SHEETFED OFFSET PRINTING
ON PLASTIC SUBSTRATES

STAFIX

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INTRODUCTION

SHEETFED OFFSET PRINTING ON PLASTIC SUBSTRATES

Please be welcome to read this eBook for offset printing on plastic materials. This guide is specifically intended for people involved in the offset printing industry, in order to give you a comprehensive overview of the main technical subjects related to offset printing on plastic materials. We have collected this content from a wide range of sources in order to provide you with useful information, whether you are new to printing on plastic materials, are currently printing on them or have already gained long-time experience with offset printing on plastic materials.

This guide starts with a brief introduction of the plastic materials you can print onto, the differences between them and the reasons why they are different to printing on paper. We will also discuss about the handling of the products, the recommended inks and the recommended printing process.

We really hope you find this information useful and enjoy reading this guide. If you have any comments or feedback, feel free to get in touch.

Enjoy!
Stafix Ltd.

PLASTIC SUBSTRATES

Plastic substrates have very different handling and printing characteristics when compared to paper products. The main difference concerning the printability of plastic materials and paper is that plastic materials are non-absorbent.

When printing on smooth, impermeable plastic foils or foil-like substrates which do not allow any penetration of the ink, it is necessary to use inks, which are specifically suited for this purpose. Basically, these inks need to be set for oxidative or UV-drying.

There are big differences between the printability of different plastics. Traditionally the printable plastics are treated with a corona process in order to increase the surface tension and achieve better printability properties. On the other side of the spectrum, there are some plastics, like synthetic papers that have a thick coating that allows you to print almost like you would on traditional paper. Thin, statically charged, poly-propylene materials require oxidative inks with low levels of mineral oil and the amount of ink should be kept low.

Plastic substrates have very different handling and printing characteristics when compared to paper products.

Variations in the degree of polymerization and the surface treatment are inevitable, that is why plastic materials may react in a different way compared to the previous batch. This is the reason why it is recommended to make some tests and to test them under different temperature conditions before a commercial run.

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WHAT TO TAKE INTO ACCOUNT WHEN PRINTING ON PLASTICS?
Plastics will not absorb fluids like paper
Plastics restrict the flow of air and other gases between the sheets of a stack
Not all plastics are the same and they can vary in ink receptivity and ink anchorage
Most plastics will attract and hold a static charge much easier than paper
Plastics generally are more costly than paper products

ABSORBING PLASTIC SUBSTRATES

Synthetic paper has evolved, and currently some of them can be printed almost like a paper product. For example, Arjobex uses a clay coating to give the material a paper-like surface for printing purposes.

Other companies do it a bit differently, but the results are similar: A product that has paper-like printing qualities. Like e.g. Synaps, Robuskin, Polyart, Yupo, Polylith, etc.

Other products like for example, Teslin, has 65 percent of its volume made up of air. It is porous, and therefore highly absorbent, allowing inks to penetrate the surface and anchor them-selves in the sheets' structure.

Remember that it is very important to make sure to follow the printing guidelines provided by the substrate manufac-turers.

