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Effect of Paper Properties on Print Quality by Flexographic Method

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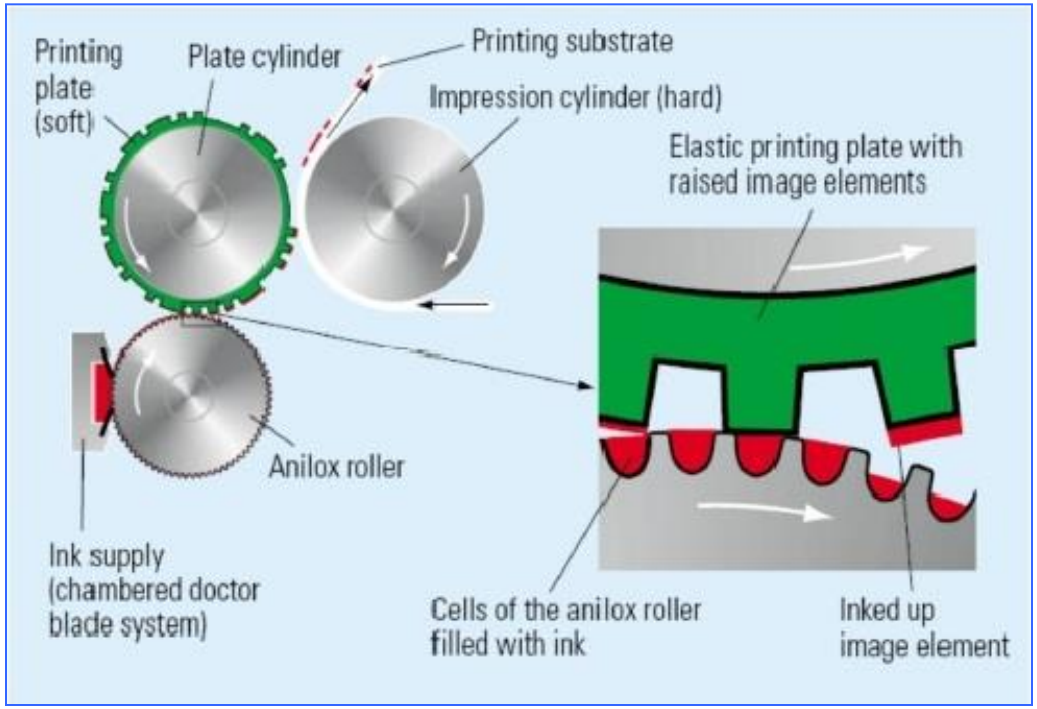
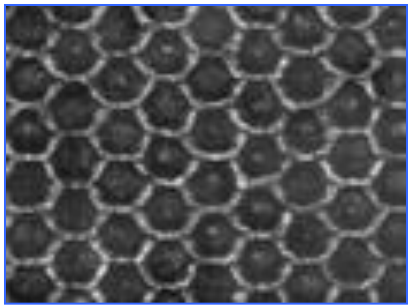
Introduction

- As functionality and quality requirements for packaging continue to increase, flexographic printing remains very important...





Introduction

- Although many types of substrates (plastics, film and foils) are widely used for flexible packaging, **paper-based materials** are still very popular because of their characteristics (e.g. sustainability, technological advances, etc.)

- By applying basic paper knowledge a flexo-printer can enhance the print performance of a particular project.

Aim of the study

- The aim of this study is to investigate the influence of surface properties of three different types of papers on print quality (i.e. print density - reflectance, gloss).
- Samples of papers, used for packaging applications, were printed by flexographic procedure under certain conditions (running speed, temperature and pressure of the impression cylinder and anilox cell volumes).

