Converting Polyimide Labels

A White Paper

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"World leaders in harsh environment label applications"

Written by: The Grand Master of Kapton® converting, "Flex" Morgan,
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CONVERTING POLYIMIDE LABELS

Foreword

Among the many materials used to produce pressure applied labels, polyimide coated label stock is one of the most difficult to die-cut. With over ten years experience of media production and primarily polyimide label stock, I have developed and learned a number of methods and processes to help in converting this difficult material. What follows is what I found worked best for my needs and should be of help and instruction to anyone die-cutting polyimide on whatever type of equipment or for any application. These instructions should greatly reduce production time and stock waste while improving the quality of your finished product. Throughout this paper when mention is made of equipment or special products used, reference will be made to a list at the end, which will give address and description of the appropriate material and its source

My years of label production have been spent working on a 7" Allied Flexomaster flexogaphic press. I have worked with other makes such as Mark Andy, Webtron, and Aquaflex, and I feel that all methods and processes I used can be easily done on any rotary die-cut converting machine. Although many presses are suitable for converting polyimide, the most important thing to remember is that the shorter the web path, the better. Polyimide is very expensive label material.

"Flex" Morgan

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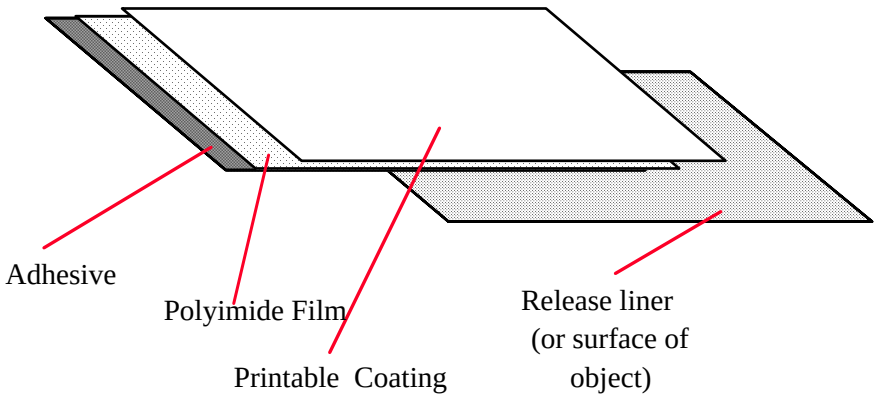
The Nature of the Beast

Polyimide label stock is comprised of a printable topcoat, applied to a very rugged, high temperature and solvent resistant film material, polyimide (also known as Kapton® ®, DuPont's tradename for its polyimide film). Other companies also now produce these polyimide films, which can also be coated for printable polyimide label stock. Like other pressure sensitive label materials, printable polyimide is made up of four layers: the printable topcoat, the base film, which provides the physical strength of the label; the adhesive layer which bonds label to its intended product; and, the liner layer which not only protects the adhesive, and allows the label materials to be wound into a roll and shipped, but also provides a strong web for die-cutting the needed labels, and a carrier for them prior to use (see Figure 1,).

Figure 1. Polyimide label



As we'll see later on, the importance of the release liner must not be underestimated. In general, high temperature acrylic adhesives are used, with 50# SCK release paper.

Why polyimide?

Polyimide film does not shrink, even at temperatures up to 500-600° F., unlike most other synthetic filmic materials. It is chemically resistant, and exhibits very high dimensional stability, i.e. does not stretch, while being coated or converted. Because polyimide films are dark amber in color, they must be coated with an opaque top-coating for any printing to be legible, and especially for the print contrast to reliably scan bar codes. These attributes make a polyimide pressure sensitive label ideal for identifying printed circuit boards and components in the electronics industry.

Printing on polyimide labels

Provided the appropriate top-coating is used, polyimide label materials can be printed on with any number of printing technologies: thermal transfer, flexographic, ink jet, dot matrix impact, laser printing, even laser etching. The type of printing you specify dictates the type of coating employed. Although a label may be printable with a certain printing technology, that printed label may not withstand the end use environment. For a detailed analysis of printing issues with polyimide labels, please contact Polyonics' Technical Service Department, at info@polyonics.com.