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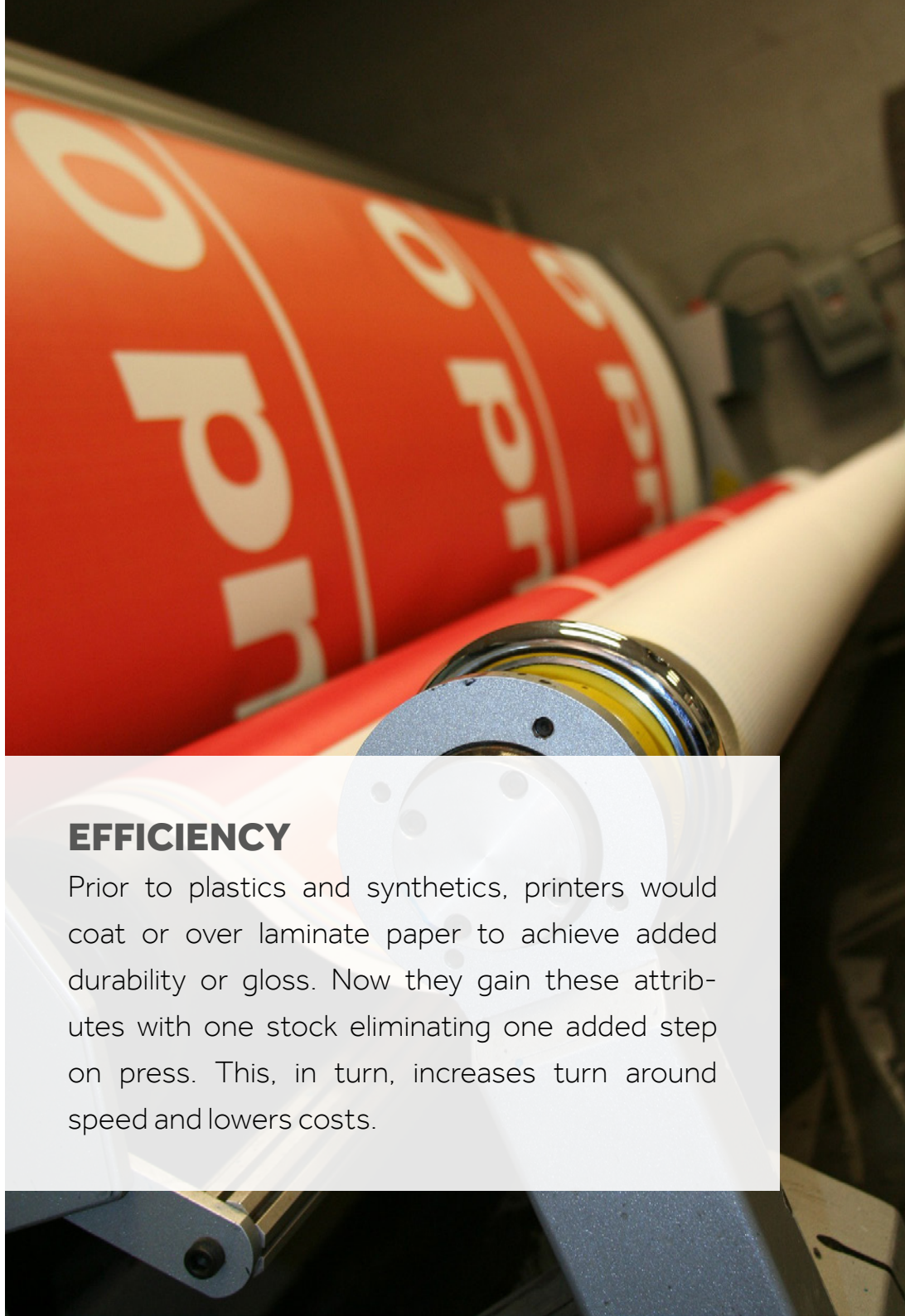
THE MOST COMMON PLASTIC SUBSTRATES

- Polypropylene (PP)
- Polyethylene (PE)
- Polyethylene terephthalate (PET), also known as Polyester
- Statically charged polypropylene
- High-density polyethylene (HDPE)
- Low-density polyethylene (LDPE)
- Rigid PVC
- Flexible PVC
- Self-cling PVC / Self adhesive Vinyl
- Polystyrene
- High impact polystyrene
- Oriented polyester
- Lenticular - Polyethylene Terephthlate Glycol-Modified (PETG)
- Synthetic papers (e.g PP, HDPE, LDPE)

ADVANTAGES OF PLASTIC SUBSTRATES

- **OUTSTANDING PRINTING QUALITY**
- **EXCELLENT STRENGTH & DURABILITY**
- **HIGH OPACITY**
- **LAYS FLAT**
- **RESISTANCE TO YELLOWING**
- **WELL SUITED FOR** frequently handled documents
- **GOOD POST-PRESS PROPERTIES;** easily slit, scored, folded, die-cut, perforated, embossed, riveted, sewn, foil stamped, and laminated
- **SUPERIOR RESISTANCE** to moisture, weather, water, oil, grease and other chemicals
- **VERSATILITY;** can be printed via offset, flexo, screen, rotogravure, letter press, inkjet and thermal transfer



EFFICIENCY

Prior to plastics and synthetics, printers would coat or over laminate paper to achieve added durability or gloss. Now they gain these attributes with one stock eliminating one added step on press. This, in turn, increases turn around speed and lowers costs.

