# Design Considerations of Microporous Topcoats to Improve Pigmented Ink Print Performance of Paper Base Glossy Inkjet Media

*Qi Sun[1], Sanjay A. Monie[2], Yoshitaka Sugimoto[1]*
1. *Grace Japan K.K., Atsugi-shi, Kanagawa-ken, Japan*
2. *Grace Davison, W.R. Grace & Co. – Conn., Columbia, Maryland, USA*

## Abstract

*Cast-coated glossy ink jet media (sometimes also referred to as paper-base glossy media), which are manufactured by cast-coating ink receptive coatings on a paper-base are popular because of good media performance at a competitive price. One of the most important performance attributes of inkjet media is the rate of ink penetration of the ink into the coating. For microporous inkjet media, the capillary forces of the pore structure determine the rate of ink penetration. On the printer side, pigmented inks are being increasingly used due to improved fade-resistance and water fastness compared to dye-based inks. Color pigments used in inks are particles, and therefore pigmented inks can be thought of as particulate dispersions compared to dye-based inks, which are solutions containing dye molecules. This particulate nature causes pigmented ink to form what might be described as a 'filter cake' on ink jet media surface upon printing. " This is especially on paper base glossy ink jet media, because they generally are easy to have a tendency with capillaries of smaller diameters in the topcoat. When pigmented inks are used with microporous inkjet media that don't have an optimal pore structure in the coating, formation of a pigment 'filter cake' can result in poor ink absorption through the coating due to lower capillary pressure. The pigment 'filter cake' can also cause poor ink fixation on media surface, with an inhomogeneous gloss and color appearance. The objective of this work is to improve capillary transport through the topcoat of paper base glossy ink jet media by selecting effective materials with increased porosity in topcoat. Our experimental results demonstrate a significant improvement in pigment ink absorption and fixation to paper base glossy inkjet media when the porosity of the topcoat is optimized to anchor the pigmented ink particles better and minimize the formation of the filtercake, thereby allowing the capillary forces in the coating to effectively absorb the ink.*

## Introduction

The structure of topcoats of cast glossy ink jet media play a critical role in determining printed performance, which include the following attributes:

1) High color optical density
2) Sharp image resolution
3) Rapid ink absorption capacity
4) Water fastness
5) Fade resistance from light (ultraviolet) and ozone.

Pigmented ink systems are gaining in popularity for desktop as well as wide format ink jet printers because of good water, light and ozone fastness characteristics. Pigmented inks are pigment dispersions, (especially black-pigmented ink, which has a coarser particle size) compared to dye inks of which are solutions. Therefore, formation of a 'filter cake' on the media surface results in an insufficient rate of ink absorption, which can result in:

1) Poor ink fixation properties on media surface
2) Inhomogeneous color performance
3) Non-uniform gloss appearance
4) Poor sharp image resolution

The objective of this study is to engineer the porous structure into the topcoat of cast glossy ink jet media with selection of appropriate coating pigments which will inhibit the formation of the ink filter cake and improve the media's print performance.

## Experimental

Laboratory cast coating equipment was used to apply the glossy topcoats in this study. The cast coating process uses a heated, polished metal drum of which serves the dual function of both imparting gloss as well as drying the wet coating in contact with the polished drum surface.

A representative formula for a two-layer, cast-coated ink jet coating is shown in Figure 1. The Epson PM-4000PX printer was used to generate the test patterns that were evaluated for pigmented ink absorptive performance. PM-980C was used to evaluate the dye-based print performance.

***Cast Coated Glossy Media***

| Base Coat Material | Parts (Dry) |
|---|---|
| Micronized silica gel[1] | 100 |
| PVOH polymer[2] | 4 |
| Polyvinyl acetate latex[3] | 22 |
| Cationic Polymer[4] | 10 |

1. SYLOJET® P508, Grace Davison
2. PVA-117, Kuraray.
3. AM-3150, Showa Highpolymer
4. CP-103, Senka

| Top Coat Materials | Parts (Dry) |
|---|---|
| Nano particle pigment[1] | 100 |
| Binder[2] | 4-5 |

1. Developmental Grace silica slurry (anionic, 25%solids), Grace Davison
   Developmental Grace silica slurry (cationic, 30%solids), Grace Davison
   LUDOX® CL-P, Grace Davison
   LUDOX® AS40, Grace Davison
   Boehmite alumina, Grace Davison
2. PVA217, Kuraray

*Fig. 1. Cast Coating Formulation*

## Result

The experimental results are shown in Table 1. In experiments, Grace colloidal silica grades LUDOX® CL-P and LUDOX® AS40 have a nominal average particle size of 22nm. Anionic porous nano silica slurry (call slurry A below) and cationic porous nano silica slurry (call slurry C below) are with 300-400nm median particle sizes. EM5075 is a nano particle Boehmite alumina. Suitable selected big pigment slurry A, slurry C and EM5075 support building an effective interparticle porosity in top coat of which support making a sufficient porous structure in top coating layer (figure 2). An effective established porous structure in topcoat of cast glossy ink jet medias improves its printed performance under pigmented ink printers (figure 3).

