



DIGITAL COATING

CHROMOJET VALVE JET TECHNOLOGY

VERSUS

PIEZO INK-JET TECHNOLOGY



WHAT DOES DIGITAL COATING MEAN?

- Digital coating is a kind of selective printing
- It uses pastes and fluids with a high amount of solid content

EXPECTATION ON DIGITAL COATING

- Wide range of applications
- Coating is applied mainly at the surface = material saving
- Each side of the substrate may have different coatings and functions
- Different types of fluids, chemistry may be used at the same time - for textiles with localized functions
- Easy change of shapes, pick-up viscosity, concentration
- Wide range of speeds
- Even coverage and distribution
- No washing and cleaning of the application system needed because it is a closed system
- No clogging and drying inside the system
- Easy handling and adjustment
- No waste and environmental friendly
- Short runs with many variations



POSSIBLE DIGITAL TECHNOLOGIES

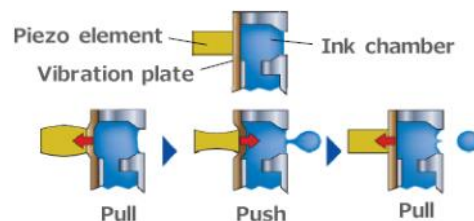
- Ink-jet technology
- Valve jet technology

Digital Coating is expected to significantly reduce the amount of waste, energy consumption and raw material usage. New functions and combination of functions will be created. Mass customization is possible.

INK-JET TECHNOLOGY BASICS

HOW INK-JET WORKS

- Electric voltage expands and contracts the piezo
- Individual droplets with a volume from 2 - 200 picoliter are ejected from a nozzle with a diameter in the range of 5-20 μm (diameter of human hair is about 100 μm)

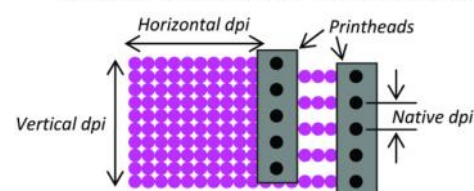


Basic function of a piezo printing element

RESOLUTION

- There is a native resolution of the print head and a print resolution which might be higher in most cases.
- To get a higher resolution in x or y axis the number of passes is increased.
- Higher print resolution means more ink, slower speed and higher cost.
- Resolution should not be higher than needed!

$$dpi_{Horizontal} = frequency (hz) / carriage speed (ips)$$



Relation between native and print resolution

The resolution is the main parameter to control ink pick-up. Higher resolution means more droplets and therefore higher pick-up at a lower speed.

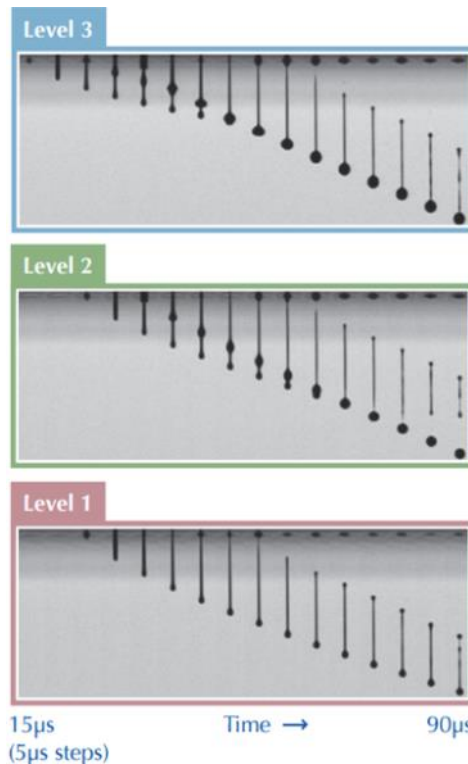
DROPSIZE

Ink-jet works with individual droplets generated by a piezo actuator. For pile products the most important parameter is the amount of ink needed to achieve good penetration and saturated colors or good coverage of coatings.

