Benefits of Controlling the Interfacial Chemistry of Paper

PaperCon 2011
May 1-4
Northern Kentucky Convention Center
RETHINK PAPER:
Lean and Green

ALTANA

BYK Additives & Instruments

ECKART Effect Pigments

ELANTAS Electrical Insulation

ACTEGA Coatings & Sealants








A global specialty chemicals player with leading positions
in demanding specialty markets

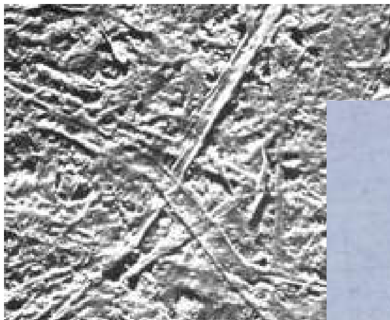
Our Core Strengths

Modification and Control of interfacial chemistry

Supplying specialty additives for the Paint, Plastics and Ink markets

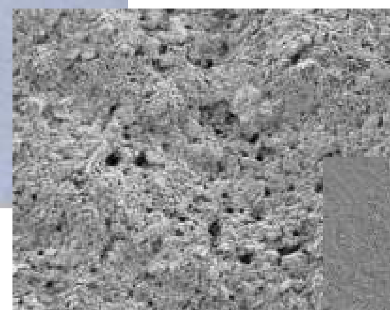
Focusing on the paper coatings market, we apply our knowledge and capability to modify paper coatings and the surface characteristics of coated paper for improving printability and convertibility

Paper Surface improvement Processes



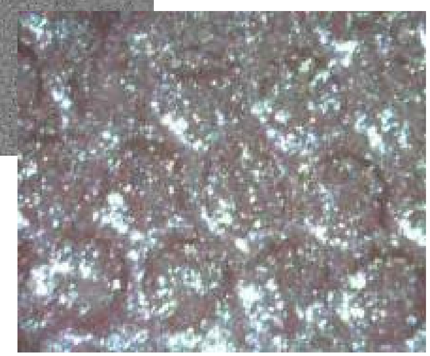
Surface sizing

Single coating

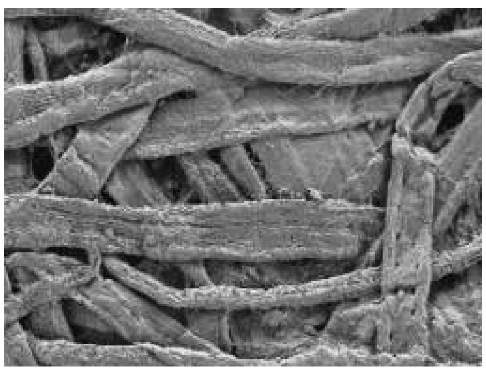


Precoat

Topcoat



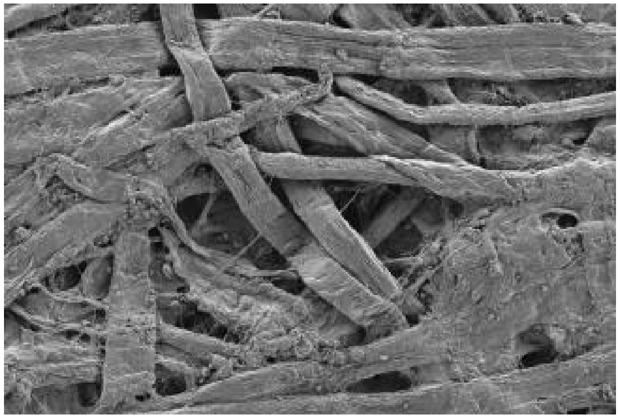
Metalized and embossed



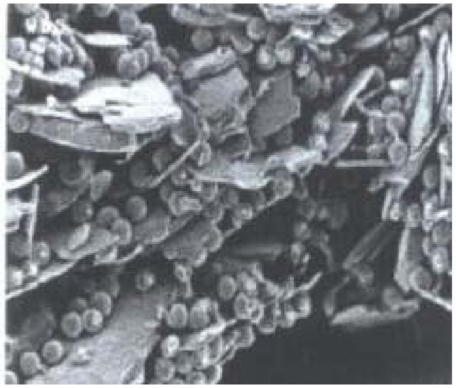
Base paper

Paper is a Non Homogeneous Substrate for Many Printing and Converting Processes

Paper remains porous



Base paper



Coating layer

Modeling Paper as a porous system

Darcys Law

$$Q = \frac{K\,\Delta P}{\eta \Delta L} A$$

Q = flow rate
K= permeability coefficent
ΔP = pressure drop Difference
L= Flow length
A = Area of cross sectional Area to flow
η= fluid viscosity

$$\gamma_{sl} = \gamma_{sg} - \gamma_{lg} * \cos\Theta$$

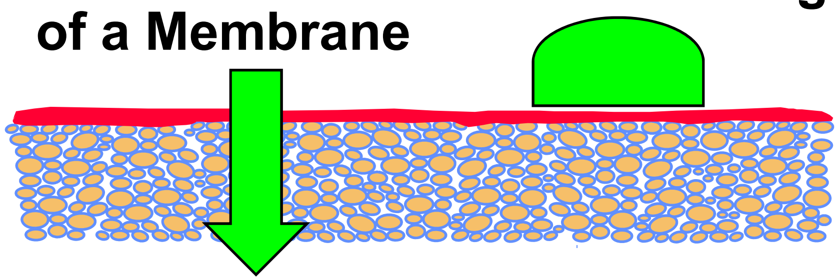
γ_{sl} = cohesion
γ_{sg} = Adhesion
γ_{lg}= surface tension

Permeabilty of a Membrane

Surface wetting

Coating

paper



Coating and surface sizing to increase uniformity

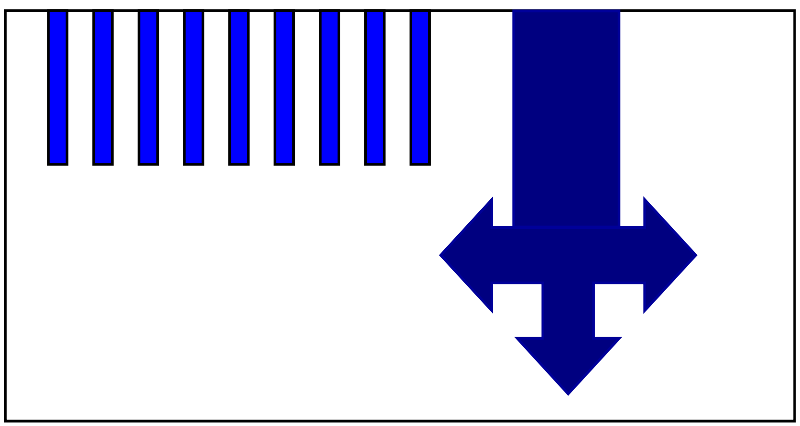
Modeling the Physics of Capillary Rise and Pore Fill

Bosanquet = $\epsilon\ f\ (1/R,\ \gamma\rho t^2)$; Lukas Washburn = $\epsilon\ f\ (R;\ \gamma\eta t)$ (t<<1^;)

