Nanofibrillated Cellulose in High-quality Inkjet Coating

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Gerd Papier, Schoeller Technocell
Ralf Gericke, PTS

Using photo paper as an example of a demonstrator for the application of NFC in high-quality inkjet paper

Inkjet Photo Paper in general

Lab Trials by PTS

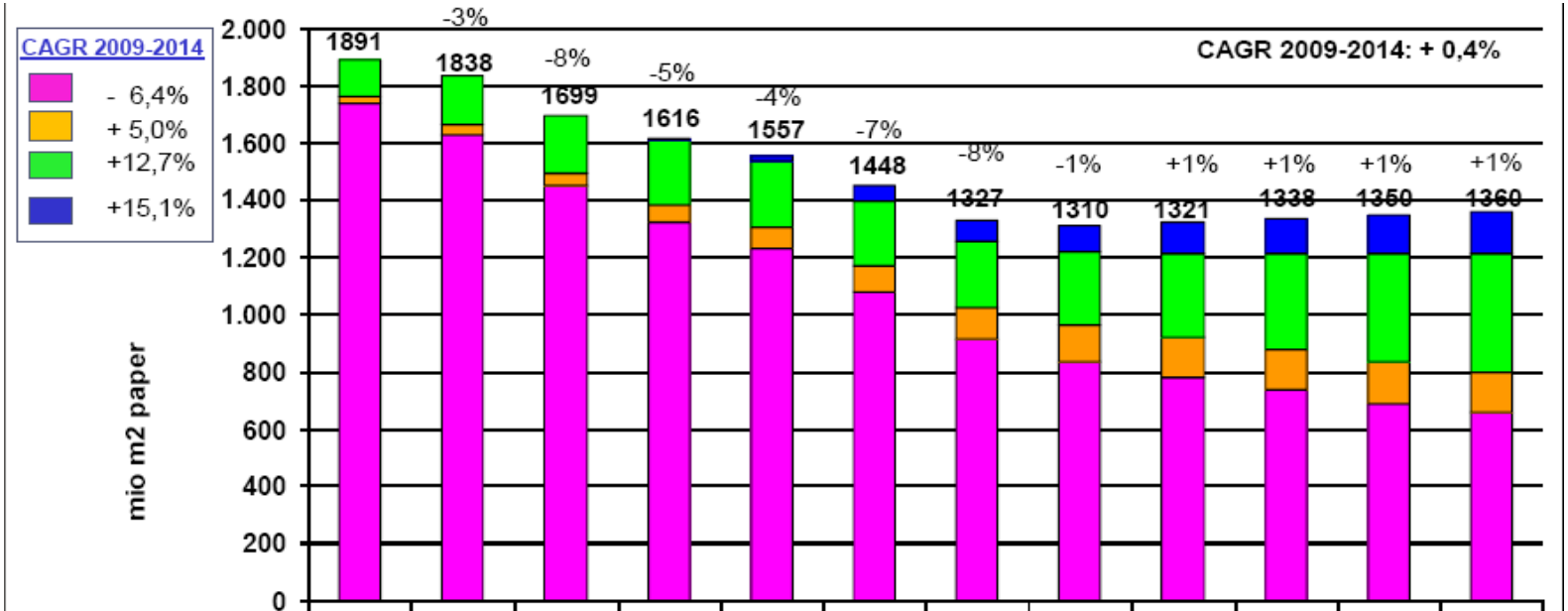
Manufacturing of Inkjet Photo Paper on Pilot Coater

Evaluation of Results

Photo papers are made by 4 major technologies:

- Silverhalide, which is still the largest part
- Inkjet, which is the fastest growing
- Thermal Transfer, used eg. in kiosks (Kodak)
- Toner, used for photo books

