Effect of coating structure and cationic charge level on inkjet printability

Frank Gref, Päivi Miettinen, Jaana Heinonen, Mika Sundquist, Martti Toivakka

UPM
The Biofore Company

Åbo Akademi

Demands of inkjet printability

- High speed inkjet runnability with low smearing tendency, requires a paper with
  - high ink absorbency → good ink hold out
    → show through problems
  - Cationic charge → Fixing the ink on the paper

- High absorptivity is traditionally achieved with highly porous and absorbent silica pigments and hydrophilic additives such as polyvinyl alcohol
  → These solutions are expensive

Our solutions

Good ink hold out and low show through

- New generation Polyvinyl Acetate Acrylate polymers (VAcA)

Cationic coating colour

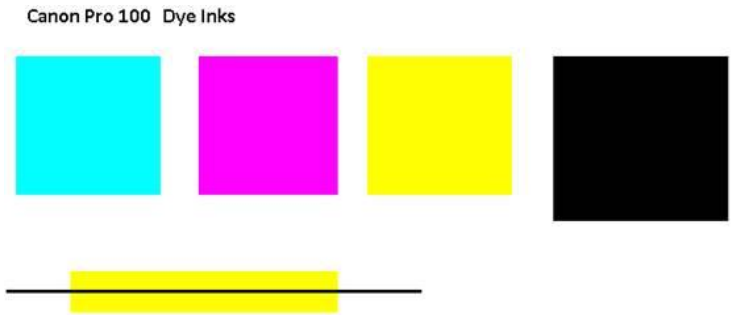
- Cationic additives which enable the use of anionic pigments such as PCC and GCC
- Use of porous and cationic pigments (FP 300CS) together with VAcA

  → Cost efficiency

Both traditional film and blade coating methods suitable

- High ink penetration demands even coating layer thickness

Procedure and execution of the study



- Different coating color formulations were tested in laboratory scale and printed with a desk top printer (Canon Pro 100)

- The most promising coating color formulations (regarding rheology and enhanced printability) were chosen for pilot coating trials

- Coated papers were printed with a high speed printing machine and dye inks

Coating color formulations in the pilot trial

pph= parts per hundred parts pigment by weight

	Coating color			
	1	2	3	4
Cationic charge	low	medium	high	high
Porosity	low	medium	medium	high
PCC	70pph	70pph	70pph	
GCC	30pph	30pph	30pph	
Structured cationic specialty pigment (FP 300 CS)				100pph
$CaCl_2$ addition	x		x	
VAcA (CHP 1000i)		6pph	9pph	5pph
Cationic additive 1 (CH IQ 1001)		30pph		
Cationic additive 2 (CH IQ 1002)				7.5pph
Cationic starch amount	high	low	medium	
PVA	0.5pph	0.5pph	0.5pph	
Cationic polymer (FL 28405)			1pph	