The key to success for a polyimide label's use in the field is to make sure that the right coating is matched to the printing technology employed, and that the subsequent finished, printed label survives its intended use.

QUALITY, QUALITY, QUALITY

In order to be successful in producing high performance polyimide labels, the overriding focus throughout prepress, production, finished goods packaging, and shipping must be on **quality.**

The highest quality labels possible are required in today's markets to satisfy user demands. Consider the fact that bar code labels are used not only to track items through production in the electronics industry, but also for post sales service. Bar codes which do not scan can result in large financial losses for the end users, i.e. a bar code label is now viewed as a component on a circuit board. If the label does not scan, or falls off, the board is defective. Bar code labels used in the electronics industry are shrinking in size, as small as 0.1" x 0.1"; consequently, a piece of dust or other surface contaminant can prevent the label from being used at all, due to poor print quality or a non-scanning label.

Attention to the details required for superior quality will also reduce production waste and rework. This is of paramount importance in polyimide label production, since about 75 % of the cost of the label is primarily due to the high cost of the polyimide materials, rather than labor and overhead, which one would normally associate with label converting. These issues are specifically addressed in another Technical White Paper, *"Harsh Environment Label Converting"*, available from Polyonics' Customer Service Department.

Several criteria define how a particular label is specified for its use:

- Print quality: Match printer, ink, and label stock
- Label performance
  - Label dispenses properly
  - Print survives environment
  - Label adheres to desired surface, as required

Label quality is also influenced by the quality of its manufacture:

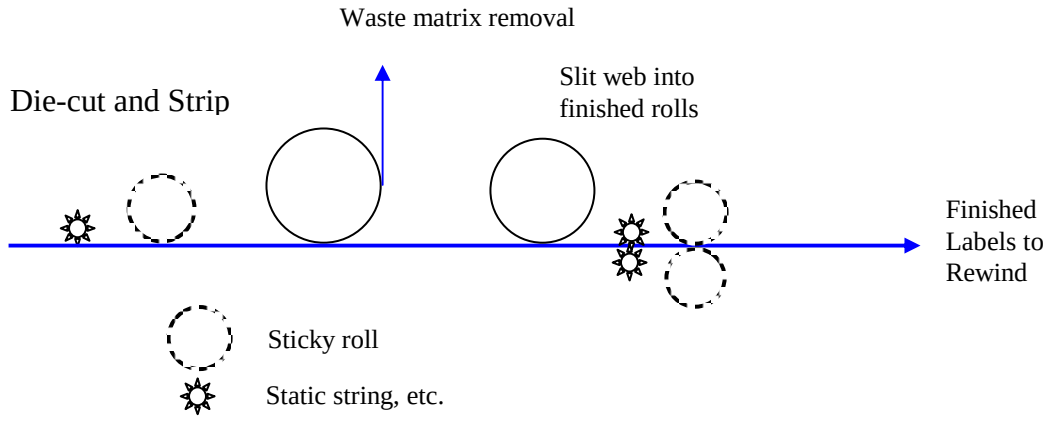
- Dimensional accuracy (meet customer specification)
  - Label dimensions
  - Gap and spacing
- Roll cleanliness (interfere with printability)
  - Dust on label surface
  - Paper dust (edge of release liner)
  - Slitter dust from coating
- Fingerprints or other surface contamination
- Core integrity (Fibers or other chaff)

To reiterate, it is critical to reduce waste, ensure complete rolls, and reduce dust throughout the production process. Throughout this discussion, reference will be made to steps that will reduce dust on the finished roll. From slitting raw stock to packaging rolls there are many things that can be done to make your work of the highest quality possible.