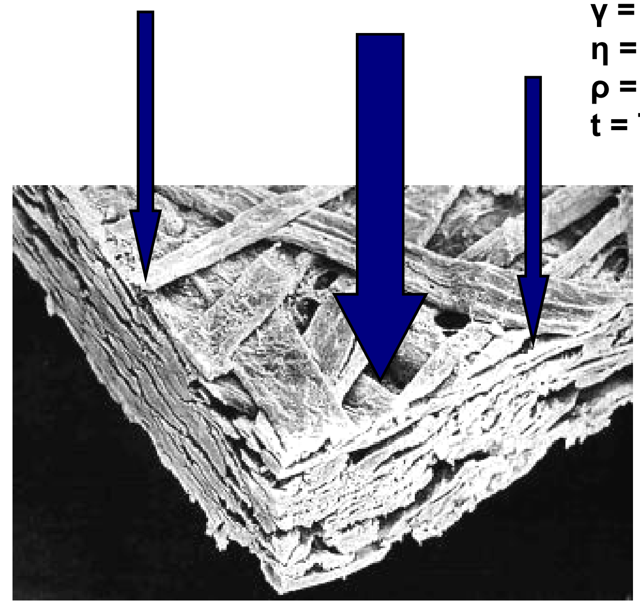
γ = Wetting
η = Viscosity (T)
ρ = Material
t = Time

ϵ = Void Area of Surface

Bosanquet **Lukas- Washburn**



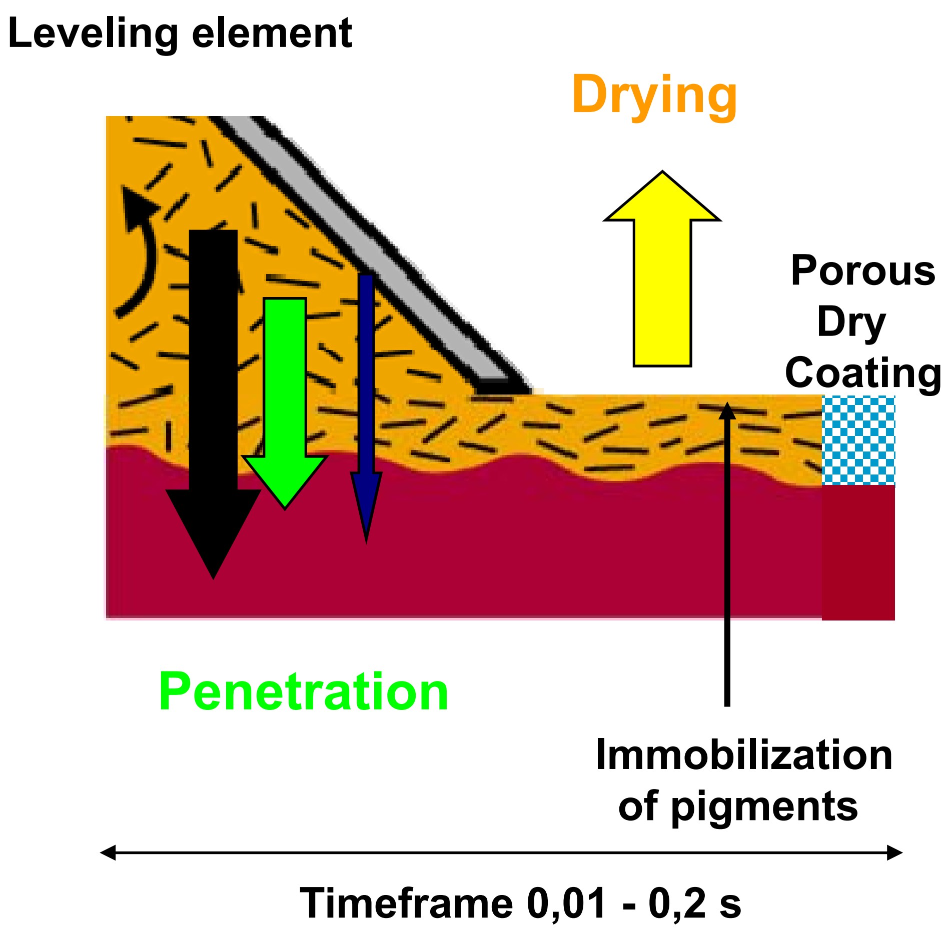
Model Capillary system



Real Paper system

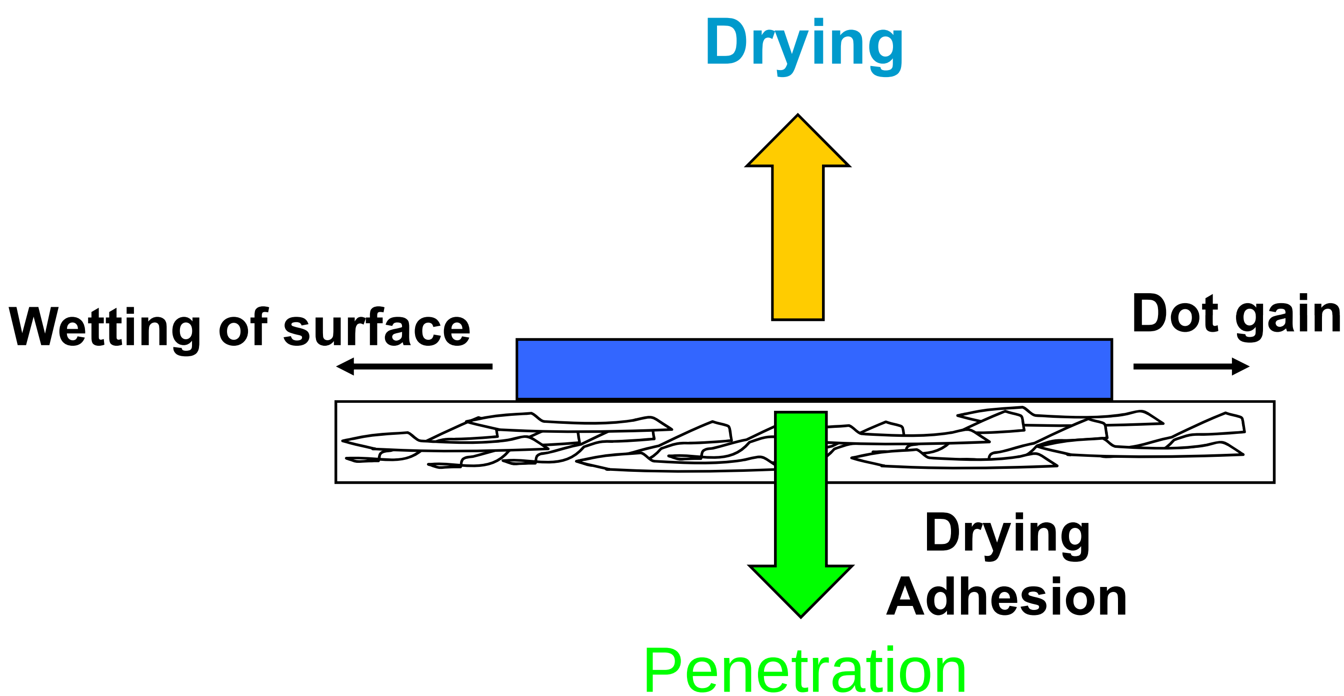
- **Bosanquet small pores = fastest liquid uptake ~ R = 0,05 µm**
- **Lukas-Washburn = most liquid uptake R > 0,25µm**

Paper substrate during Coating



- Penetration of liquid into the base paper
- Dependent on
  - Water retention
  - Viscosity
  - Application type
  - Dry content
  - Speed
  - Paper sizing