High speed inkjet printing trials

- Dye ink printer Ricoch InfoPrint 5000
- Speeds 32 m/min and 64 m/min

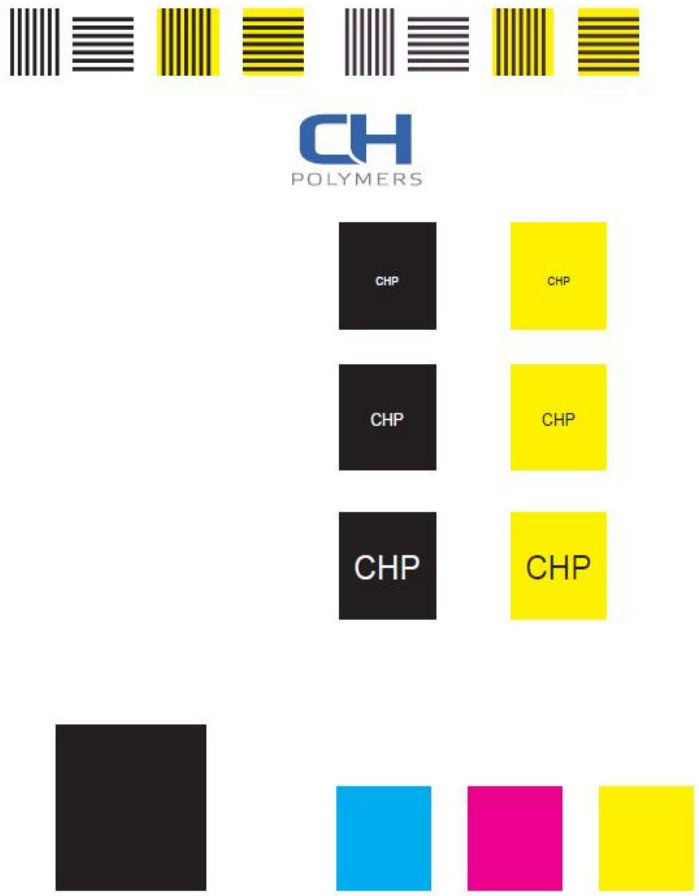
Analysis of the inkjet printability

Inkjet printability was studied for

- water fastness
- wet rub resistance
- print through
- ink evenness (mottling and graining)
- intercolor bleeding

In addition

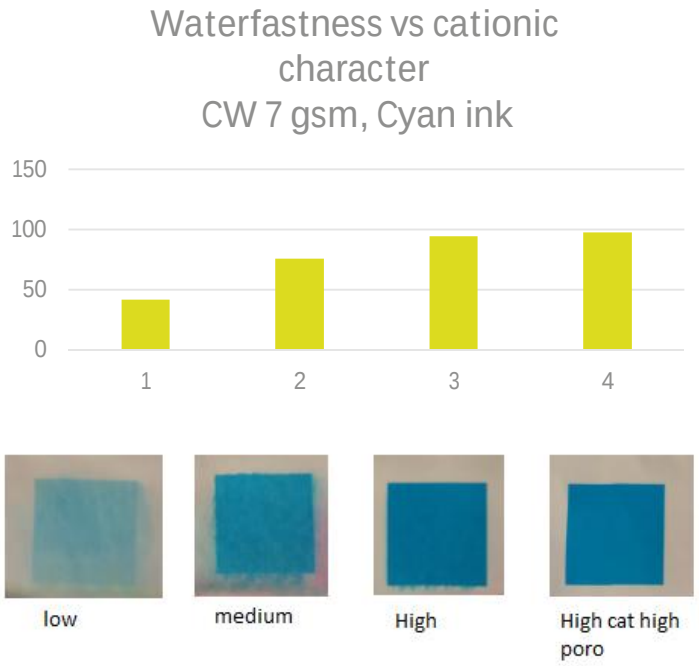
- Hg-porosimetry analysis from coating color tablets
- Cross section cuts of printed papers



