Optimierung der Streichtechnik Modul 2

Optimale Bedruckbarkeit Wechselwirkungen zwischen Druckfarbe und Papier

Mottling Phänomene bei gestrichenen Papieren

Mottling phenomena on coated papers

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Outline

- **Define „mottle“ and different subtypes of print mottle**
- **Analysis of print mottle**
  - laboratory and practical tests
- **Spotlight on some aspects of**
  - backtrap mottle
  - water interference mottle
  - midtone/screen mottle
- **Image analysis of mottle**
  - method
  - benefits
  - shortcomings
- **Conclusion**

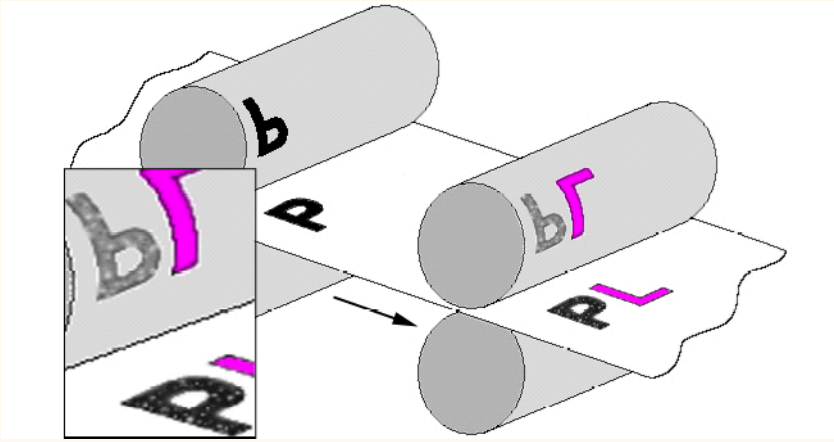
Definition Mottle

"A general term used to describe a printed image that is undesirably blotchy or coarse."

Types of Mottle + Definition

Backtrap Mottle

- Ink applied to paper surface on a preceding printing unit of a multi-colour press will be transferred onto the blanket in a subsequent unit and then be re-deposited onto the next sheet. If this occurs unevenly, the print can become mottled.
- Note: On an ideally uniform material an equilibrium ink-film thicknessis formed on back-trap blankets.

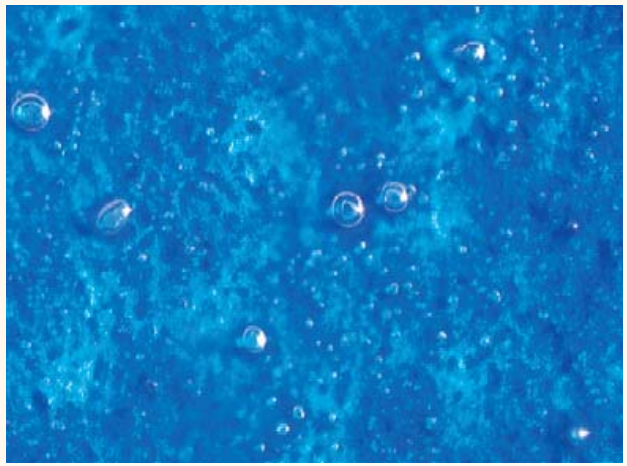


Salmela P.; Offset-print mottling measurement using machine vision; MastersThesis; Lappeenranta University of Technology (2003)

Types of Mottle + Definition

Water Interference Mottle (Fountain Solution Mottle)

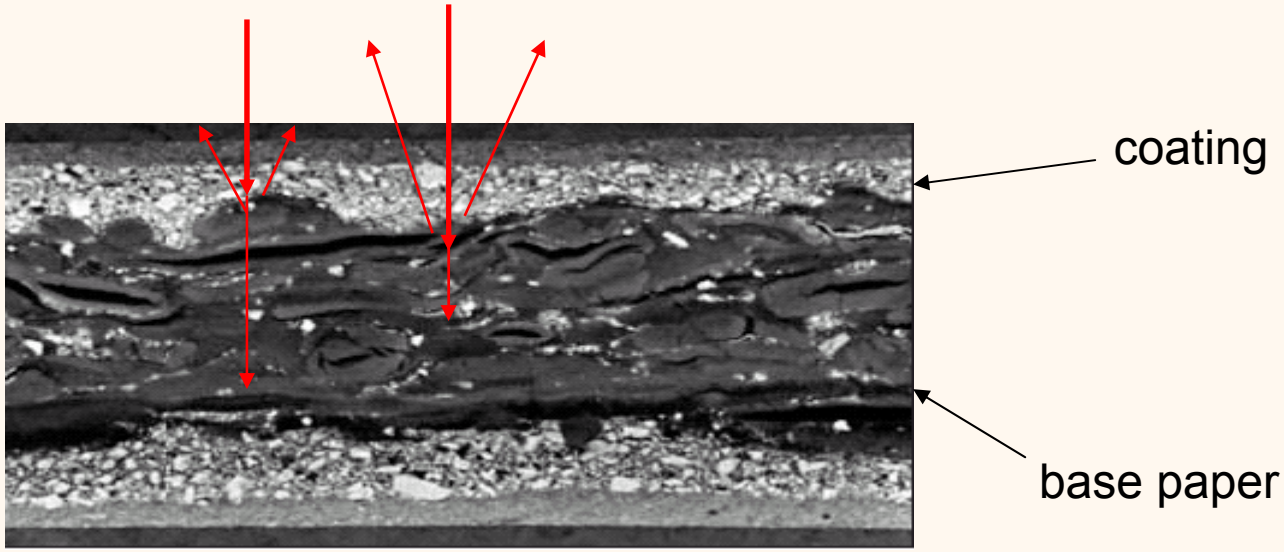
- Water transferred to paper surface on a preceding printing unit of a multi-colour press should be absorbed uniformly by the coating before it reaches a subsequent printing unit.
- Locally uneven absorption of water will prevent uniform transfer of the ink.
- A mottled print will result.



Types of Mottle + Definition

Midtone Mottle (Screen Mottle)

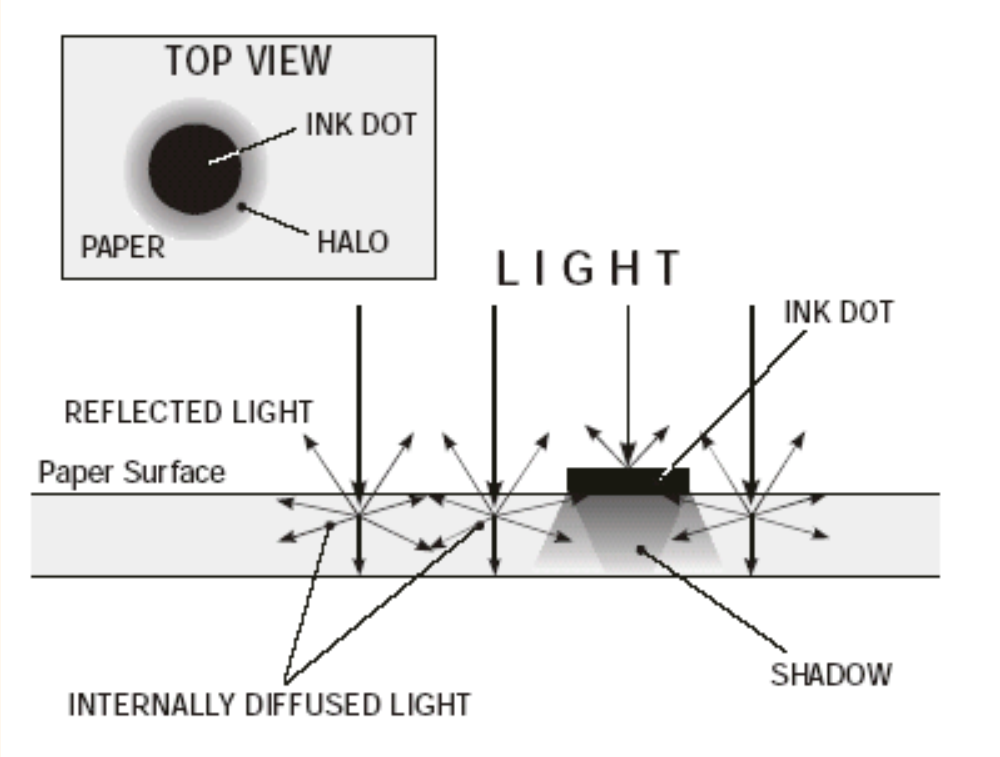
- Uneven print result in 30 - 60% screens, caused by differences in the scattering and absorption behaviour basepaper / coating.
- Effect can occur in one colour printing and even in case of perfectly formed dots of equal density (optical effect).