The dropsizes is an important parameter to deliver the right amount of ink needed.

Dropsizes ranges between 2 and 250 picoliter - depending on printhead.

The bigger the dropsizes, the more ink and more speed are required at a certain level of ink.



This picture shows the generation of droplets with 3 different sizes

INK LAY-DOWN OR INK PICK-UP

The total amount of ink lay down (= pick-up) to the substrate is calculated as follows:

$$\begin{aligned} \text{Pick-up (ml/sqm)} &= x\text{-dpi} * y\text{-dpi} * 1000/25.4 * 1000/25.4 * \text{dropsizes(pl)} / 1E9 \\ &= x\text{-dpi} * y\text{-dpi} * \text{dropsizes} * 1550 / 1E9 \\ &= x\text{-dpi} * y\text{-dpi} * \text{dropsizes} / 650000 \end{aligned}$$

INK-JET BASICS

Advantages of digital coating

- Tiny droplets can eject smallest amounts of fluids
- Precise dosing
- Up to 30.000 droplets per nozzle and second
- High productivity using

Disadvantages

- Fluids are very limited and high in cost
- Very low viscosity (between 5 and 20 cps)
- Controlled surface tension required
- pH should remain between 5 and 8
- Glycols and other surfactants are needed to avoid drying-in at nozzle outlets
- Pigment size must be in the range of 500 nanometer - high milling cost
- Difficult to achieve high coverage
- Pigments and binders in high concentrations are difficult to handle



Expectation	Reality
Low cost	High cost
Long lifetime of printhead	1 - 3 years if treated well
Tolerant on viscosity, surface tension, particle size	Fluid must be within a very narrow tolerance
No clogging	High degree of filtration is needed
Easy drying of applied coating	Difficult to dry because presence of glycol is a must
Cheap	Expensive



Ink-jet technology will find its place in high-end applications:

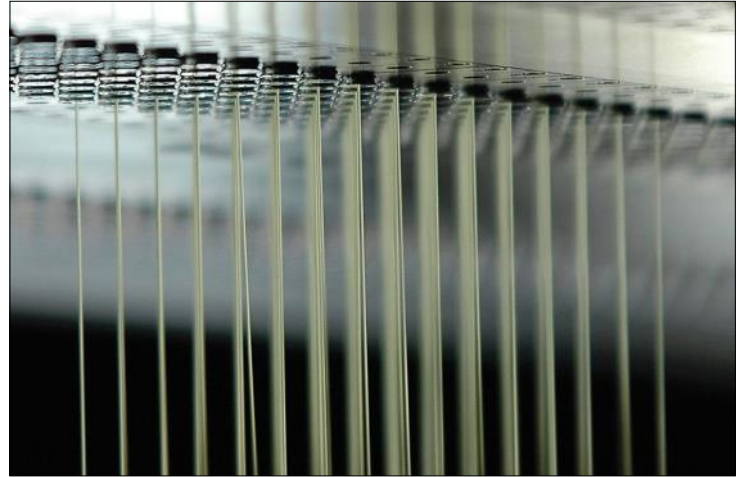
- Medical applications
- Electronic manufacturing
- Special functional chemistry on technical textiles

- Zimmer Kufstein can help to develop applications using piezo inkjet technology
- We have test units, drop watcher, viscometers, tensiometers, steamers, dryers, UV curing,.....
- We can develop, optimize and modify inks and fluids
- We can develop new applications in the fields of textile printing and coating

VALVE-JET TECHNOLOGY

PRINCIPLE

An electromagnet activates a plunger which is opening and closing the outlet of a nozzle.