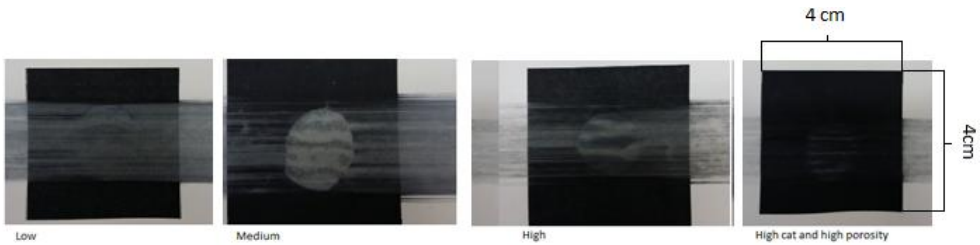
CH POLYMERS

RESULTS

Effect of cationic charge on high-speed inkjet



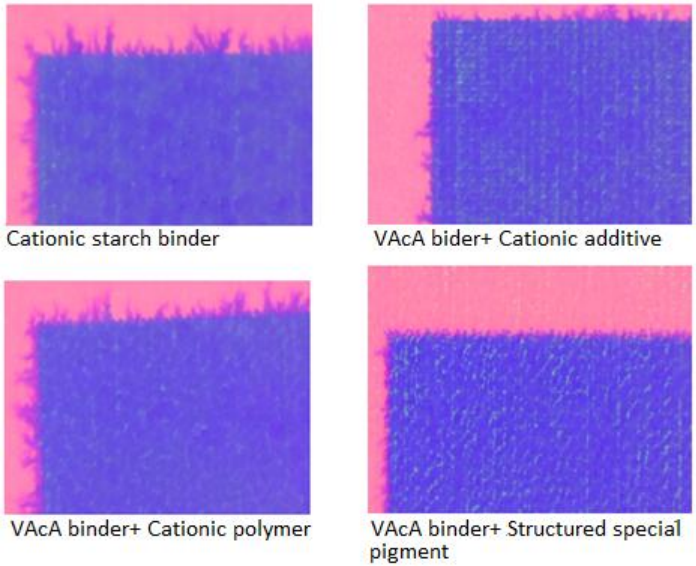
Wet rub resistance

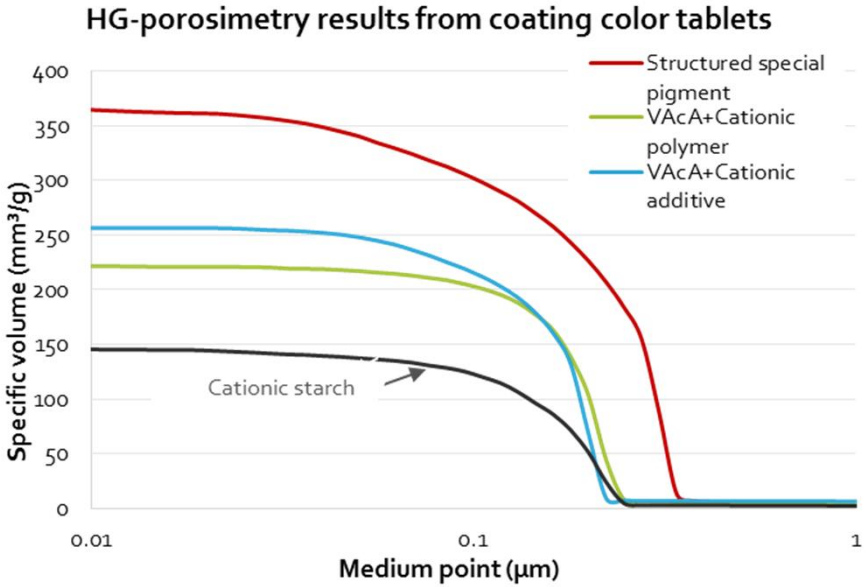


Low cat =	Cationic starch
Medium cat=	VAcA + cationic additive 1
High cat =	VAcA + cationic polymer
High cat & High porosity=	Special structured pigment

- Cationic charge has a positive effect on ink adhesion
- Porosity has a minor effect

The effect of pore size distribution on ink levelling (intercolor bleeding)



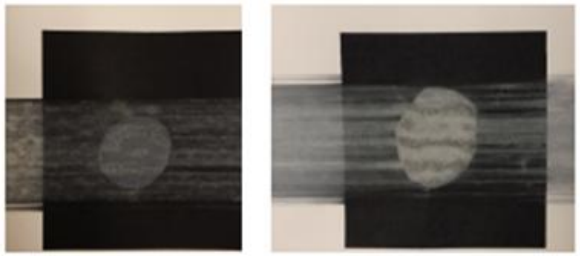


High coating color porosity can increase graininess of printed image (coat weight 7 gsm).