- **Keywords**

Paper properties, flexography, anilox, print quality

Methodology

The present study is divided into four sections:

(1a) Three types of **papers**, used for packaging applications, were selected:

- ✓ **Paper A** (double layer coated) - CARCOAT OB by Cham Paper Group
- ✓ **Paper B** (uncoated) - MG KRAFT by Interpack Italia
- ✓ **Paper C** (coated) - BRILLO PAPER 60 GSM by Cartonal Italia

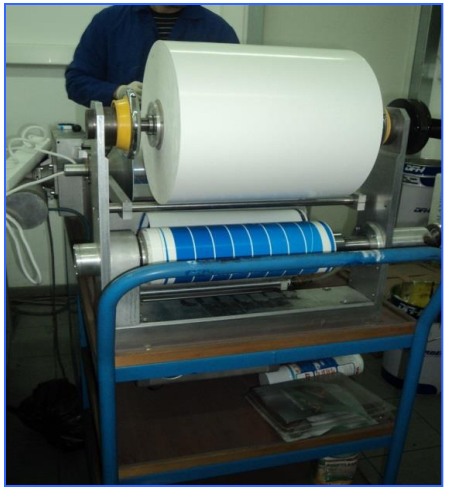
Papers, used for packaging applications, were supplied by Tsimis S.A.

Methodology

(1b) The **surface** and **optical properties** of the samples were measured:

- **Surface properties**
  - ✓ grammage,
  - ✓ thickness,
  - ✓ smoothness (according to Bekk),
  - ✓ roughness (according to Bendtsen),
  - ✓ porosity (according to Bendtsen and Gurley)
  - ✓ absorbance ($Cobb_{60}$)
- **Optical properties**
  - ✓ opacity
  - ✓ whiteness (CIE WH)

Methodology



(2) **Flexographic printing** was carried out using a printing machine Saueressig (Color proofer FP 100/300) and two different anilox cylinder cell volumes:

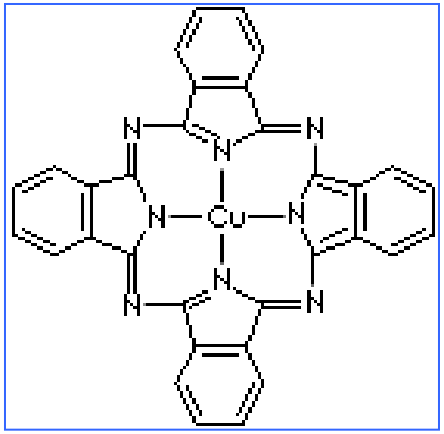
- ✓ 13.25 cm^3/m^2 (Engraving 1) and
- ✓ 7.01 cm^3/m^2 (Engraving 2).

A running speed of 25 m/min was applied, forced air heating and a nip pressure of 100 µm between the plate cylinder and the CI drum.

Methodology

- A **solvent based printing ink** (ETOH/EAC) for flexographic applications of Druckfarben S.A. (product name MXD 026 B 0000) was used.

- The chemical structure of **Pigment Phthalocyanine Blue** NC β-form (C.I. Pigment Blue 15:4)



Methodology

(3a) Density, Reflectance Spectra and Gloss of printed samples were measured:

- Spectrophotometer (Spectrophometer SpectroEye, GretagMacbeth).

- Glossmeter Sheen (Minigloss 101N 600).

Methodology

- (3b) Surface Images were taken by a Camera Troika's Litho CAM II, connected with a PC.

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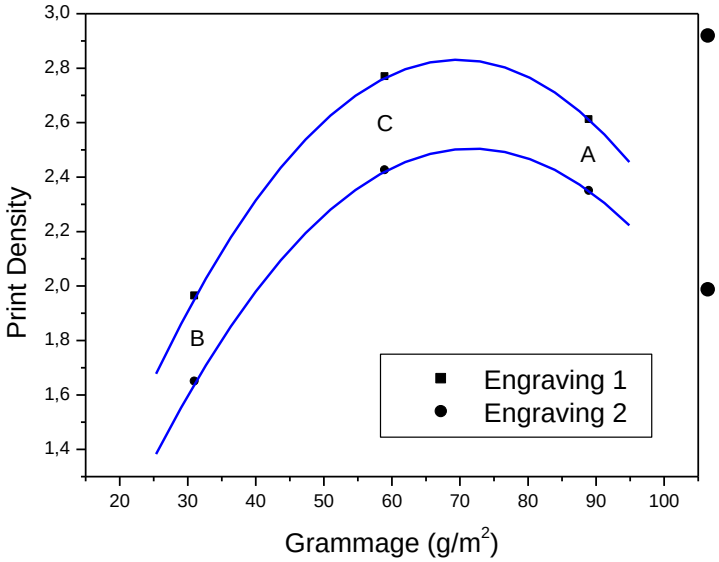
Methodology