Volume can be controlled by

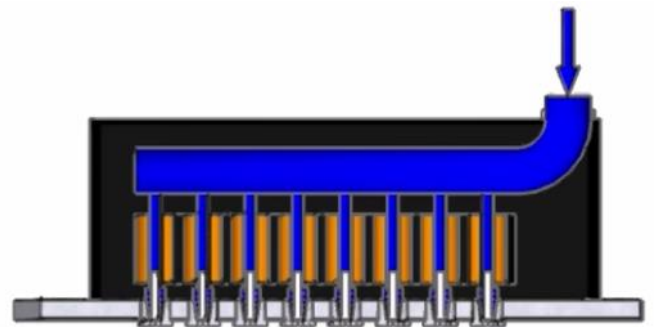
- Coverage (Rasterizing)
- Nozzle diameter
- Viscosity
- Pressure
- Head speed if system is mounted on a moving print-head

Zimmer has developed different types of valve jets with billion cycles lifetime for its ChromoJET digital carpet printing system.

These jets are also perfect for applying different coatings.

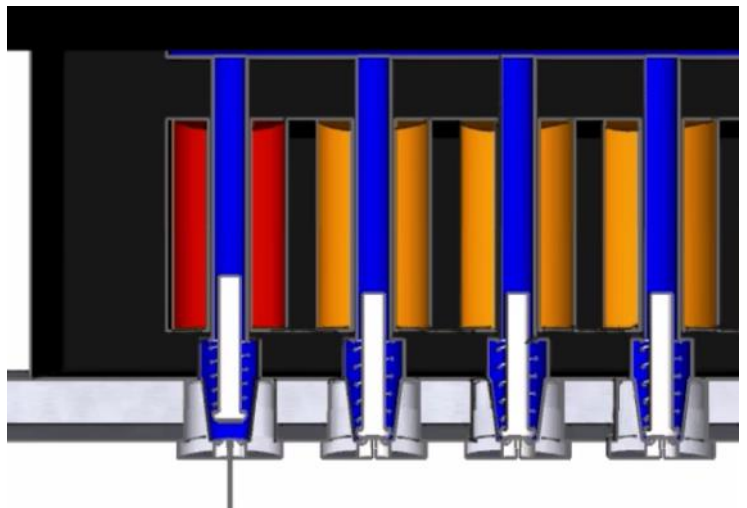
Advantages of ChromoJET valve technology:

- High range of viscosity and surface tension
- High volume of liquids can be ejected
- Particle size can go up to 20 μm
- Wide range of pH values
- For water based liquids
- Nozzle diameters from 80 to 500 μm
- Up to 1024 jets in one array



Limitations:

- Operating frequency up to 1200 pulses per second
- Minimum pressure of about 0.5 bar
- Minimum amount of pick-up is limited