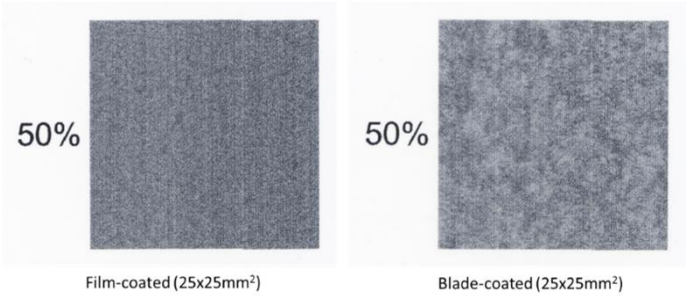
Effect of coating method

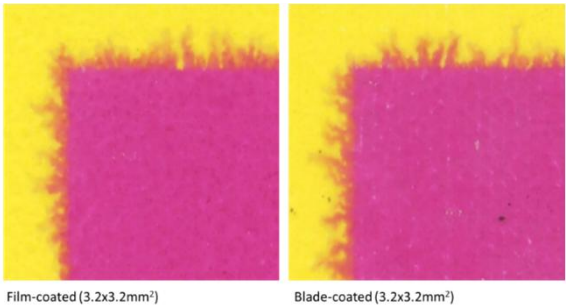
The Film coated paper has better inkjet printability than blade coated paper

- Less mottling
- Lower graininess
- Better ink adhesion
- No differences in bleeding



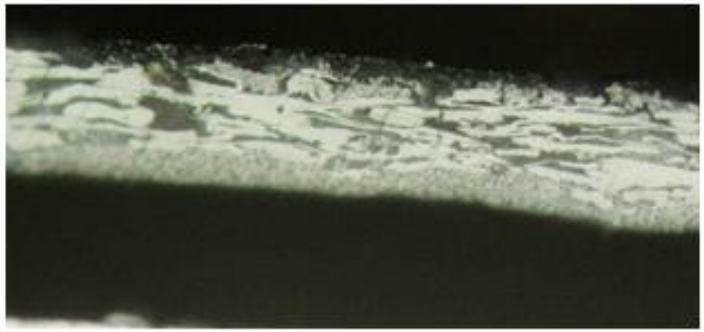
Film 7g Blade 7g



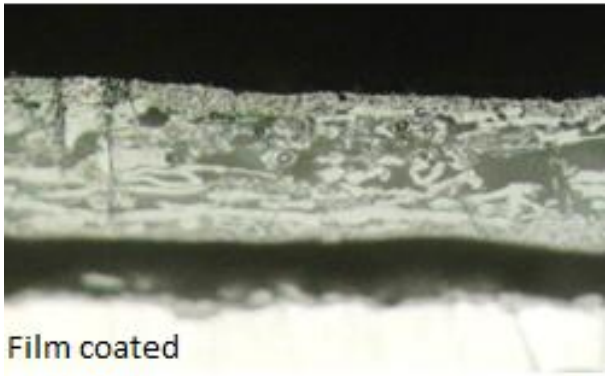


According to XPS the VAcA latex is located closer to the surface when coating with a film coater.

