# Measuring the ink wicking property of papers produced for ink jet print

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The image analysis technique (IA) described in this work uses an established statistical method (Standard Deviation) coupled with a standard IA measurement procedure (Thresholding) to capture the degree of ink movement along surface and sub-surface paper fibers that occurs immediately after the wet low viscosity ink strikes the paper surface and before the ink vehicle and solvents evaporate . This post deposit ink movement is cause of visual image distortions that are often referred to as edge raggedness, feathering, and wicking.

The common test ink jet pattern used in subjective visual print quality evaluation contains straight lines. This quality evaluation, however, digital scanners are used to acquire the test images for a computer based image analysis, dots are used as the primary test pattern, which is contrary to common practice. Using dots minimizes the possibility of the Moiré effect in the analysis: e. g. Misalignment of the rectilinear printed line with the rectilinear scanner camera and the subsequent rectilinear image analysis. In addition, dots are the basis half-tone images and the analysis program used in these tests was initially developed to analyze the quality of the offset/flexographic/gravure half-tone print; it was enhanced somewhat to handle non-contact inkjet tests as well. Practice has determined there is no difference between the perimeter wicking of a line and a dot.
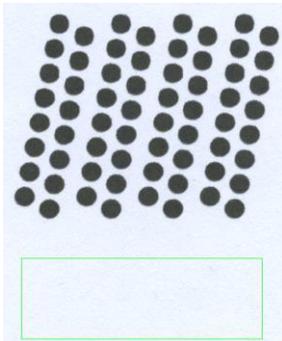
This pattern of dots distributes the print pattern across the print engine. These dots are approximately 2 mm in diameter. Dots offer many advantages to the image analyst using a high quality scanner, because even at a low resolution of 600 ppi, dots cannot be misaligned. Experimentation has shown black ink is the best and easiest indicator of wicking.

Immediately below the dots shown above is an unprinted area outlined in green. To prevent any contamination from ink over-spray on the original print, this area, with the dots above, is the final image on the page. In this unprinted area, defined by the green box, the analysis system measures the paper reflectivity and surface topography (roughness) , A typical panel display is shown to the right. Using specialized image analysis techniques and software, the IA
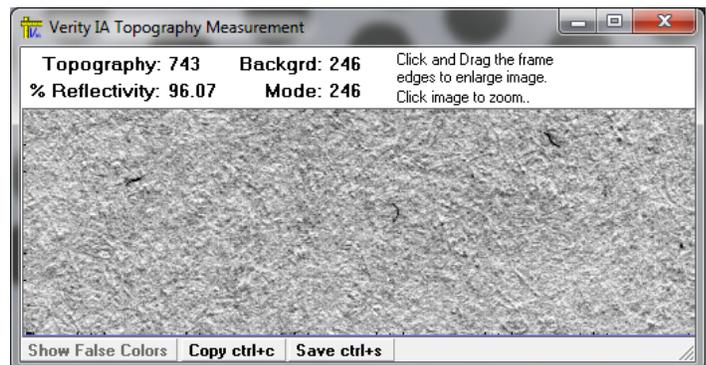
system is able display the actual topographic (roughness) surface image of the paper. This is the image of the surface on which the dots were printed. The surface reflectivity value is computed, 96.07, and is then used to mathematically set the threshold values (described below) to measure the dot properties. This area is also measured for the topography value, 743 as shown, using the Stochastic Frequency Distribution Analysis (SFDA).