VALVE-JET TECHNOLOGY

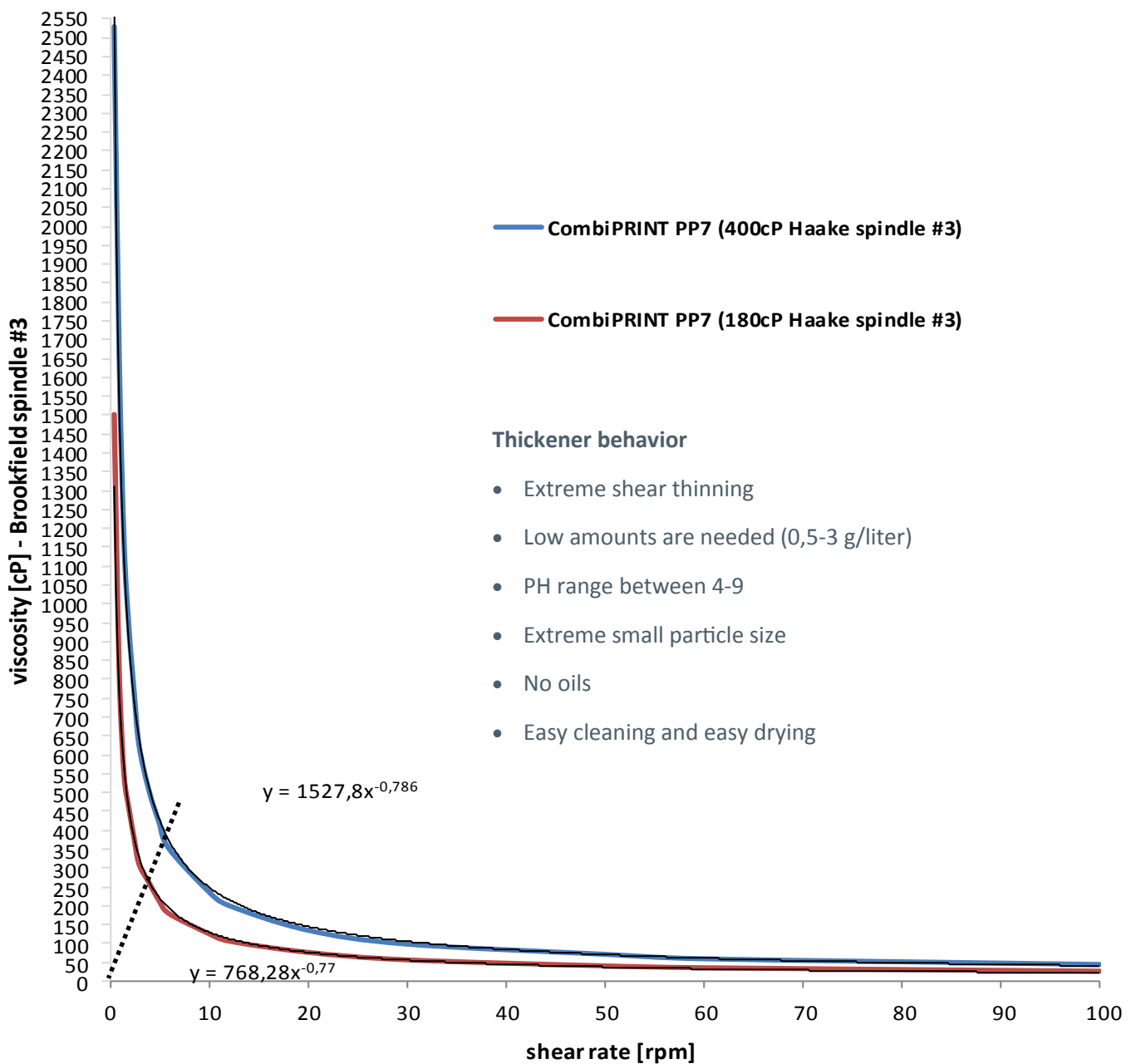
INFLUENCE OF VISCOSITY AND SELECTION OF THICKENER

A shear thinning thickener is used for printing to achieve easy flowing and sharp print definition.

During ejecting from the jet the viscosity is thin and when the flow comes to a stop the viscosity is increasing considerably. This guarantees a good flow and sharp definition.

Rheology Curve (Thixotropy)