Paper substrate during Printing

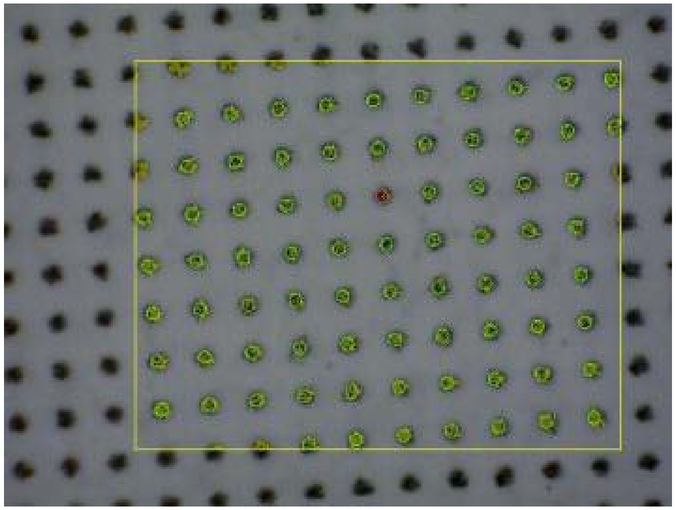


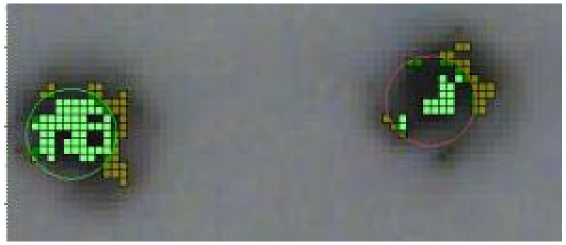
Real speed printing
Unit ~ 0,2 - 0,4 sec

System compatibility of
Wetting and Penetration of Paper Substrate
Regarding Printing system and Printing Ink

Missing dots
(gravure printing <25% of coverage)

- Topography
- Wetting problems
- Penetration – local Mottling – negative dot gain/ positive dot gain





Scratch resistance/Rub resistance

- **Changing local surface**

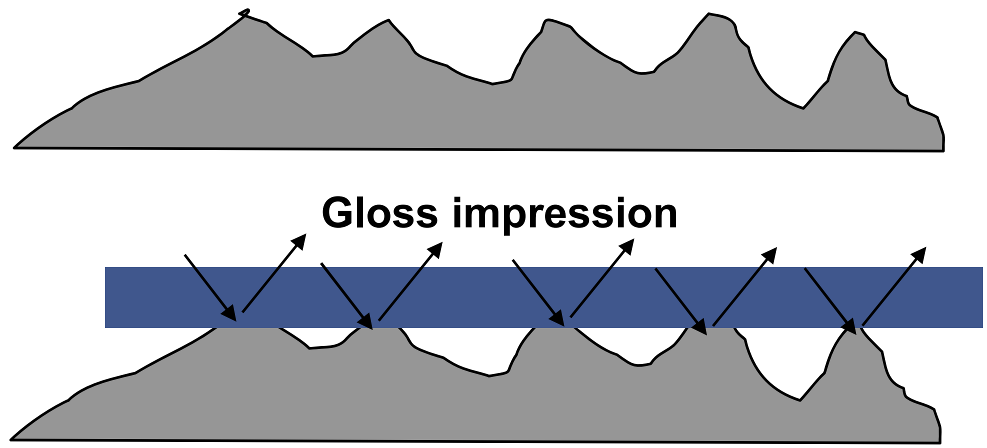
Due to handling

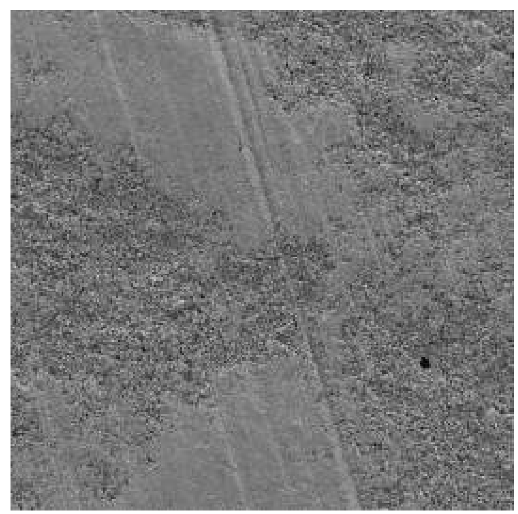
- **Gloss mottling on paper**
- **Surface scratches**

from conversion* processes

- **Printing on these surfaces,**

due to non uniformity of
liquid penetration, gives
a mottling impression





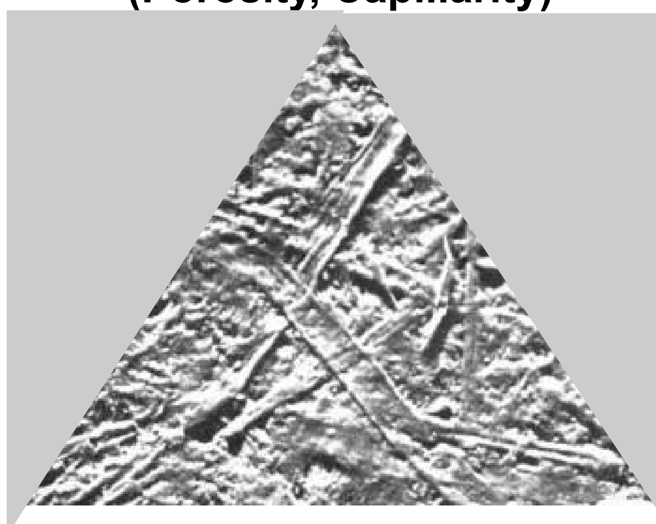
- Converting temperature and moisture*

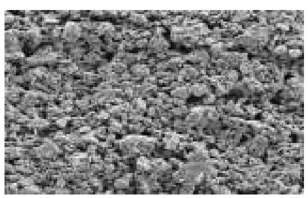
Mottling = non uniformity of Printing appearance

- Mottling is in a difference in Color density within 50 -100 µm
- Different types of Mottling can be traced to different paper substrate issues
  - Backtrap mottling = Non uniformity of paper
  - Color splitting = Adhesion of Color
  - Gloss mottling = Non uniformity of gloss surface due to penetration and wetting differences
  - Non uniformity in penetration of fountain water
  - Non uniformity of binder – binder migration due to heating and drying

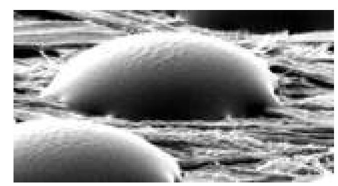
Paper Surface Characterization*

Dynamic Penetration (Porosity, Capillarity)





Dynamic Topography (Smoothness)

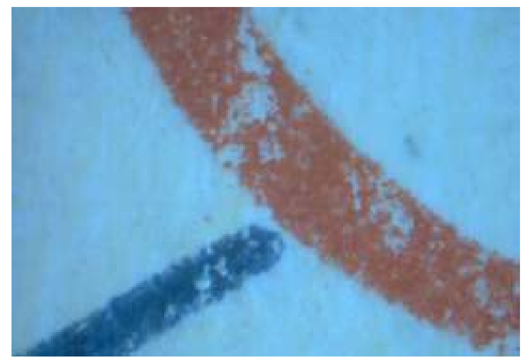


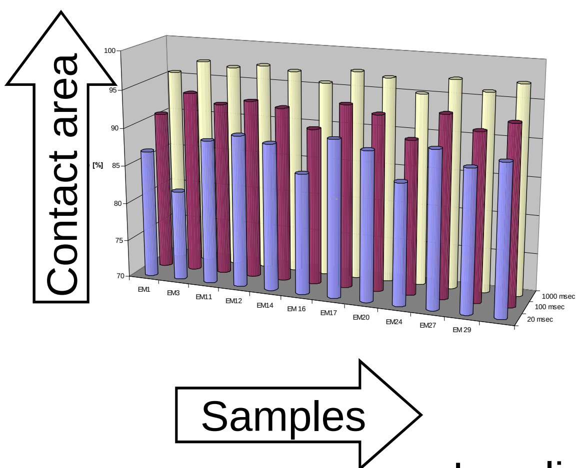
Dynamic Wetability

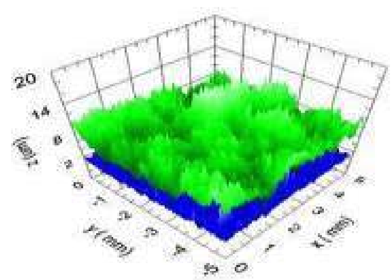
***Based on four university studies in cooperation with BYK**