Types of Mottle + Definition (2)

Midtone Mottle (Screen Mottle)

- Yule-Nielsen shadows



Types of Mottle + Definition

Paper Surface Mottle

- Uneven print results caused by paper surface defects or deficiencies (graininess, streakiness, felt or wire patterns...) that are already visible in the unprinted surface.

Printer's Mottle

- Uneven print result caused by
  - incorrect / non-uniform exposure of plate
  - uneven delivery of ink to the plate
  - ink delivered inconsistently to the substrate
  - too high ink density

....

Analysis of Mottle - Laboratory tests

Stain Tests (K&N, Croda, Porométrique Noir...):

- Dyed oil phase of ink is picked up by coating layer which then becomes stained
- Poor correlation to practical print mottle
  ➔ Print quality defects occur in the very top of the coating layer, while in stain tests the whole coating layer is penetrated by the oil-phase.

Simulating Tests (Prüfbau, IGT...):

- Backtrap Mottle
- Water Interference Mottle
- In general laboratory tests for backtrap mottle show a poorer correlation to practical printing results compared to water interference mottle tests.

Analysis of Mottle - Practical tests

6-colour testform:

Mottle Fields:

1 Backtrap

2 Water Interference

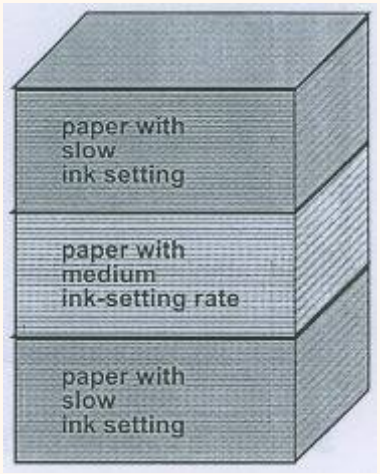
3 Midtone

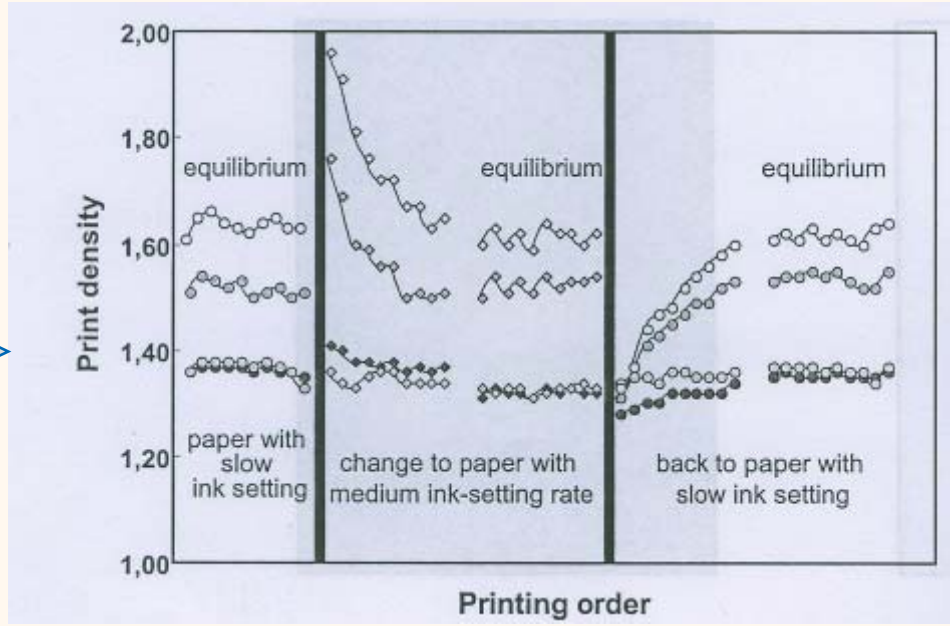
Bauer, W.; Albert, A.: Druck- und verarbeitungstechnische Erfahrungen mit dreigachgestrichenen holzfreien Papieren am Beispiel Gratkorn PM11. IMPS 2000 – Internationales Münchner Papier Symposium, München (2000)

Spotlight Backtrap Mottle

Backtrap Mottle

- Offset printing trial



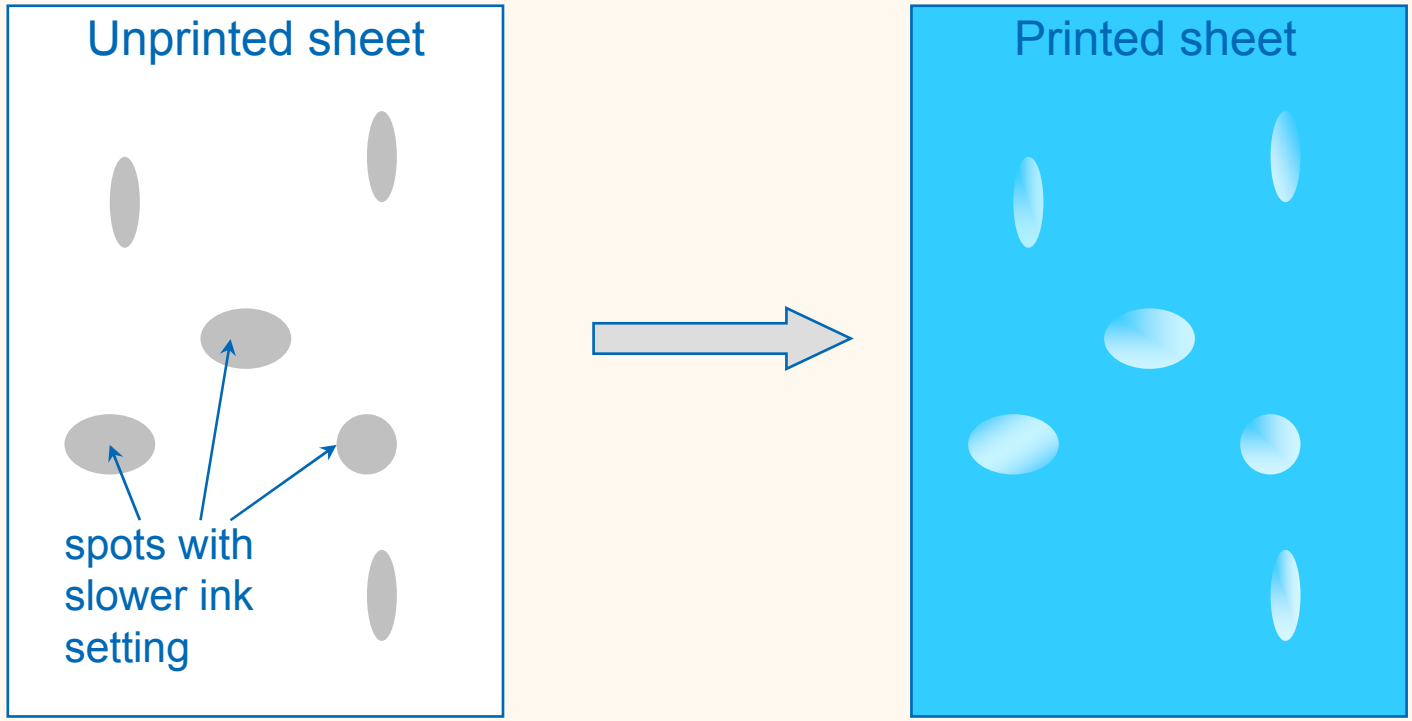


Kolseth, P..; Can offset printability be predicted by lab tests. COST E32 Symposium „Paper/Ink Properties and their Relation to Offset Printability"; Madrid (2005)