PRESS SETUP AND PREPRODUCTION

In most cases presses used to convert polyimide labels will also be used to die-cut other label stocks, such as polyesters, polypropylene, and paper. When changing over to polyimide label production the press should be as clean as possible with special attention paid to rollers and idlers that may contact the coated side of the web face. Anti-static string, tinsel, or a static dissipation device should be used before and after the diecutting station. Immediately after the tinsel, the use of fixed contact cleaning rollers[1] (before and after the die-cut station) on both sides of the web is recommended. These rollers can be high tack and will remove dust from both sides of the web, improving quality and reducing die wear.

Setup for Dust Removal



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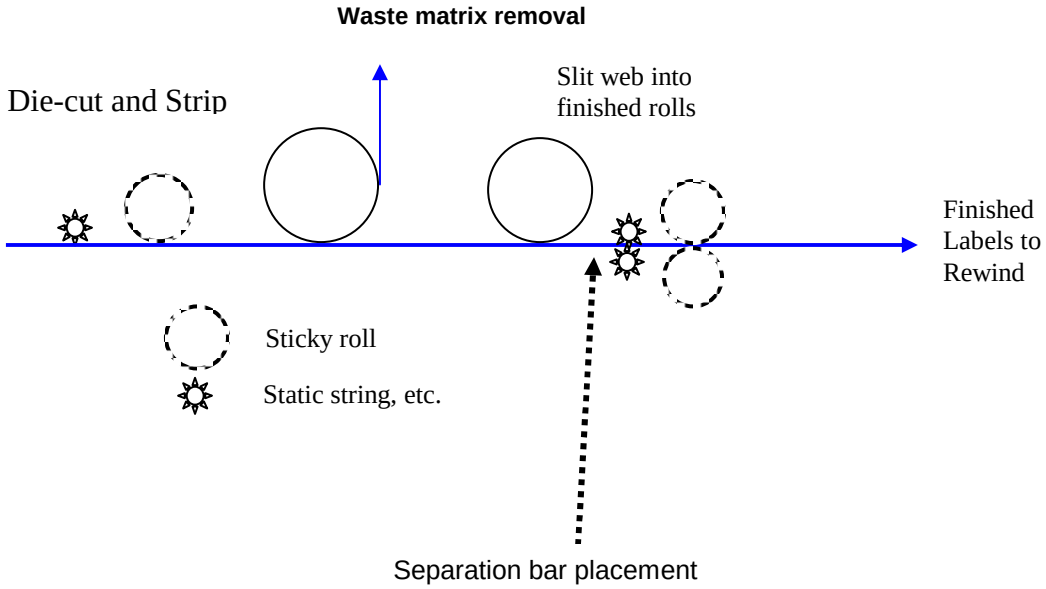
Separation bars can be installed immediately after the slitter, but before the tinsel and sticky roll, to separate the waste liner edge stock from the finished material web before passing through the rewind station, to reduce dust from die-cutting and slitting operations.



Again, contact cleaning rolls[1] can often be placed just as stock leaves the press to be wound to finished rolls to remove remaining dust from the surface of the finished labels. These rolls must be of a lower tackiness than those used at the beginning of the web path, so as not to pull die-cut labels from the finished product. If your customers demand the cleanest possible label material, a separate web cleaning system can be purchased and installed within the press[2], which uses anti-static devices, brushes and vacuum to further clean the product after the die-cutting and slitting operations. These systems are not inexpensive, ranging from $ 15,000-25,000 each.

Before setting up a job, the master roll of polyimide label stock needs to be slit to the width and length to stage the job. Because of the strength of the base kapton® film, web widths can be just slightly larger than the finished roll width, to reduce production waste. Many press operators order the precise web width required, and by running the press very slowly (even at jog speed), require no edge trim cut, with zero additional scrap due to trim cuts.

