A Basic Guide to Labels

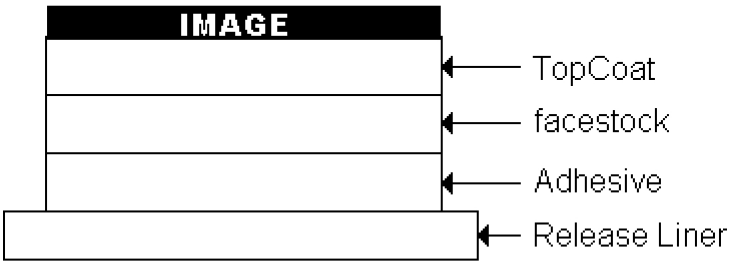
GSM BARCODING

Consumables – the key part of any identification system

It is important to remember that consumables are part of a total system, and the entire system needs to be taken into consideration before a selection is made. For example, one needs to consider what will be labeled, when it needs to be labeled and how long the label needs to last. While this may seem like a large task, the benefits that can be attained by understanding the complete solution will pay off in the long run.
Consumables are typically characterized as tags, labels, printing inks and ribbons. Tags and labels differ in that labels have a layer of pressure sensitive adhesive while tags are typically constructed of a facestock and a topcoat and are attached using some form of mechanical fastener.

Label Construction
Pressure sensitive labels typically consist of five components: a release liner, pressure sensitive adhesive, facestock, topcoat and an image, as detailed in Figure 1.

Figure 1: Cross Section of a Pressure Sensitive Label



The release liner is typically a paper or plastic film that is used as a carrier for the labels and also protects the adhesive from picking up dust and debris. The pressure sensitive adhesive is the layer that will ultimately make contact with the surface that needs to be identified.
The facestock can be thought of as the backbone for the label. It provides a surface for both the adhesive and the topcoat. The topcoat is that portion of the label that will provide the background for the image. And finally, there is the image itself.

Label components – adhesives

General considerations

One of the first things to consider when selecting a label stock is the type of pressure sensitive adhesive that is required. There are many issues to address during the selection process. A beginning list of questions is given below:

> To what type of surface will the label be required to adhere - glass, plastic, metal?
> What are the surface characteristics - smooth, rough, flat, curved, clean, or dirty?
> To what type of environment will the label be exposed? Humidity? Sunlight? What are the application and service temperatures?
> Will the labels be exposed to any chemicals?
> Does the label need a permanent, removable or reposition-able adhesive? Will the labels be automatically applied?
> Are there any regulatory requirements for the label - UL, CSA, FDA?
> What type of printing process will be used to image the labels - laser, thermal transfer, impact, ink jet, other?
> Are there any visual requirements for the adhesive?
> Are there any chemicals that are contamination concerns?

While this is not a totally inclusive list of considerations, it should provide a basic understanding of the common considerations necessary in adhesive selection.

Adhesive performance characteristics

Label manufacturers will typically refer to three characteristics about the adhesive: adhesion, tack and drop shear. The adhesion is a measure of how tightly the label adheres to the surface. Adhesion measurements are typically done under the ASTM D1000 test procedure. Test results are reported in lbs./in or oz/inch. The test involves laminating a one inch wide test strip to a panel (usually stainless steel but the exact nature of the test panel may vary for specific applications), allowing the test strip to dwell on the panel for 20 minutes and then reproducibly removing the test strip from the panel while the force required to accomplish this task is recorded. Adhesion values can vary widely depending on the type of surface. It is common to see typical values of 30 - 50 oz/inch for permanent acrylic adhesives on stainless steel test panels. The tack of an adhesive is a measure of how "sticky" the adhesive is. For example, pressing your fingers against the adhesive surface of duct tape and masking tape. Duct tape feels very sticky or tacky to the touch while masking tape does not feel as sticky. Tack values are typically measured in grams, and common values may range from 300 - 1500 grams/cm^2.

The final common measurement is that of drop shear. Again, there are standard industry tests designed to measure this property. This test is designed to measure the cohesive strength of the adhesive. The test involves laminating a small test strip (1/2" x 1") to a stainless steel panel and then applying a shear force to the test strip. This force is applied by physically suspending a 500 gram weight from the test tape. Unlike the adhesion and tack tests, this test does not measure force but rather the time that it takes for the adhesive to separate from the test panel.