Spotlight Backtrap Mottle

Backtrap Mottle

- Printing on a sheet with locally uneven ink-setting characteristic



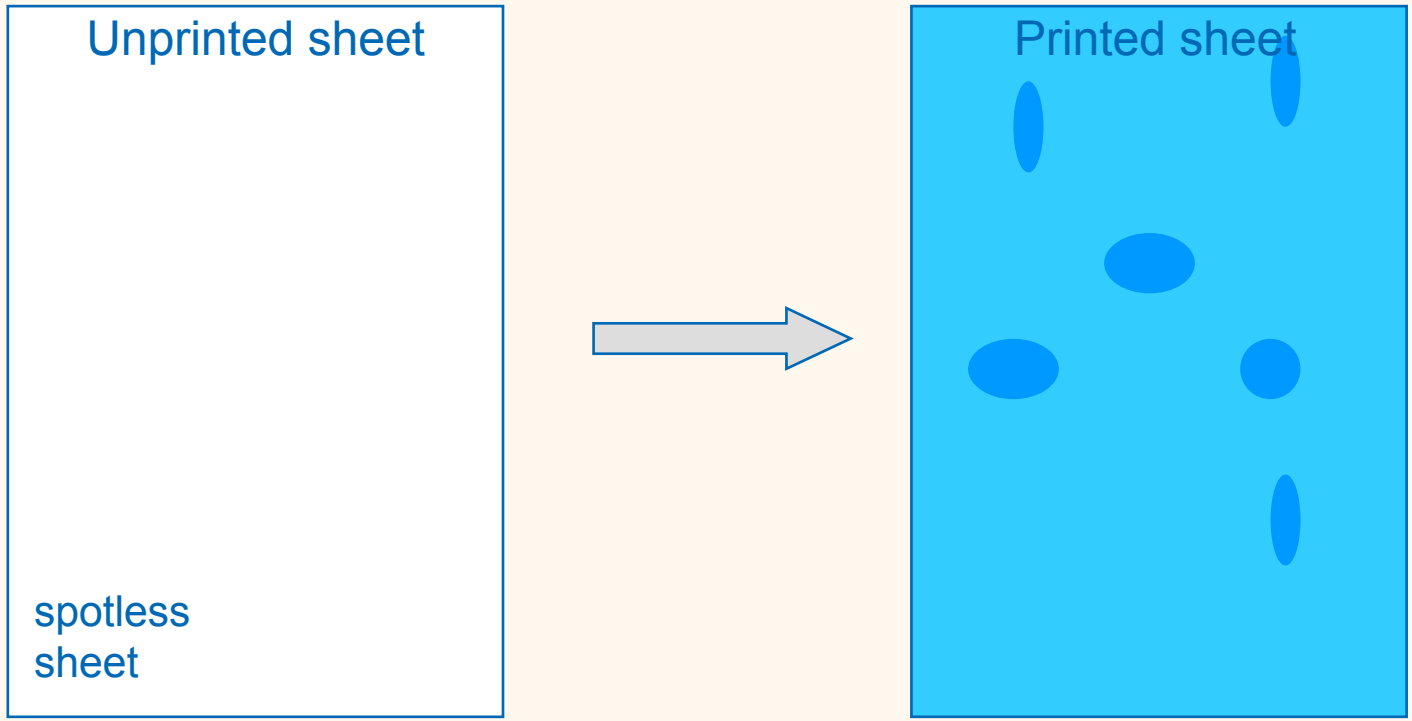
→ Sheet with „slow setting spots“ gets mottled after backtrap

Kolseth, P..; Can offset printability be predicted by lab tests. COST E32 Symposium „Paper/Ink Properties and their Relation to Offset Printability”; Madrid (2005)

Spotlight Backtrap Mottle

Backtrap Mottle

- Due to memory effect uneven print also on next sheet



→ „spotless“ sheet becomes mottled due to backtrap

Kolseth, P..; Can offset printability be predicted by lab tests. COST E32 Symposium „Paper/Ink Properties and their Relation to Offset Printability”; Madrid (2005)

Spotlight Backtrap Mottle

- Accepted view is that rate of ink tack build and strong paper-ink adhesion determines equilibrium position of how much ink adheres to paper and how much is re-deposited in subsequent printing unit.

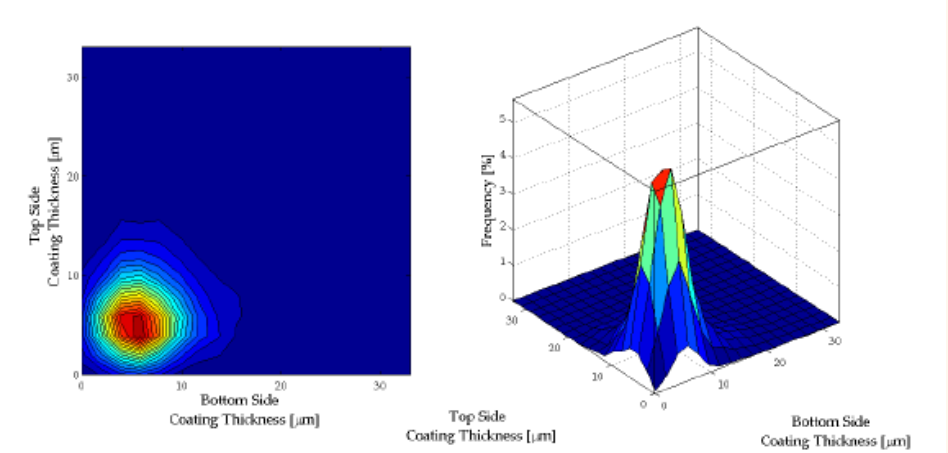
- Localised sheet surface irregularities that impede the penetration of ink vehicle into coating (e.g. variation in binder distribution, porosity distribution, coating thichness distribution...) can result in uneven ink tack build and lead to back-trap mottling.

- Whether those variations in surface properties result in backtrap mottle is depending on the level of interaction between paper - ink (+ emulsified fountain solution), which from the side of paper is mainly determined by:
  - surface porosity + roughness
  - surface chemistry
  - solubility

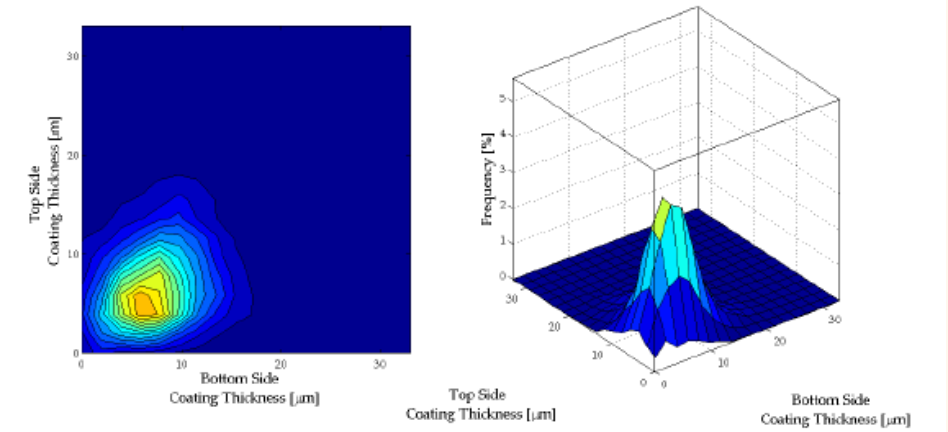
Spotlight Backtrap Mottle

e.g. Coating Thickness Distribution LWC Offset

Good rating backtrap mottle



Poor rating backtrap mottle



Spotlight Backtrap Mottle

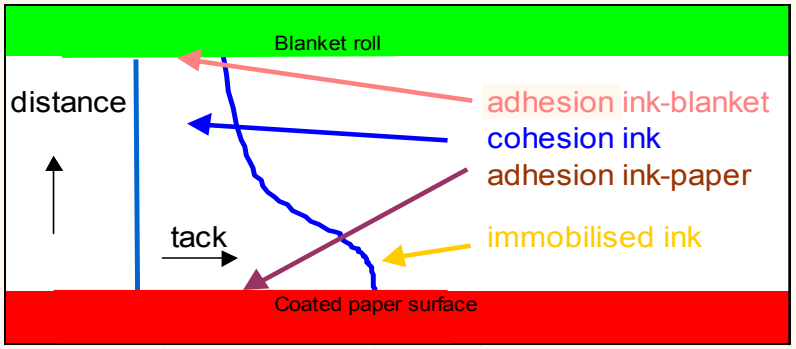
Strategies against backtrap mottling:

Traditional:

- reduction absorptivity of coating layer
- less tacky / slower setting inks

➔ necessary for papers showing low adhesion paper surface - ink

➔ setoff / drying might be impaired



Alternative Approach:

Simultaneously:

- increase absorbency paper surface
  ---> *more ink being immobilised*
- adjust surface properties in a way that adhesion between paper surface and ink dominates the cohesion within the ink
  ----> *prevents splitting at paper-ink interface*

Bauer W., Haenen J.P., Kreiner, W.: New Insights in Print Mottle Phenomena on Coated Papers. *XXX Jornadas Técnicas Nacionales de Artes Gráficas. June 2002, Porto, Portugal.*

Spotlight Water Interference Mottling

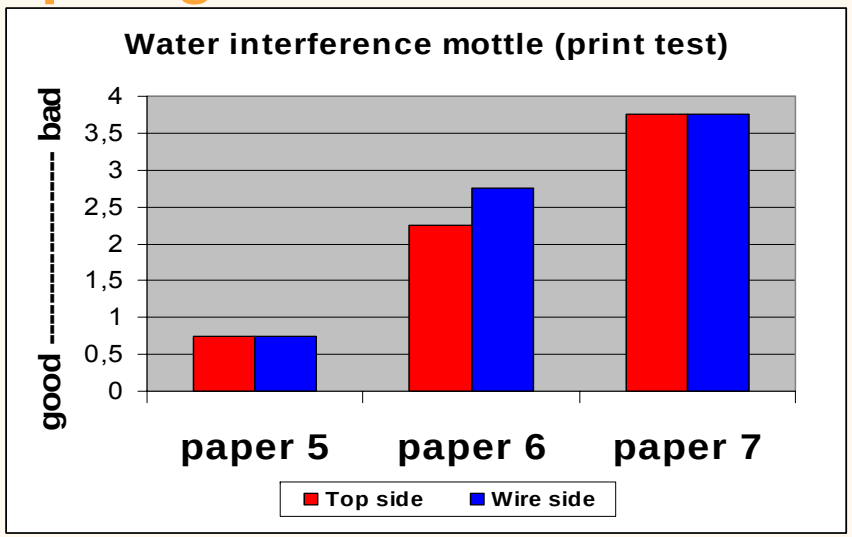
- This type of mottle is more prevalent in presses where the distance between printing units is relatively short and paper has less time to absorb water (e.g. satellite presses)
- Localised sheet surface irregularities that impede the absorption of water by the paper coating (e.g. variation in binder distribution, porosity distribution...) can result in non-uniform water uptake into the coating layer and lead to water interference mottling.
- Note that the same factors that can lead to back-trap mottle can also cause water interference mottle, only the primary medium interacting with paper is in this case the fountain solution instead of the ink.

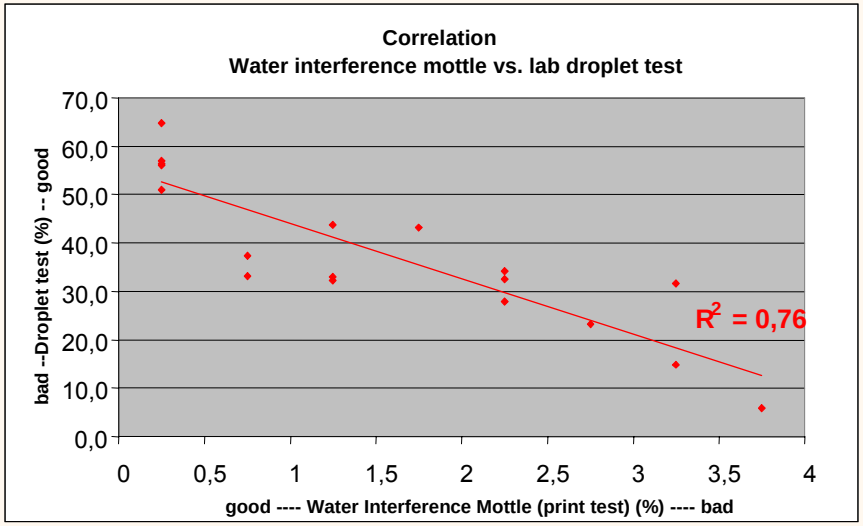
Spotlight Water Interference Mottling

- Whether those variations in surface properties result in water interference mottle consequently depends on the level of interaction between paper - fountain solution, which from the s ide of paper again is mainly determined by:
  - surface porosity + roughness
  - surface chemistry
  - solubility

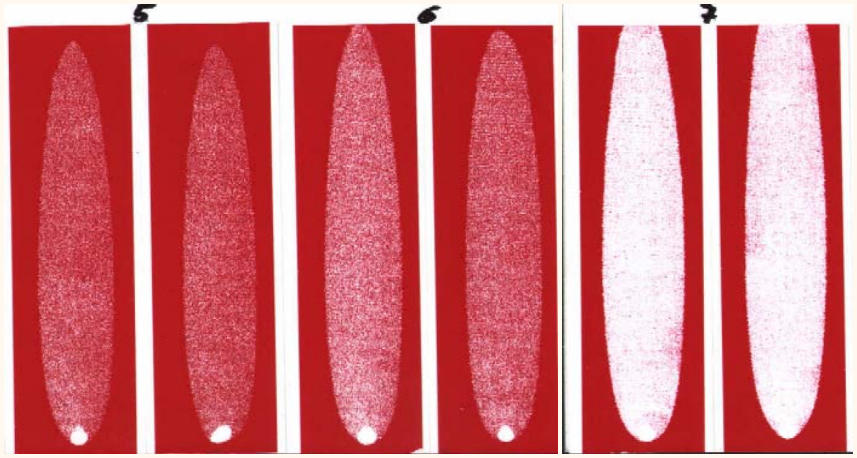
- Compared to backtrap mottle, however, water interference mottle is slightly less complex:
  - mainly related to overall absorptivity of paper surface
  - no splitting phenomena on paper surface to be considered
  - good tests available for the characterisation of fountain solutions and their wetting behaviour
  - better correlation of lab tests to practical printing

Spotlight Water Interference Mottling





Water interference test (droplet test)



Paper 5 Paper 6 Paper 7

➔ good correlation of laboratory values to printing test results

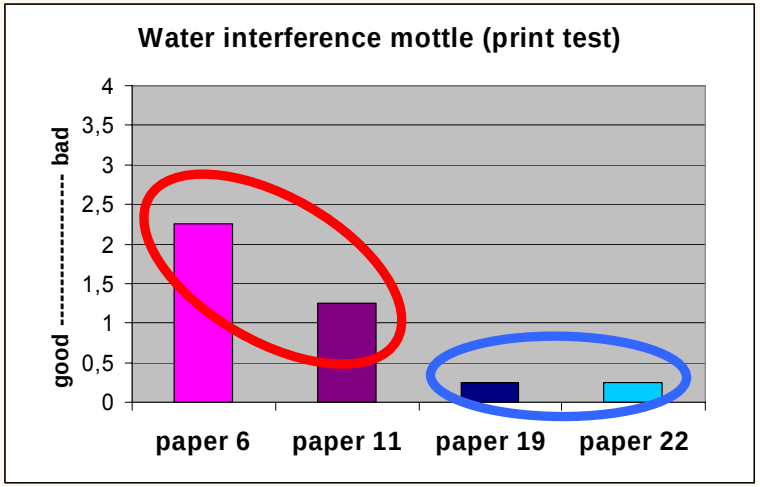
All papers come from a series of pilot trials with varying pigment / binder combination in the applied topcoat.