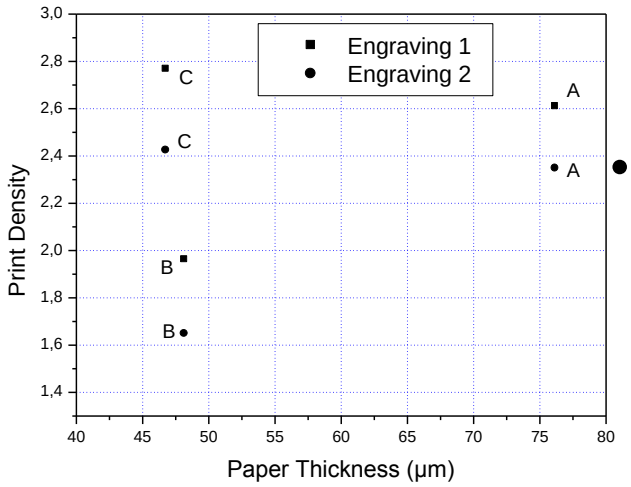
(4) Then the examined **properties** of the selected papers were compared in order to determine how they affect **print quality** (i.e. Print Density, Reflectance and Gloss) of samples printed by flexographic procedure.

Print Density of samples (engravings 1, 2) vs. Grammage of papers



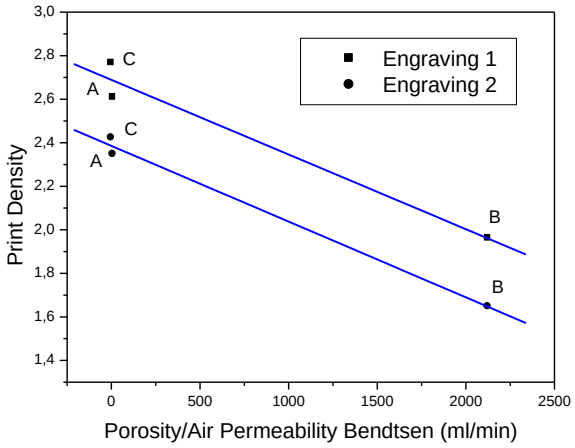
- Grammage of the examined paper affects print density but not linearly.
- Low values of Grammage give also low print density (paper B), in comparison with papers A and C.
- The type of surface treatment affects also print density; papers C and A (one and double coated) appear higher values of print density than paper B (uncoated).
- Printed samples of Engraving 2 appear lower print density than those of engraving 1, because of the lower anilox volume.

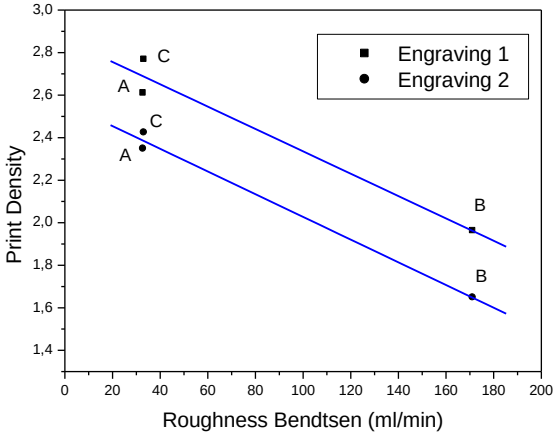
Print Density of samples (engravings 1, 2) vs. thickness of papers



- Thickness does not show to influence significantly on print density; although papers B and C have almost the same thickness, they appear different values of print density.
- The most effective factor is the pre-treatment of the surface (i.e. coating) of the examined paper. So, paper C has much higher print density than paper B, as it is coated, almost the same with A (double coated).
- Engraving 2 of the printed samples gives lower print density than that of Engraving 1, because of the lower anilox volume.