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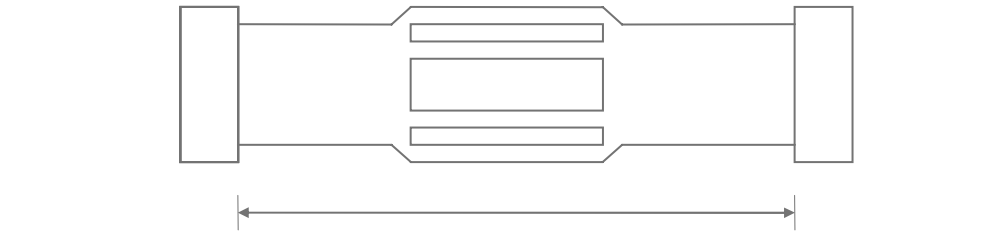
Always slit polyimide label material face up (coated side) in the press. The white pigment (titanium dioxide) in the coating is very abrasive, and will grind on cutting anvils if the material is slit face down. Of course, use all the cleaning equipment and methods discussed above while slitting, to reduce dust contamination of the polyimide label stock to be used.

Once the press is clean, and the stock slit and staged, the press can then be webbed, the web guide adjusted and the job begun. Because of high raw material cost, web setup should be done with scrap liner stock or scrap polyimide material for cutter depth adjustment. When the setup is complete, and the tooling depth adjusted, the polyimide can be fed into the press.

DIES and STEP ANVILS

After consideration of matching the label and printing technology used, press cleanliness and setup, and the quality of your pressure sensitive polyimide label material, the next important factor is the die used to cut the label. Polyimide is physically a tough film. Moreover, the coated surface is abrasive, making die-cutting polyimides an operational challenge. Having tried different die producers we chose to work with Preston engravers[3] for our polyimide dies. Working together with them over the years we found the best coating for dies, the best blade angle to sharpen blades to and other features I will mention that ease production with their dies. The die manufacturer you work with will need enough stock (100-200 feet) of the same kind of polyimide you will be cutting, in order to test the dies they produce.

Because of the high pressure often applied while die-cutting polyimide, dies should not be made smaller than 48 tooth gears as the high pressure could bend smaller dies. Also in creating drawings for label size and shape 90-degree radius corners should be avoided, as they may cause breakage problems of the web, and reduce the useable life of a die. There is a general rule of thumb that relates the circumference to the width. **The circumference should be equal to or greater than the width of the die**. The die width is measured inside the bearer bars.



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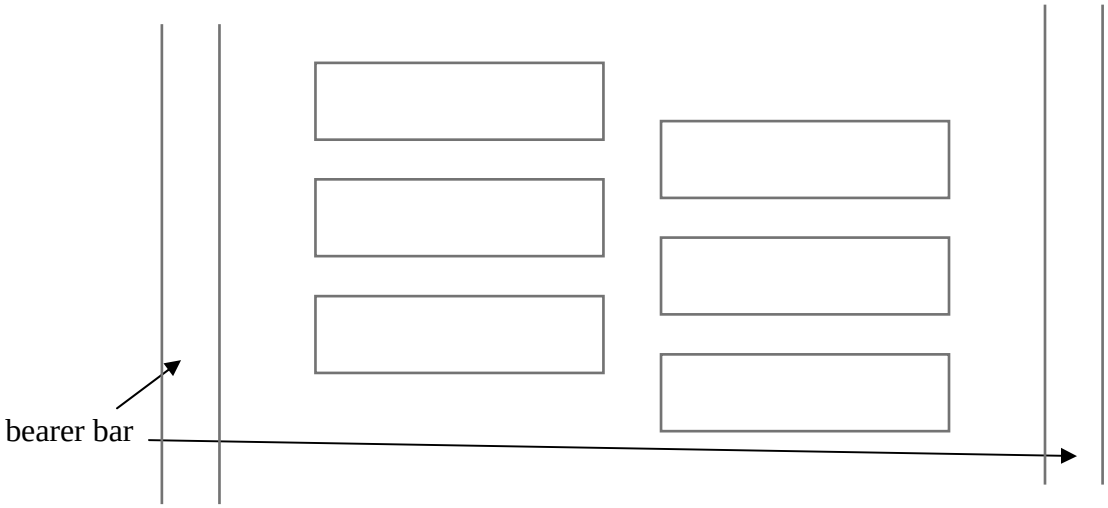
Another factor of importance to the die maker will be the type and thickness of liner used on the polyimide label stock, and what depth of cut the die is allowed to make into the base liner. Labels needed for automatic applicator systems will require **no nicking** (or "cut through") into the release coating of the liner. On the other hand, other labels that will be hand applied will allow the die cut to cut deeper into the liner, which makes die-cutting and stripping of waste matrix much easier. So unless auto-application is specified by your customer, dies tooled to hit the liner hard will perform much better than others which do not "hit" as hard.