Brookfield DV-I Spindle #3



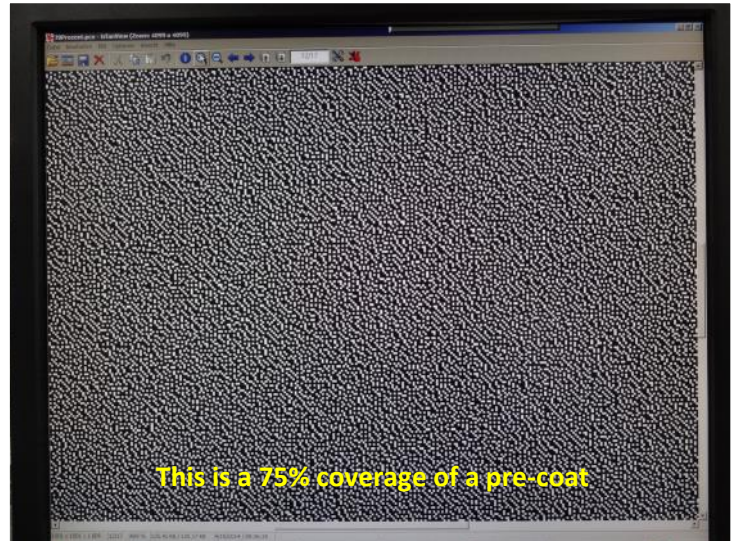
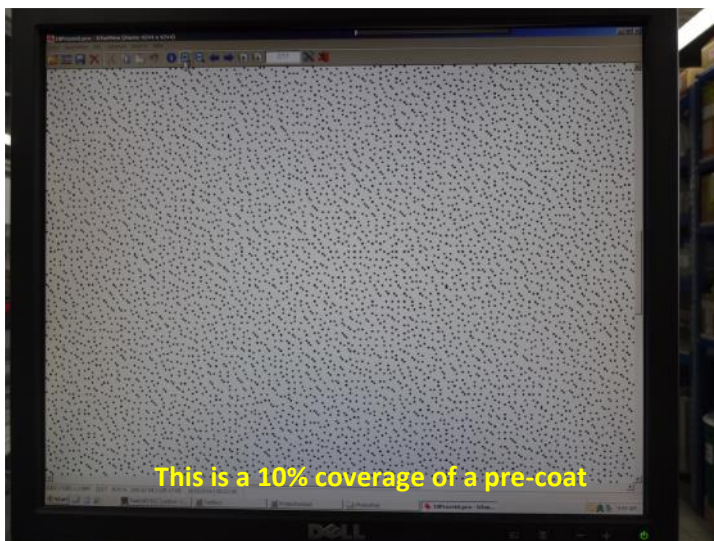
VALVE JET TECHNOLOGY

CONTROLLING PICK-UP

There are a number of parameters which influence droptime, ejection speed, coverage and total pick-up.

The easiest way to control pick-up is to rasterize the coverage.

This raster can be in a range between 10% and 100% - depending on fabric and pick-up. To get an even distribution across the fabric a roller or blade squeegee is required behind the ChromoJET application unit.