While AgX paper is declining, Inkjet photo paper is growing fast

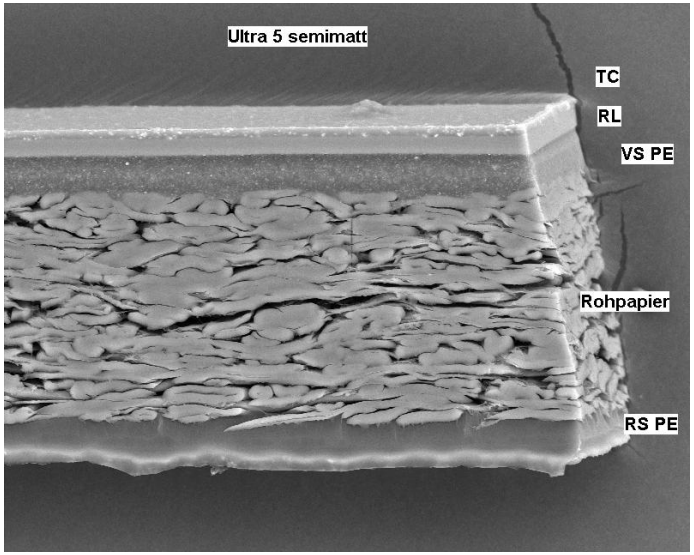


	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Photo Books (EP)	0	0	0	8	24	50	73	93	109	125	138	147
Inkjet (Home + Retail)	131	176	206	226	231	226	228	253	292	334	378	416
Dye Sub (Photo)	20	32	42	56	72	91	110	127	139	144	142	140
AgX-paper	1.740	1.630	1.450	1.326	1.231	1.082	916	837	781	735	692	657

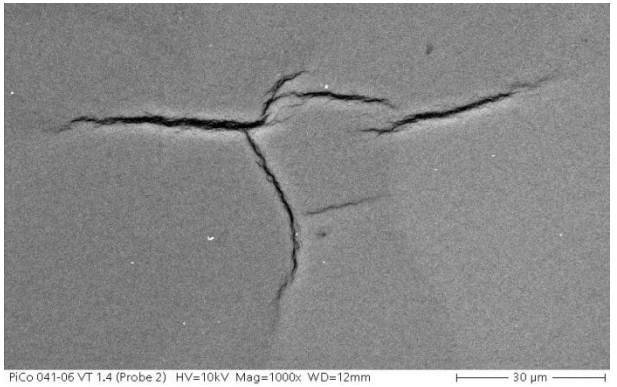
Inkjet photo paper consists of a base paper and extruded PE layers on both sides

A highly absorptive receiver layer is applied to the top side with up to 40 g/m2

- ***Pigments with high surface area are used to obtain high porosity and capacity for inkjet printing ink***
- ***PVOH is commonly used as a binder in coating colours for glossy inkjet paper***



The production speed of inkjet photo paper is limited by cracking during drying



The cohesion strength between the nano pigments and the binder competes with the retraction force of the binder during drying

The fibre network of the NFC may counteract the forces and to thus reduce cracking

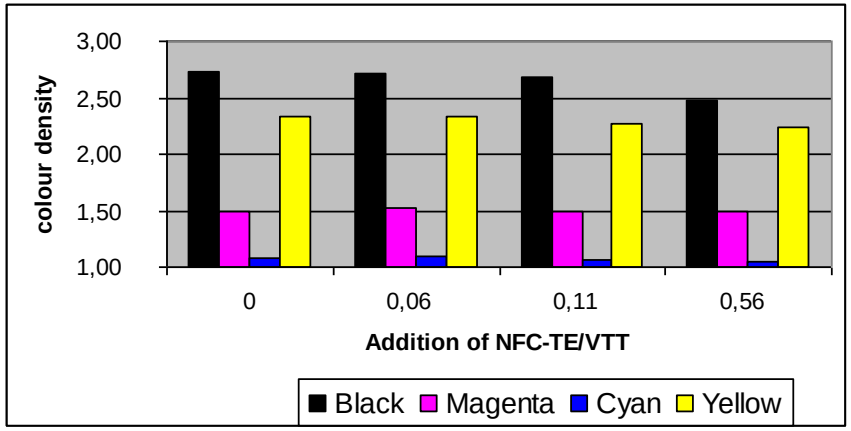
- ***Reduced cracking during drying may result in increased production speed***
- ***Brittleness of the coating may be decreased***
- ***Migration of ink dyes can be reduced***

In previous presentations about barrier coatings CTP showed good results with less cracking by combining PVOH and NFC

