Media Issues In Electrophotographic Digital Printing

Velliyur Sankaran and James Smith
Oce Printing Systems USA, Inc.
Boca Raton, Florida, USA

Abstract

Print quality is of paramount importance in both the digital industry and the print-on-demand (POD) book publishing industry. Several factors, such as, media properties, toner attributes and fusing technology, play a critical role in the quality of print output. In terms of media properties, surface characteristics (smoothness, surface treatments and energy), electrical properties and dimensional stability have a direct bearing on print quality. Toner parameters affecting print quality include particle size, toner charge to mass ratio, powder flow and melt rheology. The type of fusing (contact v/s non-contact) and fuser roll materials can also influence print quality.

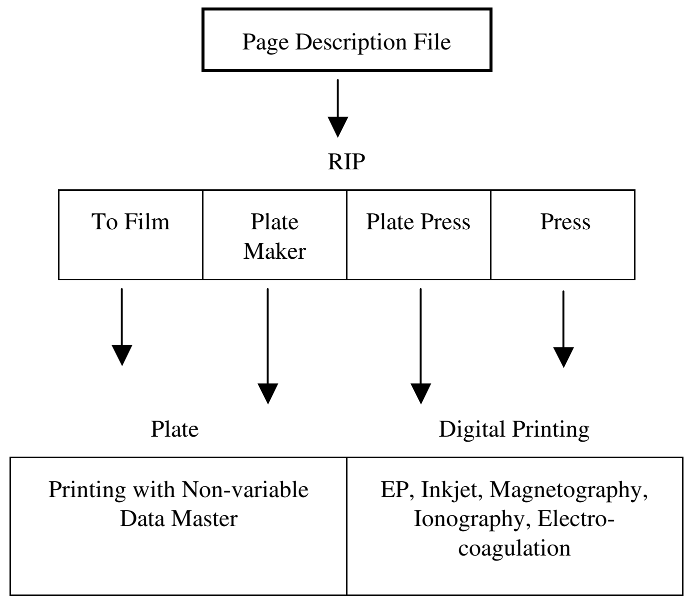
An overview of each of these factors and their influence on digital printing (both monochrome and color) will be discussed. Further, this paper is an investigation of the correlation between media and EP materials in a typical digital printing industry, new test methodology and print output quality.

Introduction

A digital printing system can be characterized to be a system that prints images directly from ripped information, without a master, so that every consecutive printed page can have different information or variable data. The technologies used in digital printing are based on electrophotography (EP), inkjet, magnetography, ionography and electrocoagulation. This paper will pertain itself with the electrophotography printing process.

The image creation process consists of normal electrophotographic steps, which are:

- Photoconductor charging
- Latent image creation
- Latent image development
- Toner transfer to media
- Cleaning of Photoconductor
- Fusing of image on media



In any electrophotographic printing process, the media properties need to be optimized to match the toner parameters and the type of fusing systems employed. The design of the systems takes into consideration issues like printer speed, type of writing head, base resin of toner and type of photoconductor.

A vital part of the electrophotographic system is the properties of toner during the fusing process. The toner melts from the solid phase into a film forming stage during fusing. The spreading of toner is controlled by the contact angle between paper and toner, viscosity and the surface energy. The surface property of paper greatly influences the spreading and adhesion of toner on paper. In addition, this property also determines the gloss level and rub resistance of printed image.

The type of fusing system also plays a significant role in EP printing process. The non-contact fusing process offers a wider choice of media like coated, un-coated, synthetic, and labels that can be used. However, contact thermo-mechanical fusing has some requirements. The fuser roll material could be hard teflon or soft silicone rubber. The media property requirements vary significantly between these fuser roll materials. Hard teflon fuser rolls require a smoother paper for good fuse quality. Smoother paper also provides a longer life for the roll (good for high speed). However, the fuse quality and resolution of images, half tones and heavy solid areas are marginal. Soft rubber rolls work well with smooth and rough papers. In addition, soft rolls provide good fusing and resolution. However, the roll life is very poor. This necessitates a creation of balance between roll life and performance.

