Applications for Polyester Media in Digital Printing Presses

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Polyester media is used in a wide range of applications for digital printing presses. However, the common denominator between all of these applications is the need for a high level of durability. Polyester offers further value due to its specific characteristics and benefits. This paper will discuss these characteristics, the manner in which they are tested and detail actual examples of some of the applications.

What is Polyester (PET) Film?

PET is polyethylene terephtalate, discovered by two British chemists (Winfield and Dickson) in the 1940's. Today this polymer or long chain molecule is commonly used in clothing, bottles or packaging materials. PET film is extruded, passed through a die and then cast on a rotating drum. After being cast it is stretched forward about three times its original length and then sideways again about three times its original width creating the biaxially oriented PET film.

This film, due to the nature of the polyester polymer and the manner in which it is manufactured, is very strong, tough, clear, dimensionally stable and relatively chemical and heat resistant.

What is Polyester (PET) Media?

Polyester media is polyester film that has been optimized for printing on the digital press. This optimization may include amongst other things chemical coatings, thermal stabilization and ultra violet inhibitors.

Chemical coatings are used to primarily allow ink or toner anchorage to the substrate. If the media is not coated there may be an image printed on the substrate, but it would have extremely poor or no anchorage to the media. This counteracts the original purpose of printing on the polymeric substrate - durability. Typically each different print technology (Dry Toner or Liquid Inks) will require a specific coating that will interact efficiently with the chemistry of the inks or toners.

Chemical coatings can also add other features to the media such as degrees of matt, translucence and opacity. These features are often critical in some of the applications that are discussed in this paper.

Thermal Stabilization is critical for media printed or fused at relatively high temperatures such as in the Xeikon engines. If the media is not thermally stabilized it will shrink a few percentage in either or both machine or transverse directions creating critical registration and handling problems. It should be stressed that although PET film is biaxially oriented during its manufacturing it will still shrink at 150-160^{o} C, making it unacceptable in high temperature processes unless it has been thermally stabilized.

Ultra Violet Inhibitors will be integrated into the media particularly when outdoor exposure or color fastness is critical in the final application.

Typical Test Procedures

A wide range of test procedures is used to qualify PET media. The common goal of all of these test procedures is to quantify and qualify the durability of the media and ultimately the printed piece, which is used in the final print application.

Some examples of these tests are:

Influence of Household Chemicals on Organic Coatings ASTM D 1308 – this test measures the durability of both the primer and the printed piece to typical household chemicals such as water, soap, acids, oils and detergents which it may come into contact with.

Abrasion and Smudge Resistance of Images – Crockmeter ASTM F1319 – this test measures the smudge and abrasion resistance of a printed and/or coated surface using a standard device and may include both dry rubbing or rubbing in a chemical environment.

QUV Accelerated Weathering Test ASTM G53- this test attempts to perform an accelerated simulation of environmental influences such as radiation and humidity. This is performed by cyclical exposure to Ultra Violet fluorescent lamps at various wavelengths coupled with exposure to condensation. Typically 500 QUV hours should compare with a year of outdoor exposure in California.

Of course it is always possible to design other test protocols depending on the final applications. Such tests have included cycles of dishwashers, washing machines, dry cleaning, underwater immersion and more.

Fading and Color Fastness

Fading and color fastness can be critical in some of the applications in which PET media is chosen. There is no logic in using expensive long lasting media if the printed image will tend to fade.

Several test procedures have been developed above and beyond the accelerated QUV tested described above. These tests essentially involve the printing of blocks of Cyan, Magenta, Yellow and Black and measuring the

color coordinates on a spectrophotometer before, during and after exposure and tracking the numerical change in the value of the color coordinates during the process.

This test can then be performed during different environmental conditions such as indoor exposure under fixed light and temperature conditions and outdoor exposure. When testing outdoor exposure it is important however to keep in mind that the result of the test can change dramatically as a result of different variables such as heat, humidity and exposure to pollutants.