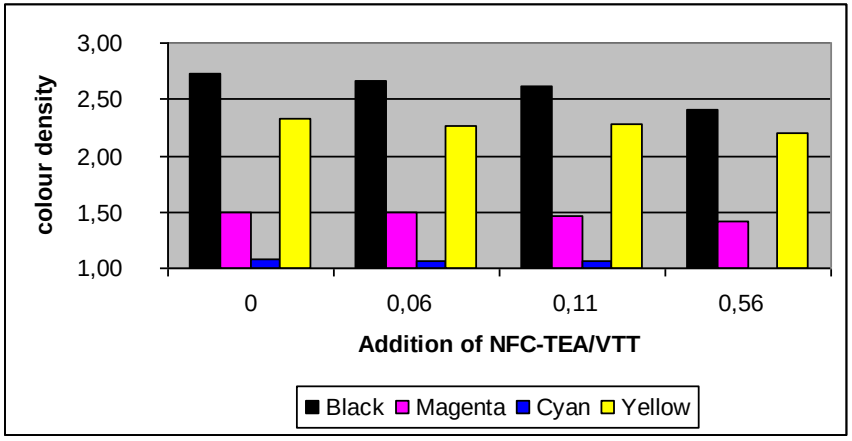
Lab trials were performed at PTS to optimise the amount of NFC added to coating colours for high-quality inkjet coating

Colour make-down had to be changed

	NFC-TEA/VTT	NFC-TE/VTT
Transparency	o	- -
Compatibility with cationic components	o	-
Viscosity of coating colour	+	-
Colour density low amount added	+	+
Colour density medium amount added	- - -	o



* Dye based ink



The pilot coater at Felix Schoeller

The pilot coater is very comparable to production coating machines in the mill and uses the same applicator system, which is a multilayer curtain head

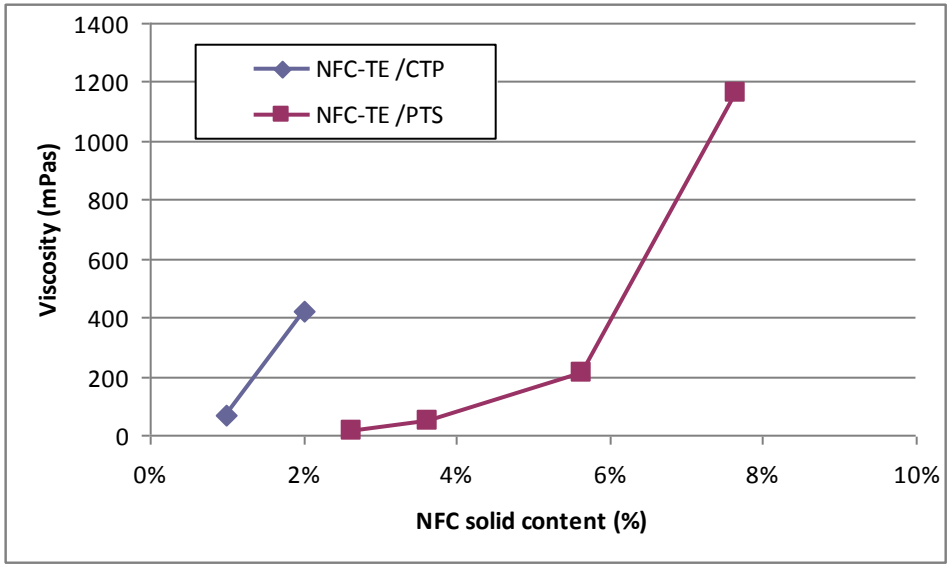
Substrates:	raw paper, RC paper, PET film
Line speed:	up to 300 m/min
Coating width:	260 mm
Coating devices:	Meyer bar, slot die, curtain coater
Drying system:	Infrared and convection dryers
Process control:	fully computerised, graphic screen
Shift system:	continuous 2-shift operation
Employees:	6

Two samples of NFC have been tested

NFC-TE/CTP and NFC-TE/PTS

Description	Solids content (%)	Viscosity (mPas)
NFC-TE/CTP	3.0%	gelatinous
NFC-TE/PTS	9.64%	gelatinous

Viscosity of diluted samples at 45° C



Experimental design on pilot coater

Cracking is strongly affected by the drying curve on the pilot and production scales