DIE CAVITY STAGGER

The die cavities across the web should be staggered to reduce the total force required to cut. **The design should allow one horizontal cut at a time if possible**. This will reduce die hop and flex.



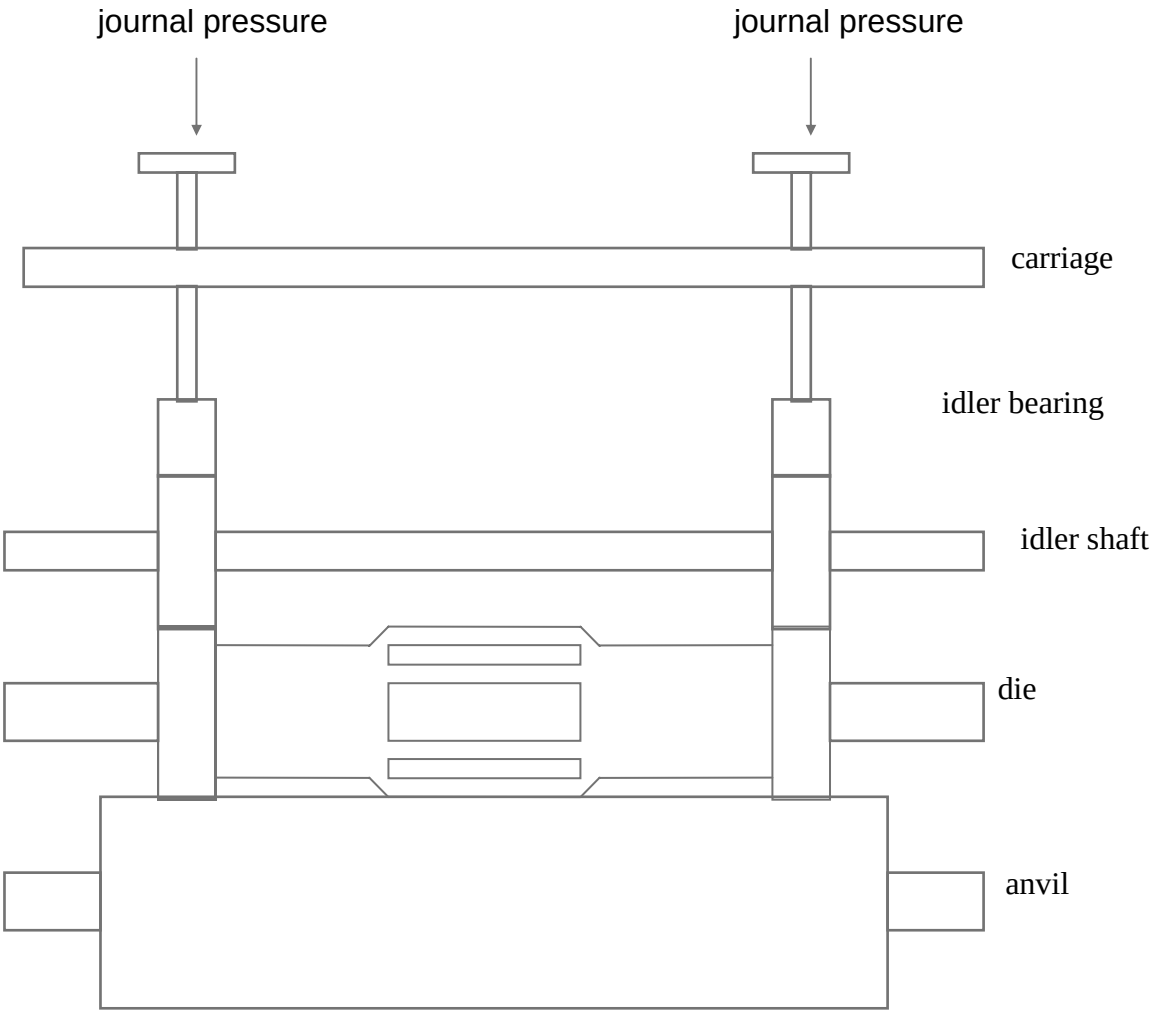
STEP ANVILS

Step anvils, either adjustable mounted in the die-cut station or removable variable depth anvils, are a great asset to label production. Use of steps will increase range of dies useable, make use of worn dies possible and make difficult applications such as thick adhesive stock possible to die-cut. Step anvils must be clearly marked as to depth of increase or decrease from standard. They cannot be used with 2 level dies or metal-to-metal dies as

damage to blades can occur. Always run a test strip after setup and double-check the liner cut to ensure proper depth of cut.