Bauer W., Haenen J.P., Kreiner, W.: New Insights in Print Mottle Phenomena on Coated Papers. *XXX Jornadas Técnicas Nacionales de Artes Gráficas. June 2002, Porto, Portugal.*

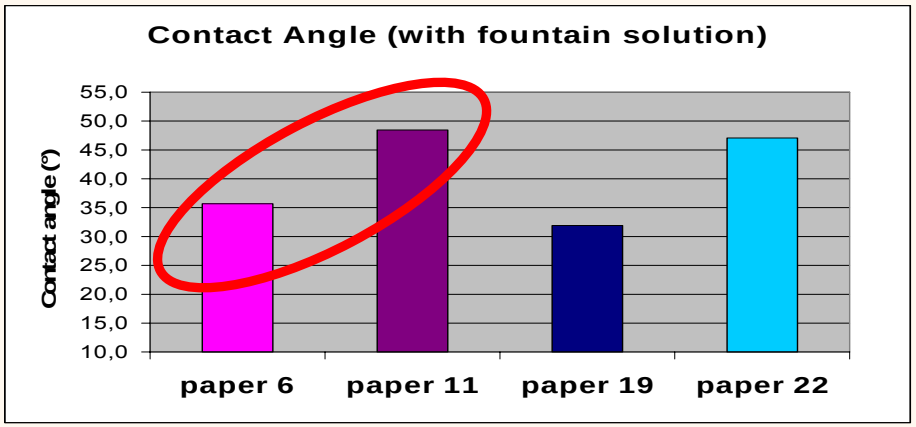
Spotlight Water Interference Mottling

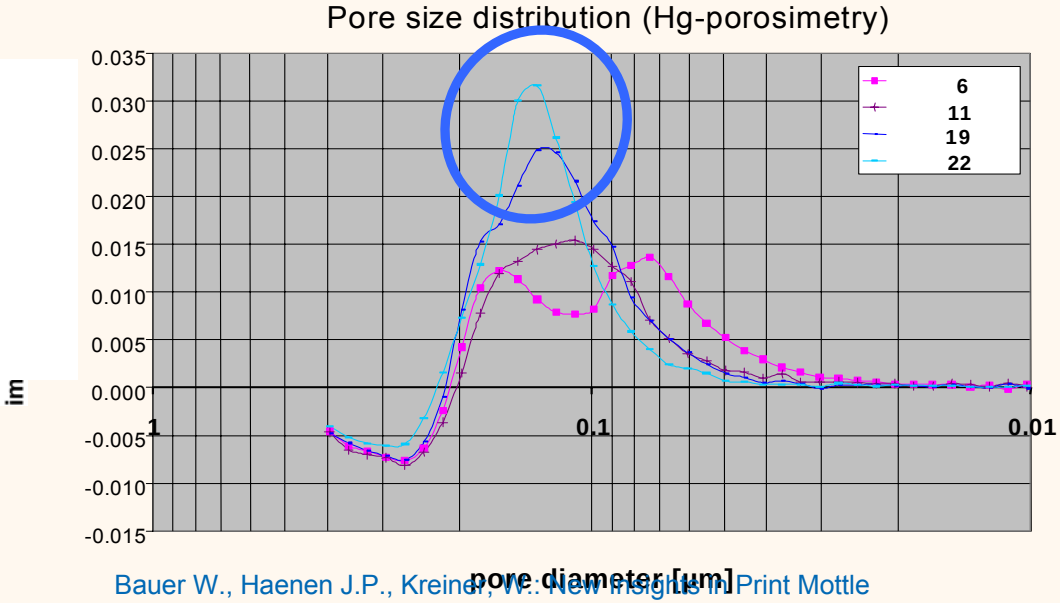
4 papers with varied surface properties (different topcoats)

mainly surface energy related



mainly surface porosity related



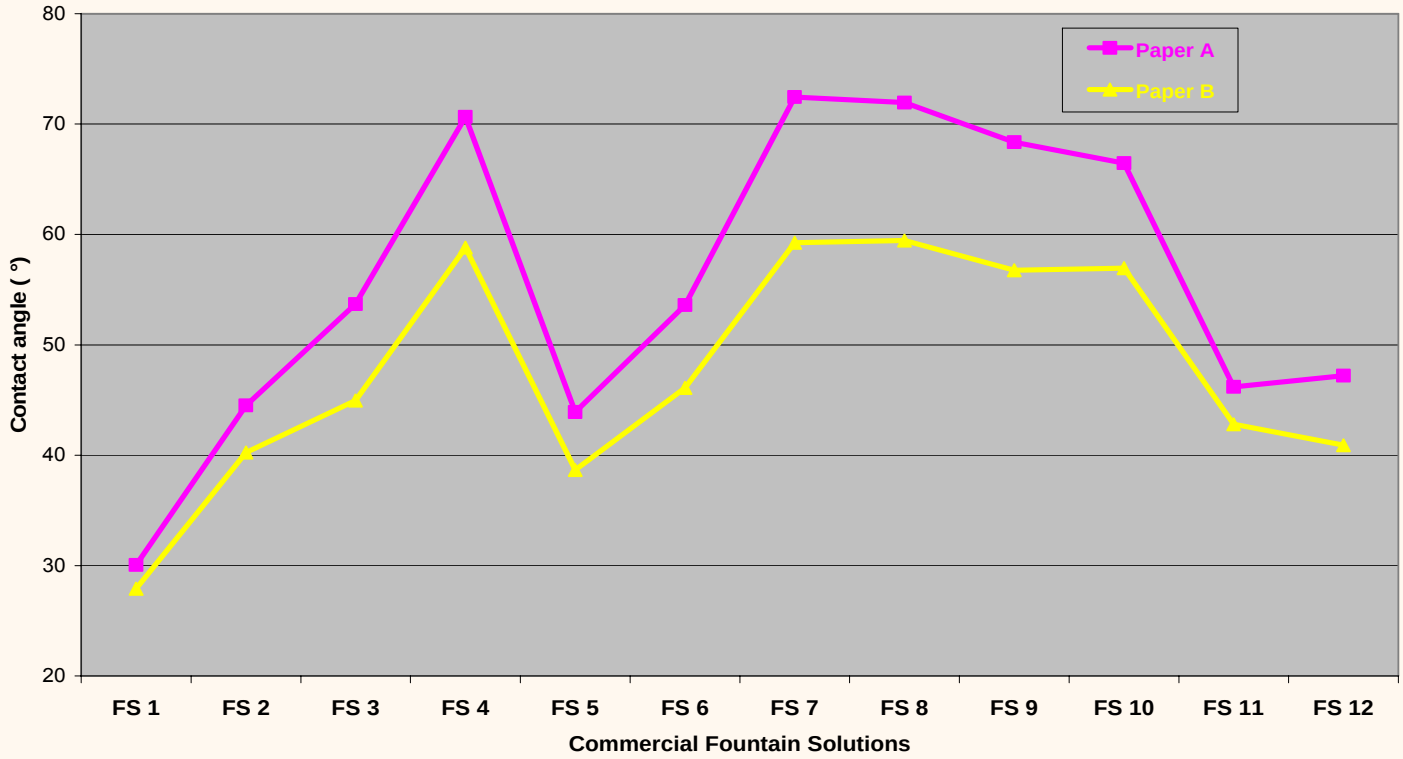


Bauer W., Haenen J.P., Kreiner, W.: New Insights in Print Mottle Phenomena on Coated Papers. *XXX Jornadas Técnicas Nacionales de Artes Gráficas. June 2002, Porto, Portugal.*

Spotlight Water Interference Mottling

Influence of fountain solution type on contact angle

- 12 commercial fountain solutions on two gloss papers



Bauer W., Haenen J.P., Kreiner, W.: New Insights in Print Mottle Phenomena on Coated Papers. *XXX Jornadas Técnicas Nacionales de Artes Gráficas. June 2002, Porto, Portugal.*