Drying section is not the same on pilot and production machines, the length of the production dryer is 104m, not realisable on a pilot scale

Experience shows that the cracking tendency increases with increasing coat weight

Trial 1 Standard product was adjusted to coating conditions which caused slight cracking in order to set a reference point. Then the coat weight was increased stepwise, so that the cracking tendency could be compared under same drying conditions

Trial 2 Samples of standard product and product containing 0.06% NFC were coated and printed in order to compare the qualities and produce samples for evaluation, coat weight 40g/m2

Trial 1: Testing for Cracking Tendency

trial	Mix	cwt [g/m2]	speed potential	microcracking 1. circle	2. circle	3. circle	sum	rating	comments
VT1.1	standard (without Cellulose)	40	+0%	56	49	40	145	4	standard
VT2.1	with NFC-TE/CTP	40	+0%	27	21	26	74	2	
VT2.2		42	+5%	31	42	42	115	3-	
VT2.3		44	+10%	31	37	42	110	5	large cracks
VT2.4		46	+15%	33	41	48	122	6	large cracks
VT2.5		48	+20%	completely cracked				6	
VT2.6		50	+25%					6	
VT2.7		52	+30%					6	

The cracking level under same conditions showed less cracking with NFC

The coating speed can be increased by 5-10 % while maintaining the same cracking level by adding NFC to the coating colours

Trial 2: Production of Samples for Evaluation

	VT 0.5	VT 2.01	VT 3.01
Raw material	**Standard**	**NFC-TE/CTP**	**NFC-TE/PTS**
Pigment	100	100	100
Hardener	0.35	0.35	0.35
PVOH	11	11	11
NFC	0	0.06	0.06
Surfactant	0.03	0.03	0.03

Solid content (%)	27.39	27.26	27.30
Viscosity (mPas) fresh	174	202	164
pH	4.66	4.76	4.7
Surface tension (mN/cm)	40	40	39

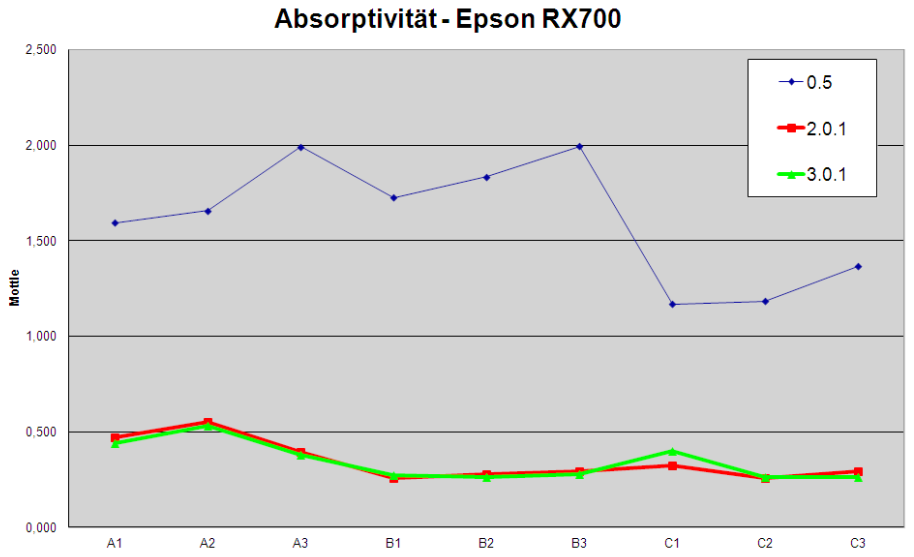
The coating mix parameters were essentially the same for both NFC`s
No problems appeared during coating

