

Defining Image Quality

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Abstract

The most important visual properties for ink jet printing are color and clarity. With the growing market of ink jet printers for industrial and home use, the importance of print quality has reached new heights. The end user requires that their printer be able to print crisp, clear text as well as high resolution graphics and photographs. The quality of the media must improve to meet the user's expectations. A simple method of improving the print quality can be accomplished by coating the media.

There are several coatings available for ink jet to improve print quality. The focus of this paper will be to explain the mechanisms of ink jet coatings and to provide print quality correlation via image analysis. Silica and Calcium Carbonate coated paper will be compared by their respected print qualities.

Introduction

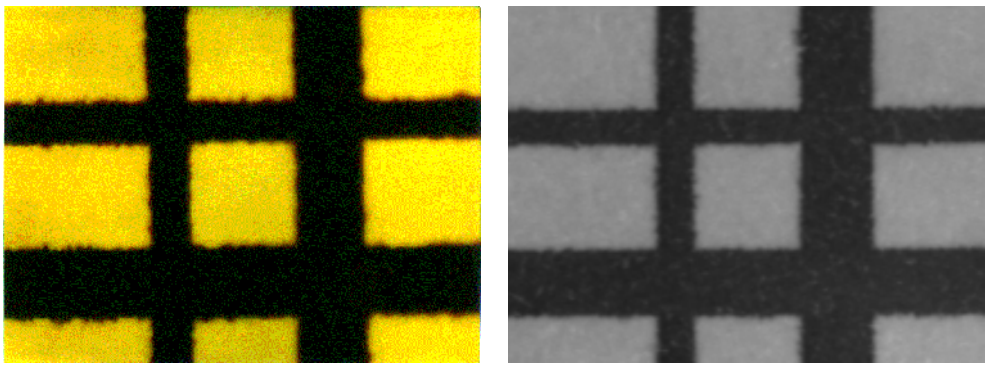
With the constantly changing market for non-impact printing, the ability to benchmark current print quality and quantify improvements will be increasingly more important for all involved parties – from supplier to end user. Of the various methods available to quantify improvements, the simplest and most effective is – regardless of printer type – the resulting print quality of the media in question.

As part of a continuous project during the past three years, Specialty Minerals Inc. (SMI) has collected and evaluated commercial media samples from our current and prospective customers. We have focused our benchmarking efforts on the following properties:

- optical density
- water fastness
- dry time
- light fastness
- ink penetration
- color-to-color bleed (a.k.a. inter-color bleed or spreading and feathering).

These samples have been evaluated over a broad range of printers from various manufacturers, including – but not limited to – Hewlett Packard, Epson, Canon and Lexmark. The media and printers utilized are updated continuously to adapt to the constantly changing media and printing technologies.

Although the human eye can qualitatively detect differences in print quality, advanced software & hardware combinations are required to quantitatively evaluate image quality. For purposes of simple comparison, we focus on two distinct yet critical parameters – optical density and color bleed (see figure 1).



Actual Print Print via Image Analysis Software

Figure 1. Grid to evaluate optical density and color-to-color bleed

Optical density is evaluated utilizing a standard ink densitometer, while the color bleed is evaluated utilizing an image analysis package (hardware & software) called ImageXpert[1]. The printed color sample is converted to a binary image and color-to-color bleed is assessed by measuring the area and perimeter of the printed hash mark pattern. A ROI (region of interest) is selected, in this case the hash pattern. The camera is calibrated and the image is captured. The computer can calculate the area and perimeter through a sequence of measurements. By utilizing computerized systems to determine print quality, factors that impact individual perception are eliminated, resulting in a quantitative measure which is compared to other samples.

By plotting the resulting spreading/feathering index (x-axis) versus optical density values (y-axis), we are able to quickly interpret quality and visually index various samples (see graph 1).

From this graph it can be seen that samples with poor optical density have poorer color bleed. These samples are from the commercial inventory of samples tested at SMI. Print quality can be improved by applying an ink jet coating to the basestock.

There are many types of substrate coatings available to the end users, each with their own mechanisms and resulting print quality. JETCOAT® 30 Specialty PCC possesses unique characteristics designed to further enhance ink jet print quality. The basic mechanisms of each coating are described in the table below.

Synthetic silica and calcium carbonate have been formulated to enhance ink jet print quality. Silica has been the primary pigment for most coated ink jet grades. Silica has been used for its porous and water loving characteristics and is able to trap the large water based ink applied by the ink jet printer[2]. Precipitated Calcium Carbonate ink jet coating pigments bind the dyes used to produce color[3]. The crystalline structure of PCC fixes the ink to the surface, which results in a higher optical density.

