

# Determination of SB-latex distribution on paper coating surfaces with ATR-FTIR spectroscopy

1.10. 2004, Cost action E32

Eija Kenttä

KCL

P.O. Box 70, 02151 Espoo

Finland

email: [eija.kentta@kcl.fi](mailto:eija.kentta@kcl.fi)

# Content

- Coating layer
- Surface sensitive ATR-IR method
- SB analysis

# Liquid transport and binder migration

**To the coating surface:**

Surface-tension driven capillary flow and convection  
 Capillary flow after coating immobilization



**Into the base paper:**

Water absorption through fiber walls  
 Capillary flow in pores  
 Pressure penetration at applicator and blade nips

Pressure filtration through filter-cake

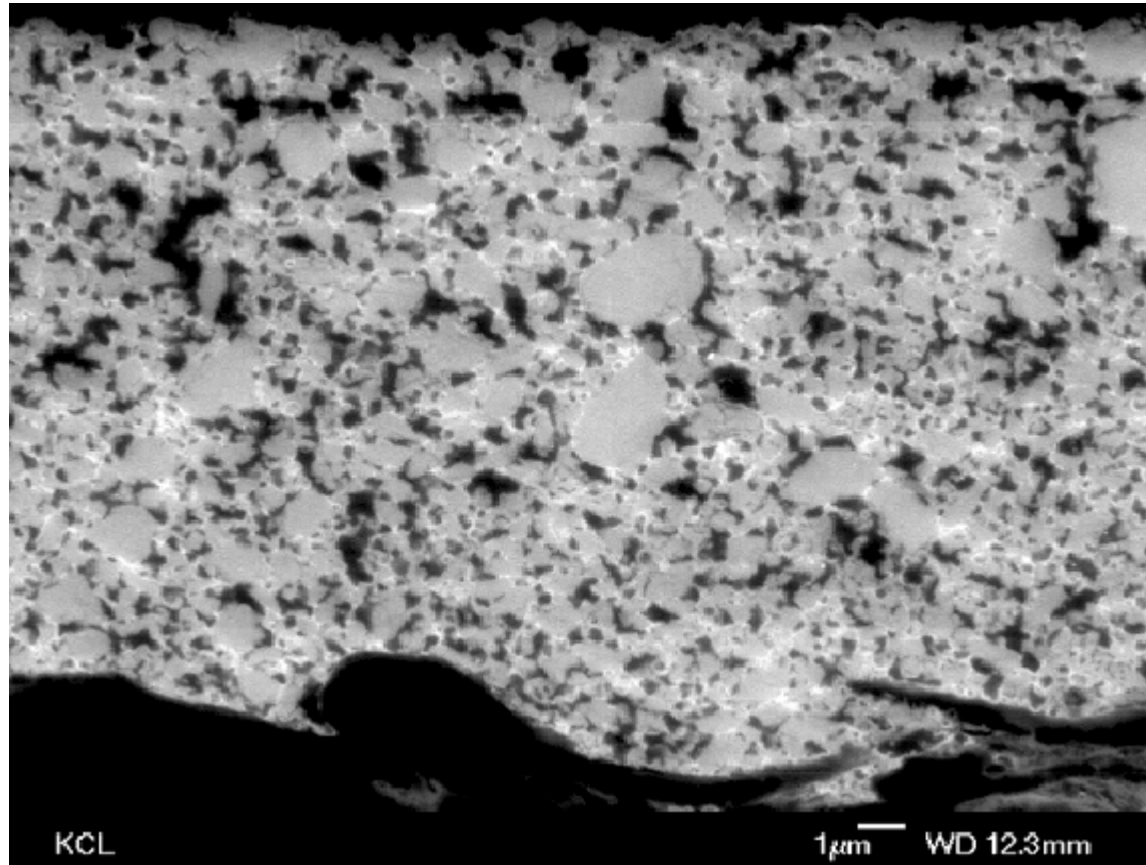
*Source: Lee, D. and Whalen-Shaw in Binder Migration, Tappi Press (1993) 19-38.*



