Fine Art Papers for Ink Jet Printing

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Abstract

Fine art papers for ink jet printing fall into two main categories: Uncoated papers and ink jet receptive coated papers.

The coating layer(s) greatly determines the ink jet paper's ability to accept ink jet printer inks and hold the deposited (printed) water-based ink within the coating layer. How successful the coating is in maintaining the shape and density of each deposited ink droplet, without migration within the coating determines the quality of the printed image.

However, the composition of the paper base helps to determine the longevity of the printed image and the integrity of the paper, both under display conditions and in dark storage. The benefits of acid-free fibers, lignin-free fibers and buffers are discussed, as well as potential problems with optical brightening agents.

The coating and paper base must be balanced with the aesthetics of the paper, i.e. texture, thickness, weight, brightness and the tactile nature of the paper's printing surface. A list of some of the current coated fine art inkjet papers is compared for their base composition.

Introduction

By the close of the 1980s, IRIS ink jet printers were installed all over the world and spinning off full-color proofs in commercial printing plants and pre-press shops. These prints were used to check color and get client approvals before starting the main print run. They definitely were not meant to last or to be displayed on anyone's walls. Most people called them "IRIS prints," or "IRIS proofs," or, more simply, "IRISes." By 1991, early digital fine-art printmakers were using the IRIS ink jet printers to make fine art prints on traditional fine art papers. Initial results were beautiful, but the dye inks used were not formulated for longevity, and prints faded significantly with just a few months of indoor display.

Within a few years, new dye inks were developed that had resistance to fading caused by light (especially cause by the UV wavelengths), and the fine art community began to accept this new form of digital printing. Fine art prints made with fade-resistant inks on the IRIS printers became know as "Giclée" (pronounced "zhee-clay"), and were often sold as limited editions. The most common fine art papers being used for these prints were Arches Cold Press and Somerset Velvet. Both of these papers had been used by the artists for many years. Arches Cold Press is one the most popular watercolor papers in the world. Neither paper had been adjusted with a special coating to make it more receptive to ink jet printing. Using these standard fine art papers, users of the IRIS ink jet printers were able to produce reproduction prints that were remarkably similar (in color and tonality to the original art).[1]

In the late 1990s other ink jet printers started to compete with the IRIS, i.e. ColorSpan, Encad, and Hewlett-Packard brands. Unlike the hertz ink delivery method of the IRIS, these printers used a thermal or "bubblejet" method of ink droplet delivery to the printing media. The operators of the IRIS printers had to make adjustments to their digital image files to allow for ink dot-gain. (Ink droplet dot-gain is where the tiny droplets of wick or migrate into the paper fibers of uncoated papers. The more the ink droplet wicks, the larger and less defined is the appearance of the droplet. The more the ink droplet retains its original diameter, the sharper the resulting image, and the greater the color gamut and density or tonal range of the image. The greater the migration or wicking into the paper's cellulose fibers, the greater the loss of image sharpness, color gamut and tonal range.) The users of the thermal-delivery ink jet printers were finding it more difficult (than IRIS users) to adjust their image file or printers enough to eliminate the dot-gain that produced "muddy" prints (blurred images that lacked good image contrast and pleasing light to dark tonal range). In 1998 and 1999, Roland and Epson respectively introduced their wide-format piezo head ink-delivery ink jet printers that offered very accurate and precise ink droplet placement. However, these printers were even more media-dependant, and uncoated papers, especially the more textured and porous fine art papers were difficult to use and produce print reproductions that had a D-Max (Maximum Density), tonal range, color gamut and sharpness that was close to the original art. Roland and Epson also introduce more archival pigment-based inks in 1998 and 2000, respectively. These piezo-delivered pigment inks, although very fade-resistant, were even more difficult to use with uncoated fine art papers, and resulted in prints with very low D-Max, color gamut, tonal range and sharpness.

There were a number of papers available with an ink jet receptive layer (we'll define these as "coated" papers throughout the remainder of this paper) in the late 1990s. Most of these coated ink jet papers were made for commercial applications, or made to simulate the look of a

silver-halide photographic print paper. There were very few fine art papers that were coated for ink jet printing. It was difficult to produce a coated fine art paper that did not "cover up" (with the coating layers) all the texture and aesthetics that artists appreciate in a very tactile fine art paper.