Another common misconception is that exposure to Ultra Violet Light is the only contributor to color fading. Whilst it is a significant factor, fading is also caused by heat and visible light.

Nevertheless the fading characteristics of any inks and specifically digital inks can be dramatically improved by integration of UV inhibitors into the PET media. In a typical construction the image would be reverse printed on the PET media so that the image is protected by both the UV inhibitors and by the PET film.

Media of this description has been printed with Indigo ElectroInk and exposed to over 2300 hours of QUV light (313nm) and shows no signs of fading whatsoever when measured on spectrophotometer. In comparison an unprotected sample shows complete disappearance of Yellow and Magenta in a shorter time frame.

Optimization of Media for Print Technology

Indigo Technology (ElectroInk) – essentially all substrates that are printed with Indigo ElectroInk need to be coated. Several coatings are available commercially for this technology but often suffer from problems of limited shelf life or extremely poor adhesion of coating to substrate. If the coating does not adhere well to the substrate there is a risk of the coating transferring to the ITM during the print process. The chosen coating obviously also needs to be chemically compatible to Indigo ElectroInks.

As temperature is relatively low in Indigo technology it is worth mentioning that the presses are not limited to printing only PET media but are capable of printing other plastic media such as PVC, PC and PP.

Xeikon Technology (Dry Toner) –The largest constraint when printing plastic substrates with Xeikon technology is the high processing temperature. This temperature almost exclusively limits synthetic media selection to PET when printing duplex jobs.

The chemical coating therefore must also have excellent heat resistance and have correct chemical affinity to dry toner particles. The media must be stabilized to eliminate potential issues with shrinkage during the process.

Printing Conditions for PET Media

Xeikon technology – PET media is typically printed at 110-130^{0}C fusing temperature and 85-95^{0}C in the GEM unit. There is no need to use the pre-conditioning unit for this media.

Xeikon via its web site has relevant script files for approved media that is qualified at institutes such as PIRA and RIT.

Indigo- There exists a differentiation between one shot technology (where all the color layers are built on the ITM at once) and four shot technology (where each color is transferred individually to the ITM and then to the substrate or media)

It is therefore recommended to use separate chemical coatings for the two Indigo technologies that will take into account the significantly different manner in which the image is built up on the media. If this is not taken into account the printer may experience either sticking of the substrate to the impression drum or incomplete transfer of the image from the ITM to the substrate.

Real Life Applications

In the relatively short time since the introduction of digital presses, multitudes of digital print applications have utilized PET media. The common denominator in nearly all of these applications has been the clear benefits of PET media in the specific application. Since the cost of PET media is 4 to 8 times higher than that of paper, there must be a compelling reason to integrate its use in the application. This reason will always be one or more of the following:

- Optical Clarity
- Chemical Resistance
- Water Resistance
- Mechanical Strength
- Heat Resistance

The following are some interesting case studies that will emphasize the advantage of the use of PET media for the specific applications.

Perhaps the most widely known case study is the **Wurth catalogue**. The “business activities of the Wurth Group are focused on trading in screws, screw accessories, chemical-technical products, furniture and construction fittings, dowels and plugs, insulation, hand tools, electric and pneumatic tools, service and care products, connecting and fastening materials, stocking and picking systems, as well as the direct mailing of workwear.”

Wurth’s catalogue, used by hundreds of its salespeople, has thousands of items in it that are constantly being changed and updated. The decision to “go digital” was perhaps therefore natural due to the ongoing need to keep this important sales tool current and relevant.

The choice to use PET media printed on a Xeikon engine was based on the following facts

- PET is difficult to tear. One of the problems with the paper catalogues was pieces of paper constantly tearing.
- PET is relatively easy to clean. Due to frequent handling in contaminated environments these catalogues tend to get dirty.

- PET is lighter than paper. These catalogues are hundreds of pages so the total weight that the salespeople carry is important.

Ultimately digital technology allows Wurth to constantly update its product offering and PET media allows it to print the whole catalogue less frequently saving the company significant money.

