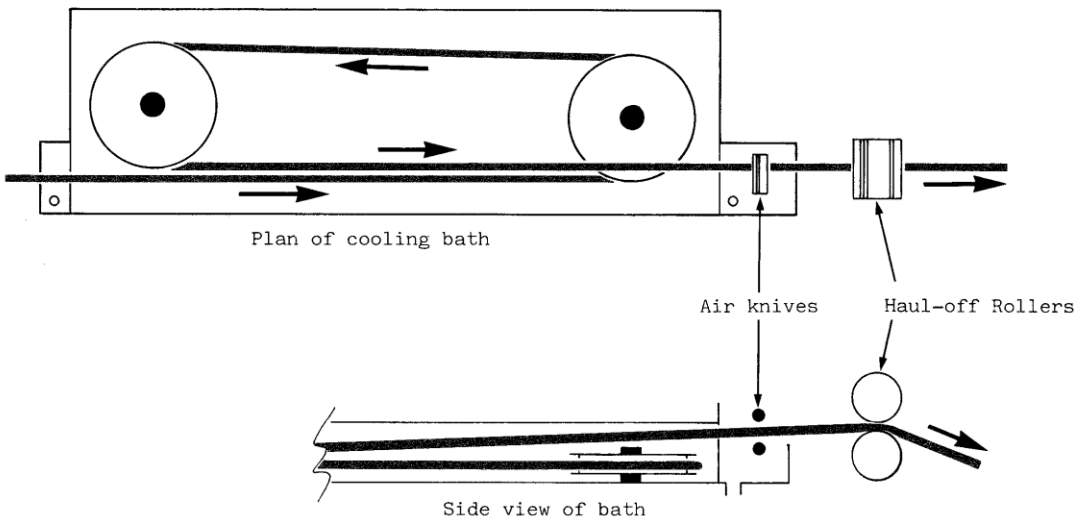
Immediately after leaving the laminating rollers, the completed profile should be passed through a cooling water bath. The length of the profile's path through the bath should be adjusted so it is still sufficiently flexible on exit to be reeled up, if this is a requirement, but still cool enough to withstand handling without distortion. The water movement should be kept relatively still as agitation can cause small bubbles to cling to the profile surface, and as the profile is still hot these bubbles can be sufficient to leave indentations in the profile surface.

Upon leaving the bath the profile should travel up a slight incline towards the haul-off to ensure that most of the water runs back towards the bath. The last traces of water can be removed with a suitably designed air knife. There should be no moisture at all left on the profile when it is reeled up or cut to length and packed, since this could lead to corrosion problems if a metallised grade of Metalon is used.

Whilst standard commercially available baths will be satisfactory, it can be advantageous to use a trough 40cm wide. This will allow the extrusion to be passed round horizontally rotating reels in the bath so trebling its passage through the water. This avoids the need for either excessively long cooling baths or the use of two baths in Tandem (see Fig.4.). The reels should be resistant to corrosion by water and made from either polythene, rigid PVC or phenolic laminate. An adequate supply of clean cool water of reasonably constant temperature is, of course, essential, as is a drainage system to a sump or reservoir. It is also advisable to have provision for adjusting the height of the bath.

The final haul-off may consist of plain rubber rollers, if simple sections are produced. However, such rollers may seriously distort particularly complex or delicate profiles, and in this instance rollers with matching profiles may be necessary. Very heavy sections will probably need caterpillar type haul-off s to grip them firmly over an appreciable length. Here again adjustment for height can be an advantage.

FIGURE 4



The final operation in the process may require the profile to be cut to length using a guillotine blade, and where this process is used it is essential that the blade is kept sharp in order to minimise polyester/metallising separation during the cutting stroke.

TYPICAL OPERATING PROCEDURE

A typical operation for producing a PVC extrusion laminated with Metalon using the suggestions in the previous pages, could be described as follows:

The extruder is started up in the normal manner as for any regular PVC extrusion. As soon as it is producing a homogenous melt of good finish, the drive motors to the laminating rollers and the final haul-off are started and the radiant heaters are switched on if these are to be used.

With all the top rollers in the raised position, the extrudate is led through the laminating rollers, the water bath and the final haul-off equipment. The speed of the rollers is adjusted to take the extrudate from the die with virtually no pull-down, and the final haul-off is set to give a section of roughly required dimensions. Accurate sizing is not possible until the Metalon has been applied.

The Metalon tape is now introduced by leading it through the felt tension pad, over the tension control arm, past the heater, through the guide plates or forming shoe and under the first top roller, which can then be gently lowered into position. Any further top rollers being used can be lowered after the leading end of the Metalon has passed under them. As this leading end moves through the final haul-off, the normal working tension will have been established on the profile and the material now leaving the extruder should be marked either with a wax pencil or by pinching with the fingers. When this mark has passed through the final haul-off, a sample may be taken to check the profile's dimensions.

Regulating the speeds of the laminating rollers and the final haul-off can now make adjustments to the overall size of the profile. If the profile is oversize, the laminating rollers can be speeded up until they remove the die-swell, but no more. Any further reduction in size can be affected by speeding the final haul-off. If the profile is under-size, the final haul-off should be slowed down until either the desired size is reached or the profile becomes slack in the water bath.

Attempting to peel back the Metalon tape from the extrusion can roughly assess the bond strength of Metalon to the extrusion. If it appears satisfactory, a sample should be submitted to a thorough and more controlled test in the laboratory.