Evaluation of Samples

cutting dust is lower with NFC
brittleness is slightly improved

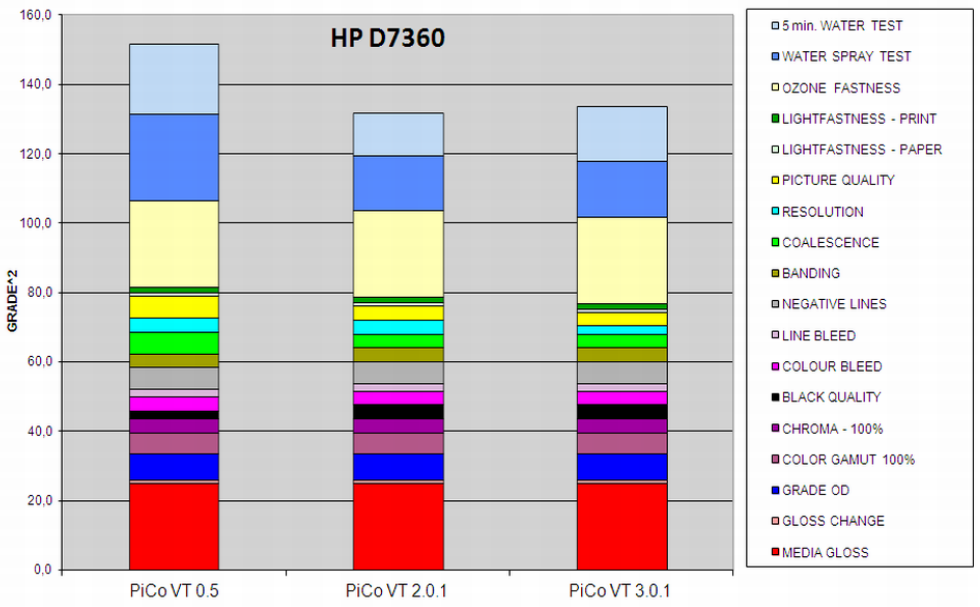
	cutting dust [mg]
PiCo VT 0.5	5
PiCo VT 2.0.1	2
PiCo VT 3.0.1	1

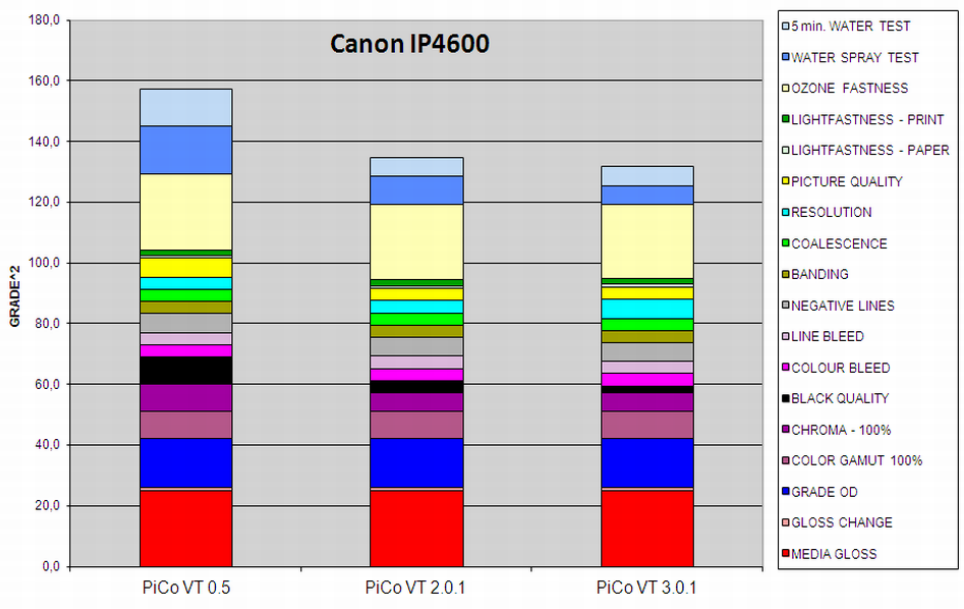
absorptivity is higher with NFC
mottle Index is lower,
representing less coalescence



Evaluation of Samples

water resistance in particular can be improved by adding NFC to the coating colour