# Factors which may affect latex migration

- Base paper
  - Coating components
  - Application and drying
-

# Coating layer structure



HR-SEM cross-section of a carbonate-SB coating



# An example of coating colour formula

			Dry weight/kg
<b>Clay</b>	<b>80</b>	parts	200
<b>Calcium carbonate</b>	<b>20</b>	parts	50
<b>Latex</b>	<b>11</b>	parts	27.5
<b>Thickeners</b>	<b>0.9</b>	parts	2.25
<b>Additives</b>	<b>0.1</b>	parts	0.25
<b>Water amount</b>	<==> wanted solids content		

**Pigment(s) sum is 100 parts**



# Coating components analysed with IR directly from coating

## Absorptions in Mid-IR region 4000 – 400 cm<sup>-1</sup>

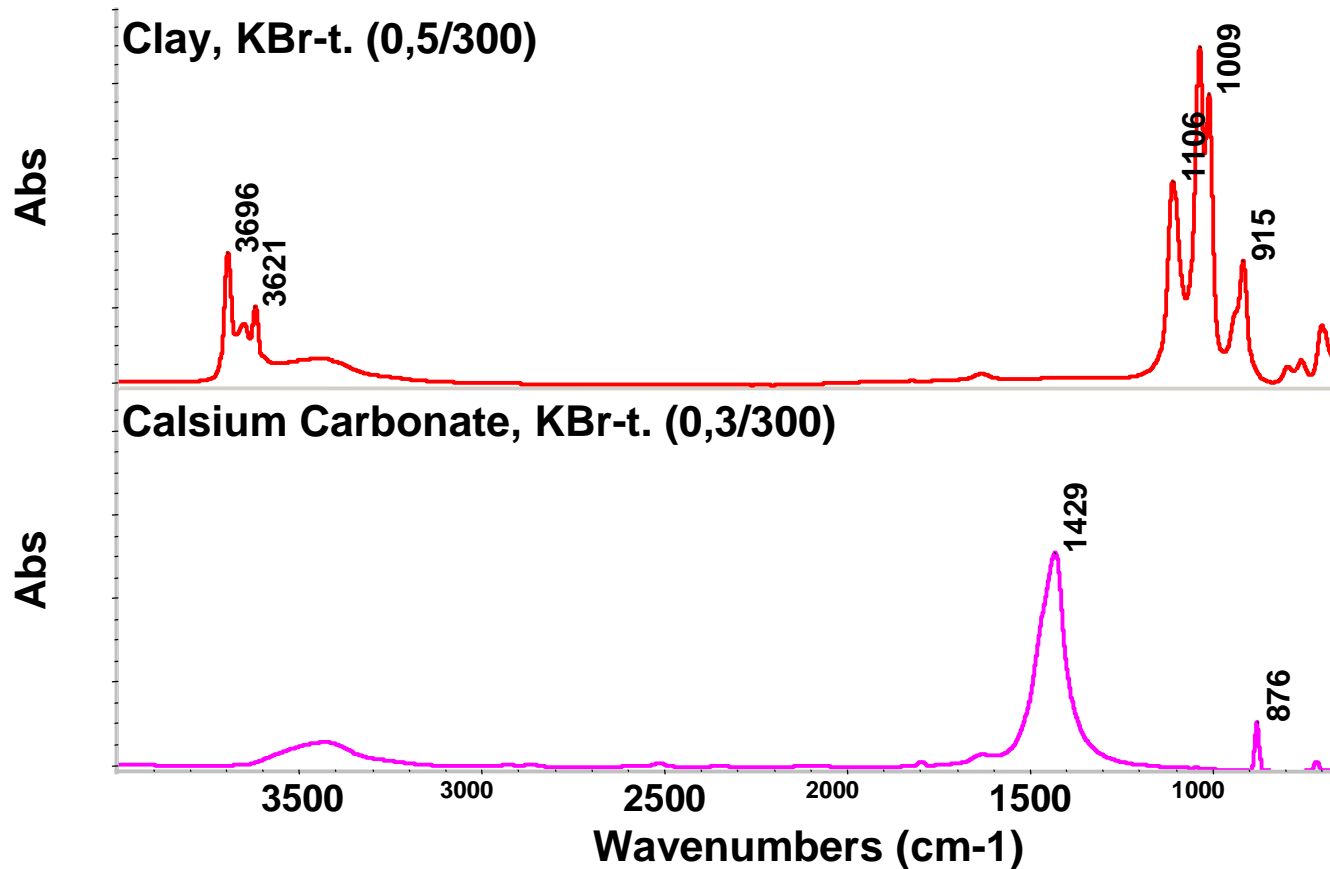
- Pigments

Clay, talc, carbonate and gypsum pigments have strong IR bands,  
TiO<sub>2</sub> have broad bands

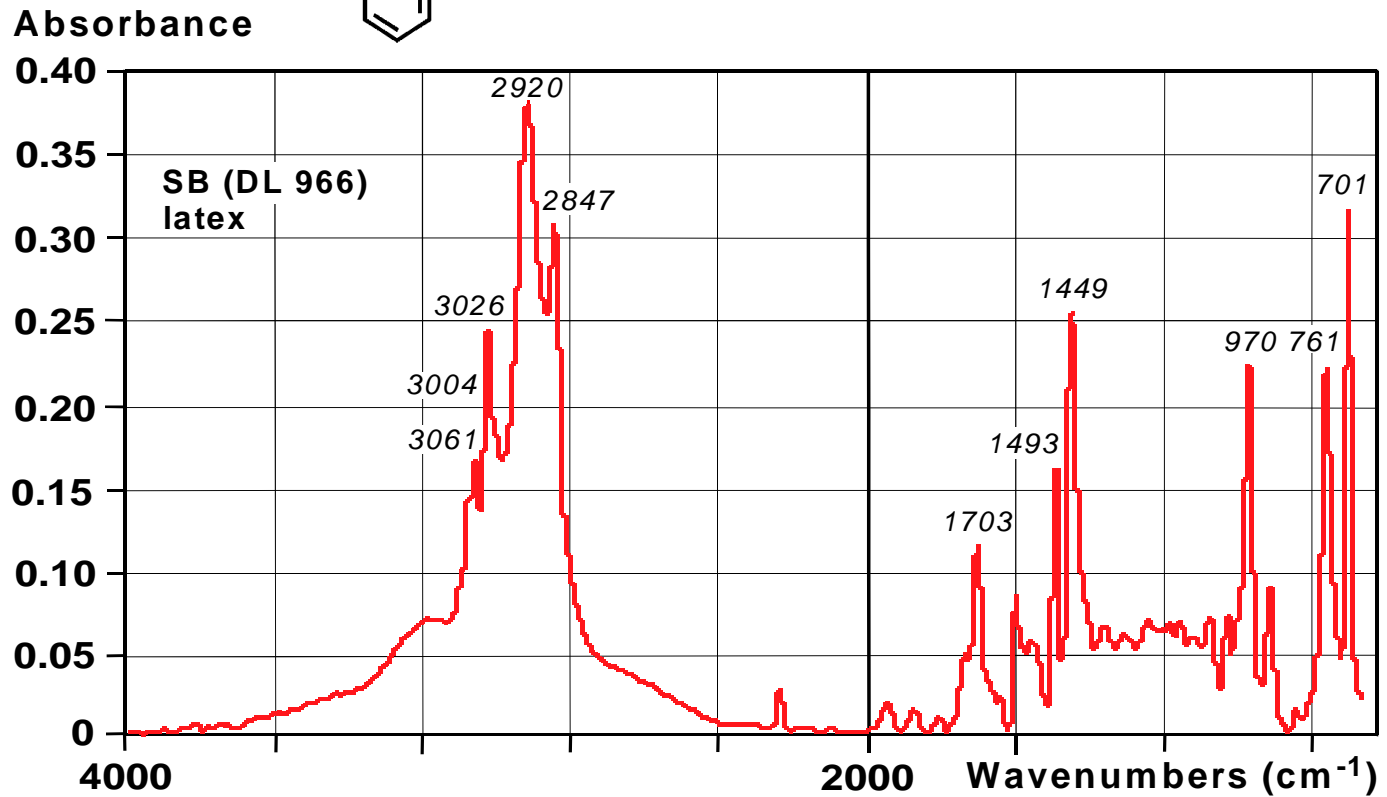
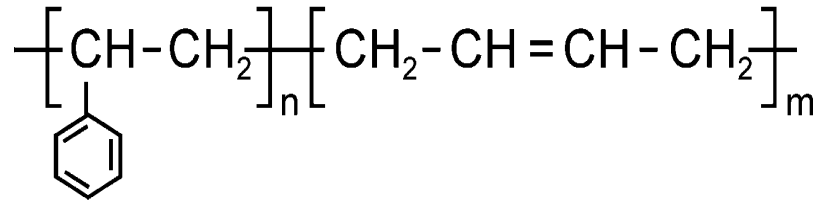
- Latexes