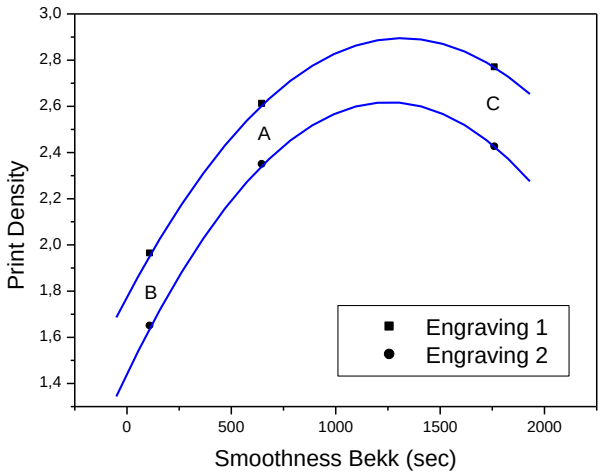
Print Density of samples (engravings 1,2) vs. porosity and roughness of papers





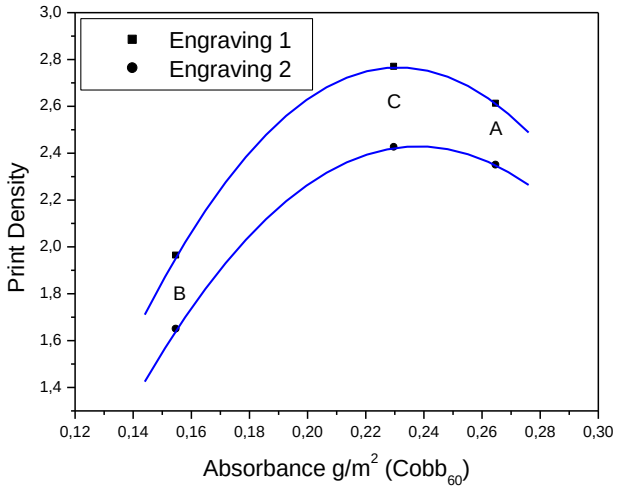
- Print density is affected by the porosity and surface roughness of the papers.
- As the values of porosity and surface roughness increase, print density decreases.
- As it is known a porous paper should be printed with large amounts of ink in order to give a print density in a satisfactory level, because ink does not remain on its surface but it penetrates into the pores. So in this case the printed samples do not appear so glossy and bright and they show low values of print density.

Print Density of samples (engravings 1, 2) vs. smoothness of surface



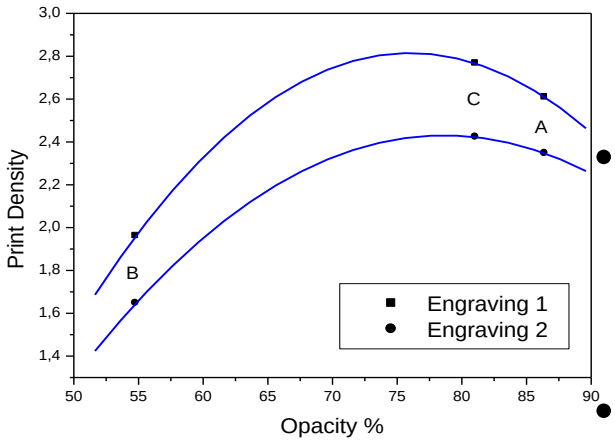
- As smoothness increases, print density increases too.
- Coated papers A and C -with smooth surfaces- have much higher print density than uncoated paper B, which has a rough surface with low smoothness.
- It is confirmed that a smooth paper has much better quality and print density than a rough one.

Print Density of samples (engravings 1, 2) vs. absorbance of surface



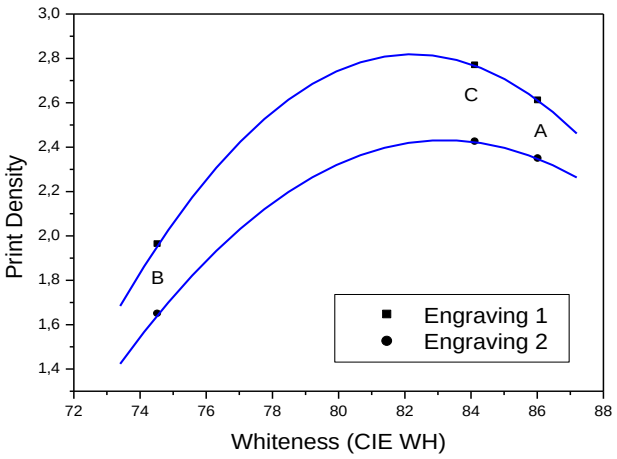
- The absorption of water is a very important property for printing process of papers, especially when water-based inks are used.
- Although paper B has high air permeability, it shows the lowest absorbency in water in comparison with coated papers A and C.
- Coated papers appear less permeable against air or water or both of them.

