TRANSCONTINENTAL

reflex™
SteriTouch®

High Performance Films
TECHNICAL MANUAL

1. INTRODUCTION

reflex™ is a high grade, graphic overlay film developed to meet the exacting requirements of Screen Printers, Membrane Touch Switch and Fascia-panel manufacturers and their end users. It is coated on one side with a print receptive layer for UV and solvent-based inks. On the other side it is coated, in a cleanroom certified to ISO Class 7, with an advanced UV radiation cured resin. The hard-coated surface is a formulation developed to have exceptional chemical resistance and hardness, combined with an option of maintaining emboss-ability with an extensive switch life. Transcontinental Advanced Coatings believes it has achieved the optimum balance with reflex™ in both CE Gloss, LT Textured and LT Digital grades.

reflex™ CE Gloss is optically clear with an abrasion resistant finish. The coating has been specially developed so it can be embossed and reflex™ CE Gloss hard coat can be selectively textured with screen printable texturing lacquers.

reflex™ LT Textured and LT Digital incorporates SteriTouch® antimicrobial additive during the manufacturing process. Based on innovative silver technology, SteriTouch® is designed to reduce the growth of harmful organisms, such as bacteria, mould and fungi. It is particularly effective against illness causing bacteria including MRSA, E.coli and Salmonella. SteriTouch® remains entirely safe for even the most sensitive applications.

1.1. Technical Data: reflex™ CE Gloss

Please refer to the Technical Datasheet on the website www.tc.tc/advancedcoatings

1.2. Technical Data: reflex™ LT Textured and LT Digital

Please refer to the Technical Datasheet on the website www.tc.tc/advancedcoatings

2. PRINTING GUIDELINES

2.1. reflex™ can be used with solvent based and UV inks. UV screen printing inks have the advantage of faster processing speeds and of potentially being more environmentally acceptable. reflex™ LT Digital is also suitable for use with many digital print technologies.

2.2. Keep printing facilities and equipment free from dust and contamination. A clean working area greatly enhances printing quality.

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2.3. The use of static eliminators prevents the **attraction** of dust onto the substrate surface and improves sheet handling. Film cleaners are also an effective method of cleaning a substrate surface.

2.4. Further dust reduction can be ideally achieved by maintaining levels of relative humidity of around 55% RH and low working temperatures of around 65-70°C.

2.5. Printing of UV lacquers should be carried out away from other UV sources such as direct sunlight and exposure units.

2.6. The recommendation is that all inks should be tested for their compatibility with the reflex™ Graphic Primer Layer.

3. DRYING GUIDELINES FOR SOLVENT INKS

3.1. Because of the impermeable nature of polyester substrates, printing inks may take longer to dry than on substrates that absorb solvents.

3.2. Ensure that the printed ink is completely dry prior to subsequent printing operations. Failure to do this may result in the build-up of retained solvents and lead to deterioration in adhesion.

3.3. If the presence of retained solvents need to be accurately monitored, the use of a gas chromatograph is recommended. Alternatively, gravimetric tests can be carried out.

3.4. A number of drying methods are appropriate for drying printing inks. One of the more efficient methods is air jet drying, evaporated solvents being removed by a moving air stream.

3.5. reflex™ is based on heat stabilised polyester film, which can withstand drying temperatures up to 110°C without significant residual shrinkage or color change occurring. However, some inks may be susceptible to surface skinning when rapidly dried at high temperatures. It should be noted that wherever possible an extended drying time be used. Generally, it is found that the longer the dwell time in the dryer the better the results in print adhesion. Typically ink adhesion is improved after 24hrs due to the post curing effect. If available, multizone ovens should be used which can be adjusted to give lower temperatures in the early zones of 70-80°C, increasing the temperatures to 90-100°C in the final zones. Higher temperatures may be required for conductive inks. Single zone dryers can be used for temperatures of 90-110°C.

4. CURING GUIDELINES FOR UV INKS / LACQUERS

4.1. Inks and lacquers cured using Ultra Violet radiation are very popular as the demand for fast processing speeds and solvent-free systems grow.

4.2. Conveyor speeds depends on the quantity and power of lamps. For example, 6-8 m/min is recommended for one lamp, increasing to 9-11 m/min for two lamps.

4.3. Particular care should be taken to follow safe handling recommendations for UV inks.

4.4. The printing / drying recommendations given here cannot cover all eventualities. It is recommended that all inks are tested in production type conditions before usage. If printing problems continue consult either your ink supplier or contact your local reflex™ supplier. Please follow all Health and Safety precautions suggested by ink / lacquer suppliers.