Topography of Paper surface

Printability – no color acceptance
In areas of no contact

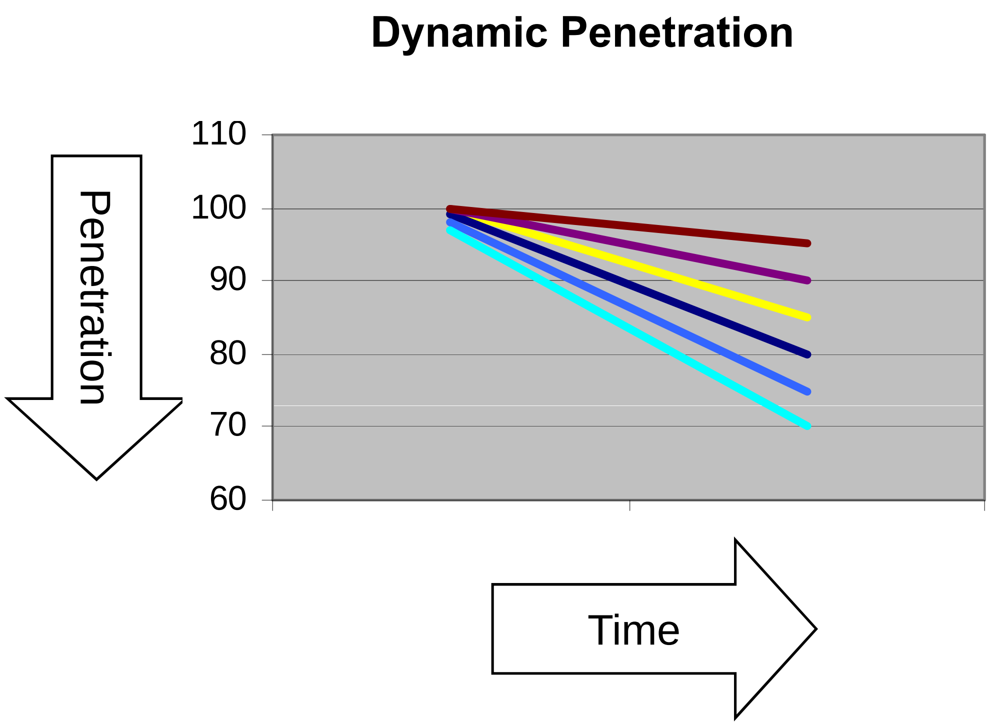


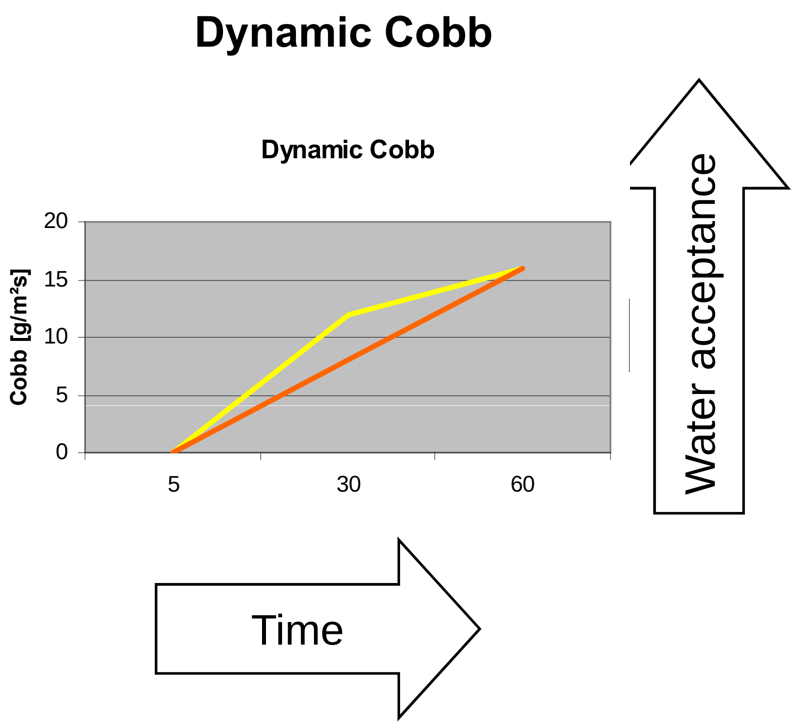




Leveling of Varnish before the next convention step

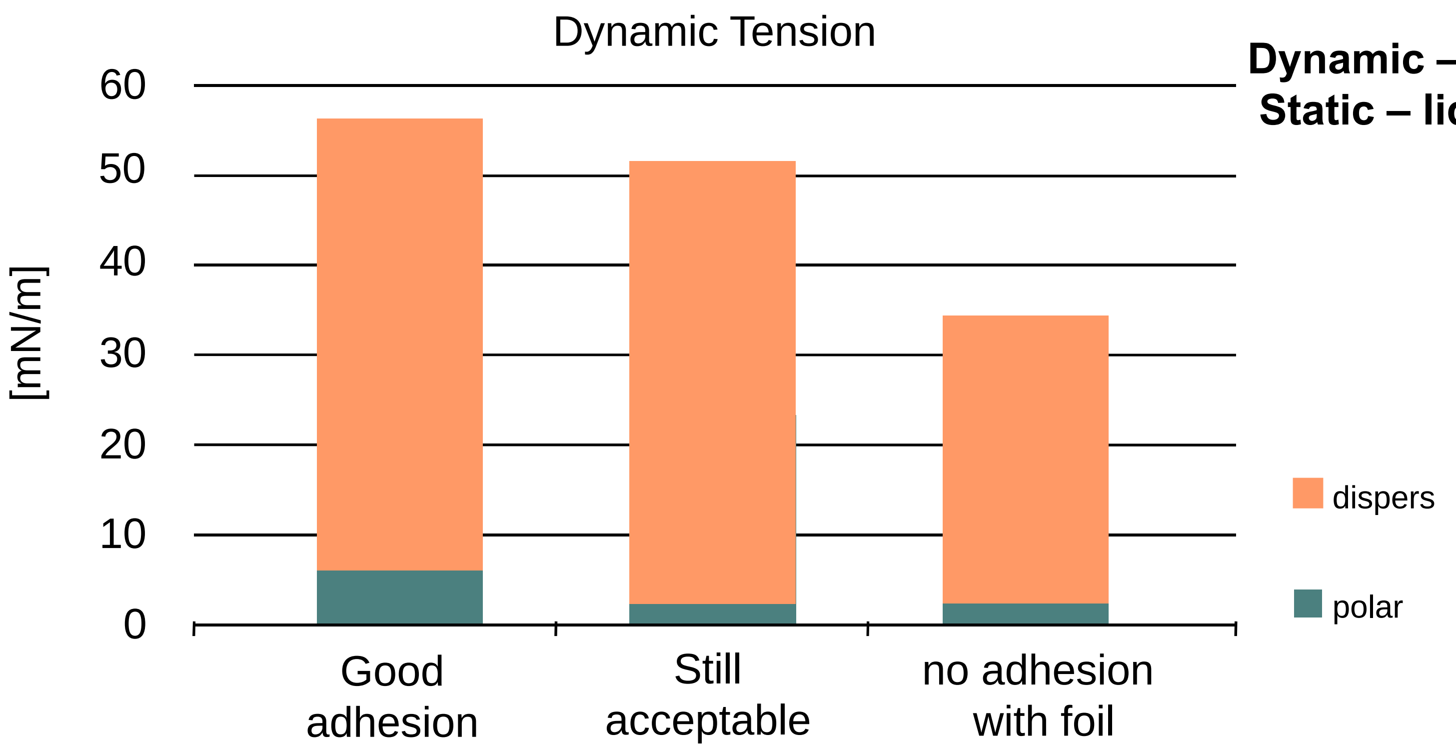
Dynamic Penetration (Capillarity, Pores)