Types of adhesives

There are three general classes of pressure sensitive adhesive: rubber, acrylic and silicone. Each class of adhesives can be further divided into permanent, removable and reposition-able adhesives.
Rubber- based adhesives are the oldest type of pressure sensitive adhesives (PSAs). Typical characteristics include good wet out on surfaces, high initial bond strength, limited temperature resistance, poor UV resistance, less solvent resistance than acrylics and low cost. Typical applications that are well serviced by these adhesives are names plates on textured plastics and curved surfaces as well as wire and cable markers.
Acrylic-based adhesives have a large product range and is probably the most widely used due to their broad range of properties. While the adhesive wet out may not be as good as rubber-based adhesives, the aging, weathering, clarity and temperature resistance greatly outperform rubber- based products. Typical applications include industrial tapes, product ID, graphics labels, and many work in process applications. The final class is that of silicone adhesives. Silicone adhesives have excellent solvent/water resistance, high temperature stability (above 350^{o}C), UV resistance and good performance at very low temperatures. However, in addition to these benefits, they are also accompanied by a high price tag. Typical applications are those that involve high temperatures including work in process applications.

Label Components - Release Liners

The release liner can be thought of as a carrier for the pressure sensitive labels and it does not come into contact with the object that the label will identify. Therefore, the general requirements for a liner are slightly different than that of an adhesive. Release liners are commonly paper or plastic films. Within each of these classes there are several sub classes. Typical liners range in thickness from 2 - 5 mils. Paper densities have been modified to provide the end user with products specific for improved die cutting and for automatic application characteristics.
It is critical to consider the interaction between the adhesive and the release liner when selecting a release liner. The label must release smoothly from the liner without tearing or stretching this protective sheet, this is particularly important in label applicator systems where the label is automatically removed from the liner.
The printing technology selected for use with the label will also help to steer the liner selection process. For example, some plastic film liners cannot be used in laser printers due to the fact that the film will melt when it encounters the high temperatures required at the toner fusion roll. Additionally, some paper liners may be unacceptable in specific applications such as clean room environments.
The recent past has seen the introduction of "linerless" labels. No release liner is required with this technology. Here, the label material is self-wound, eliminating the need for a separate release liner. While this eliminates the need for the liner, the technology is not yet capable of supporting many high performance materials.

Label Components – Facestocks

In most applications, the facestock selection is critical. This component of the label can be thought of as the skeletal system of the product and it will determine the tensile properties. A number of factors need to be considered including:

Service temperatures that the label must endure
Chemical resistance, what chemicals at what concentration UV
and humidity stability
Abrasion resistance
Type of printing system that will be used
Surface to which the label will need to adhere (smooth, rough, flat, curved) Tear resistance
Method of dispensing desired
Cost

There is a wide range of facestocks on the market today. In general they can be grouped into paper and film types. In the paper category there are coated and uncoated types, as well as natural and synthetics. Paper's advantages are that it can be easily printed using a variety of inks and is relatively low cost. However, paper has poor tear strength and abrasion resistance. Typical applications for paper-based labels include shipping and some warehouse identification labels.

The film category is much more diverse. They are a number of plastic materials that are available as films such as vinyl (PVC), biaxially-orientated polypropylene (BOPP), polycarbonate (PC), high density polyethylene (HDPE), low density polyethylene(LDPE), polyester (PET), polyethylenenaphthalate (PEN), polyvinylflouride (PVF), polyetherimide (PEI) and polyimide (PI) to name a few. The performance characteristics and cost of these materials is very wide spread. Table 2 contains a comparison of some of the common facestocks available today.

On the lower end of the performance and cost scale there is polyethylene. This film has good tear strength, chemical and abrasion resistance; however, the film stretches easily and can be difficult to die cut. Polyethylene labels are often encountered in packaging applications.

Polyester is towards the middle of the price scale. It has good tear strength and abrasion resistance, long term UV stability, dimensional stability and is available in clear, white and metalized versions. Polyester is a very common facestock in the industrial and medical labeling markets. Typical examples include, component ID, asset ID, and work in process.

Polyimide completes the high end of the price scale. This high performance film has excellent high temperature resistance and can typically be used for applications that require exposure to temperatures up to 600^{o} Fahrenheit. It has good tear strength, chemical resistance and dimensional stability; however, it has an amber color. One of the most common applications for this facestock is in the area of work in process for printed wiring assemblies.

Table 2: Relative comparison of typical facestocks.