Some of the early experiments with ink jet receptive coatings produced coated fine art papers that were able to work well with the newer ink jet printers, but lacked longevity. The images on these papers either faded quickly (by changed color significantly, due to one or more of the ink colors fading faster than the others), or the paper's coating or base quickly began to discolor. As the popularity and demand for fine art digital print making increased, the ink jet printing industry quickly saw that more coated fine art papers were needed, and that there was a need not only for image quality and aesthetics, but that these needs must be balanced with archival concerns.

The purpose of this introduction was to show the importance of ink jet receptive coatings when using today's modern thermal and piezo ink jet printers. This paper does not attempt to examine and compare the coating composition, as these formulations are highly guarded trade secrets. The focus of this paper is on the composition of the coated ink jet papers' fiber base, which are more publicly known, and which can greatly affect the integrity and longevity of the coated paper. As the inks use in today's ink jet printers have become more archival, it is important to artists that fine art ink jet papers meet similar standards for longevity.

The balance of this paper examines how pH, OBAs, buffering and the type of fiber base content affect the permanency of coated fine art ink jet papers, and compares some of the currently available coated, fine art ink jet papers.

Observations on Paper Permanency

Fine art papers that have no optical brightening agents (OBAs), that are acid-free, lignin-free, 100% cotton, and that are buffered (usually with a calcium carbonate reserve of about 1.5% - 2.0%) have an estimated paper life expectancy of 500 years or more (based on the American National Standards Institute and the American Society for Testing Materials).

The two most important factors that affect the quality of paper are the presence of impurities and an acidic pH. Finished papers may contain natural impurities, such as lignins that have not been removed during processing, unnatural impurities, such as residual chemicals, like sulfites, not washed out during final processing.

WHY LIGNIN-FREE? Lignins, which are the combined glues that hold plant cells together, are undesirable in a finished paper product. They age poorly, turn brown, become acidic over time, and resist the natural bonding of cellulose fibers to each other. If lignins are not removed and are left in contact with the surrounding cellulose fibers in paper, their acidity will break down the cellulose and the paper will become brittle.

Lignins comprise 20 to 30 percent of wood, but less than 1 percent of cotton fibers (despite this <1%, cotton is considered "lignin-free"). Because of the high concentration of lignins in wood, papers made from wood pulp discolor and eventually self-destruct. Although there are methods for the removal of most or all of the lignins, unless the residual chemicals used in these processes are also dealt with, embrittlement and acidification will only be postponed. For this reason, wood pulp papers are generally avoided for permanent artwork. Because it is nearly lignin-free, paper made from 100 percent cotton is most desirable.

However, "alpha-cellulose" papers (which are mostly lignin-free wood pulp papers) offer an inexpensive compromise to cotton. Alpha-cellulose wood pulp papers offer a greater degree of permanence than regular wood pulp papers, but without the higher expense and greater permanency of cotton. Hahnemühle, Lyson and Lumijet each offer three fine art papers that have a mixture of cotton and mostly lignin-free wood pulp fibers.

WHY 100% COTTON? Paper is composed of plant cellulose fibers. Cellulose is a polymer of the sugar glucose and is used by plants to produce cell walls. The source of the cellulose fibers, and the degree to which that source is refined, determine the nature and quality of the paper produced. Cotton fiber is up to 10 times stronger than cellulose fibers made from wood, and cotton is naturally acid and lignin free.

WHY ACID-FREE? pH describes the acidity, alkalinity, or neutrality of something. Distilled water has been assigned a pH value of "neutral" 7, which represents equal concentrations of acid and alkali. Each whole number represents a factor of 10-ten times more or less acidic than the number above or below it. The more acidic a paper, the faster the cellulose will break down, resulting in a shorter lifespan. A number of factors can influence the pH of a paper. Residual acids from processing, alum sizing, fillers used to create bulk, oils used to make paper transparent, optical brighteners, atmospheric sulfur dioxide, and the presence of lignins can all result in a pH of 4.5 or lower.