CHALLENGES WITH PVC

PVC, also known as vinyl, has considerable amounts of plasticizers, release agents, stabilizers, etc. These components are necessary in order to achieve its flexible characteristics but at the same time they might cause complications with the oxidative drying of the ink.

Sometimes, under specific storage conditions, the plasticizers might migrate to the surface, penetrating into the printing ink and softening it. This is possible even after the ink has dried. This migration phenomenon of the plasticizers happens because the plasticizers are extremely solving substances. That is why there can be a risk that a job that has already been delivered in perfect condition might have a complaint weeks after delivery.

RECYCLABILITY AND DISPOSAL

While commonly used plastics have today become widely accepted, some raise concerns about the impacts of the manufacturing, use and disposal of plastics on public health and on the environment. The most controversial plastic in this regard has been polyvinyl chloride (PVC). The concerns over PVC have largely revolved around three issues:

1. CHLORINE

The chlorine-based molecules of vinyls are linked to several health concerns. Chlorine, a known human carcinogen, makes up to more than half of the compound and creates dioxin when PVC is manufactured or burned.

2. ADDITIVES

PVC contains many toxic additives, stabilizers and plasticizers, such as phthalates, lead and cadmium. These are not chemically bound and can easily leak out. This for example, restricts the material from being safe for contact with food or being used for products intended for children.

3. FIRE

PVC has a lower melt temperature and produces poisonous hydrogen chloride gas and dioxin when burned. This causes a serious health hazard for example, in case of been incinerated.

PVC can be recycled when it is kept separated from other resins. The problem is that the material's recycling level is low and if you mix PVC with other plastics, it can contaminate the entire recycling stream.

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STORAGE AND ACCLIMATIZATION

With all plastic materials it is very important to make sure they are acclimatized to press room conditions before going to press.

Plastic materials are typically stored in a heated warehouse and after that they can spend several days in transit on the way to your premises. Especially during the winter period the pallets can be subject to extremely low temperatures. Therefore when the material arrives at your premises, it must be allowed to acclimatize a while before making any attempts to print or process the stock.

Plastic sheets that have not been acclimatized properly will not process well. Cold materials may be more rigid and less flexible than materials that have been acclimatized to ambient temperature. This can lead to problems with feeding through the press and can also cause color and registration complications.

RECOMMENDED PRESS-ROOM ENVIRONMENT

It is important to monitor relative humidity and the temperature of the pressroom. The ambient temperature and humidity may be too high or too low, which may affect ink tack and drying and cause a 'static charge' that would hinder the efficient feeding of the plastic substrates.

The Industry's ideal pressroom climate control is: 52% (+/-5%) at approx. 21° C

A monitored standard pressroom environment allows for uniform printing quality not only with plastic substrates but also with paper, cardboard and absorbent materials.

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The temperature difference between transportation, storage and pressroom will vary depending on the time of the year, affecting the necessary time for the conditioning of the material. During the warmer summer months it is advisable to allow the material to acclimatize in the pressroom for several hours before processing. During this time the pallets should be unwrapped and the strapping removed to allow the material to 'relax'. This will aid sheet feeding through the press.

Plastic sheets that have not been acclimatized properly will not process well.

During winter months when the temperature during transportation can fall to subzero conditions, it is advisable to allow the material to acclimatize for several days before beginning to process the sheets.

BEST PRACTICES

Once the sheets are unwrapped and acclimatized in the pressroom, always check the temperature at the center of the stack. It is probable that the outside edges will feel warm but the center remains still too cold to process.

Do not open more material than necessary for the printing run. Rewrap any remaining material in order to protect it from dust and changes in the humidity and temperature.

Remove the top and bottom sheets, which may have been damaged during packaging, handling or transit.

Remember to follow the storage and acclimatization guidelines provided by the substrate manufacturer!

PRE-PRESS RECOMMENDATIONS

Avoid having high amounts of ink in the artworks. Normally, the total ink coverage (TIC) should not exceed 300% in the artwork. Make sure to double-check the individual recommendation for each plastic substrate since there are some plastic substrates that recommend lower quantities of TIC. For reducing the amount of ink under color removal (UCR) and / or Grey Component Replacement (GCR) are recommended.