JOURNAL PRESSURE (Bearer bar)

Most label printing and converting presses use an idler roll and bearings to apply pressure to the die and then to the anvil. However the pressure is applied, it **should be directly applied to the journals or bearer bars,** not on any of the shafts associated with the die, bearings, or carriages.



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HYDRO JACK / PRESSURE READOUT - DIAL

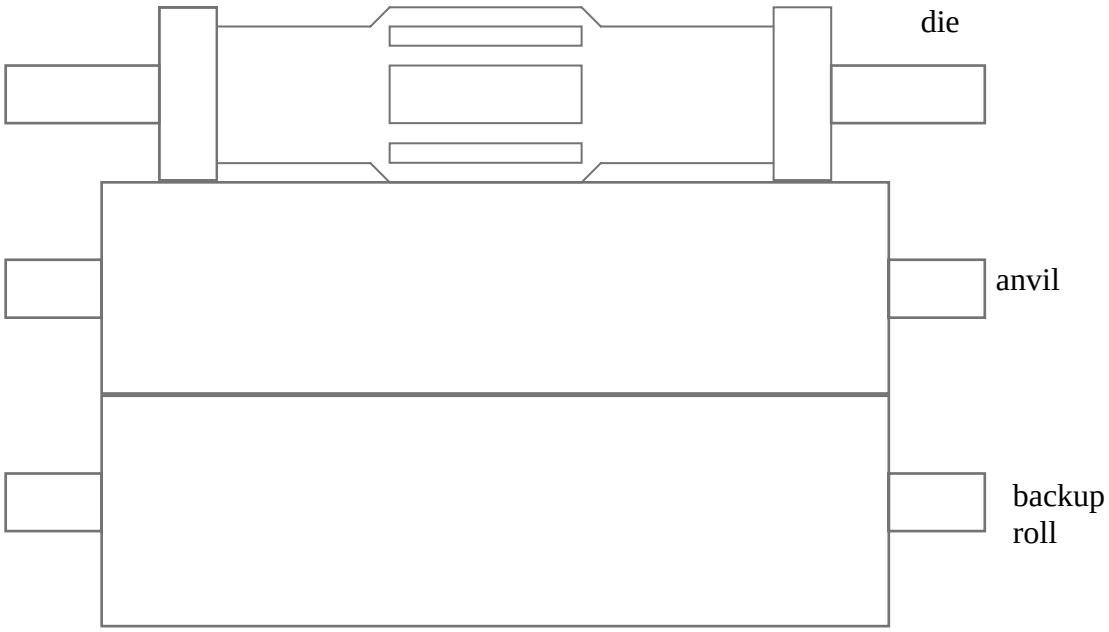
The use of Hydro jacks and pressure dials has become very popular. This **assists in the application of pressure at the bearer bars and not the shafts**. Pressure can be monitored during the life of the die and recorded for repeat set-ups. The maximum pressure that should be applied is 1200 lbs. At 700-800 pounds the die should be retooled.