Facestock	Tensile Strength	Chemical Resistance	Heat Resistance	Cost
Paper	Poor	Poor	Poor	Low
Polyethylene	Very Good	Very Good	Good	Low
Polypropylene	Excellent	Very Good	Good	Moderate
Vinyl	Poor-Good	Good	Fair	Moderate
Polyester	Excellent	Very Good	Very Good	Moderate
Polyvinylflouride	Excellent	Excellent	Good	High
Polyimide	Excellent	Excellent	Excellent	High

Label components – topcoats

Three components of a label have been discussed, the adhesive, the liner and the facestock. If the discussion were to conclude with these elements, the user would be able to purchase a label that would adhere to the desired surface, withstand the exposure to the environment but it may provide little or no value to the end user. This is due to the fact that many times in order to be useful; the label must be printed with some information. The topcoat is that portion of the label that allows for the information to be added to the label.
Topcoats can range from very thin clear coatings to rather thick-pigmented coatings. In some cases the topcoat may be used to apply a color to the label background; however, in most cases the primary purpose of the topcoat is to provide a receptive surface for the image. Just like the interaction between the adhesive and the release liner is critical, the topcoat and printing technology must be compatible. For example, a thermal transfer topcoat must be relatively smooth so that it can accept the THT ribbon ink, while an ink jet receptive topcoat needs to be porous to allow for controlled ink penetration.

Print Technologies

It may be surprising to learn that the type of print technology that one wishes to use or that is recommended is a key driving force in label selection. One must consider the range of questions that have already been addressed. For example, will the label be exposed to any chemicals that could attack the image? What temperature does the image need to withstand? And how long does the image need to remain legible?

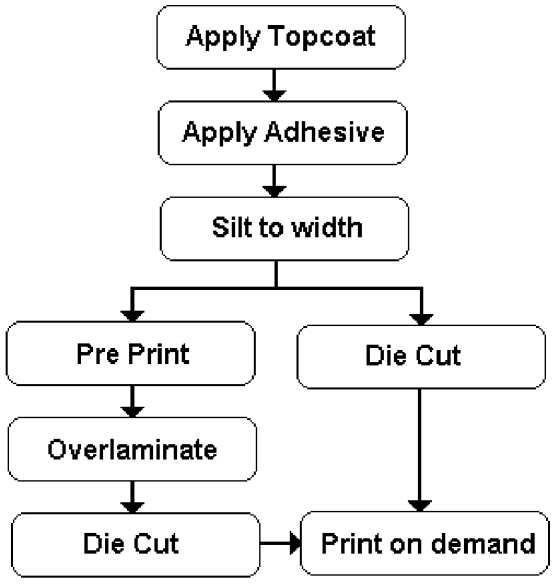
Over laminates

If the imaged label will be exposed to severe chemical or abrasive environments which are outside the scope of the chosen technologies limits, an over laminate can be used to add durability. Over laminates are typically a, clear film with a clear pressure sensitive adhesive. The over laminate can either be applied manually or form part of an automated application system after the image is printed when using in- house label production, alternatively it can be applied after the label has been imaged at the off site converting house.

Label Manufacturing Process

There are several steps in the manufacturing process for labels and the order of these steps may vary from one manufacturer to the next. One of the first steps is to apply the topcoat to the facestock. See Figure Two. Topcoats are typically fluid mixes that can be coated onto the facestock using a variety of coating techniques such as slot die, reverse roll, gravure, or flexographic coating. This coating is dried and cured onto the facestock.
The pressure sensitive adhesive is then applied to the opposite side of the facestock. This may be accomplished with a wet coating process using any of the techniques outlined above. Additionally, many manufacturers may use a process in which a previously dried "transfer adhesive" is laminated to the facestock. Both the topcoat and the adhesive coating processes are usually performed on material that ranges from 24" to 60" in width. Once the adhesive and topcoats are applied, the wide roll form material is slit or cut into smaller width rolls that will fit onto standard converting equipment. Typical widths are 4" to 18" depending on the material and equipment. The process of converting the narrow web roll form material into small labels is called die cutting. These presses can be rotary or flat bed. In this operation, a die is used to cut the labels into the desired dimensions. The labels remain on the release liner while the matrix or waste is removed. Many presses of this type also have the ability to add background color, constant copy, or serialization to the labels.

F**igure Two: Flow chart of the typical label manufacturing process**.



The type of converting process that is used will depend on the end user's application for the label. In some cases, labels may be die cut so as to allow the label to be used more effectively in automatic application equipment. In other cases, the labels made are sheeted so that they can be used in a laser printer. After conversion, the labels are inspected, packaged and shipped to the end user. If the end user is going to be printing labels on demand, the end user will complete the manufacturing process by running the labels through a printer to apply the required identification information.