CUTTING SHAPES: Avoid designing sharp corners and try to round the inner corners because the inner-sharp corners might cause the plastic substrate to tear.

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PREPARATION BEFORE PRINTING

1. **ALWAYS ARRANGE PRE-TESTS** of the plastic material you intend to use for a commercial job using the right design, inks, varnish, lamination and post-press methods.

2. **CONSULT YOUR MATERIAL AND INK SUPPLIER** for the most recommended product(s) that would suit your application.

3. **KEEP IN MIND** that if you need to use different oxidative inks on press than you would normally use, you might need to set the fountain solution to be compatible to the ink. Make sure that you ask about this from your ink supplier so you have the right fountain solution PH value and alcohol level.

4. **ALLOW ENOUGH TIME** for the acclimatization process. Each material supplier has their own recommendations depending on the quantity (weight) of the material and the difference in the temperature between storage and pressroom.

5. **RESERVE SOME EXTRA DRYING TIME** (up to 72 hours) depending on the material, design and amount of ink, between printing the first side and second side (on a two-sided job) or before conducting any post-press and finishing process.

6. **TEST THE PRINTED MATERIAL** under the end use conditions, E.g. installing it to the surfaces intended, testing it under the final application conditions.

INK ANCHORAGE ON PLASTIC SUBSTRATES

Especially, when printing with UV curable inks, one of the main challenges presented by plastic substrates consists in the anchorage of the ink on its surface that is extremely smooth.

Separating agents, slip agents and plasticizers migrating to the surface may negatively influence the anchorage of UV-curable inks to different pretreated films, foils and synthetic materials. Therefore it is recommended to carry out preliminary tests before printing the final job

CHOOSING THE RIGHT INKS

Since plastic substrates do not absorb any liquid, they have very different handling and printing characteristics when compared to paper products. Therefore special inks are required.

Depending on the offset printing technique you will use, there will be different issues you must take into consideration. Most commonly offset inks will dry either by:

1. Setting (physical drying)
2. Oxidative drying (chemical drying)
3. Ultraviolet curing (photochemical process).

1. SETTING (PHYSICAL DRYING)

This drying mechanism means that the liquid components of the inks (the oils as well as the emulsified fountain solution) should penetrate quickly into the substrate's surface (e.g. special coatings from substrates such as synthetic papers or into the structure of porous synthetic materials). This type of drying starts immediately at the contact of the ink with the material and should take a few minutes.

The setting is providing a first fixing of the inks on the substrate. The drying becomes more critical if the penetration speed decreases or the amount of ink applied in the artwork increases.

2. OXIDATIVE DRYING (CHEMICAL DRYING)

This is the most common drying method used for printing on plastic substrates. The drying reaction takes place by molecular linkage between vegetable or mineral oils with oxygen.

For that reason, the ink layer should be supplied with sufficient oxygen in the delivery pile; the necessary space for allowing the access of oxygen to the pile can be secured by applying drying powder. During this drying process a solid ink layer is formed from the liquid ink.

3. ULTRAVIOLET CURING (PHOTOCHEMICAL PROCESS)

Commonly known as UV curing, is a fast curing process in which high intensity ultraviolet light is used to create a photochemical reaction that instantly cures the ink. Using light instead of heat. Liquid monomers and oligomers are mixed with a small percentage of photo initiators, and then exposed to UV energy. In a few seconds, the ink instantly hardens; this is a solventless process, which cures by polymerization rather than by evaporation

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PRINTING PROCESS

1. RUNNABILITY

Good runnability comprises the different factors that let you run your job efficiently through the press with low down time, low material waste and consistent quality.

A very important part of achieving good runnability is to achieve an efficient feeding. Efficient feeding is the key for high print speed and good economy.

Since most plastics will attract and hold a static charge much easier than paper, one of the key issues for achieving an efficient feeding is to store and acclimatize the material according to the material's supplier guidelines.

For more acclimatization tips, please refer to our acclimatization chapter on page 9.

FEEDING:: In order to improve feeding, fan the sheets properly prior to loading. If you are printing with oxidative inks, you should run in short lifts of 200-300 sheets. Set the feeder for printing on plastic substrates. When starting to print begin running at a lower press speed before increasing to the desired printing speed progressively.