5. CUTTING GUIDELINES

The reflex™ range of coated films is based on optical quality, heat stabilised, print receptive polyester. The nature of polyester makes it extremely strong and durable, giving reflex™ enhanced longevity and reliability. The hardcoat has been formulated to give maximum adhesion to the base film. Particular care should be taken when cutting materials based on polyester films. The hardness and structure of polyester polymers can cause internal film delamination when the polyester is subjected to the shear forces present during cutting operations. Provided the correct precautions are taken when cutting polyester there should be no occurrence of delamination. The two most extensively used methods for cutting polyester are guillotining and die-cutting. The following recommendations are based on the experience of manufacturers who have successfully cut and processed reflex™ polyester films.

5.1. Die- Cutting

Steel-rule die cutting is a popular and inexpensive cutting process used for polyester. Points to optimise the cutting method are outlined below.

5.1.1. Blade Profile

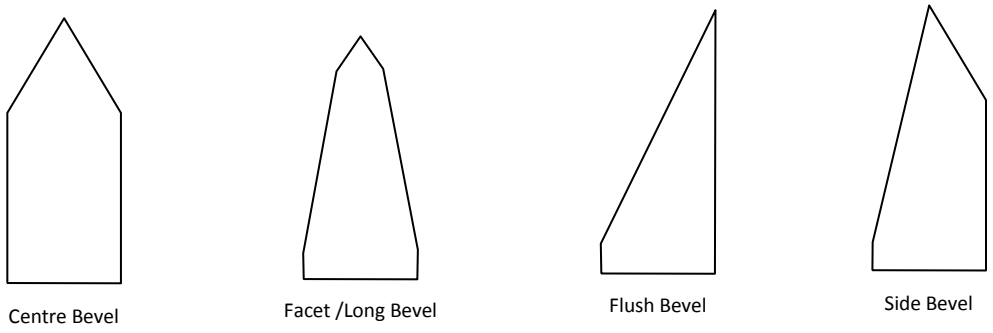

Figure 5.1.1. Steel-rule designs

Several different steel-rule bevel designs are available as illustrated above. Centre bevel is more common and should provide the longest wear-life. A facet or long bevel can give a cleaner cut because the longer bevel reduces material displacement whilst the broad tip stays sharp. A facet bevel is particularly recommended when cutting thicker gauges of polyester. Side bevel profile is recommended for cutting assembled membrane touch switches and other multi-laminates of polyester. The long bevel side should face the trim or scrap of the material being cut. The flush bevel rule can provide a clean cut, but care must be taken that the weak tip is not damaged.

5.1.2. Blade Specification

A 2-point rule (0.7mm thick) is generally recommended for cutting reflex™. The blade edge should be maintained in excellent condition. It is recommended that the blade should be regularly sharpened by grinding the edge. Steel rule dies are manufactured by two different methods: laser and jig. More accurate tolerances are achieved with a laser cut die (±0.1mm) compared to a jig-cut die (±0.4mm). Independent tool manufacturers should be consulted for advice on suitable tools for different applications. The tool hardness can be varied, however, reflex™ polyester is best cut using a tool with hardness of between 420 and 450 VPN.

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5.1.3. Die Design

It is likely that the part being cut from the die will have slightly different dimensions from the die itself, the difference depending on the rule design, size and shape of part and film thickness. It is likely that cut out shapes will be larger and stamped holes smaller. It is therefore recommended that dies are designed with dimensions at either end of the tolerance range of the material to be cut. Dies to cut out shapes should be made slightly smaller than the part size indicated on the print drawing. Dies to cut out holes should be slightly larger.

5.1.4. Press Operation

The more common press used is a platen type. The platen should be made with hardened steel with a steel or Formica make ready plate. The use of a softer material can improve blade life. However, it is important to ensure that the film is held firmly throughout the cutting operation. This can be achieved by using a foam of around 40"° Shore hardness or a composite of foam and a more rigid material. The following precautions should maximise cut quality during press operation:

a) Cut each piece individually.
b) Avoid any contact between the steel rule die and the platen by applying ejector foam rubber over the entire area.
c) If possible the film should be cut before laminating other layers.
d) Apply heat to either the film or the tool.
e) Ensure that the hardcoated surface faces the tool.
f) Design parts to be cut to have radius corners, avoiding sharp angled corners and complex shapes.
g) Cuts made less than 3mm apart may cause weakness in the film and should be avoided.