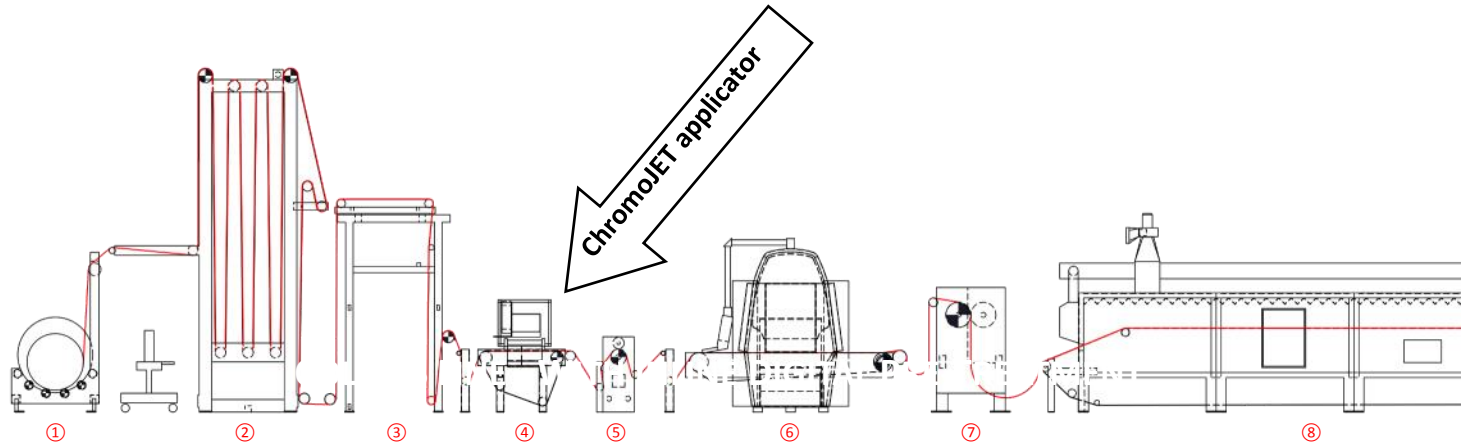


Calculation of possible pick-up ranges using ChromoJET-800 jets

Parameter	min	max	pick-up range
Pressure	0.6 bar	3 bar	5
Head speed (1 m/sec = 100%)	40%	100%	2.5
Coverage by raster	25%	100%	4,0
Variation by pressure, head-speed, and coverage			50
Viscosity (root function)	50 cps	200 cps	2
Variation by pressure, head-speed, coverage and viscosity			100
nozzle diameter (square function)	120 µm	280 µm	5
Theoretical variation and range of pick-up			1 : 500

VALVE-JET APPLICATIONS

COLARIS | INDUSTRIAL INK-JET PRINTING ON POLYAMIDE CARPET



COLARIS CARPET PRINT LINE WITH CHROMOJET INLINE DIGITAL PRE-TREATMENT

- 1) Carpet unrolling
- 2) Roller compensator
- 3) Carpet centering device
- 4) ChromoJET applicator for inline pre-treatment of the carpet
- 5) Distribution & penetration roller
- 6) **COLARIS** digital inkjet piezo printer
- 7) SupraPRESS for enhanced penetration of the print
- 8) Horizontal inline steamer
- 9) Carpet washer with vacuum extraction
- 10) High-capacity nozzle dryer or stenter dryer
- 11) Roller compensator
- 12) Carpet winder

A combination of the ChromoJET valve-based digital inkjet print system, successfully used in the carpet print industry for many years, with the COLARIS digital piezo-based inkjet printer makes it possible to push the print resolution beyond any limit known so far.

The ChromoJET technology is used as a digital applicator for inkjet pre-treatment onto the print substrate. The applied pre-treatment is equally distributed in the pile fabric by a penetration roller, subsequently the substrate is printed with the COLARIS inkjet piezo printer in a wet on wet process.

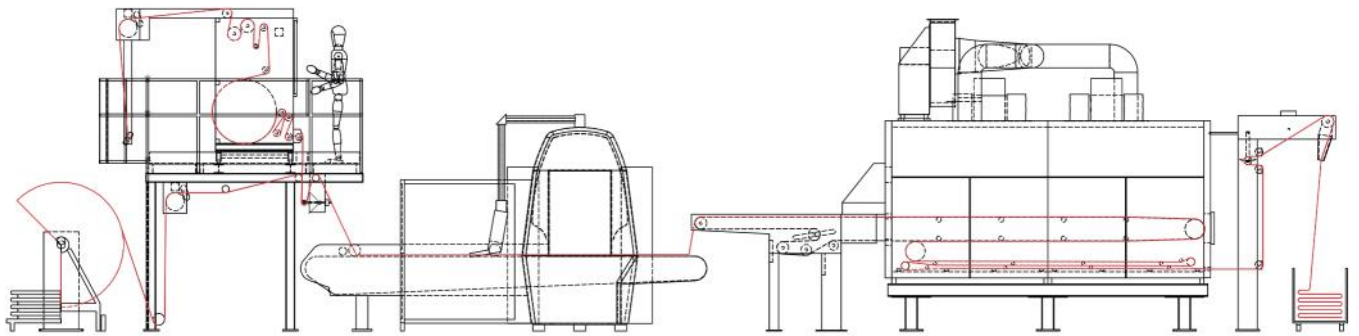
This specially developed process combines the advantages of both systems: The proven penetration by ChromoJET technology and the high-resolution printing by COLARIS inkjet piezo printer.

Print resolution can reach or even exceed 800 dpi. A large color gamut with highest image quality including fine degradation of colors are the benefits. Reproduction of photographic images becomes much easier by using real four-color printing with CMYK process colors.