Effect of coating method



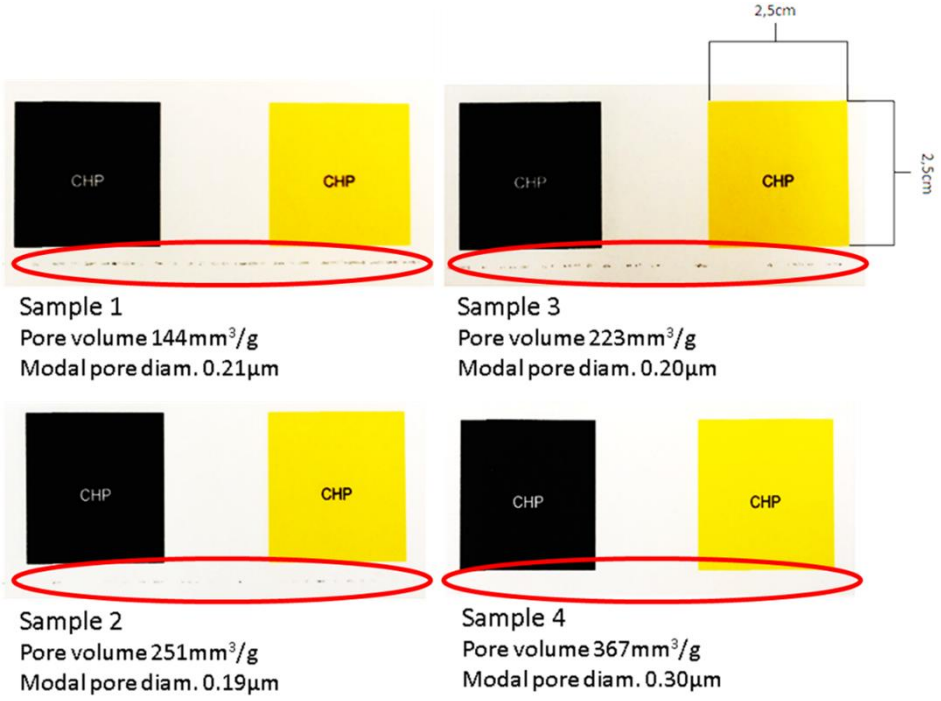
Blade coated



Film coated

- The ink penetration on the film coated paper is more even
- Slightly bulkier coating layer with film coated paper
- With blade coating the ink seems to end up closer to the surface
  - → more smearing.
  - → Higher mottling.

Smearing problems during high speed printing



Sample 1
Pore volume 144mm^3/g
Modal pore diam. 0.21µm

Sample 3
Pore volume 223mm^3/g
Modal pore diam. 0.20µm

Sample 2
Pore volume 251mm^3/g
Modal pore diam. 0.19µm

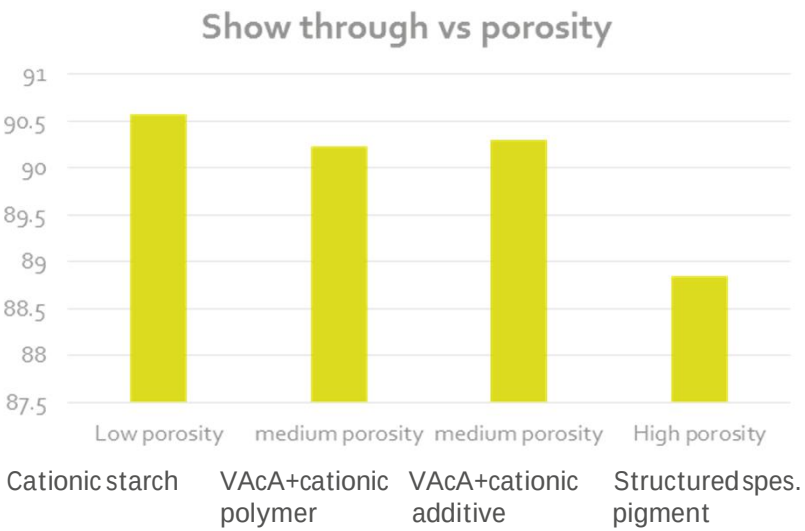
Sample 4
Pore volume 367mm^3/g
Modal pore diam. 0.30µm

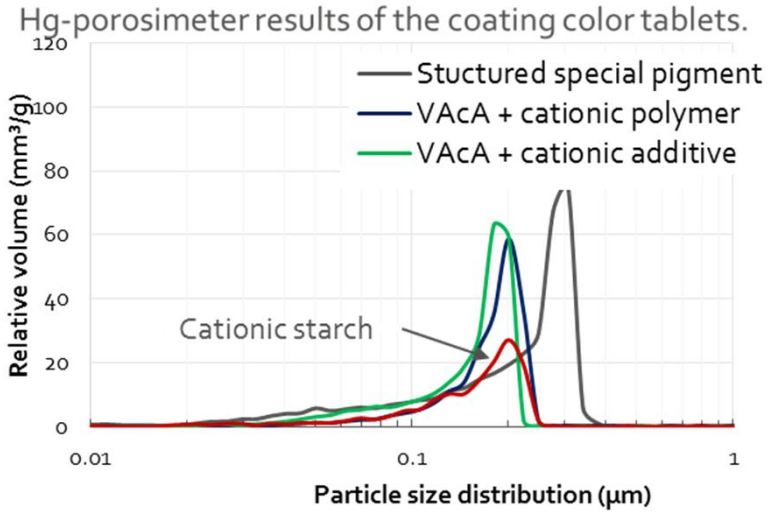
Too low porosity with high ink levelling causes smearing in high speed ink jet printing