5.2. Guillotining

Guillotining is a less common method for cutting polyester, although it can be an efficient method for preparing stacks of sheet material. The following recommendations will ensure that satisfactory results are achieved.

5.2.1. Blade Material

A flame hardened low alloy steel blade is an appropriate material for guillotine blades. Good blade properties can be obtained using heat-treated high-speed steel with a VPN value of 700.

5.2.2. Blade Maintenance

Providing the blade is of correct material type and is maintained and used properly it should give up to 80 hours of continuous use before needing re-sharpening. Polyester film is susceptible to internal delamination, this characteristic is worsened when blunt or chipped blades are used. The blade quality should be closely monitored, particularly when thicker films are being cut. As with die cutting the blade profile should be ground as a double bevelled edge to optimise cutting performance. When stacks of sheets are to be cut they should be limited to the quantities shown below:

175 micron polyester	250 sheets per stack
125 micron polyester	300 sheets per stack

6. EMBOSSING RECOMMENDATIONS

6.1. Introduction

The reflex™ range of coated films is based on optical quality, heat stabilised, print receptive polyester. The nature of polyester makes it extremely strong and durable, giving reflex™ enhanced longevity of switch life and an enhanced tactile response. This property makes it ideal for embossed membrane touch switches.

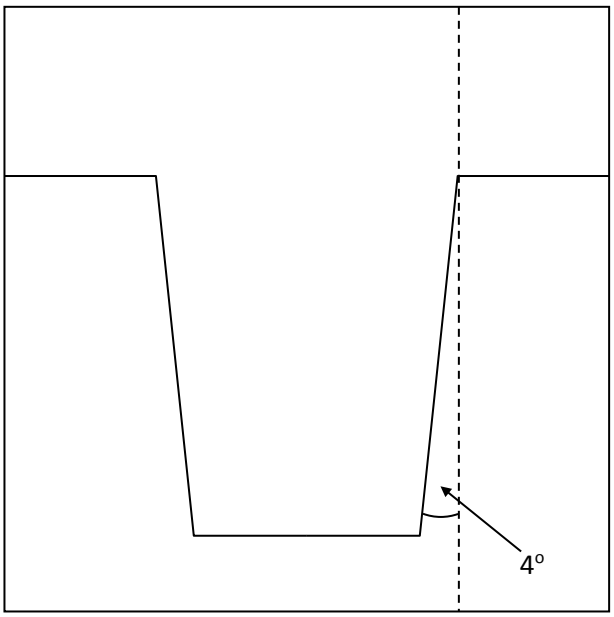
Embossing is used to raise areas, letters or designs. If reflex™ films, designed for embossing are used, there should be no loss in the very high switch life of polyester. Because of the different mechanical properties of polyester, allowances should be taken when embossing reflex™ to ensure good results.

There are a number of methods to satisfactorily emboss reflex™ polyesters to achieve a first-rate finish and performance.

Due to the high strength of polyester, male/female embossing tools designed for polycarbonate may not give the same sharpness of finish. To compensate for the difference between polyester and polycarbonate the following recommendations should be followed.

6.2. Tool Design

Figure 6.1. Typical draft angle



6.2.1. The space between the male and female tools should be designed to be the same thickness of the printed film (ink + film). It is important that the tool tolerances are tight to improve emboss definition.

6.2.2. Minimum draft angles of 4 degrees should be designed into both female and male walls as shown in Figure 6.1 above.

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6.2.3. A draft or bevelled edge can enhance the aesthetics of an embossed switch. A small draft angle on the finished part is controlled by the draft angle of the male tool, combined with a tight tolerance fitting tool set. Care should be taken with very low draft angles because of the potential damage to the graphics ink layer. A finished part with a high draft angle can be achieved by increasing the female tool aperture. In this case precautions should be taken to avoid a reduction in the clamping effect of the tool.

6.2.4. Movement around the embossed area should be minimised by ensuring the male and female tools hold the film tightly.

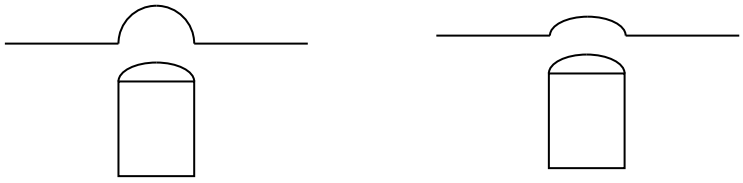
6.2.5. The male tool should be approximately 25% higher than typically needed for polycarbonate. The depth of the female tool must accommodate this greater tool height.