VALVE-JET APPLICATIONS

COLARIS | INK-JET PRINTING ON COTTON TERRY TOWEL PRODUCTS



COLARIS³ - TOWELS

Total length: approx. 19 m

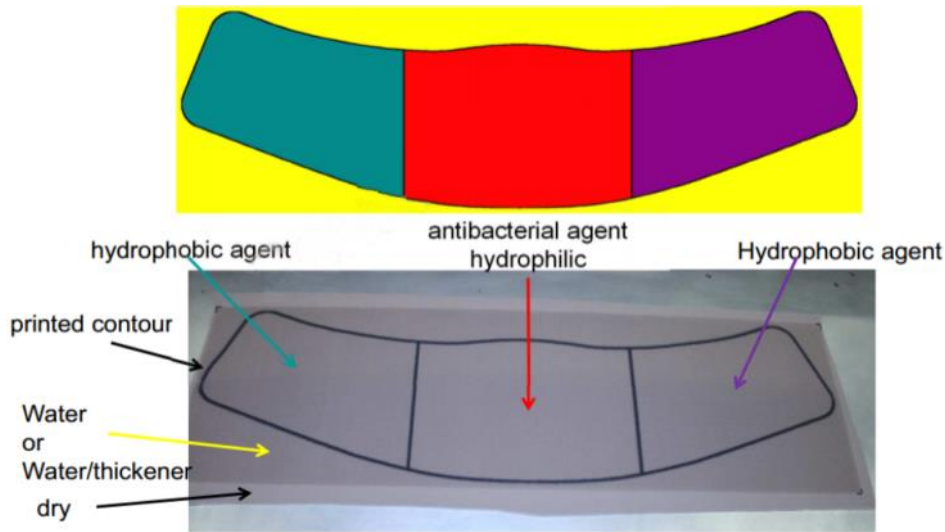


ChromoJET printhead with 128 jets to apply pre-coat for reactive printing (synthetic thickener, urea, sodium-bicarbonate)

Applied amount is in the range of 150-300 g/m²

The press roller distributes the individual dots to form an even layer of pre-coat for Colaris digital printing

VALVE-JET APPLICATIONS



For these tests we used a ChromoJET sample printer equipped with HSV800 type jets.

Various types of hydrophobic and hydrophilic components were used at the same time.



- Brighter regions have hydrophilic behavior after wetting with water spray
- Dark regions show a hydrophobic behavior
- When the fabric is dry no difference in color remains coating chemicals are not visible.



VALVE JET APPLICATIONS

CHROMOJET TABLE TOP PRINTER



TECHNICAL DATA

Print size	300 x 300 mm
Number of colors	4
Jet type	HSV400 with various nozzles
Jets per color	8
Nozzle size	100, 150, 200, 250 µm
Media pressure	0.5 - 3.0 bar

The ChromoJET Table Top Printer is perfect for product and process development in a small scale.

Small removable medium tanks provide quick and easy change of fluids and dyes.

Designs can be uploaded from a normal PC.

Resolution, rasterization, pressure, head-speed, nozzle size, viscosity:

These are the parameters to control penetration, pick-up and definition.

Needs very little space on a table.

DIGITAL COATING

Comparison between ChromoJET valve technology and piezo Ink-jet technology

Technology	ChromoJET Valve-Jet	Ink-Jet
Dropsize	20 nl with 100 µm nozzle and 500 cps	2 to 250 pl
Frequency	Up to 1200 Hz	Up to 20.000 Hz
Pressure	0.6 - 3 bar	No pressure
Viscosity	Shear thinning behavior recommended Up to 600 cps	Newton behavior needed Up to 15 cps; must be within 2 cps
Nozzle size	100 to 300 µm	5 to 20 µm
Particle size	Up to 20 µm	Up to 1 µm
Medium temperature	10 - 50°C; can vary	Up to 60°C ; fixed value between x and 60°C
Critical parameters	All parameters must be within the limits	Viscosity, surface tension, particle size, drying behavior, temperature

Zimmer offers customer oriented developments and applications using inkjet and valve jet digital printing and coating technologies. Right now we are building a new technology center for digital textile applications.

Contact us !



INNOVATION

QUALITY

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