Fig. in upper left corner has the lowest porosity (printing speed 32 m/min

Fig. in the bottom right has highest porosity (printing speed 64 m/min)

Porosity of coating colors affects on show through



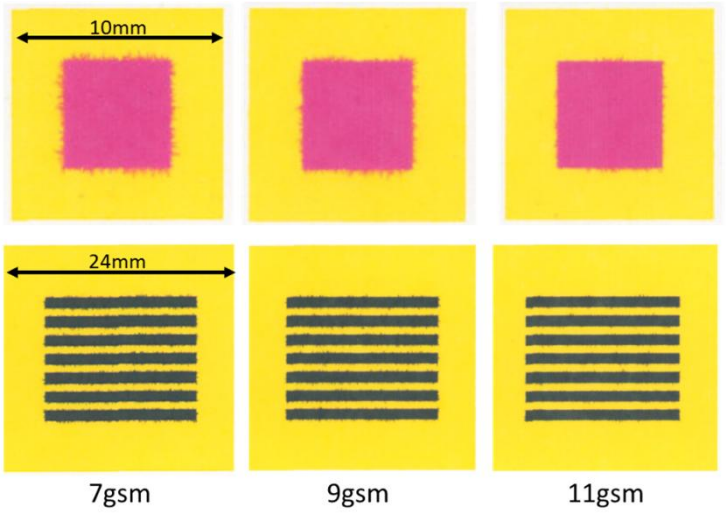


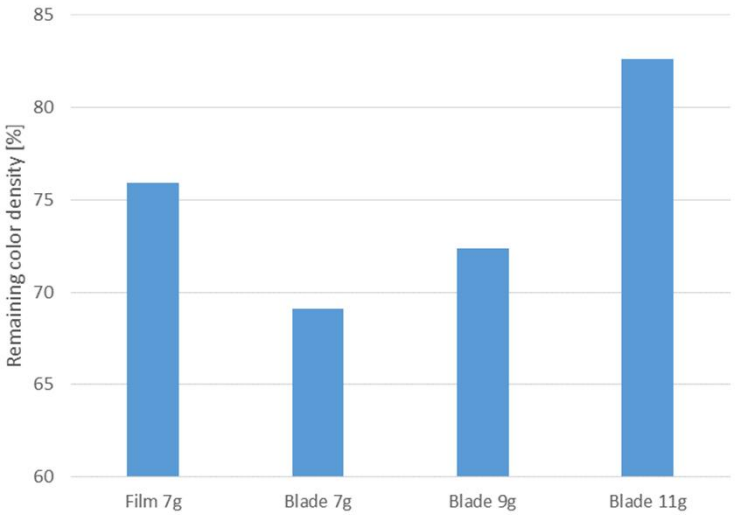
The most porous coating color causes high permeability which is beneficial in high speed inkjet printing, but causes high show through and graininess problems

(Show trough is evaluated by measuring the L-value from the reverse side of the print. Higher L-value=lower show through)

Effect of coating thickness on inkjet printability

- When the coating layer thickness increases
  - intercolor bleeding decreases
  - ink adhesion improves





Conclusions

- A cationic charge of the paper coating was clearly a necessity for good ink adhesion when printing with anionic dye-based inks
  - The higher the cationic charge of the coated paper, the higher water fastness and wet rub resistance.
  - Best solution is structured cationic pigment with VAcA latex
  - Also good results by traditional pigments together with cationic additive and VAcA latex

- The pore structure of the coated paper correlated well with the inkjet printability.
  - The most porous coating had best high speed inkjet runnability even at high printing speeds.
  - Best solution by structured cationic pigment together with VAcA latex

- The print through caused by a permeable coating can potentially be improved by using more VAcA latex or by closing the base paper surface

- In the presented study, paper coated with film transfer technique showed better inkjet quality than paper coated with blade coating technique