The following paper properties are critical for both runnability as well as printability considerations. This becomes more critical when printing was done in high-speed twin tandem mode:

Media Issues in EP Printing:

Runnability:

Paper Properties	Process Characteristics
Moisture	Process Stability
Electrical	Stackability
Formation	Curl
Surface	Odor
Chemical Composition	Blistering
	Post Processability

Printability:

Paper Properties	Print Characteristics
Moisture	Mottling
Electrical	Optical Density
Formation	Gloss
Surface Energy	Deletions
Smoothness	Toner Adhesion
Dimensional Stability	

Moisture Effect

A higher moisture content will result in a conductive paper. Conductive paper will have poor toner transfer, along with curl, mottle and deletion issues. A lower moisture content will result in a resistive paper, which can cause static problems in the paper path. About 40% of moisture loss result after printing. Another 20% is loss in a tandem twin application. A good dimensional stability and stiffness reduces moisture effects on the paper. A uniform paper structure, with good formation, will reduce wrinkling tendency, provide acceptable curling and will insure good processability.

Dimensional Stability

Dimensional stability relates to the propensity of paper to expand in high moisture conditions and contract when moisture decreases. Generally, cockle and deletions result from a combination of non-uniformity in the paper and high drying shrinkage. A modification of paper making process may accelerate this problem.

Paper Curl

A paper curl occurs when there is non-uniform contraction/ expansion in the sides of paper. By addressing fiber orientation, anisotropy, filler content and built-in drying stress, the curl effects can be minimized.

Stack Lean Issues

Fiber orientation angle and paper shrinkage can cause stack lean. A high hygorexpansivity can also result in stack lean. Stack lean can be minimized by reducing fiber angle and cross grain shrinkage.

Cross Grain Shrinkage Effect

A cross grain shrinkage greater than 0.8 percentage can cause pin-feed forms to pull off the tractor holes. This may result in a paper jam or paper tear. The dimensional changes should be kept to a minimum level to solve this issue.

Paper Stiffness in Cut-Sheet

Low stiffness in cut sheet papers can result in jams and/or double feeds. This effect can be reduced by adjusting filler content, refining and controlling drying.

Porosity Effect

A porous paper can cause mis-feeds with a vacuum feed system. Again, by adjusting filler content, refining, and calendering, the effect can be minimized.

Resolution in Color Printers

Sometimes drastic dimensional changes can cause fuzzy print quality due to overlapping of one color on another in sequential color printing.

Test Methodology

The tape peel test indirectly measures the surface energetics of the paper. The standard 3M 810 tape is applied on the un-printed paper sample under a constant load. The tape is then peeled at a slow rate using a label peel tester (Model # 80-90-01). The procedure is outlined as follows:

- Activate the “TMI Lab Master Release and Adhesion” tester by depressing “Lab Master Release & Adhesion”.
- Select “Run Test” from the selection menu
- Cut specimen 2” X 4”
- Select size of material for testing in menu of “Run Test”.
- Disengage sled by moving lever to “Disengage”.
- Attach sample to sled at pre-determined mark by using two-way tape.
- Verify sample is properly secure to sled. If needed, secure sides of substrate with tape. This will prevent

sample from moving or lifting from sled when "Lab Master" is engaged.

- After sample is in place, firmly secure 4 ½ - 4 ¾" standard 3M 810 tape the length of specimen leaving ½ - ¾" remaining at front end of specimen to attach to clamps.
- Confirm no air pockets are present in 3M tape.
- More lever to engage.
- Depress "Return"
- Wait for "Lab Master" to calibrate.
- After calibration, "Lab Master" should have a small green box located left bottom of screen reading "Start".
- Peel back and attach remaining potion of 3M tape in clamps of the peel tester.
- Depress "Start"
- Graph will appear shortly after measurement.
- Move mouse, located on the far right, as to incorporate accurate data.
- Depress "Accept"
- Under "Specimen" use value under "Average" as measurement of that particular sample.
- Measure five samples and take average.

Sheffield Values (SU)	Peeling Resistance (g/in)
110 (Felt)	148.66
156.5 (Felt)	199.74

From the peel force, one can predict the fusability of paper, after evaluation of media performance in printers.

Conclusion

Paper properties, printer parameters along with EP properties of materials, play a significant role in digital printing. Still depending on the output quality desired, these interactions can be balanced to achieve quality in digital printing.

References

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Biography

Velliyur Sankaran has been with Oce Printing Systems for the past two years. He has worked with electrophotographic materials for over 25 years, most of which was conducted for IBM. He has a M.S. in Chemical Engineering and Polymer Science.

James C. Smith received a B.S. degree in Pulp & Paper Science Technology and a B.A. in Chemistry from North Carolina State University in 1997. Since June 2000, he has worked for Oce Printing Systems USA, Inc. His work is primarily focused on evaluating substrates for printability and runnability through laser printers, analyzing different toners for electrostatic charge/mass ratio and supporting field engineers, sales and marketing for printer and media related issues.