The Development of Inkjet Printing Media for Digital Production Printing

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Abstract

The development of a new inkjet media starts with a clear definition of performance goals, together with a deep understanding of related printer-ink-media interactions. Physical properties, which are influenced with the system, include caliper, stiffness, friction and paper stability. Corresponding imaging properties include optical density, banding, coalescence and color-to-color bleed. And, finally, we need to review the post-printing properties such as handleability, permanence and ink abrasion resistance. The relative importance of those properties differs depending on the intended use of the printed document.

Once the product is well defined, we need to decide on the appropriate, if any, coating technology. The coating options include the swellable, the porous and the hybrid ones. Swellable coatings are preferred for fade resistance, whereas porous coatings are better for instant dry time, a fundamental need in the *Digital Production Printing* arena.

Introduction

Analog vs. Digital Printing Processes

Many technologies exist in both analog and digital form, such as music, photography and television transmission. Printing processes are no exception. Analog printing processes use some sort of printing plates and include technologies like letterpress, flexography, offset lithography, gravure and screen-printing. Digital printing processes can either be *impact printing*, such as dot matrix, or *non-impact printing*, such as thermal transfer, electrophotography (EP) and inkjet (IJ).

Digital technologies have been usually associated with the generation of documents in small quantities or documents with variable information. However, technologies such as EP have already entered the market of medium to large production runs, historically reserved for analog processes. On the other hand, IJ began to erode the EP market in the 90's (cheaper color reproduction is one of the reasons). This trend is expected to continue through our current decade.

Piezo and Thermal Inkjet Technologies

IJ printers produce images using drops of ink. They are ejected from a printhead and they can be generated in a *continuous flow* or *by demand*, the latter including piezo and thermal technologies (TIJ). With piezo, the water or solvent-based ink is ejected from the printhead by a pumping action of a piezo electric crystal when an electric pulse is applied. With thermal, a superheated vapor bubble ejects a drop of water-based ink at high velocity.

Ink Absorption and Inkjet Media Flexibility

TIJ inks have very low viscosity, compared with offset lithography and other press inks. The typical carrier-to-colorant ratio is more than 90% of the volume of the inks, while that of a typical offset ink goes from 20 to 50%.

All of this liquid will finally land on the printing media, where it needs to be managed, i.e. evaporated or absorbed. With TIJ, where water is the main ink carrier, the ink won't be evaporated instantly, unless the printer has a heating device. On uncoated fiber-based media, fibers and fillers will then absorb this ink, but it may go too deep into the paper and, therefore, the colors may look poor. On uncoated films, all this ink will stay on the media surface, with no adhesion to the film itself. Therefore, a coating is needed to absorb this liquid ink in the media surface.

The fact that IJ is a non-contact printing technology allows for a wide variety of media to be used. This range includes fiber-based papers (made of cellulose or synthetic fibers), photographic papers with all kind of finishes, and films, like vinyl, polyester, polypropylene…

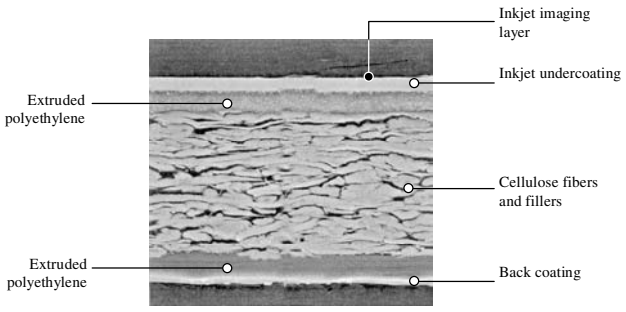

Figure 1. Cross section of an inkjet photographic paper

Inkjet Coatings

Every printing technology has some unique requirements for the media coating: *Electrostatic* coatings should be conductive, *Liquid EP* coatings should be designed to provide good ink adhesion and *IJ* coatings should have a good ink capacity. Coatings are also very helpful to enhance the color gamut of the printed image and allow the ink drops to have better definition. In addition, the media will have improved properties like opacity, whiteness and smoothness. This IJ coating applied on absorptive media like paper bond will be lighter and thinner than that on non-absorptive media, like backlit film.