TREATED DIE

Most coated Polyimide or Kapton® material has an abrasive top coat that will shorten the life of standard dies. Each individual die manufacturer has developed a method to **treat the surface of the die to reduce wear**. The use of these die will reduce the amount of pressure required to cut and increase the footage before retooling.

ANVIL BACKUP ROLL

Available on most label presses and converting machine is a backup roll for the anvil. This roll is located beneath the anvil roll and gives **added support to the anvil**. Die cutting Polyimide or Kapton® in the station with the backup roll will **reduce anvil flex and potential die hop**.



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HARDENED ANVIL ROLL

The anvil roll used for cutting Polyimide or Kapton® material should be fully hardened versus a case hardened roll. Most label presses have a fully hardened roll in the main die cutting station or have one available.

STRIPPING

Proper stripping or removal of the waste lattice after die-cut is very important to the quality of the finished product. Again, due to typical small size of labels called for in polyimide production, the problem of pre-dispensing labels, pulling up with the waste matrix ladder must be overcome. Stripping the waste directly after the label stock passes under the die improves control of label loss. Use of ejector foam in the die cavities will also help labels stay on liner after cutting. An adjustable roller between die and take-up station allows operator to vary the angle of stripping. Sometimes adjusting the speed of production, and changing the tension of the take-up roll of waste stock will improve results. Another trick of the trade we discovered was that application of heat to the web prior to die-cutting improves the attraction between labels and the liner, which reduces pre-dispensing. On our presses we merely turned on the in-line heaters normally used when printing (vs. die-cutting blanks). For presses without heaters, a portable heat gun can be mounted to heat the stock before it reaches the die-cut station.

DIE CUTTING POLYIMIDE STOCK

With polyimide webbed through press, the proper die in place, its time to analyze pressure and began die-cutting. We purchased a pressure bridge assembly with pressure gauges from Rotometrics through our die supplier[3]. With this equipment, we could maintain even pressure across the die and maintain records for each die: the cutting pressure needed, and the number of cuts, in order to monitor when re-tooling was needed. However, pressure is applied to your die, always use the least amount needed to successfully cut stock. Also on long run jobs you may want to reduce the pressure later as heat from friction of running will expand metal and therefore increase pressure.

It was not uncommon for us to have three tools for high volume production parts: one tool actively used, a second on the shelf, and the third out, being re-sharpened. In this way, we were never down while we waited for tooling.

Once the label is cut from raw stock, the waste matrix/ lattice should be stripped from the web, immediately after the die, and attached to the waste rewind. Adjust tension, rollers, or speed to ensure even removal of the waste matrix to prevent the labels from pre-dispensing/being pulled up with the matrix.

With the labels cut from the web, the next operation is to slit the web to the width(s) required for the finished rolls. While adjustable slitter blades are commonly used, we found that they produce excessive slitter dust (from the paper liner) because of the blades vibration, or "chatter", as they run. We used a fixed die with continuous metal-to-metal slitter blades, set to the finished roll widths for each specific label size/die used. These dies, besides producing much less dust than adjustable blades, also improved quality in terms of maintaining constant cut-to-label edge margins, reduced setup time before production, and, of course, reduced scrap before and during production.

As the polyimide travels through press, all possible web cleaning should be done before and after each step, as well as immediate removal of the outside trim waste[4]. The finished label stock may now be attached to the take-up rolls. After setting the press for proper roll length, or the required number of labels, the job is ready for production.

You should always wind the polyimide labels onto plastic cores[4] rather than cardboard ones, in order to eliminate the introduction of dust into finished rolls. Also during production runs whenever there was dust buildup on nip rollers or idlers that contact the polyimide face stock, each roller was cleaned between runs with lint free wipes[5] and a 1:1 mixture of water and alcohol (IPA, or iso-propyl alcohol).