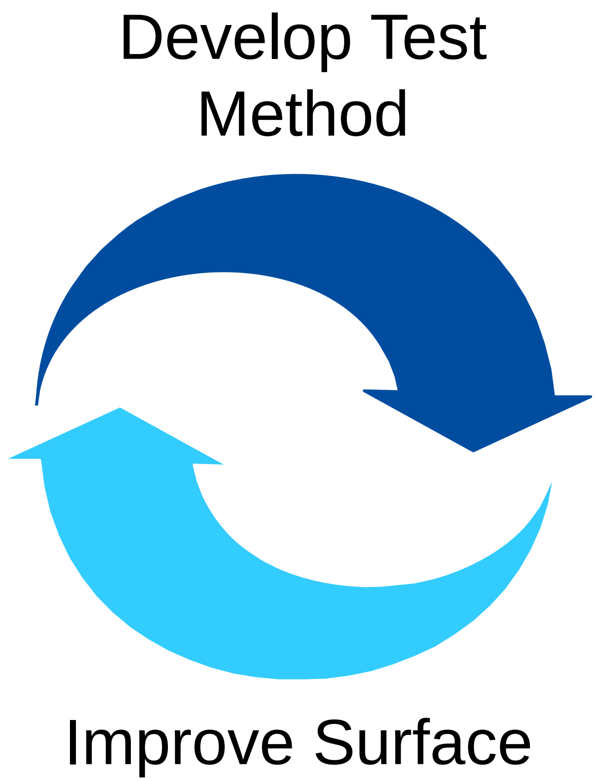
Dynamic Wetability

Reduction of polar part – still acceptable
Reduction of polar and disperse part – no adhesion



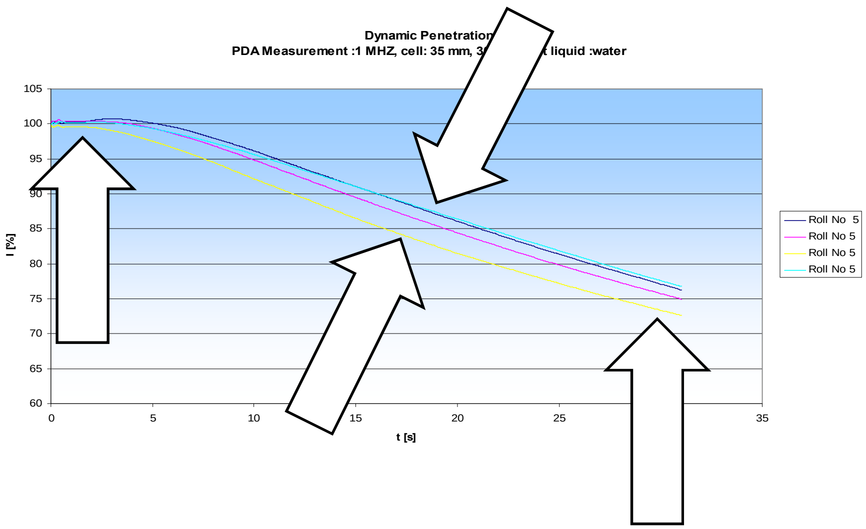
Dynamic –time related
Static – liquid related

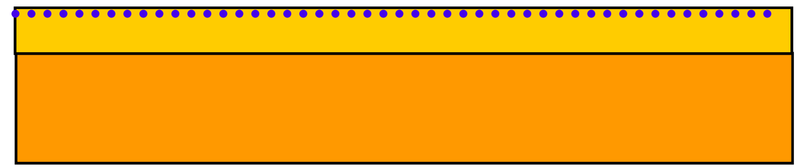
Characterization of Paper surface



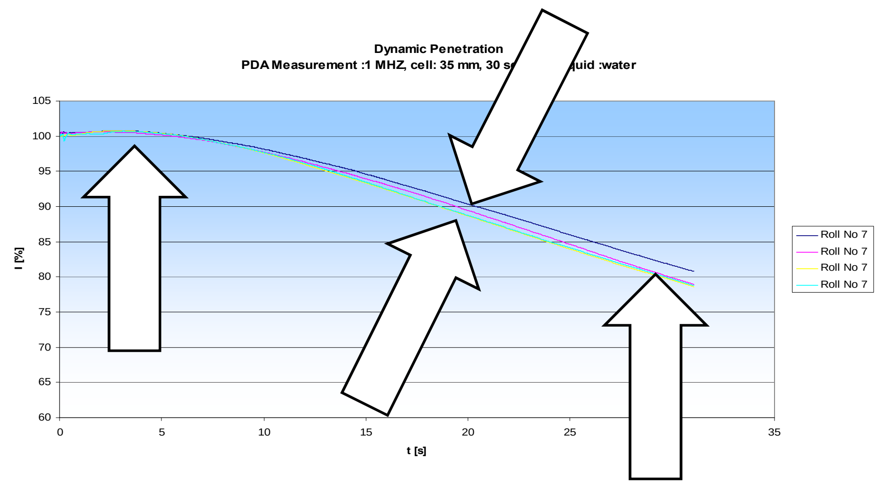
Characterization of paper surface to predict printability and convertibility and to improve conversion steps

Case study:
Topcoat uniformity control



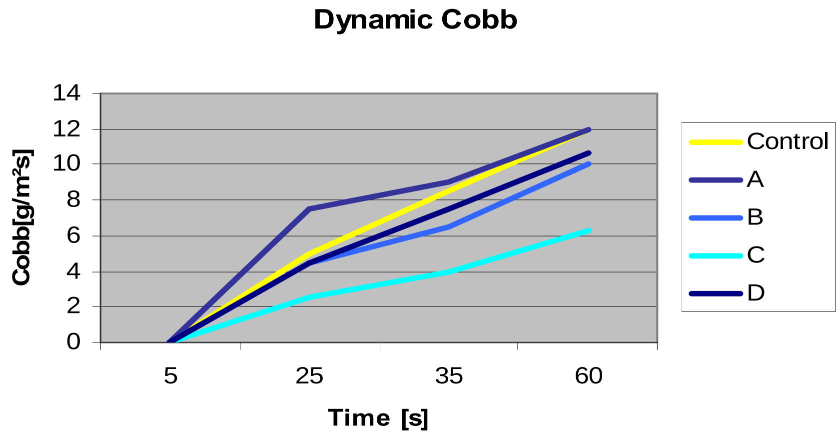


Additive in Topcoat

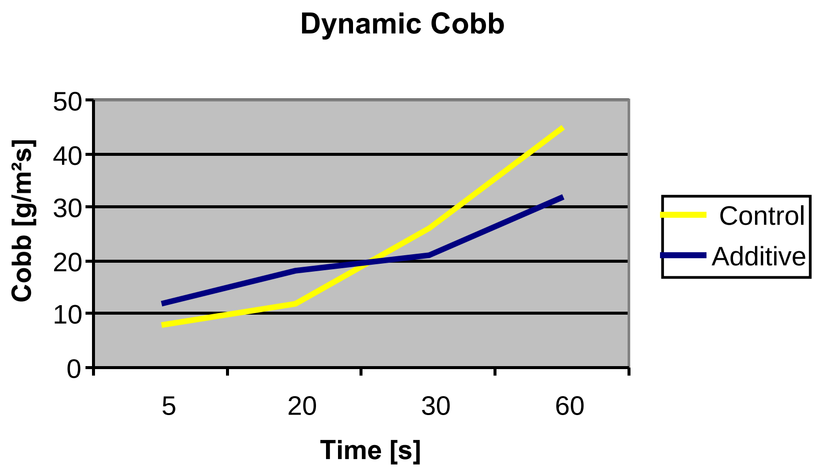


- **Increased wetting phase**
- **Increased uniformity**
- **Lower penetration speed**