Inkjet Coated Papers and Inkjet Photo Papers

IJ coated papers consist of a raw base and a receiver layer. The base contributes to the physical support and the absorption of part of the carrier from the ink. The color receiver layer provides capillarity for fast drying; it is a reservoir for most of the ink carrier and holds the ink colorants (dyes or pigments), giving better image quality. This raw base is made of fibers and fillers. The color receiver layer is of a porous nature and consists of inorganic **pigments** (like silica), polymeric **binders** (like polyvinyl alcohol) which bind the pigments to each other and to the fibers, and some performance **additives** (like optical brighteners).

IJ photo papers (Fig. 1) consist of a photo base (paper with an extruded polyethylene layer on both sides, which gives them their gloss appearance) and a complex multi-layer coating. These coatings can be **swellable** (they inflate when water is absorbed, such as the soft contact lens), **micro-porous** (carrier is absorbed through the coating *holes*, similar to water in sand) or **hybrid**.

The Development Requirements of Inkjet Media

IJ is a technology widely used for printing in both small and large format. We need a broad understanding of the physical, printing and post-printing media properties when doing development for any of these formats.

The media *physical* properties include:

- **Caliper**. It is usually limited by the distance from the printhead to the media. This distance is usually very low in order to avoid dot placement errors. On the other hand, it cannot be too low, as cockle from paper may induce printhead crashes.
- **Coefficient of friction**. Media loading issues, like media picking, are due to friction problems.
- **Dusting**. A poor coating adhesion will result in dust particles which may clog the printhead nozzles and affect the media loading process.
- **Gloss**. It also has an effect on color gamut.
- **Lamination peel strength**: most large format prints will be laminated.
- **Paper dimensional stability**. Inkjet inks will swell cellulose fibers, causing cockle.
- **Stiffness**. Most printers will have a limit for the media stiffness.
- **Tear strength, Opacity, Brightness, Grammage, Fluorescence, Yellowing, Roughness**…

The media *printing* properties include:

- **Color gamut and optical density**. Photo papers have more ink capacity than coated papers and, therefore, better color vibrancy.
- **Area fills uniformities**. Issues like coalescence, banding, mottle and bronzing should be avoided.
- **Color to color bleed**. Color will mix to each other if it remains on the surface for too much time.
- **Line roughness, Feathering, Wet cockle**…

The media *post-printing* properties include:

- **Image permanence**. Light and air will generate color fading. The coating technology and the inks will have a big influence on fade resistance: porous papers will fade much quicker than swellable media, as well as dye-based inks compared to UV resistance inks.
- **Handleability**, like ink abrasion resistance, highlighter resistance, waterfastness and post-print curl.
- **Dry time, dry cockle, laminability…**

Inkjet Media for DPP

These DPP media will have some specific needs, different to those media used in current desktop or large-format printers. Here are some of these unique requirements:

- **Dry time**: these media will be printed at high speeds. A combination of a porous coating together with a printer heating device will be needed.
- **Paper dimensional stability**: it is critical for good color registration and to avoid dot placement errors, as well as printhead crashes.
- **Handleability**: offset papers have a very good ink abrasion and highlighter resistance.
- **Price**: they need to be competitive with current press papers. The media should be coated in the size press during their high speed manufacturing process. Coating pigments should be applied at higher viscosities.

Therefore, the use of the current offset papers for TIJ DPP is a valid option only if some treatments are applied to these papers in order to achieve some of the previously discussed features.

Biography

Roman Barba i Mundó received his M.S. degree in Paper & Printing Industrial Engineering from the *Escola Tècnica Superior d'Enginyers Industrials de Terrassa* (UPC) in 1992. He joined Hewlett-Packard in 1994, working in the area of Large Format Inkjet Media. His work has primarily been focused on the development of Coated Papers and Porous Photo Papers for the HP DesignJet inkjet printers.