Since Wurth's pioneering decision to change the way it manufactured its catalogue, many other companies in Europe and the USA have followed its lead in the use of PET media.

Telephone Cards have been another significant application for PET media. The telephone cards in discussion are temporary cards distributed for free by major telephone providers.

These cards are printed digitally so that they can be separately numbered with both a series code and an activation code. The use of PET in this case is so that the consumer can safely keep the card for the period of time needed, without it tearing or otherwise deteriorating until the company sends permanent cards.

The same idea is presently used for a multitude of **loyalty and consumer club cards,** saving the need for costly and time consuming over-laminating stages.

Overhead transparencies continue to represent a large amount of the PET media used in digital printing. A very interesting and specialized application in this field belongs to an Indigo Print Provider who makes sets of transparencies that are illustrative diagrams from educational books such as anatomy, biology and chemistry. In this case the print provider's customer is the publisher and the volume per run of between 10000-30000 A3's perfectly suits digital technology.

Polyester with its optical clarity and mechanical strength is really the only option in this application.

Shelf marking digitally printed on PET media is widely used by several major global retailers such as Home Depot. The majority of the shelf markers are printed with "traditional" print technologies but when a quick update is needed the digital press is used centrally with overnight distribution of the printed material to the outlets and stores.

In this case PET media is used for its tear resistance and cleanability.

Signage is slightly limited by the maximum output width of the technologies but nevertheless many signs can and are printed with digital printing technology. Some good examples are signs in fast food outlets and rotating signs with a multitude of different advertising pieces.

These signs are often changed frequently and may wish to focus on a weekly promotion, which demands digital printing technology. PET media is used because the chemical coatings offer excellent light dispersion and the media is sufficiently heat resistant to withstand the lamps used in the signs.

In the case of rotating signs PET media is a natural choice due to its excellent mechanical stability and strength that allow many rotations of the sign with no wear and tear.

Labels are in many ways extremely well suited to digital technology. Many labels include variable images or data.

Other opportunities for digital labels are in language versioning and trial marketing. Many technical labels used in the transport, electronics and appliance industries are made from polyester, due to its durability. These labels are used for tracking, identification, warning, certification and instructions. Many of these labels either incorporate variable information or are relatively short runs and therefore digital printing is an excellent choice.

It should, however, be mentioned that until recently this market niche has been severely limited by the lack of finishing equipment for die cutting, matrix stripping etc., on the back-end of the presses. Both Indigo and Xeikon have recently made significant progress in offering solutions for these problems through partnering with providers of finishing solutions.

With technical labels durability is the key. These labels need to continue to be readable and scannable after exposure to extremely demanding conditions such as heat, cold, acids, grease and oil, water and solvents. Polyester is the optimum material in these environments.

It should be also noted that each industry (automotive. electronics etc,) has set its own demanding standards and specifications for the labels used in the industry. The digital print provider must be aware of these specifications and take them into account in the choice of both face materials and adhesive.

Membrane Touch Switches (MTS's) are used widely in electrical appliances**.** The first layer of a membrane touch switch is generally a print receptive clear polyester film with a print receptive coating on one side and a scratch resistant coating on the other side. Traditionally the graphics are reverse printed with silk screen and the scratch resistant coating is the first surface of the switch. This is an excellent application for digital printing as many of the print jobs are short to medium run and may incorporate variable data.

The finished switch needs to meet a wide range of tests including flex life, chemical resistance and barrier properties. Polyester is the preferred and optimum solution in this market presently and there is almost no doubt that digital printing will significantly change the manner in which the graphic layer for the MTS is manufactured.

Conclusion

The use of Polyester media in digital printing opens up a wide range of opportunities and applications for the print providers. These opportunities extend beyond the traditional realm of commercial printing into a wide range of industrial and graphic applications.

Imagination, initiative and ingenuity in technical applications utilizing PET media have opened up a broad spectrum of new possibilities for the print providers that were largely unperceived by the OEM manufacturers. In general, these applications afford a higher revenue and profit than standard commercial printing can ever offer.