6.2.6. Tool specification and manufacture can be simplified by only matching the dimensions horizontally.

6.2.7. Tool dimensions should be designed so they are correct at the typical working temperature of the tool, not at room temperature.

6.2.8. Because of the nature of the difference in yield behaviour of polyester compared to polycarbonate the profile achieved by the same tool differs as shown in Figure 6.2 below.

Figure 6.2. Polycarbonate / reflex™ Polyester
The profile achieved using polycarbonate is similar to the tool profile, whereas profiles embossed using polyester tend to be flatter and wider.



6.3. Temperature Control

6.3.1. Ideally heat should be applied to the embossing area. The film should be heated to around 80-90°C (ie above the Tg of 68°C) around the embossed area but remain below the Tg in the background areas. This can be achieved on plate tooling by introducing an insulating layer in non-embossed areas.

6.3.2. The heat being applied to the tool depends on the dwell time, and the depth of emboss required. It is recommended that a small batch trial be carried out to assess optimum temperatures and dwell time.

6.3.3. The optimum emboss temperatures are around 80°C, particularly for tactile embossing. At low temperatures, the embossed height is low due to stress surrounding the emboss area. At high embossing temperatures (110°C) the embossed profile may change as shown in Figure 6.3.

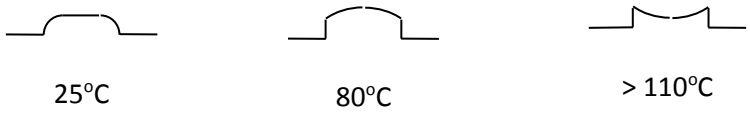


Figure 6.3. Emboss profiles at different temperatures

6.4. Tool Manufacture

Materials with high hardness, such as magnesium, are appropriate for manufacturing embossing tools. Plate tools may be produced by etching, machining or moulding.

6.4.1. Etched Plate Tooling

Etching is a cost effective and widely used tool manufacturing method. As indicated earlier, greater depth is required in tools to be used for embossing polyester. Particular care must be taken to ensure the tight tolerances in the design are retained.

6.4.2. Machine Plate Tooling

Tools can be manufactured with more precision and with more detail if they are machine made. This process can be more expensive but allows more complex shapes, such as control dome profiles, to be produced. Matched glass reinforced plastic (GRP) tooling, discussed below, can be used to avoid wearing down a machine master

6.4.3. Cast Plate Tooling

A cast tool can be manufactured from rubber or GRP. Rubber tooling can give badly defined profiles. It is unnecessary to allow for the normal tool clearances because of the flexibility of rubber. GRP cast tools can give excellent results although care should be taken to operate GRP tools at higher temperatures to ensure the 80+°C operating temperature is achieved. This is due to the poor thermal conditions of GRP versus metals.

6.4.4. Non-Matched Plate Tooling (Hydroforming)

This type of tooling involves the use of one tool with the required profile embossing onto a resilient surface. A particularly satisfactory method uses metal female/fluid filled reservoir. This involves applying high pressure to a fluid filled reservoir, which forces a flexible diaphragm to form the profile of the polyester to that of the female tool. Both hot and ambient temperatures may be employed; the best results coming from a hot emboss. The increasingly popular method of embossing demands significant capital investment, which may be avoided by using companies specialising in this type of work on a custom basis.

6.5. Press Usage

reflex™ polyesters can be embossed using a number of different types of press. These should be maintained in first class condition to fully maximise emboss quality. The press used may be a typical clamshell or platen press or a more specialised unit, such as a pillar press. These require the use of flat plate tools as previously discussed. The following recommendations should help in the embossing process.

6.5.1. Clamshell Press Recommendations

A clamshell press is commonly used for other applications such as die cutting. It should be noted that a worn or badly set up press will give badly registered finished parts. A normal

clamshell press may need to be modified to include a heated platen and variable dwell adjustment. Press manufacturers are usually able to carry out such modifications. The platens should be completely flat, square and parallel throughout the press stroke.

6.5.2. Pillar Press Recommendations
A pillar press can also be used for other work such as hot foil stamping and cutting film substrates. The maintenance on such machines is less critical. As with clamshell presses a heated platen and variable dwell adjustment are important features.

6.6. Summary

6.6.1. Tools designed for polyester need to take account of its strength and elasticity. They should have tight tolerances and be designed to firmly clamp the substrate.

6.6.2. The polyester should be heated to above its Tg of 68°C. Temperatures of 80-90°C are preferable.

6.6.3. Presses typically used in industry can be used but they need to be well maintained and carefully used.

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