WHY BUFFER THE PAPER? Recent study has shown that even the purest cotton papers will become slightly acidic, even though they left the mill at a pH ranging between 6.5 and 7. This may be due to the nature of the paper itself, or because of exposure to air polluted with sulfur dioxide and oxides of nitrogen --common pollutants caused by the burning of fossil fuel, which turn water molecules into sulfuric acid and nitric acid. To cope with the natural and unnatural acidification of paper, some manufacturers add buffers to the paper. Buffers such as calcium carbonate can absorb a significant amount of acid. Buffered papers are often slightly alkaline with a pH around 8.5. A pH moderately higher than 7 is not considered harmful in paper.

WHY OBA-FREE? "OBA" is an acronym for "optical brightening agent". Many paper substrates have optical brighteners added to increase their apparent whiteness. The cellulose fibers comprising paper have a natural yellow color that is bleached during manufacturing, but some slight

yellow remains. To counteract this yellow color, a "bluing" agent is added to paper. The bluing agents are actually ultraviolet dyes that work by fluorescing the invisible ultraviolet light into visible light (OBAs absorb ultraviolet light and re-emit it as visible blue and violet wavelengths), thereby making the paper to appear brighter or whiter. OBAs are known as "fluorescent agents" because they strongly fluoresce under "black light" (a good test to see if a paper has OBAs).

However, many paper makers believe that optical brighteners interfere with permanence, because they can break down over time and can cause irregular yellowing of the paper (or the inkjet coating), or cause acidity in the paper, which can lead to a premature deterioration of the paper structure. In fact, the Library of Congress defines an archival paper to be OBA-free.[2]

A Comparison of Coated Ink Jet Fine Art Papers For Permanency Features

(The Following is not meant to be a complete and comprehensive list of all coated fine art ink jet papers, but is a list of the more commonly used papers that were available at the time this paper was written.)

Coated Fine Art Ink Jet Papers That Are OBA-Free, Acid-Free, 100% Cotton, Lignin-Free and Buffered:

PremierArt Hot Press Fine Art Paper
Epson UltraSmooth Fine Art Paper
PremierArt Matte Scrapbook Photo Paper for Epson
Museum Digital Art

Coated Fine Art Ink Jet Papers That Are OBA-Free, Acid-Free, 100% Cotton, Lignin-Free, But are NOT Buffered:

Arches Infinity
Crane Museo*
Epson Smooth Fine Art Paper (by Crane)*
Epson Textured Fine Art Paper (by Crane)*
Concorde Rag
Entrada Natural
Illuminata Photo Rag, Warm Tone

Coated Fine Art Ink Jet Papers That Acid-Free, 100% Cotton, Lignin-Free, But are Not Buffered, Nor Do They Claim to be OBA-Free:

Hahnemühle Photo Rag
Hahnemühle William Turner
Somerset Photo Enhanced
Epson Somerset Velvet
Epson Velvet Fine Art Paper
Entrada Bright White
Illuminata Photo Rag, Cool Tone

Coated Fine Art Ink Jet Papers That Are Acid-Free, But Are Not 100% Cotton, Are Not Buffered, Nor Do They Claim to be OBA-Free:

Hahnemühle German Etching
Hahnemühle Torchon
Hahnemühle Albrecht Durer
Lumijet Classic Velour
Lumijet Museum Parchment
Lumijet Flaxen Weave
Lyson Standard Fine Art
Lyson Soft Fine Art
Lyson Rough Fine Art

*Crane's idea of "buffered" is a little different than the industry standard. The industry standard adds a certain amount of calcium carbonate per kilogram of pulp. Crane does not add calcium carbonate, but instead processes (washes) the paper with water that contains calcium carbonate.

References

1. Harald Johnson, *Mastering Digital Printing*, pp. 2-10. (2003).
2. Steven Saitzyk, *Art Hardware: The Definitive Guide to Artists' Materials,* pg. 326 (1987).

Biography

Royce Bair has been a technology consultant for Inkjet Art Solutions, Inc. since 1998. He's the editor of "Inkjet News & Tips", an ink jet industry newsletter that focuses on applications in photography and fine art. Mr. Bair has been involved in professional photography and publishing since 1971, and his photographs have been widely published in national magazines. He's been a national convention speaker for the Professional Photographers of America and the Professional Photographers of Canada.