It is not possible to give any clear guidance on the running speeds, which can be reached when laminating Metalon in this way, as much will depend upon the profile and the type of machine being used. Provided the extruder's capacity is not reached and the die design is good, the only limiting factor to the speed is the control of the Metalon tape through the forming guides.

SLITTING OF METALON

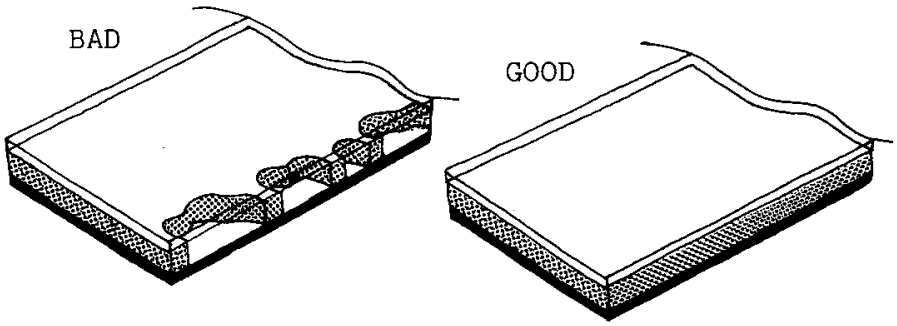
Chamberlain Plastics International Limited operate a very comprehensive slitting service which enables us to supply all grades of Metalon laminates slit with great precision and to the highest standards of presentation in widths from 3mm upwards. We appreciate that some customers prefer to carry out their own slitting locally, so we offer the following guidance on the successful slitting of our product.

The slitting of the more complex laminates, such as Metalon/Tedlar® is crucial to their subsequent performance, as the edges of such laminates can be easily disturbed during the slitting process. This can result in the laminate becoming vulnerable to attack by moisture.

It follows, therefore, that the highest standards of slitting must be maintained and that particular attention be paid to the slitting of very narrow tapes, as these are especially sensitive to damage.

For those users who prefer to convert the product into tape themselves we suggest the following test method to assess slitting standards:

Samples of slit tape, together with a standard tape sample of acceptable quality as a control, are immersed in a 10% sodium hydroxide solution at room temperature for thirty minutes. They are then rinsed in cold water, dried and compared to the standard tape sample. The extent of ingress of the caustic solution into the metal layer can then be noted.



We use a sample length of tape, which is longer than the circumference of the slitter knife, and immerse it in the sodium hydroxide solution contained in a 1 litre-measuring cylinder. This allows us to use a long sample with only one, not very severe bend. It is important that a control sample of known performance is always used at the same time to ensure that any variations, such as solution strength or temperature, are catered for. The solution must be changed regularly to obtain comparable and reproducible results.

The slitting system we use is shear cutting, similar to a scissor action. To obtain consistently good results, it is important to pay special attention to:

1. Knife quality
2. Minimal depth of cut
3. Accurate tension control of the Metalon web.

Each machine will, of course, produce varying and individual results and its performance is best evaluated and adjusted by checking the quality of the tapes produced by using the above test method.

EXTRUSION DESIGN

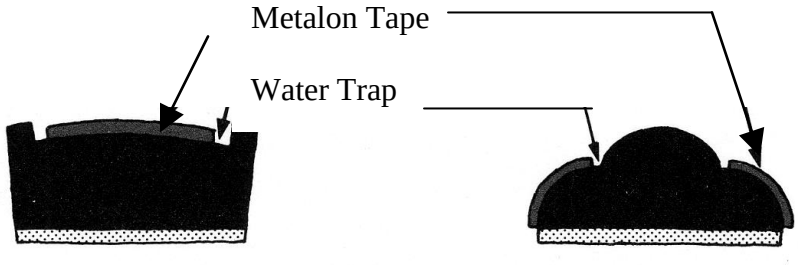
As Metalon is a laminated construction, it is sensitive to damage along its slit edges or at the end of a tape on the profile, where the layers of the laminate sandwich are exposed. Special attention should therefore be given to the profile design so that it offers some protection to the Metalon.

On profiles used internally, where the Metalon forms the surface of the finished product, the amount of eventual handling and abrasion will usually determine the necessity for protecting the edges of the tape.

On a decorative internal-use section, which receives little or no abrasion from handling, such as a curtain track extrusion, it is not essential to design the profile specially to protect the edges of the Metalon. On a drawer pull section, however, which would receive considerable handling in service, the profile would need to be designed so that the Metalon is effectively recessed into the surface.

On sections that are exposed to weathering or moisture, special care must be taken to avoid moisture penetration into the laminate, which can result in corrosion spots or larger areas of metal removal. Ingress of this sort can be avoided on encapsulated sections by appropriate extrusion design, end-sealing or end protection by means of protective caps.

Where a Metalon/Tedlar laminate is applied to the surface of an externally used extrusion, it is vital that the edges of the tape are protected against moisture ingress. The diagram below shows extrusion designs where the tape edge is not protected and where damage to the tape will probably result. On the left hand profile in the diagram, the edge of the tape has been protected against mechanical damage by the raised side of the profile, but the resulting design has produced a ‘water trap’, where moisture can collect and attack the tape edge.



The diagram below shows extrusions where the edges of the tape are protected against damage by being buried in the extrusion itself or by being wrapped underneath and covered by the double-sided adhesive mounting tape.

For more information, please contact our Sales desk.