Spotlight Water Interference Mottling

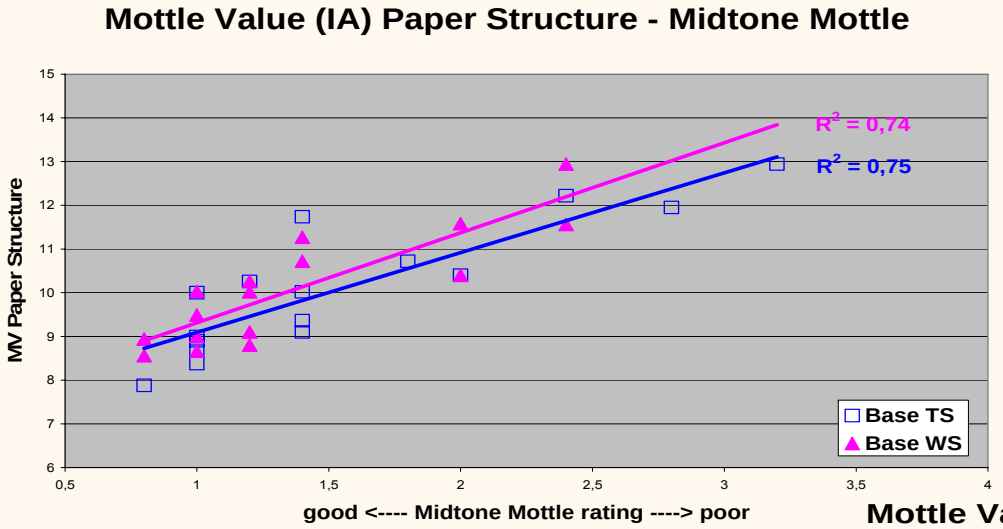
- Fountain solution influence dominates paper influence regarding contact angle.
- Whether this leads to ink refusal / water interference mottle is depending on the overall absorptivity of the paper surface to the fountain solution (pore structure + roughness)
- Besides ink refusal too low contact angle may lead to piling, picking, overemulsification of fountain solution in ink .... .
- Some measures to improve in water interference mottle from the paper side have a negative effect on backtrap mottle or other printability related parameters.

Spotlight Midtone Mottle

- While backtrap and water interference mottle are mainly caused by interaction phenomena paper-ink-fountain solution, midtone mottle is predominately an optical phenomenon related to structural parameters (formation, coating thickness, topography).
- There is a rough analogy to the well-known Moiré effect, where structures appear when superimposing two sets of screens. In midtone mottle one of the screens would be the paper.
- Midtone mottle is visible already in one colour print, with all dots printed perfectly. Backtrapping on subsequent units may increase or decrease the mottle effect.
- Papers showing midtone mottle are not necessarily critical with regard to backtrap or water interference mottle.
- Midtone mottle effects are quite well understood (but often difficult to cure)

Spotlight Midtone Mottle

Correlation of structural parameters to Midtone:



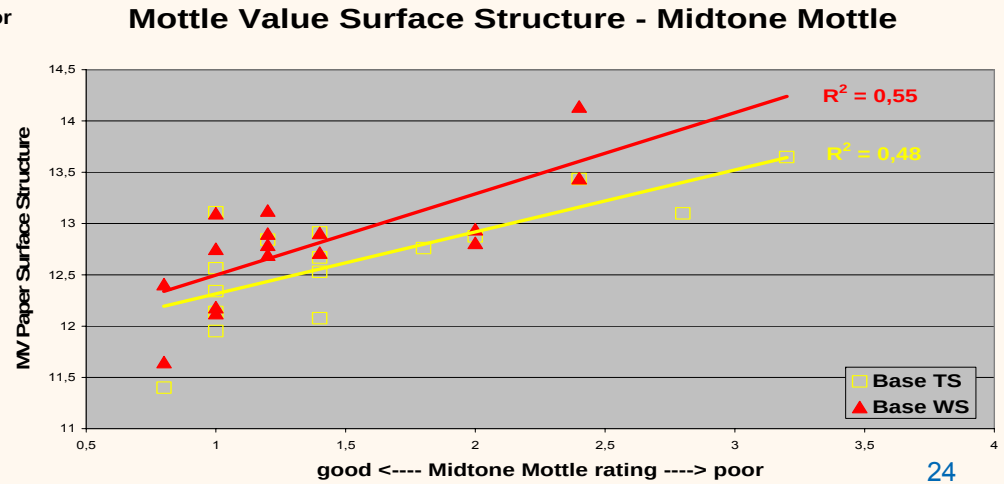
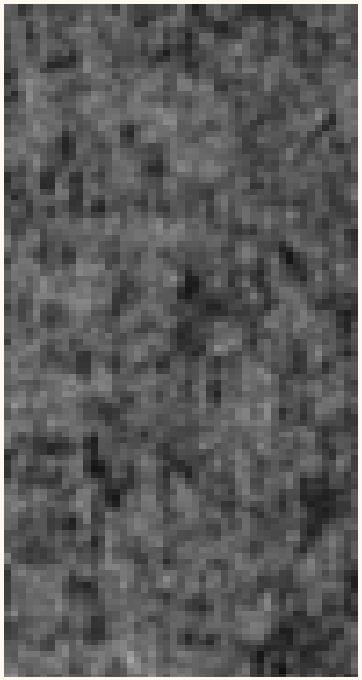


Image Analysis of Mottling Phenomena

Targets:

- Objective evaluation / rating of print mottle (DOMAS, Mottle-Viewer ….)
- Evaluate size and orientation of unevenness



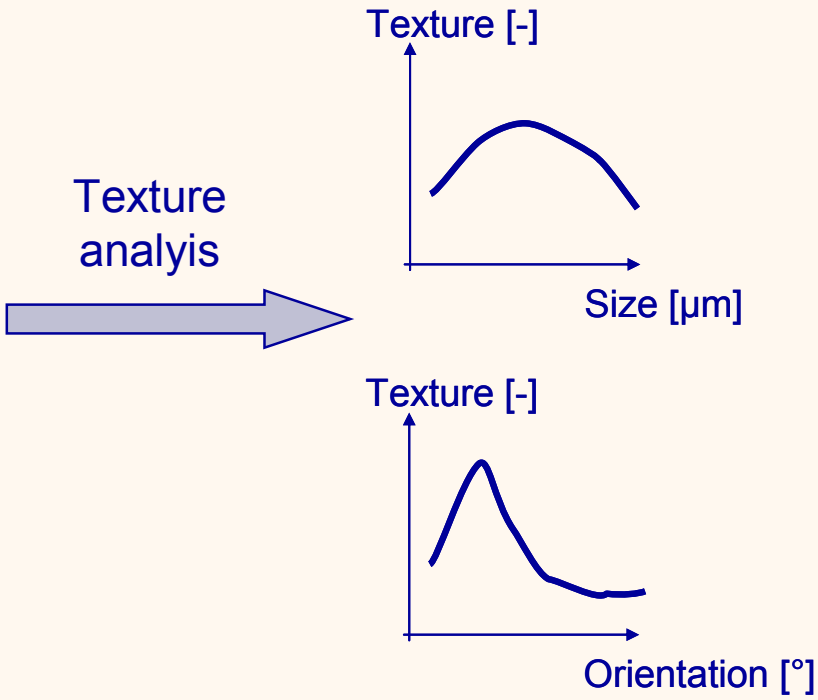


Image Analysis of Mottling Phenomena

Texture Analysis of Paper Structures

- Co-Occurrence Matrix
- Fractal Dimension
- Tamura Features
- MRA
  - MRA / Wavelet - transformation
  - MRA with FIR-Filter
  - MRA with FFT-Filter
  - .....
  - *MRA-Segmentation*
- Powerspectrum FFT

Principle:

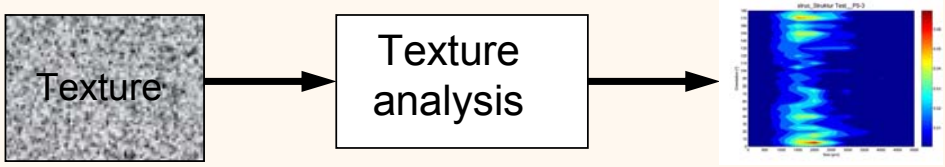
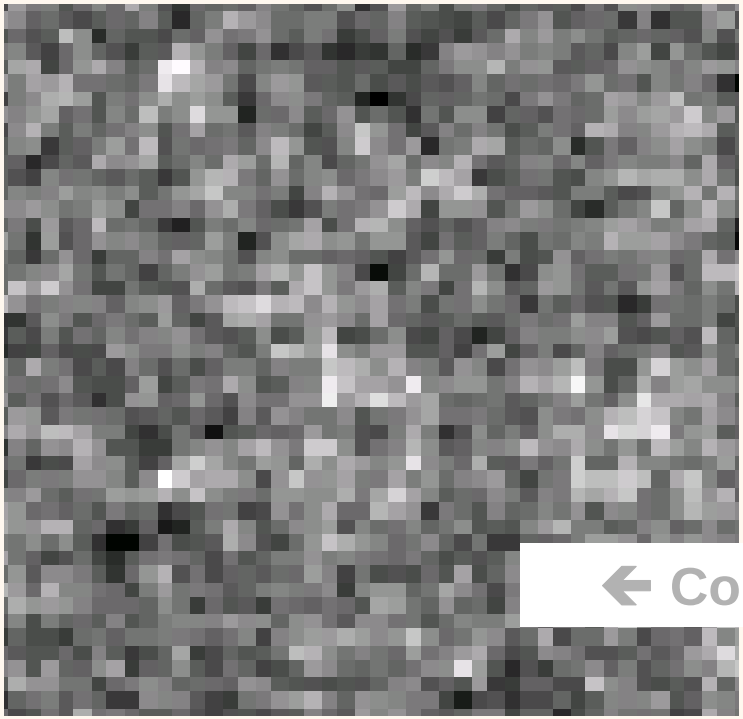
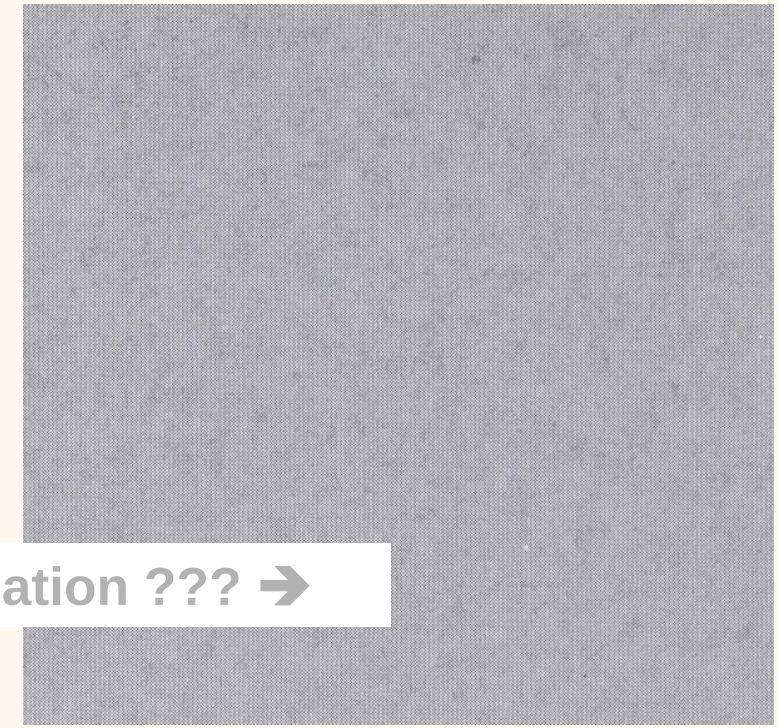


Image Analysis of Mottle - Benefits

Ambertec Mass Distribution



Screens 40 % black scanned image



← Correlation ??? →

Image Analysis of Mottle - Benefits

- Information on the scale/size, orientation and intensity of various paper structure related properties can be obtained by using the same method and checks of correlation to print mottle can be performed.
- Preconditions:
  - data must be transformable to 2-D „pictures“
  - high resolution of measuring instrument (in µm range)
  - measured area must be large enough
- Example of local paper properties evaluated:
  - mass distribution (base) paper
  - coat weight distribution
  - surface roughness (laser)
  - binder distribution in paper surface
  - .....

Image Analysis of Mottle - Benefits

Statistical Evaluation

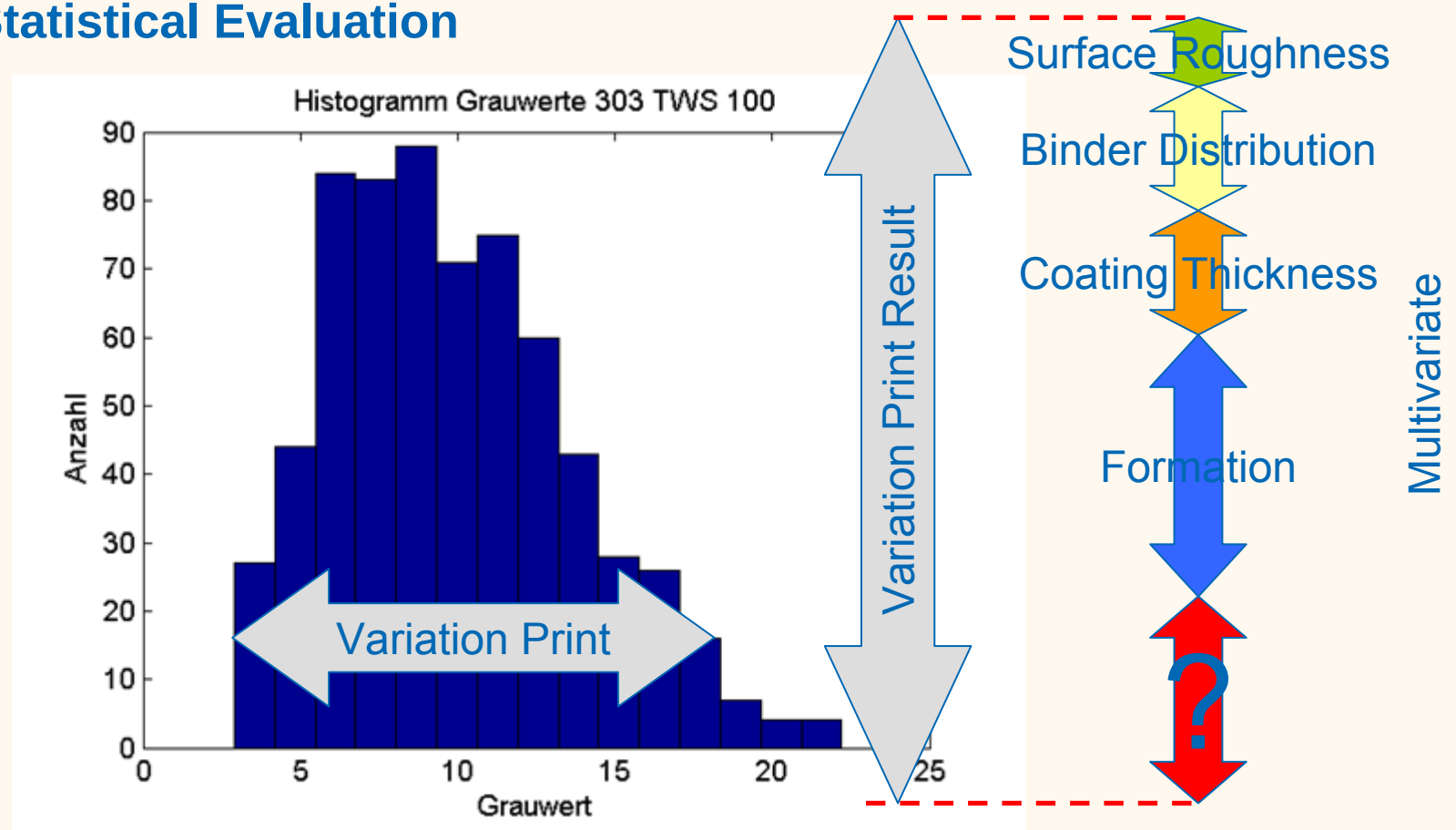
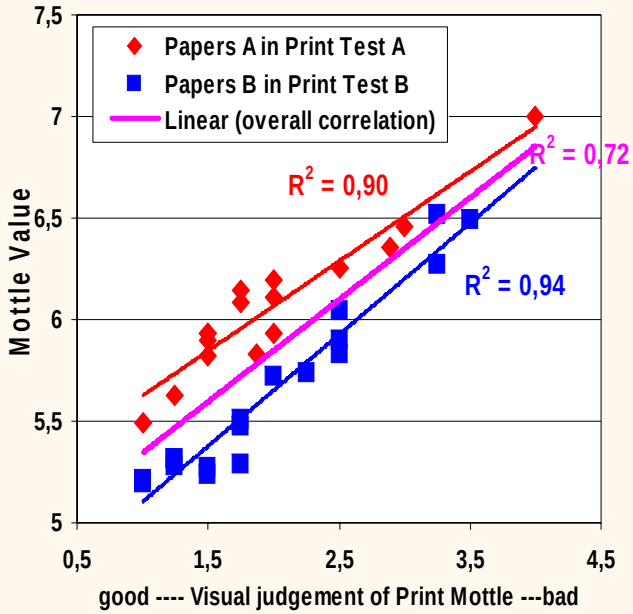
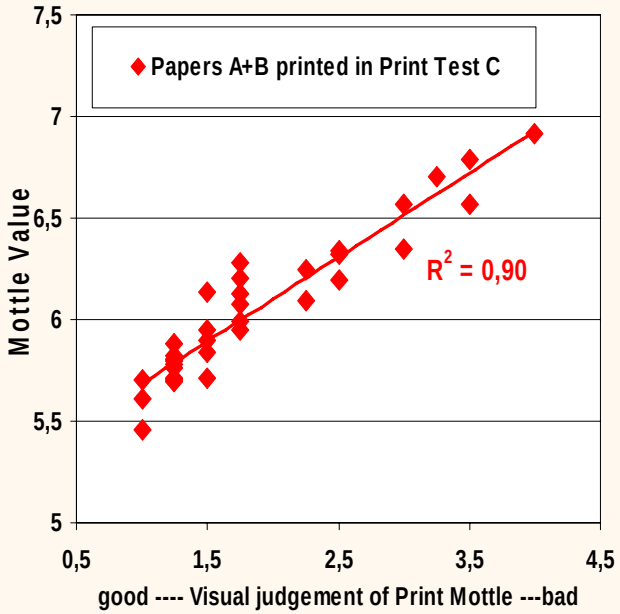