Print Density of samples (engravings 1, 2) vs. opacity of papers



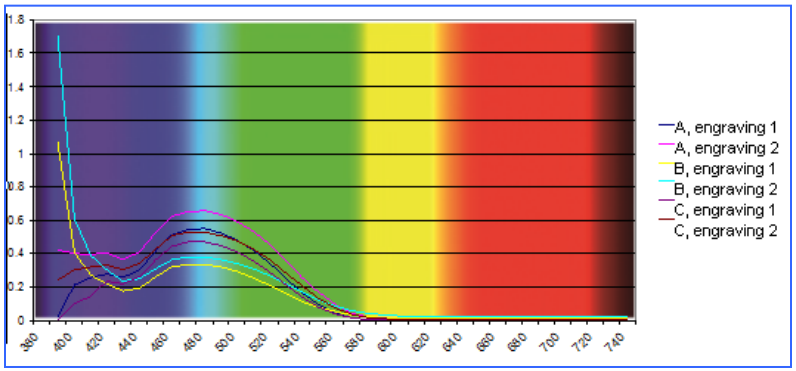
- Opacity of paper influences considerably print density; High opacity (and low transparency) is related to better print density.
- Uncoated paper B has low opacity and low print density, while coated papers A and C appear much higher print density.
- Coated and opaque paper surfaces should be selected, when high print quality is required.

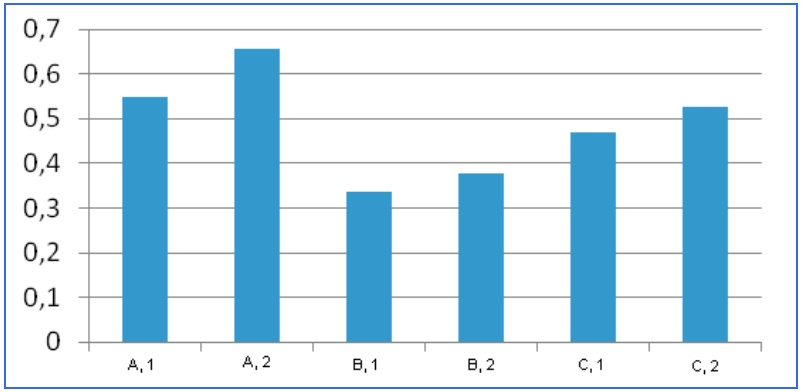
Print Density of samples (engravings 1, 2) vs. whiteness of papers



- Whiteness, one of the most important optical properties of paper is related with print density.
- As the values of Whiteness increase, print density increases too.
- Paper B that has low Whiteness appears low print density, as expected, while papers C and A (one and double coated) appear much better print density.

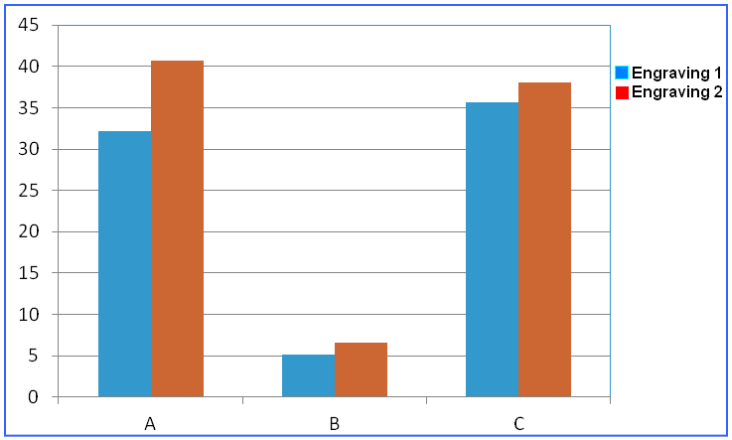
Reflectance Spectra and λ_{max} of printed samples