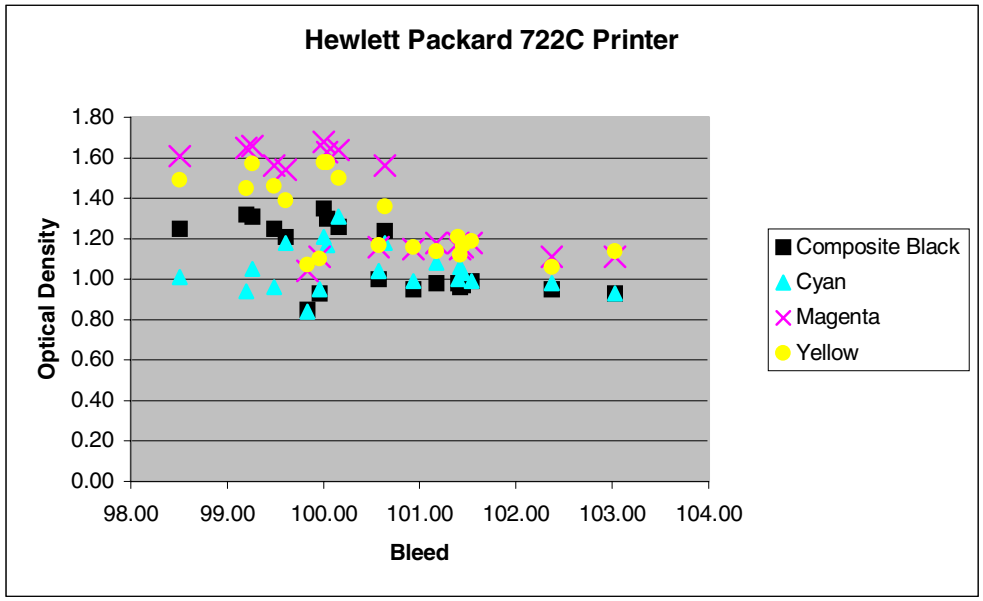


Table 1. Ink Jet Coating Description

Synthetic Silicas	**Pigment Type**	JETCOAT® 30 Specialty pcc
18.0 – 24.0 microns	**Coating Thickness**	8.0 – 12.0 microns
Absorb entire ink formulation	**Mechanism**	Precipitate dyes
Optical scattering	**Coating Optics**	Transparent
0.5840 cc/g	**Coating Porosity**	0.3725 cc/g

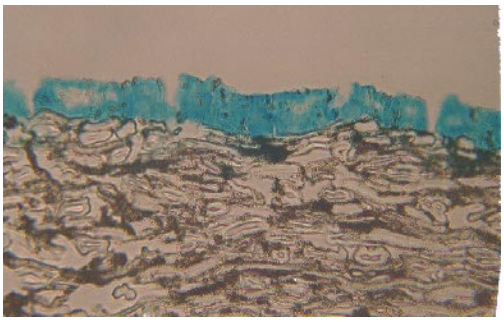


Image 1. Silica Printed Media

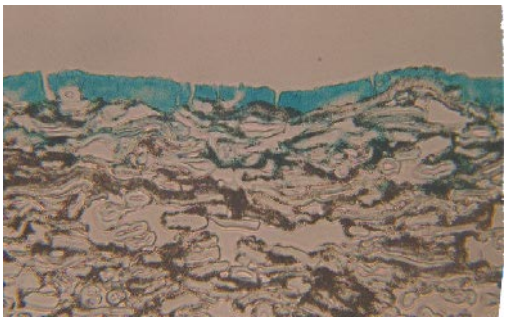


Image 2. JETCOAT® 30 Specialty PCC Printed Media

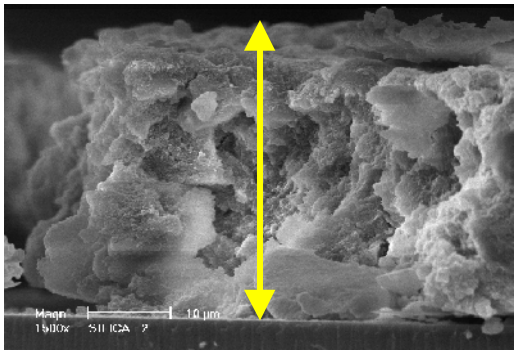
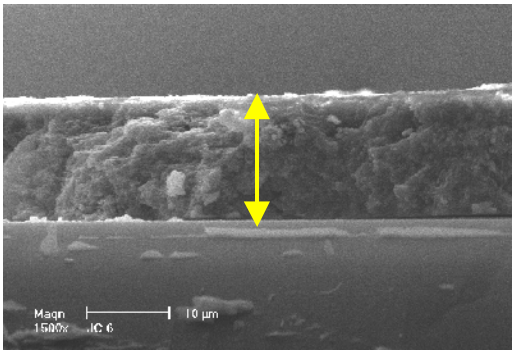


Image 3. Synthetic Silica Coating Image



4. JETCOAT® 30 Specialty pcc Coating

The colorant penetrates into and is trapped by the coating. The coating functions as a filter and the water and solvents penetrate into the base media below. The fine particles allow the non-ink portion of the drop to be absorbed by the basesheet. Image 1 is a cross-sectional SEM of a media coated with synthetic silica and image 2 is media coated with specialty PCC. These images illustrate the colorant adhesion to the PCC versus the silica.

As a result of the pigments fundamental differences, a thinner layer of PCC can print equal to or better than synthetic silica (images 3 and 4). The four images above show – in detail – the mechanisms and resulting print quality. The print quality is greater as a result of the increased optical density and the lower color bleed.

References

1. Wolin, D. A Unique Approach to Automatic Inspection of Ink Jet Nozzle Paltes. 9th Annual IMI Ink Jet Conference Proceedings (2000) pp. 2-29.
2. Chapman, D.M., Coating Stucture Effects on Ink-Jet Print Quality. TAPPI Proceedings 1997 Coating Conference pp. 73-93.
3. Donigian, D.W., McFadden, M. G., McKay, J., Wernett, P.C., Inkjet Dye Fixation and Coating Pigments. TAPPI Proceedings 1998 Coating/Papermakers Conference pp 393.
4. SMI internal document.

Biography

Annmarie is a 1995 graduate of Allegheny University. She holds a B.S. in Environmental Science. She began employement at Specialty Minerals' (SMI) Bethlehem facility in 1997 and has been involved in non-impact and impact printing technologies since she started. In her most recent role, Annmarie is the technical liason for SMI's non-impact pigment business.