Substrate Developments in Fine Art Media

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Abstract

The digital printing of art reproductions and original digital art has blossomed into a major application for water based ink jet printing. Canvas, art paper, textiles, photo paper and specialized art media have evolved over the last decade along with printers and ink technology. I will review some of these developments and the current state of the science of ink jet art reproduction and digital art. With the development of higher resolution printers for UV curable ink jet printers and dedicated textile printers a new set of tools are becoming available to the artist and publisher. The impact of these developments and their potential to continue the rapid growth in this field will be discussed in this paper.

Introduction

In the early days of fine art and art reproduction utilizing ink jet digital printing, the Iris printer was the only device capable of producing high quality ink jet prints. Initially food coloring dyes were used on substrates not designed for ink jet printing. Since then the artist community has continually searched for new inks, media and ways to use them to create a large variety of ink jet printed "original" art, art reproductions and multimedia art. The search continues for new tools to achieve an ever widening range of art expression.

In addition to the aqueous dye based inks of the Iris printer, thermal and piezo drop on demand ink jet technologies have enabled the use of many new chemistries including pigmented aqueous and solvent printing, textile dye and pigment printing, dye transfer printing and now even UV curable ink jet printing. An ever growing number of suppliers are developing media designed to work with these ink chemistries and the printers which deliver them. Our industry now provides a wide range of solutions for the artist.

Traditional art substrates

Gesso coated canvas used for oil painting, cotton rag art papers used in water color painting and glossy and satin photo papers are coated with ink jet receptive coatings to control the penetration and spread of the ink and have been available for many years. These products have been evolving over the years to accommodate changes in ink and printer technology. With the growing use of pigmented inks the media developers have been technically challenged to deal with colorants which tend to stay on the surface of the coating and not penetrate with the ink fluid as dyes do. The biggest challenge has been to achieve a glossy photo paper which dries rapidly to avoid bleeding and coalescence of the ink in high speed printing but also to avoid gloss non-uniformity and metamerism. These are real challenges for the media designer and are continuing to be a work in progress.

Most artists and art reproduction firms have adopted pigmented ink printers over dye ink printers for longevity. Epson's Ultrachrome ink technology and HP's pigment ink technologies are overwhelming favorites by end users for producing prints intended for long term use. To achieve the high resolution fast drying performance required for today's printing systems micro or nano porous coatings are dominating the world of photo paper and other satin and glossy coated nonabsorbent substrates. These are critical since swellable coatings take far too long to dry and dyes on microporous substrates are readily attacked by pollutants such as ozone even in extremely low concentrations.

Solvent Media for Art Applications

This conversion to pigments from dyes leads us to the next step in media design. Art and photo media designed for water based inks generally will not accept solvent based inks and produce the desired performance. Canvas specially prepared to receive mild solvent pigmented ink is available from several suppliers. With the development of high resolution solvent printers, like those Mimaki and Roland have introduced, this is a natural progression in production of art works by ink jet. Now the challenge is to provide the other media.

Several manufacturers are developing traditional cotton rag art paper and photo paper with coatings optimized for these high resolution solvent printers. These will offer advantages to the artist or reproduction firm an ink/media solution which should not require a protective coating after printing. Unlike water based inks which contain very little binding polymer the solvent inks contain binders which hold the pigments onto uncoated plastics like PVC. These binders will anchor the pigments to the coating on the paper and provide a considerable amount of protection not afforded by most water based inks.

Since solvent inks are designed to print on non-porous substrates a much wider variety of substrate materials can be used successfully with these inks. Since the inks still provide only a thin layer they can be abraded easily when printed on smooth non-porous substrates a protective coating or laminate may be required depending on the end use. However if the paper or canvas is coated with a properly designed coating that binds to the solvent ink binder and pigment then no protective coating will be required in most art applications. This improves both the cost effectiveness of the process and retains the original look of the media.