Changing liquid Penetration speed



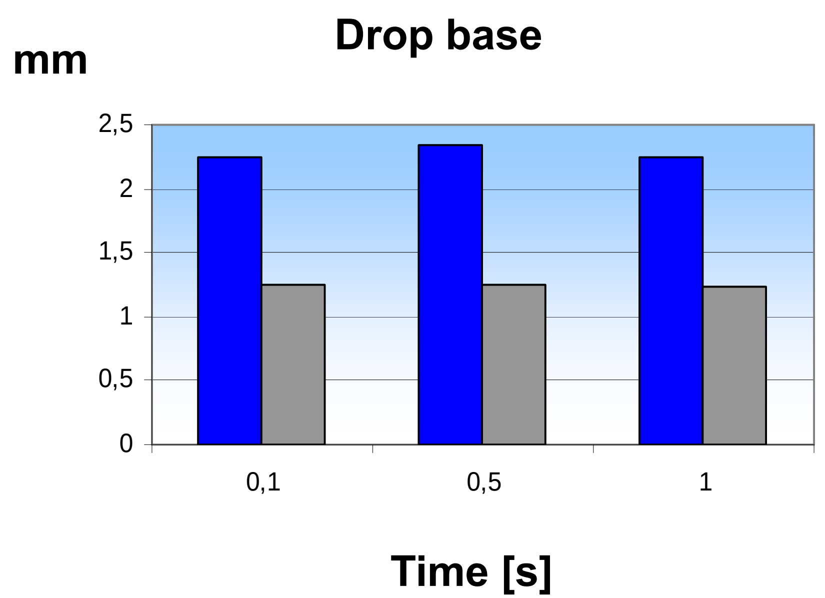
Different additives



Special modified system

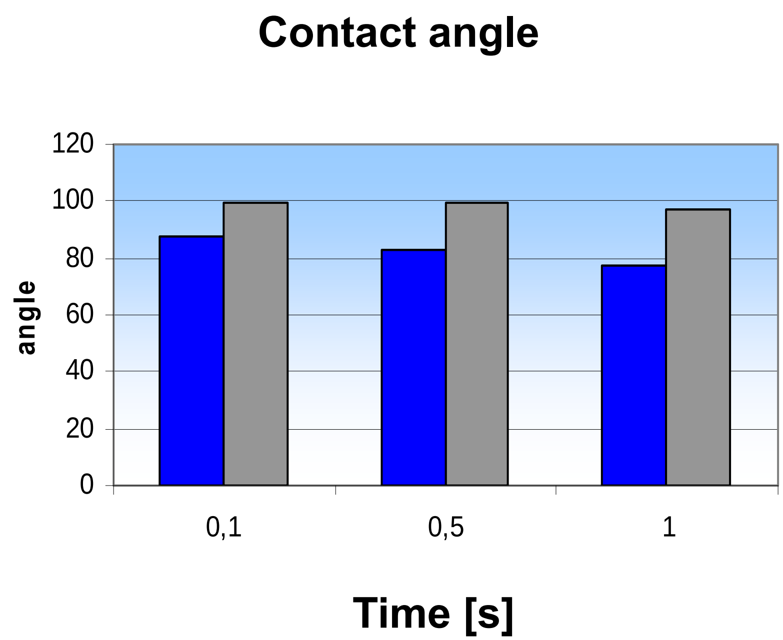
Increase surface Adhesion
Reduce Penetration – binder migration topcoat
Good printability combined with improved paper uniformity