A strong air supply is essential for feeding plastic substrates. Position the feeder air blowers so that the air separates the first 10-15 sheets to minimize blocking. Use additional side blowers, if necessary and position them at the front of the stack.

PRINTING PRESSURE: The printing pressure should be maintained as for standard coated paper, as the printing surface of the plastic substrates is usually very smooth and therefore there is no need for additional pressure.

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ANTI-STATIC DEVICES: As already mentioned earlier, plastic substrates tend to attract and hold static charge much stronger than paper products. Therefore, the use of anti-static bars and ionizers is highly recommended to prevent blocking in the stack.

With the exception of when printing on statically charged film, which demands not to use any anti-static device in order to preserve the static properties of the material.

TROUBLESHOOTING: Most commonly offset printing presses have either an ultrasound or an optical sensor, and in some cases both, to detect double feeding. Although technology has evolved significantly in the printing presses, sometimes when printing on transparent, very glossy or multilayer materials, the machine can falsely detect double feeding even though there is only one sheet going into the press. When this happens, it is recommended to turn off one of the sensors (test alternating both options) and if the false double feeding persists try turning off both sensors.

DID YOU KNOW?

Printing on plastic substrates reduces significantly the need to clean the printing blanket, since plastic substrates produce less dust associated with paper materials.

To improve feeding run in short lifts of 200-300 sheets, for oxidative printing is recommended to use smaller pallets for drying the material.

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2. DAMPENING SOLUTION

The dampening solution wets the non-printing areas on the printing plate to prevent the ink from adhering. The solution helps to cool both the ink and rollers.

Please consult with the ink supplier for the suitable acidity and PH value of the dampening solution.

LEVEL OF ALCOHOL

Keep the alcohol level at the levels recommended by the ink supplier. Some of the inks recommended for printing on plastic substrates recommend a higher level of alcohol compared to the traditional inks intended for paper and absorbent substrates.

The advantage of adding IPA (Isopropanol Alcohol) in the dampening solution is that when it evaporates, less water is transferred to the blanket. This results in less water transfer to the plastic substrate and the ink can dry more quickly.

LEVEL OF WATER

Print with low levels of water. Most of the plastic materials that don't have a receptive coating absorb practically no water and therefore very little water is needed (roughly less than half of what would be required with paper). The plate requires only enough water to keep the surface wet.

DID YOU KNOW?

Good resistance to the adhesive tape test does not necessarily imply a good scratch resistance (nail test). Varnishing with UV-curing varnish containing slip agents, like silica, can improve scratch resistance. However, this will not improve the anchorage to a given substrate.

A good tape resistance is essential to ensure trouble-free further processing of the printed material.

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3. COATINGS AND VARNISHES

Some applications might require a stronger anchorage than others. For example if you need the material to have a high rubbing resistance, applying a varnish can be a solution. Remember to discuss with the substrate manufacturer regarding the compatibility of the material with different coatings or varnishes.

It is important to test the compatibility of the varnish since some varnishes/coatings develop a high tension on the surface applied after drying/curing and this might cause the corners of the printing material to curl.

Don't use any type of coatings or varnishes when printing on statically charged film. Without exception, the coatings and varnishes will eliminate the static properties of the material.

4. USE OF ADDITIVES

If you are using oxidative inks designed for non-absorbent plastic materials due to the already fast drying ink behavior it is not recommend adding additional additives to the ink.

5. DRYING

Naturally, the printer would like to have a fast drying in order to process the job in a promptly manner. If the drying process is affected by influences from outside, like a limited supply of oxygen in the pile, too much fountain solution, bad penetration of the substrate, or a high amount of ink, the ink-drying time may be extended considerably. When printing with oxidative inks, the ink needs some time to set after printing.

In order to speed up the drying process it is critical to apply a small amount of ink and to have a good supply of oxygen in the pile. The drying can also be speeded up in the repro stage by reducing the total ink coverage (TIC) of the artwork. For reducing the amount of ink under color removal (UCR) and / or Grey Component Replacement (GCR) are recommended.

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UV-OFFSET: Avoid excessive heat when curing the inks, adjust the UV-lamps to a minimum level that cures the inks but does not stretch the plastic substrate. If too much heat is applied this can cause challenges in the registration especially at the tail of the sheet.