Radiation Cured Ink Jet Ink in Art Applications

The newest ink technology, UV or radiation cured ink jet ink, offers the artist a new freedom that could only be dreamed about until now. Now the artist can print on nearly any substrate and produce art not possible with either water or solvent based inks. In addition many of the printers are capable of printing on ridged substrates as thick a 2 inches! Printing is one thing, the ink sticking, forming a proper sized spot and having good color are quite another. Remembering that colored ink jet inks use subtractive color to generate the color you want. The color gamut you can create depends on the reflection or transmission of white light by the substrate. The furthest from an optically clear or bright white substrate the more it degrades the color gamut. The light passes through either from the back in a translucent or transparent substrate or from the front and is reflected back through the ink to the observer in an opaque substrate. So while you can print on most substrates the nature of that substrate not only affects the spot size but also the color you see. In addition for translucent or transparent substrates you will need considerably more ink to provide the color density you want since the light only passes through the ink once verses twice on reflective substrates.

To address this problem, developers of UV inks have developed white ink. The white ink is printed under the image on dark reflective media or over the ink when a clear backlit application is desired. Again to give good results that white ink must be totally opaque so that it covers the color beneath completely. A good example of this ink is offered by DuPont in their 22UV ink jet printer.

Resolution of most current ink jet printers using UV inks has not yet reached the level of the water or solvent based printers. Work is underway in several companies to reduce the drop size and increase both firing frequency and nozzle count to catch up with the solvent and water based printers in image quality. Most UV inks available today produce spots which are smaller than the comparable water or solvent based inks when comparing the same size drop. When available these printers will provide the image quality artists are expecting to see based on their experience with traditional printers.

Novel new technologies

Perhaps one of the most interesting new technologies just now finding its way onto the market is named “Smart” film. It is a low glass transition temperature memory film which has been developed to provide a very thin substrate which is highly conformable, yet transparent. The first application for this film is in the product called Fo2Fuse® [1]. This product in its initial launch is aimed at the craft market for home ink jet printers however in wide format applications it can provide the artist with very high quality images with either mild solvent or water based pigment inks on a normal wide format printer. See Figure 1.

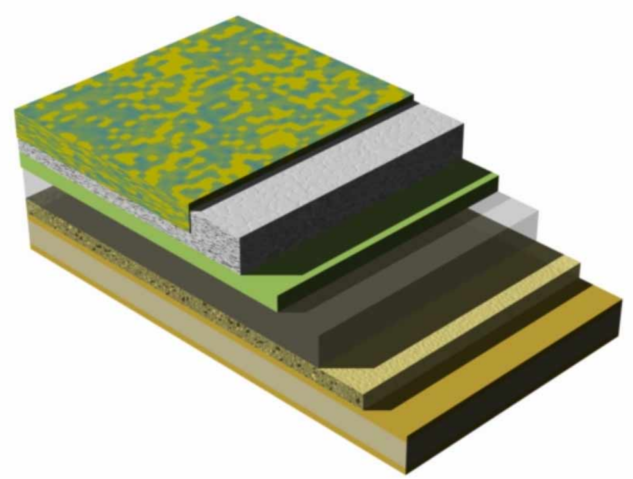

Figure 1. *Fo2Fuse® product structure. From bottom to top: {5} silicone coated polyethylene clad paper release liner; {4}solvent acrylic permanent adhesive; {3}TG 25 conformable memory film; {2}sub coating and microporous matte water resistant ink jet coating; {1} ink layer.*

The Fo2fuse Imaging Sheet {2-4} and the release liner {5} make up the two parts; the Imaging film and the Carrier sheet.

The patented Imaging film {3} is a soft memory forming polymer, that has the ability to soften at room temperature and be formed to a texture and/or 3D form, using only hand pressure and with no mechanical intervention. For the film to keep the shape its shape, it must be permanently anchored in position with the adhesive. If not anchored when it is heated above room temperature it will go back to its original flat form. The adhesive used is an aggressive high tack water resistant pressure sensitive and it provides the high bond strength between the film and the texture. The adhesive is protected with a releasable paper liner that is removed just prior to the application process. On the other side of the film there is a thin matte, opaque white, micro-porous inkjet coating applied, that is both highly ink absorbent and water resistant.