Dynamic Wetting - Drop Measurement



With surface Additive

Control



Increased wetability
Larger drop base
Lower contact angle

Rapid Indication of Paper surface characteristic

Different paper surfaces and Effect Pigment in

- **Gravure Printing**
- **Flexographic Printing**

Impression of Printing in

- **Color**
- **Mottling**
- **Gloss**

are related to paper surface characteristic

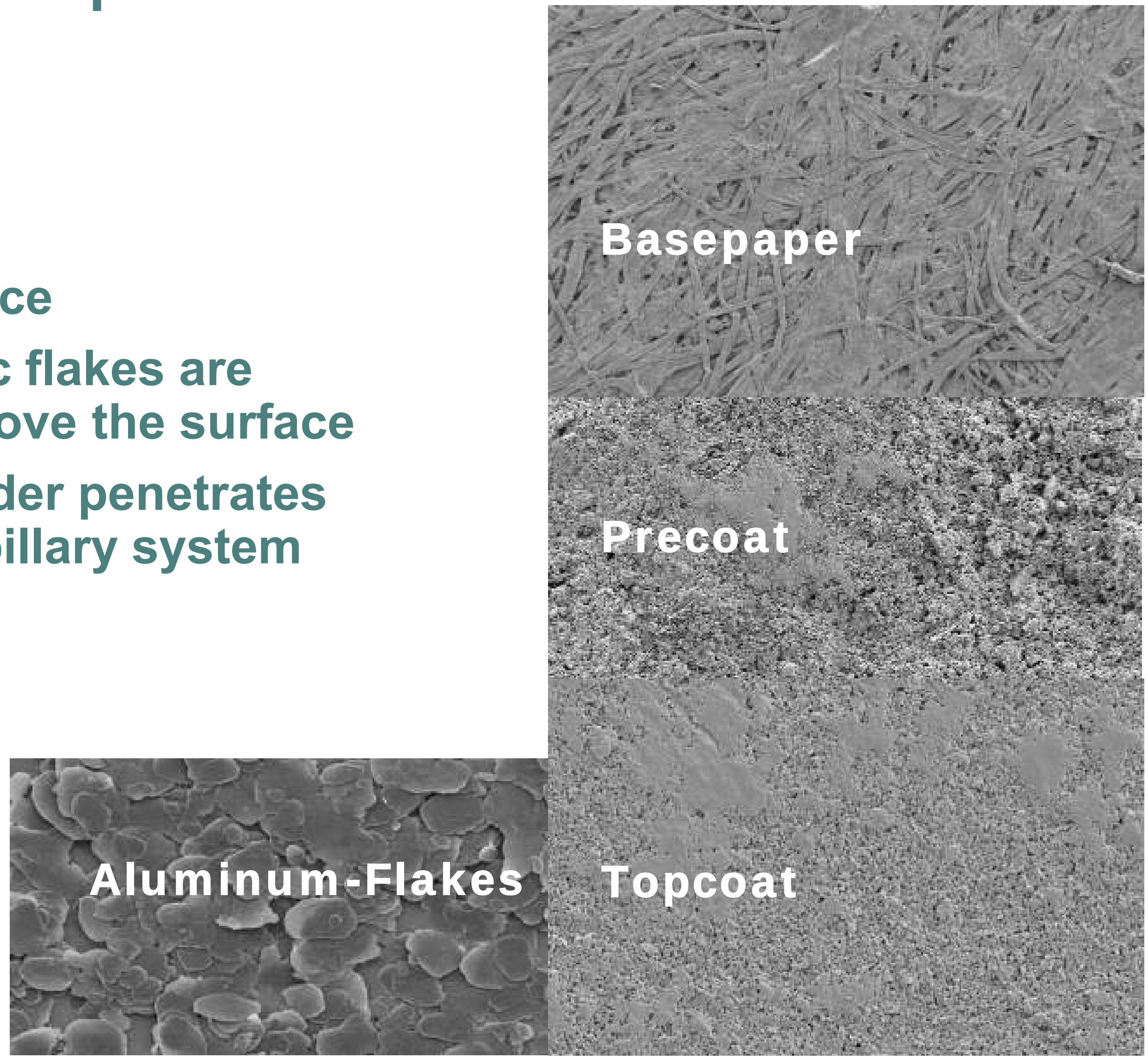
Flexo Printing

Pilot machine 100m/min Different paper source

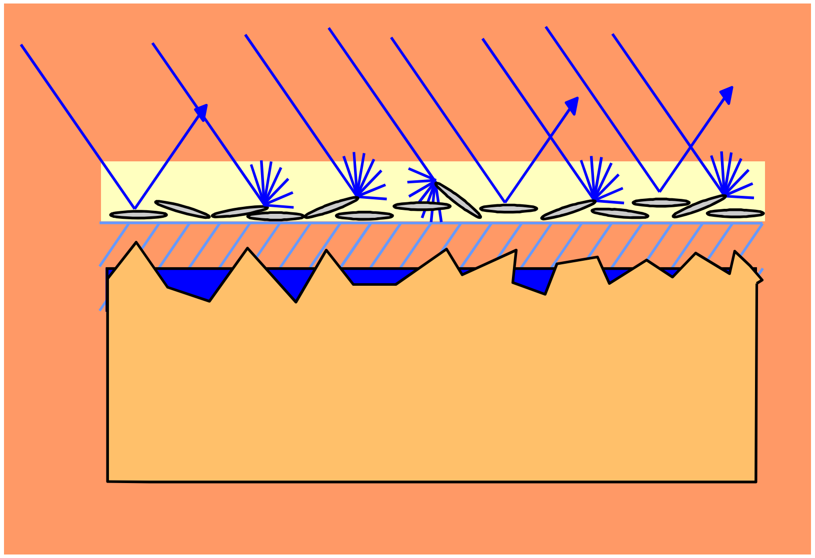
Gravure Printing

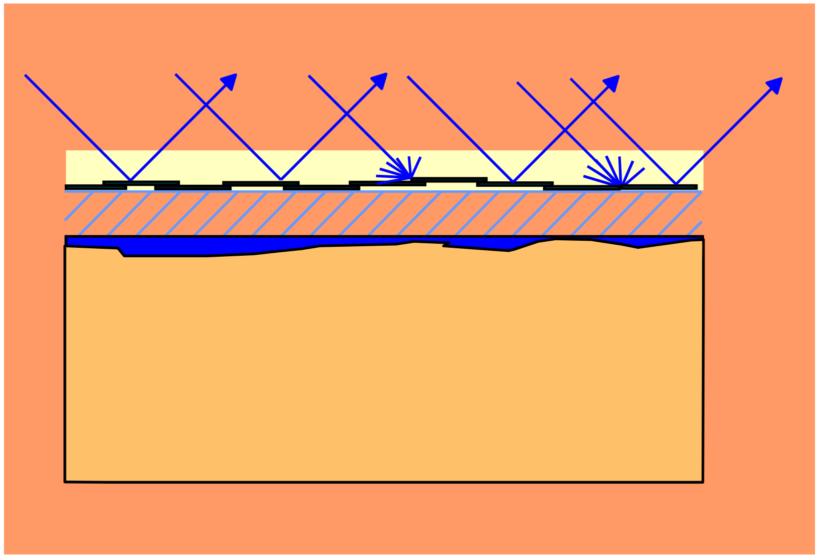
Laboratory and Pilot print device

- Paper surface
- The metallic flakes are oriented above the surface
- Ink and binder penetrates into the capillary system



Pigment orientation at the surface

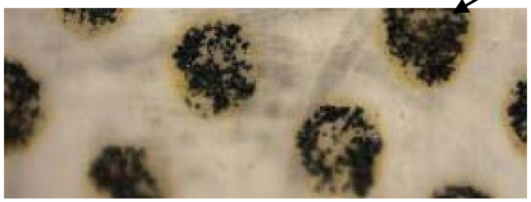


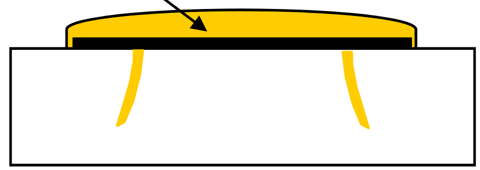


Topography related gloss development
Light reflection increases with oriented mirror like surface

Color Impression

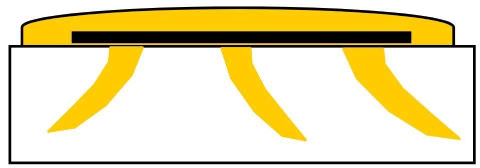
Metallic pigment





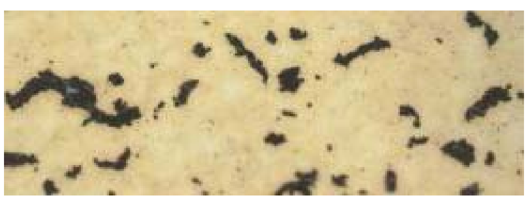
Perfect color

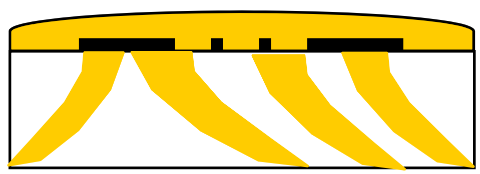
Color match metallic print dot



Color mottling
Color Separation

Increasing Color absorption enlarges print dot

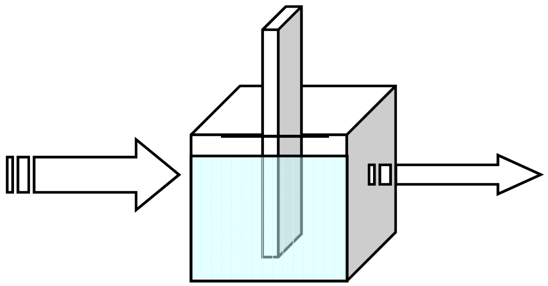




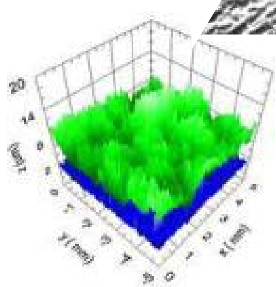
No Print dot

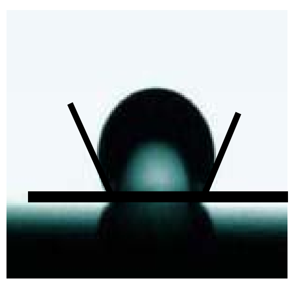
Total Binder absorption metallic pigment flocs

Our method for characterizing Paper is a fingerprint of the surface for predicting runability during coverting processes



Dynamic Penetration of Liquids





Dynamic Topography

Dynamic Wetability

Metallic Ink Color

Using and understanding Interfacial Chemistry to explain and control material behavior

Most application, performance and appearance defects are caused by undesirable differences in surface tensions.