Multiple Thresholding - The Measurement of Ink Wicking

To measure the dots the software uses a concept known as "Thresholding". To understand the workings of a threshold one must first understand the image in which the measurement will be made is an 8-bit derivative of a full color 24- bit image. In an 8-bit image the pixel luminance (brightness) can have a value between 0, (pure black), to 255 (pure white). To see and to measure an object within the image it must contrast with its immediate surroundings. The degree of contrast is determined by the pixel luminance value (i e. pixel or picture element brightness). The IA program extracts or identifies the object of interest based upon the threshold value; those pixels having a value less than or equal to the threshold value are identified as being of interest. The IA program measurement algorithm then associates the identified pixels to form the objects that are then measured and reported. The associated pixels forming the object of interest, in our case a dot image, are further analyzed to compute the size or area of the dot expressed as the equivalent diameter in the dot images below. These multiple thresholds are set using a rigid mathematic progression based upon the reflectivity measured in the unprinted area described above. These progressive thresholds measure the dot from its core or darkest value through to its fully wicked condition as shown below. It is the same dot in all the pictures taken from the IA system in an actual test.
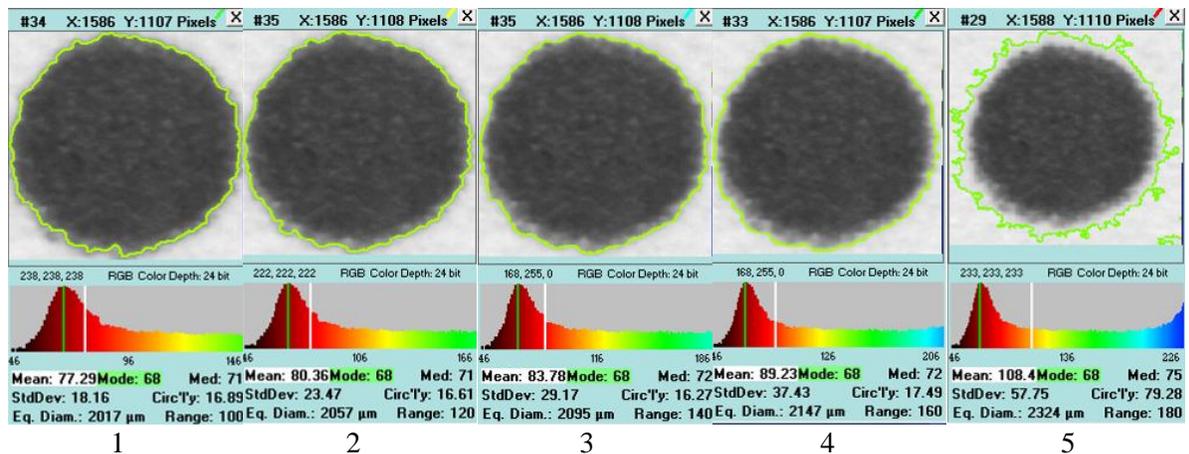
Below each of the images are data and the pixel luminance histogram derived from the application of progressively higher thresholds. The green line traces the perimeter of the dot.
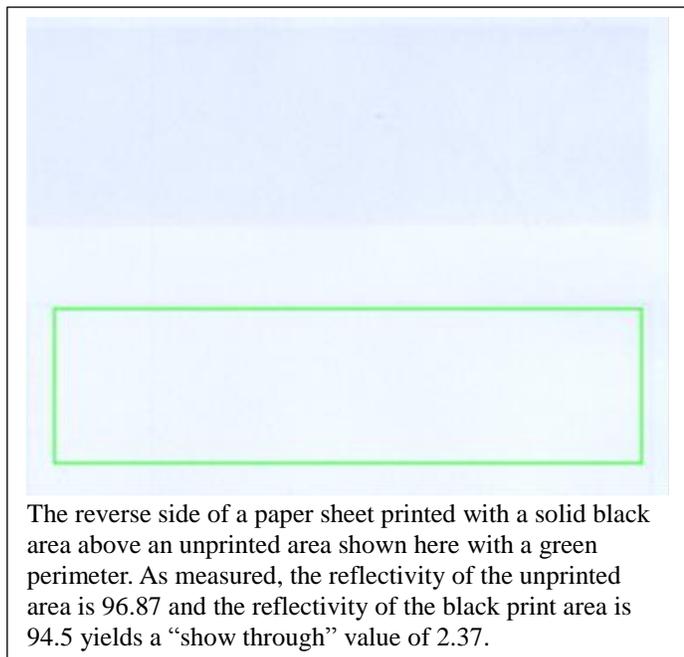
With the lowest threshold in picture 1, the core or darkest portion of the dot is measured, as indicated by the equivalent diameter (Eq. Diam) measurement of 2.017 mm. As the threshold is changed the measured equivalent diameter becomes larger and the other property measurements change as well. The table below illustrates the variation of these measured properties.

	1	2	3	4	5	Std Dev
Equiv. Diam (size)	2017	2057	2095	2147	2324	**119.6**
Mean Luminance	77.29	80.36	83.78	89.23	108.4	**12.3**
Range luminance	100	120	140	160	180	**31.6**

From this analysis and the computation of the measurement standard deviation, it appears all measured dot properties vary with change in threshold values. The size measurement standard deviation was chosen as the primary indicator of ink jet wicking.

Show through – Paper Porosity

Ink Jet requires the vehicle, primarily water, to be evaporated or absorbed into the paper. When absorbed the vehicle carries fine pigments with it. The degree to which this penetration occurs can be measured quite readily by examining the reverse side of a paper printed with a solid area and compare the reflectivity of the solid area to an unprinted area. The image to the right illustrates this phenomenon:

The reverse side of a paper sheet printed with a solid black area above an unprinted area shown here with a green perimeter. As measured, the reflectivity of the unprinted area is 96.87 and the reflectivity of the black print area is 94.5 yields a "show through" value of 2.37.

The paper that follows applies these measurements to a variety of papers, makes visual comparisons, and evaluates the various methods presented here.