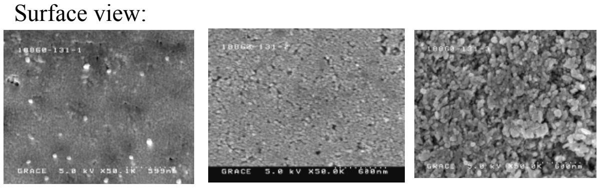
**Table 1 Experiment Result**

| | | Sample | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| | | Absorptive coat | P508/CP103/PVA117/AM3150=100/10/4/22 | | | | |
| Topcoat | Nano particle pigments | LUDOX CL-P | 100 | 50 | 50 | | |
| | | Cationic slurry C | | 50 | | | |
| | | Boehmite alumina | | | 50 | | |
| | | LUDOX AS40 | | | | 100 | 90 |
| | | Anionic slurry A | | | | | 10 |
| | Binder | PVA217 | | | | 5 | 5 |
| | | OLZ1371 | 4 | 4 | 4 | | |
| Print Quality | Epson PM-980C (Gloss Paper) | K | 2.427. | 2.501 | 2.238 | 2.699 | 2.603 |
| | | C | 1.625 | 1.891 | 1.847 | 2.480 | 2.426 |
| | | M | 1.838 | 1.734 | 1.689 | 1.693 | 1.685 |
| | | Y | 1.199 | 1.072 | 1.110 | 1.196 | 1.168 |
| | | Ink Absorption | Good | Good | Good | Good | Good |
| | Epson PM4000PX (Gloss Paper) | K | 1.585 | 1.624 | 1.740 | 2.082 | 2.022 |
| | | C | 0.618 | 0.669 | 0.629 | 0.655 | 0.645 |
| | | M | 1.057 | 1.098 | 1.032 | 1.183 | 1.157 |
| | | Y | 0.787 | 0.781 | 0.749 | 0.792 | 0.786 |
| | | Ink Absorption | Poor | Good | Good | Poor | Good |

SEM Analyses:

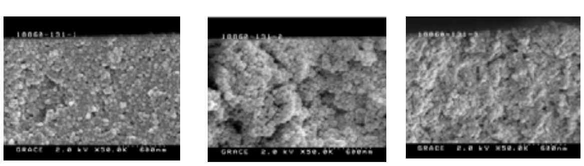
1. Cationic topcoat

Surface view:



CL-P CL-P/slurry C=50/50 CL-P/EM5075=50/50

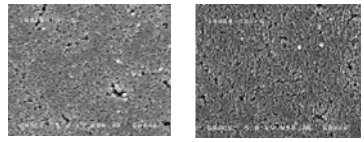
Cross-Sectional view:



CL-P CL-P/slurry C=50/50 CL-P/EM5075=50/50

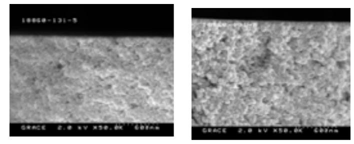
2. Anionic topcoat

Surface view:



AS40 AS40/slurry A=90/10

Cross-Sectional view:



AS40 AS40/slurry A=90/10

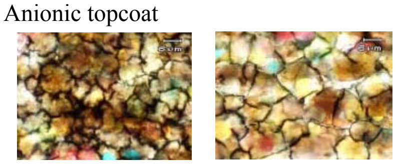
*Figure 2: SEM Micrographs showing a more porous coating microstructure by combinations of Grace pigments*

Figures 2 demonstrates that use of a suitable selected pigment combination in a cast-coated topcoat can provide a more effective pore structure to the coated surface as well as the coated layer. It allows fixation of the-pigmented-black ink particles firmly within interparticle porosity, thereby avoiding formation of a pigment filter cake on the media surface, and enables homogeneous color and gloss appearance from the printed media. The improvement in print results can be observed in the optical microscopic images of the printed media surfaces (Epson PM-4000PX printer) shown in figure 3. An obvious improvement in pigmented-black ink absorption can be observed in the topcoats with more interparticle porosity.

1. Cationic topcoat:

CL-P CL-P/slurry C=50/50 CL-P/EM5075=50/50

2. Anionic topcoat



AS40 AS40/slurry A=90/10

3. Worse example from commercial cast base gloss ink jet media

***Figure 3: Optical micrographs showing improvement in black-pigmented ink absorption by combinations of Grace pigments***

## Conclusion

Effective interparticle porosity in the topcoat layer of cast glossy ink jet media is the key to preventing formation of a filter cake with pigmented inkjet inks, which deteriorates pigmented print quality. Effective interparticle porosity in the topcoat can anchor pigmented ink particles within the porous structure of the topcoat, providing a homogenous printed color performance and uniform gloss appearance. Combining selected bigger pigments with higher porosity and fine particle pigments in topcoats of cast-coated paper base glossy media is a way to build effective interparticle porosity in the topcoat.

## References


[1] Wolfgang Storbeck, Daniela Dietrich, Rita Schneider, "Fixation of Pigmented Black Ink on matte coated ink jet Substrates", NIP21, International Conference on Digital Printing Technology.

[2] Qi Sun, Michael R. Sestrick, Yoshitaka Sugimoto, "The Role of Nanoparticle Silica Pigments in Microporous Glossy Ink Jet Media", ICISH'05.

[3] Hyun-Kook Lee, Margaret K. Joyce, and Paul D. Fleming, "Influence of Pigment Particle on Glosss and Printability for Ink jet Paper Coatings", NIP20, International Conference on Digital Printing Technology.


## Author Biography


*Qi Sun works for Grace Japan K.K., a subsidiary of W. R. Grace. He is a Regional Technical Service Manager for Digital Media in Asia Pacific. Qi Sun is based in Grace's lab in Atsugi, Japan, where he conducts studies on the use of pigments in inkjet media. He is a member of IS&T.*