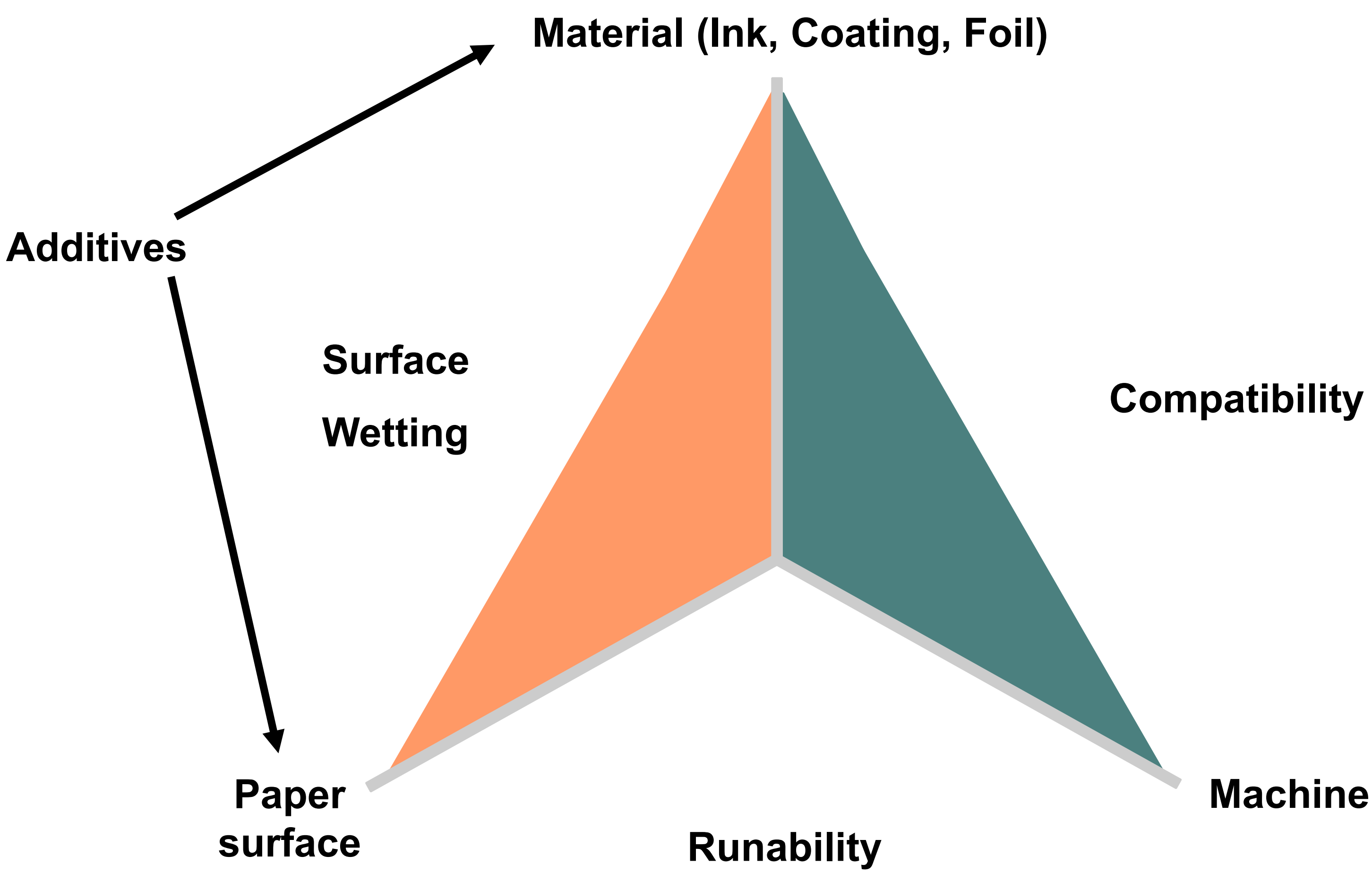
Surface tension modifying additives can be used to control and modify material interactions.

- Material flow is always from areas of low surface tension towards areas of higher surface tension

Surface defects from wrong defoamer choice

A defoamer with balanced incompatibility destroys the bubble; a defoamer that is too strong can create surface defects

Influence of Components in converting process Printing & Converting combines material in a machine



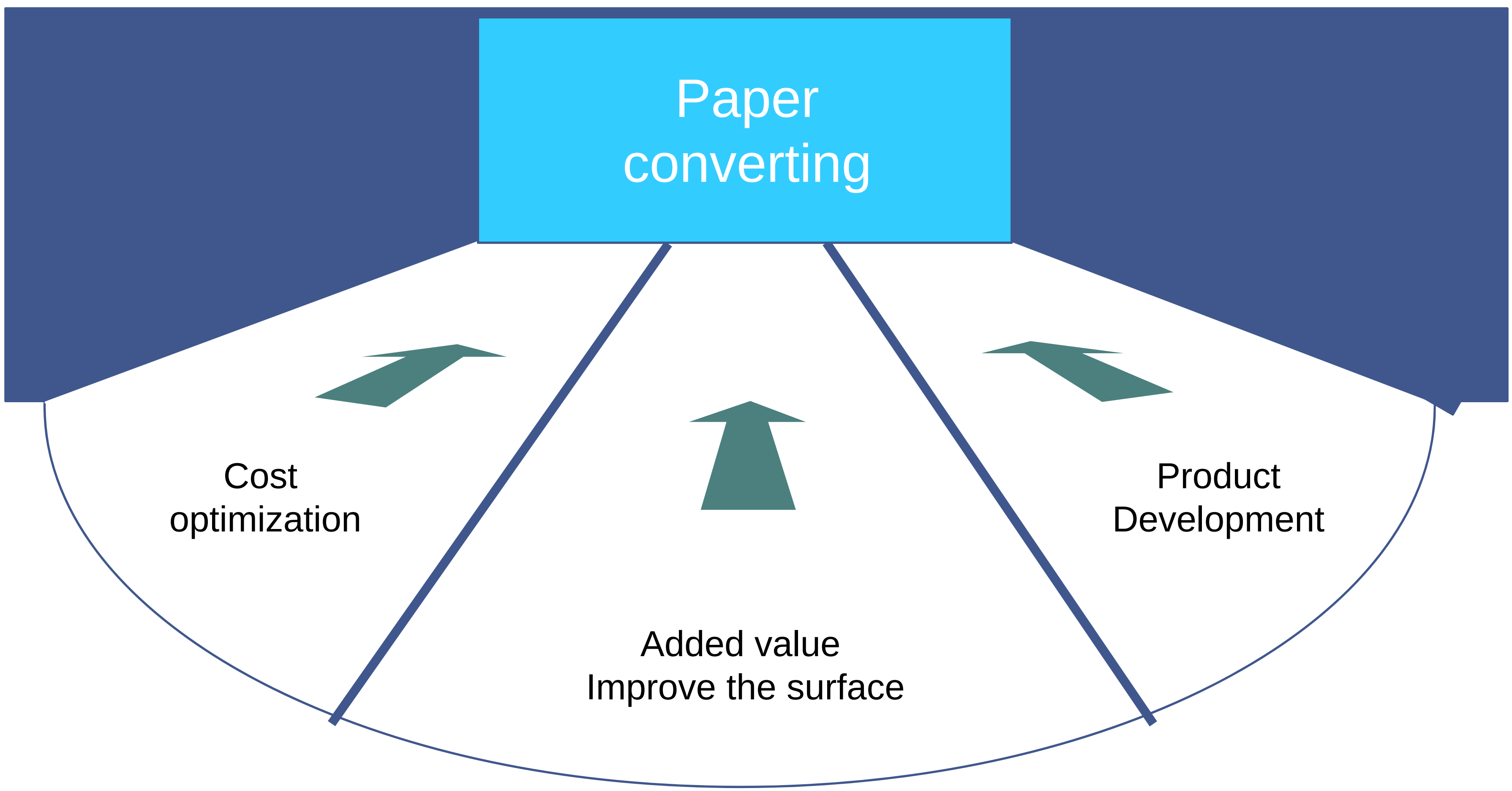
Test Color for Paper Surface Characteristics

Highly sensitive Printing Ink
For magnifying
paper characteristics

Impression of Printing in
- Color
- Mottling
- Gloss

lead to the related
paper surface characteristic

Supporting the value chain via Interfacial Chemistry Control



Questions?