The other part of the construction of the Imaging Sheet is the Carrier sheet which is folded over the top edge of the Imaging film and held in place by a thin strip of glue (the Tab). The folded edge of the tab is perforated so that after printing, the Carrier can easily be removed before the application process begins. The tab is used to protect the edge of the film during the printing process, so that it is neither damaged or jams the printer during the printing process.

So after printing the liner is stripped off and the imaged film is applied to whatever substrate is chosen. Canvas, wood, textured plastic sheet or whatever the artist chooses can be used. A small paint brush is used to press the memory film into the texture of the substrate. The adhesive keeps it in place. The film and ink jet coating stretch without breaking over a considerable amount of relief allowing three dimensionality to the image if the artist chooses

This enables printing with water based or mild solvent based printers onto a printer transportable film which becomes like a “portable coating” when it is applied to the final substrate.

Additional products are being developed using this memory film which will give the artist even more choices in fabricating their ink jet digital art.

Art on Textiles

Clearly there are numerous ways to print on art canvas type substrates and they have been covered already. There are many textile substrates other than canvas to consider. Both transfer and direct printing are options and each offers ways to produce fine art on textiles.

Transfer Printing

Certain manmade fibers like polyester are dyed using disperse dye technology in analog printing and dying processes. Lower molecular forms of these dyes can diffuse or sublime from a carrier sheet, usually a special paper, to the fabric. The digital image is printed on a printer using sublimation dye inks then using heat and pressure sublimed into the textile. This has become a popular way to make flags and banners but can also be used to produce textile art. With the Mimaki printer for example very high resolution printing can give very vivid high resolution images on polyester based textiles.

Direct Printing

The much more flexible process of direct printing comes with much more complexity. Pigment printing is perhaps the simplest of the direct printing methods. A good example is the DuPont Artistri printer with pigmented inks. DuPont offers a wide variety of colors so that the usually restricted gamut of pigments may be increased to produce a wide gamut. Here only a heat treatment by heated rollers is required to bond the pigmented inks onto the fibers of the fabric. This technique is particularly good on cotton and cotton blends. No special treatment of the fabrics is required prior to printing.

To print with conventional dyes for textiles much more preparation of the media is required and post-treatments are much more cumbersome. They are similar to those used in traditional analog textile printing operations. For example silk dyes are available as ink jet inks and they can be used to produce the vivid colors achieved by traditional screen printing. Silk pretreatment with chemistry to fix the dyes along with ingredients for controlling dot shape and size are required to achieve high resolution bleed free images. Steaming and washing are required after printing to fix the dye and to remove the pretreatment and any excess dye. Similar techniques of preparing the textile are required for acid, disperse, and direct dye ink jet printing as well. Though it is a more complex process for very short runs of textile art these techniques are available to the artist who previously had to produce screens in order to print on textiles a very labor intensive and costly process for very short run printing.

Conclusions

In summary the artist has many new tools to use to produce art as original art, reproductions and as multimedia art. Most any substrate can now be digitally decorated using ink jet technology and the many substrate solutions are available today. New ways for artists to exercise their creativity become available every day. With water, mild solvent, textile dye and UV ink technologies and the printers to deliver them nearly any substrate can be decorated to produce what the artist wants to produce.

References

[1] www.fo2fuse.com

Author Biography

Dr. Work is President of Work Associates, Inc. a company he formed upon his retirement from DuPont in 2001. Dr. Work received his B. S. in Chemistry from Auburn University 1966 and Ph. D in Chemistry from the University of New Orleans in 1971. Following a Post-Doctoral Research Fellowship at the University of Hawaii, Dr. Work joined DuPont in 1972. Dr. Work holds 7 US patents, has published more than 40 technical papers and articles and is a frequent speaker at conferences worldwide. Dr. Work led the team that initiated and developed the ink jet inks business for DuPont.

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