Image Analysis of Mottle - Shortcomings

- Correlation of „mottle indices“ determined via image analysis to visual rating of print mottle is also influenced by slightest differences caused by printing machine….
- Results are also influenced by non-mottle print disturbances like streaks, spots ... .
- Visual rating of print tests is faster.





Conclusion

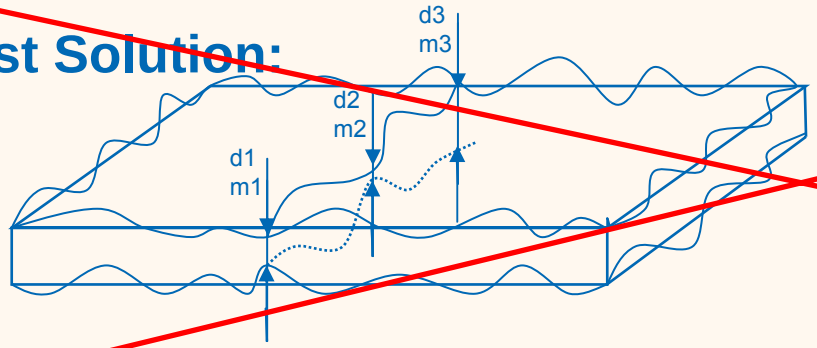
- Improved understanding of the physical and chemical properties of paper surfaces is the key in the optimization of coated printing papers.
- Print quality is only to a minor part a „global“ property.
- Local variations are of special interest

→ Methods to measure local variations at high resolution in the micrometer range are required:

- local mass variations (formation)	available
- local coat weight variations	partly available
- local surface chemical variations	extremely complicated
- local surface porosity variations	extremely complicated
- bulk structural variations	still missing

Conclusion

Best Solution:

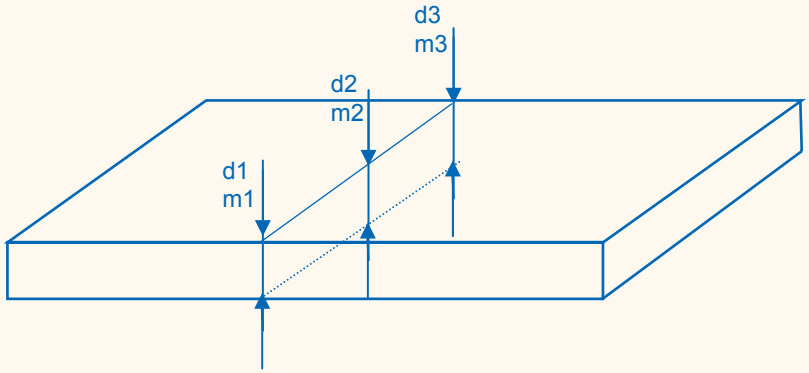


heterogeneous:

$d_1 \neq d_2 \neq d_3 \neq \ldots \neq d_n$

$m_1 \neq m_2 \neq m_3 \neq \ldots \neq m_n$

.....



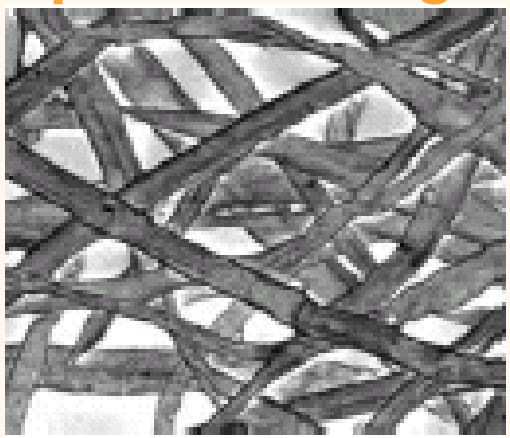
homogeneous:

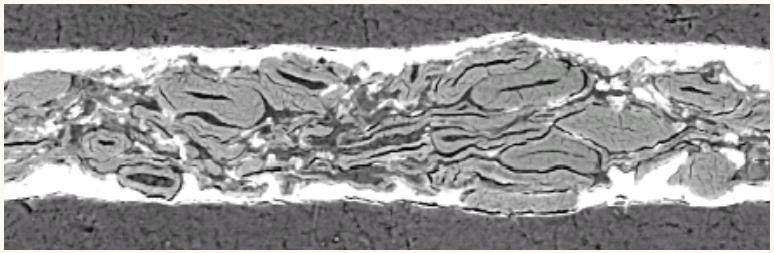
$d_1 = d_2 = d_3 = \ldots = d_n$

$m_1 = m_2 = m_3 = \ldots = m_n$

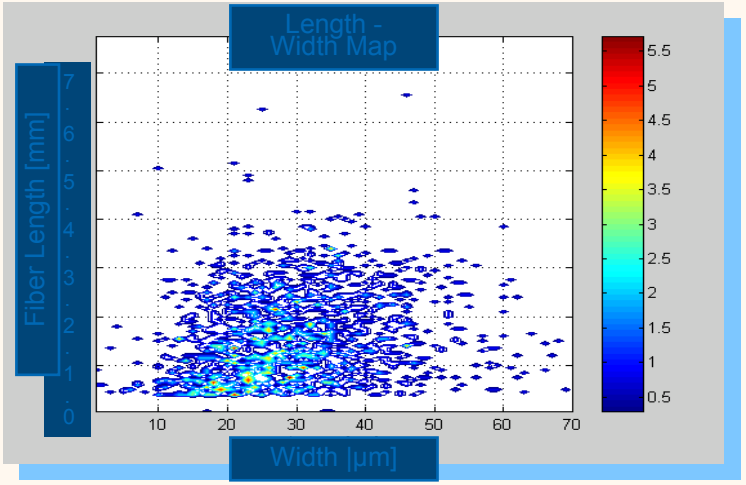
Make a perfectly homogeneous, uniform paper!

Paper- a homogenous material?





All variations in paper structure influence the behaviour of paper



1 cm² coated paper (100 gsm) consists of:

~ 7.000 – 12.000 single fibres

~ tenths of billions of pigment particles

The papermaker's challenge

Make

homogeneity

out of

heterogeneity!!!!

BRISTOW and KOLSETH [1]:

"If it were not for the fact that paper exists, this task would be considered impossible by any sensible engineer"

[1] Bristow, J.A.; Kolseth, P. (Editors): Paper – Structure and Properties, International Fiber Science and Technology Series, Volume 8, Marcel Dekker, New York (1986), S. iv

Thank you for your attention!