During production, the take-up tension of finished rolls should be as low as possible to reduce adhesive bleed around the edges of the labels, that could cause them to stick to the backside of the liner on the layer of labels over-wrapping them. When the finished roll length is reached, each roll should be removed and the tension of the wind can be reduced slightly by hand to help prevent problems while rolls are stored. This is particularly important during the summer months, if you customers are located in hot climates.

At this time the edges of the rolls may be cleaned by tapping them on contact cleaning mats[1], before being put each roll into a bag. You should use anti-static bags[6], and place each individual roll in its own bag to maintain its cleanliness. You would be wise to seal each bag with a label explaining the importance of cleaning printers and printheads, in order for your customer to achieve the best possible printing results with polyimide labels.

During the production run, press speed should be such that the operator can watch the web for missing labels, mill roll splices, or defects of any kind. The goal of course, is to produce finished rolls with no missing labels and no splices that would disrupt printing. You may need to create so-called "blind splices" in

your finished rolls, by cutting out splices or defects and then overlapping the ends of the web and cutting through gap between the labels. Now using strong splicing tape[7] on the backside of the liner only a continuous roll of labels is created that will allow continuous printing and application of labels.

SPECIAL APPLICATIONS, PROBLEMS, SOLUTIONS

Excess Label Pre-dispensing
If even with heated web, correct tension and using ejection foam (8) in die cavities, many labels are still being taken up in waste stream, then using stock with a tighter release will often correct the problem.

Aggressive or Thicker Adhesive
When the customer requires a special adhesive for the end use, dies will need to be tooled to hit hard, and the label stock must be run with high tension on the waste stream lattice. Polyimide is a tough film. A thick adhesive exacerbates the cutting problem. In this case you should also evaluate either a polyester or glassine liner.

Other Liners
When using other liners, it is most important that dies are tooled to cut to that liner. In case of polyester liners, die should be tooled to hit hard and tension adjusted to remove waste lattice. Also take-up tension on finished roll must be low as possible as these rolls with polyester liner will wind very tightly creating a problem with adhesive oozing from edges of labels.

Special Shapes or Very Small Labels
Pre-dispensing of labels will increase as size of label is reduced or when unusual shapes are needed. Label loss can be reduced with use of tighter release liner, extreme angle of stripping waste from die or doubling ejection foam in die cavities to increase downward pressure on labels.

Release Liner Issues
For the purpose of this paper and in fact die cut production in general; the type of liner used on label stock is of major importance. The material used and the release value of the coated side will affect the way in which the stock will die-cut, strip and the end products usability. While the use of polyester liners has been increasing the main material used is still paper based, with the most common weight of 50 lbs. In this paper it will be assumed that the material being used will be polyimide coated film with standard adhesive on a 50 lb paper liner. 1 mil polyimide label stock, and labels for auto-apply applications, the use of either a glassine liner, or a polyester liner is common.

SOURCES OF EQUIPMENT AND SUPPLIES

1. Contact Cleaning Rollers + Mats
   R.G. Egan Equipment
   Rota Dyne 2512 W 24th St.
   Chicago, IL 60608-3798

2. SIMCO (web cleaning systems)
   Hatfield, PA (215) 822-6401

3. Preston Engravers (Division of Roto-Metrics)
   9 Thompson Rd.
   East Windsor, CT 06088-9695

4. Plastic Cores, 3" I.D.
   Northcore Industries
   S 5417 Old Lake Rd.
   Baraboo, WI 59313

5. Cheesecloth wipes (lint free)
   McMaster Carr part# 7340T22

6. Anti-Static Bags
   McMaster Carr part# 2096T-24-25-26

7. Clear Splicing Tape
   3M part# 8401

8. Ejection Foam (for die cavities)
   Mc Master Carr part# 8722K61

9. Polyimide label materials
Polyonics, Inc. 867 Rt 12 Westmoreland, NH 03280 1-888-POLYONX
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Kapton® is DuPont's tradename for its polyimide film products.