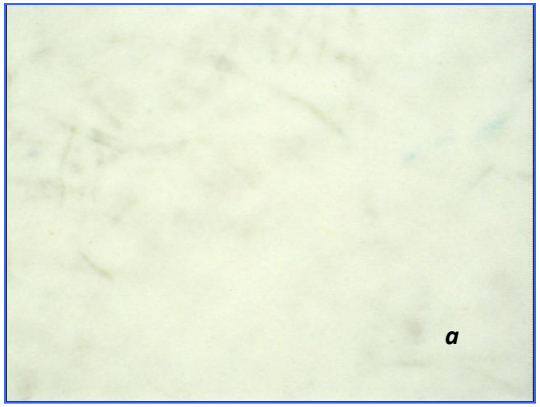
- Reflectance Spectra of samples show λ_{max} at about 460-470 nm (characteristic region of cyan).
- There are some differentiations between the three types of papers, regarding to the value of reflectance and especially between the two engravings 1 and 2.
- The values of λ_{max} are decreased in the order A>C> B
- These values are influenced by the degree of coverage of the paper surface.

Gloss of printed samples (engravings 1, 2)

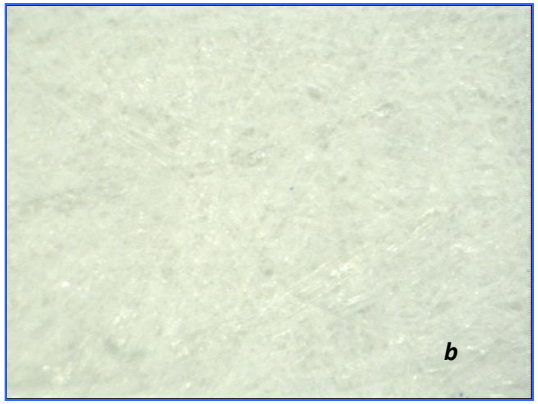


- A more uniform and thin layer of transferred ink results in improved and more compact dots and thus in a more uniform orientation of colouring matters at the surface of printed samples (A>C>B).
- The values of gloss of printed samples are only slightly differentiated between engravings 1 and 2.

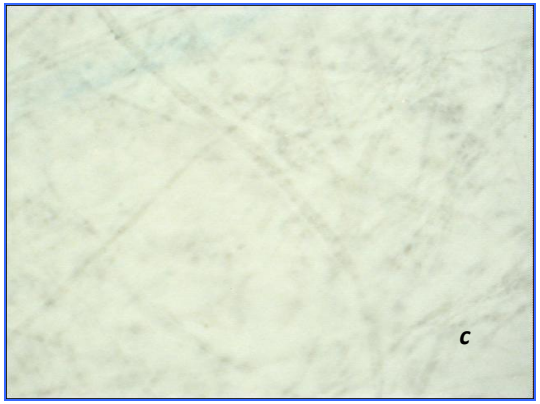
Images of unprinted samples of papers (x30)