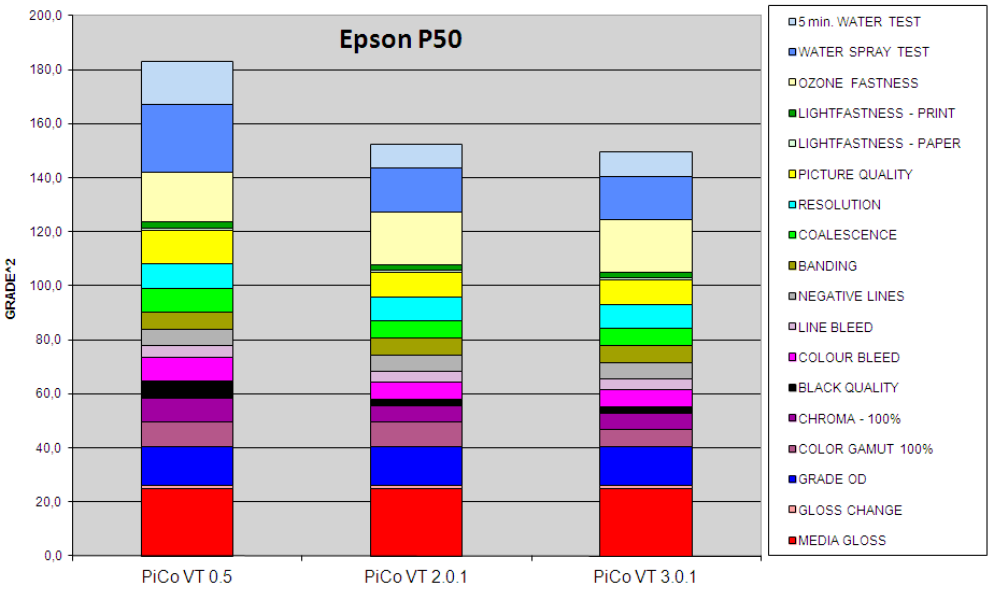


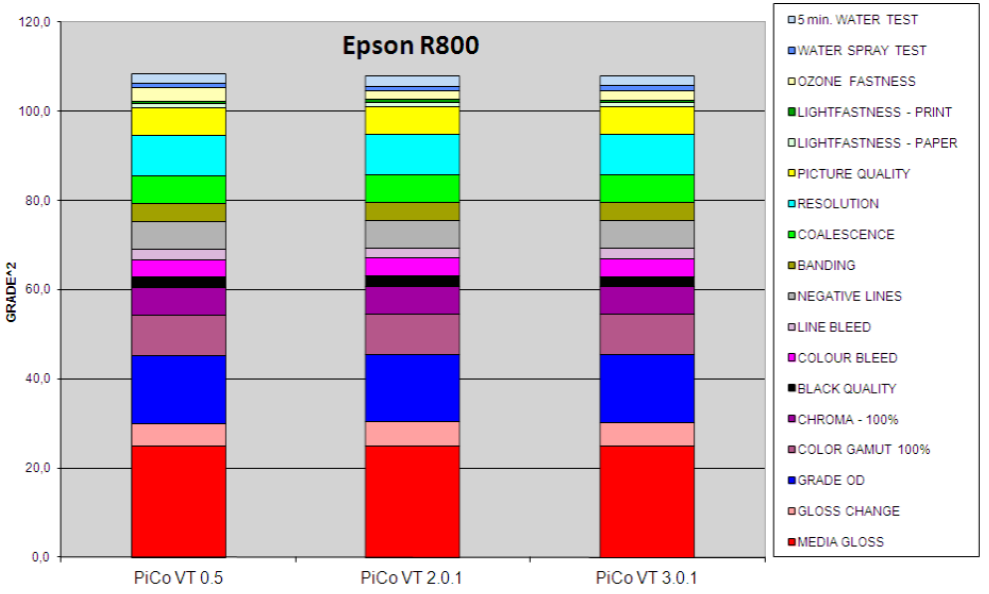


...the lower the pile, the better the quality

Evaluation of Samples

no quality improvement if pigment based inks are used - see Epson R800





...the lower the pile, the better the quality

Summary

Inkjet photo paper was coated on a pilot coater using technology comparable to production machines

The cracking level was lower with 0.06 % NFC in the coating colours; the potential for speed increase is estimated to be 5-10 %

Printed samples as demonstrators did not reveal any no-go parameters

Water fastness, absorptivity, bronzing and brittleness are better with NFC, especially if dye-based inks are used

Trials with double concentration of NFC showed a visible decrease in gloss

Acknowledgement

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