Particularly for thin and softer plastic substrates it is recommended that the intensity of the lamps should increase progressively in the running direction of the material, applying less intensity on the first lamps and more intensity on the last lamps before delivery, this will help to reduce the shock of the sudden change of temperature in the substrate.

When using a hybrid-printing machine turn off the IR lamps, since the heat does not accelerate the drying when using UV curable inks. The use of IR lamps can extend the drying time, due to higher temperature in the stack.

TIPS FOR FASTER DRYING WITH OXIDATIVE INKS

- **APPLY MINIMAL FOUNTAIN SOLUTION**
- **AVOID HIGH AMOUNTS OF INK**
- **USE A LARGER GRAIN POWDER** to facilitate drying. Larger grain powder allows more air to pass between the sheets and therefore facilitates faster drying.
- **DRY THE SHEETS IN A WELL-VENTILATED ROOM.** After the ink is touch-dry you can ventilate lightly the stack.
- **DRY THE SHEETS IN SMALL STACKS** (250-300 sheets) in order to prevent the stacks weight blocking the airflow.
- **DO NOT USE IR DRYERS**; the intensity of the IR lamps may cause the plastic substrate to expand due to excessive heat. Additionally the IR lamps may extend the drying time, due to higher temperature in the stack.

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POST-PRESS AND PACKAGING RECOMMENDATIONS

- **ALWAYS TEST** the design, adhesives, laminations and bindery processes before an actual production run.

- **MOST PLASTIC SUBSTRATES** can be die-cut just as paper materials. Avoid sharp corners because they might cause the plastic substrate to tear, always cut round the corners when die-cutting or kiss cutting. When trimming, use sharp, nick-free blades.

- **PERFORATING AND DIRECT MAIL** inserting are also possible but remember to check the guidelines provided by the substrate manufacturer.

- **WHEN POSSIBLE, PACK THE MATERIAL FLAT**, plastic materials have memory and they will reminisce the shape they were packed. For flexible plastic materials, roll them up with the printed side facing outwards if sending them in a tube. Do not fold the printed material for shipping.

- **AVOID PACKING THE MATERIAL** with products that emit VOC's (Volatile Organic Compounds / Solvents).

- **DO NOT TO PACK** the material in vacuum-sealed packaging while the ink's drying process is still ongoing, The VOC's emitted during the drying process can cause challenges with the plastic materials. Some plastic materials might curl or bend, or statically charged films might lose their static.

TEST BEFORE	Before running a job, test the printability of the material, the post-press and the material's compatibility with the intended application.
ANTICIPATE	Order the required inks, varnishes, etc. Reserve enough time for cleaning the ink units and anticipate the additional drying time before the post-press. Reduce the TIC on the artwork. Round the corners of the shapes to be die cut or kiss cut.
ACCLIMATIZE	For achieving effcient feeding it is key to acclimatize properly the material. The time needed depends on the quantity and the difference in temperature between storage and press room.
PRINTING	Run in short stacks, Avoid too strong pressure in the cylinder, use antistatic bars (if not statically charged film), revise compatibility of dampening solution with the ink (ph values and levels of alcohol), print with low levels of water, avoid heavy layers of ink.
DRYING	Use larger drying powder (Oxidative inks), dry the material in a well ventilated room, avoid the use of IR lamps, for UV-offset avoid excessive heat, set the first lamps at a lower intensity and increase on the following lamps.
POST-PRESS	Make sure you use previously tested varnishes and coatings, Use sharp and nick-free blades for cutting and trimming. When die-cutting or kiss cutting round the sharp corners in orer to avoid tearing.
PACKAGING	Pack the material flat. For flexible plastic material pack them with the printed image to the outside. Do not fold the material. Avoid packing the material with products that emit VOC's.

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2 There should be as little as possible limitations on which surfaces, and where, you can install your advertising.

3 You should be able to trust that you are not damaging the surfaces, which you are using the materials on.

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WANT TO KNOW MORE?

Stafix Ltd. is a manufacturer of specialty printing materials used mainly in POS advertising. All our products are glue-free and easy to install.

The materials can also be removed without leaving any residue or cleaning afterwards. STAFIX® -materials are recyclable and PVC-free.

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DATA SHEETS & PRINTING GUIDELINES

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