Paper A



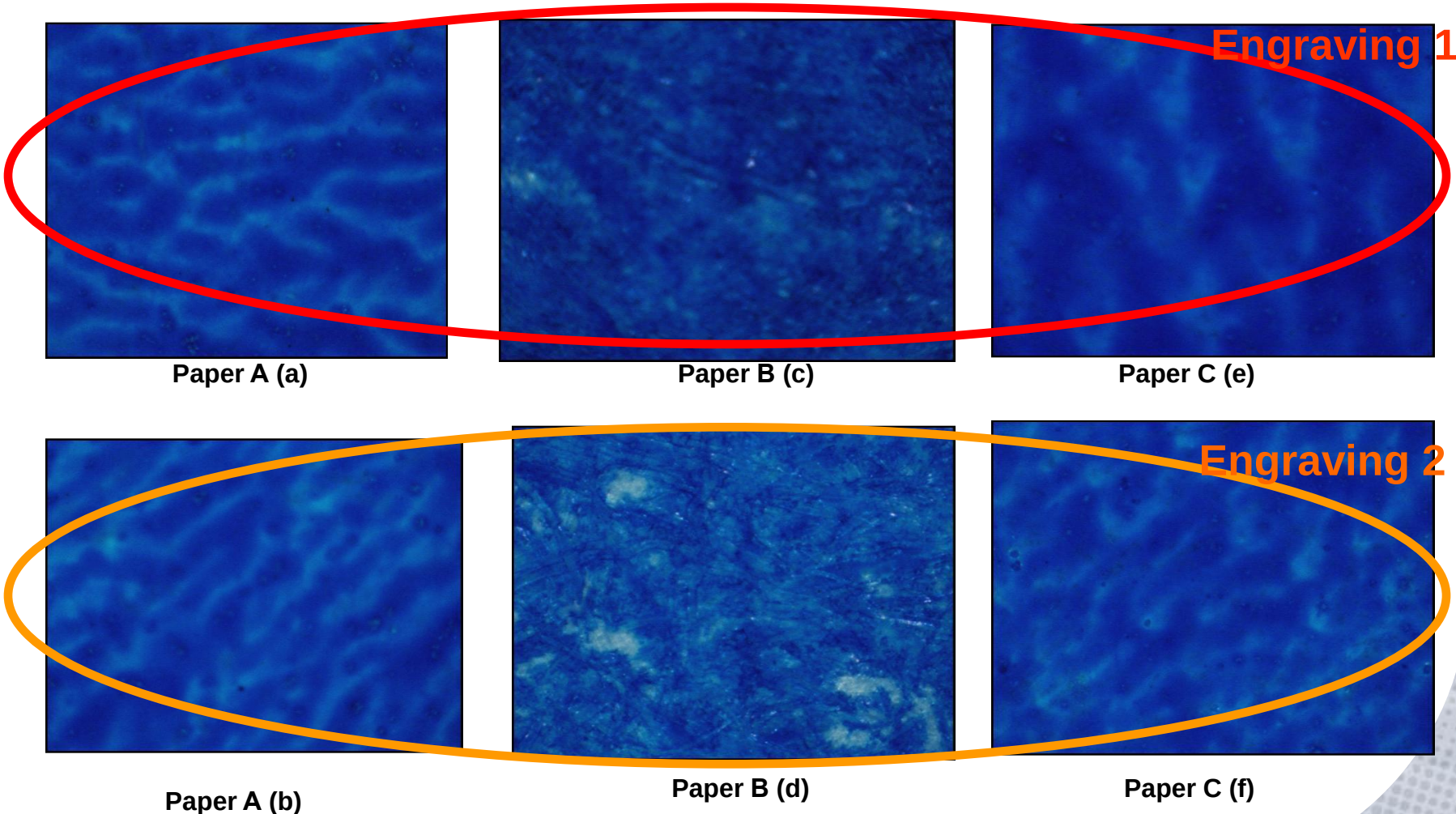
Paper B



Paper C

- The surfaces of papers are observed and as it is expected, paper A (double coated) shows to have the whitest and smoothest surface in comparison with papers B and C.
- Paper B shows high surface porosity, while its fibers are more obvious, because it is uncoated.

Images of printed samples of papers at Engravings 1 and 2 (x30)



- Print Density is influenced considerably by paper quality.
- Papers A and C show better print quality than paper B.
- Coverage and print density is expected to be more uniform and complete and the film forming of ink to be better in the case of engraving 1 than that of engraving 2.

Conclusions

- ✓ Grammage of the examined papers affects print density but not linearly.
- ✓ Thickness of papers does not influence significantly on print density.
- ✓ Print density appears to be affected by the porosity, roughness, smoothness and absorbency of the examined papers.
- ✓ Opacity and Whiteness of papers influence considerably print density.
- ✓ It is confirmed that the characteristics of anilox cylinder (i.e. cell volume) affect significantly print density.

References

- B. Thompson, Printing materials, Science and Technology, Pira International (1998)
- R. Todd, Printing inks – Formulations Principles, Manufacture and Quality Control Testing Procedures Pira Press, Leatherhead (1994)
- The Printing Ink Manual, 4rth Edition, R.H. Leach, Blueprint, London 1988
- Johnson J., Aspects of Flexographic Print Quality and Relationship to some Printing Parameters, thesis, Karlstad University Studies, 2008
- Parker, J.R.: Fundamental Paper Properties in relation to Printability, Fundamentals properties of paper related to its uses, Bolam, F., Ed., Technical Division, The British Paper and Board Industry Federation, London, pp. 517-543, 1976
- Kugge C., Johnson B., Improved barrier properties of double dispersion coated liner, Progress in Organic Coatings 62, pp.430–435, 2008
- Zang, Y.-H. and Aspler, J. S. Factors that affect the flexographic printability of linerboards, Tappi Journal, 78(10), pp. 23-33, 1995

- **Thank you for your attention!**

Acknowledgements

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