PVAc- or acrylate latex medium bands  
SB latex medium or weak bands

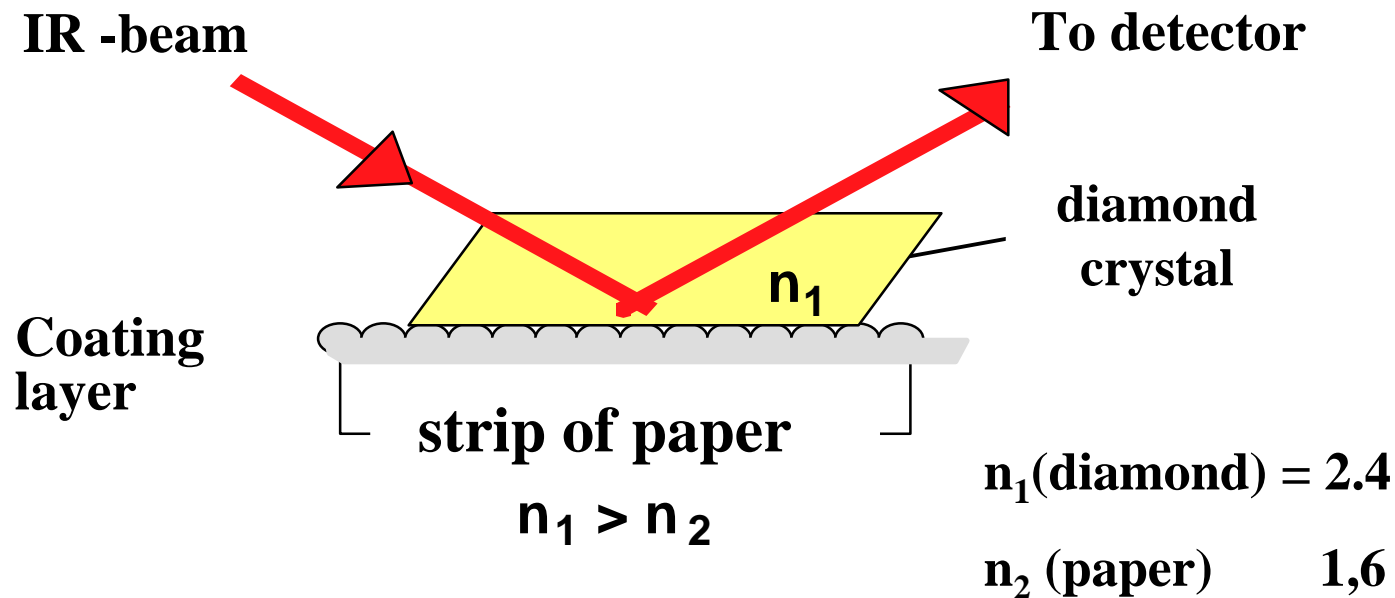
# IR spectra of carbonate and clay



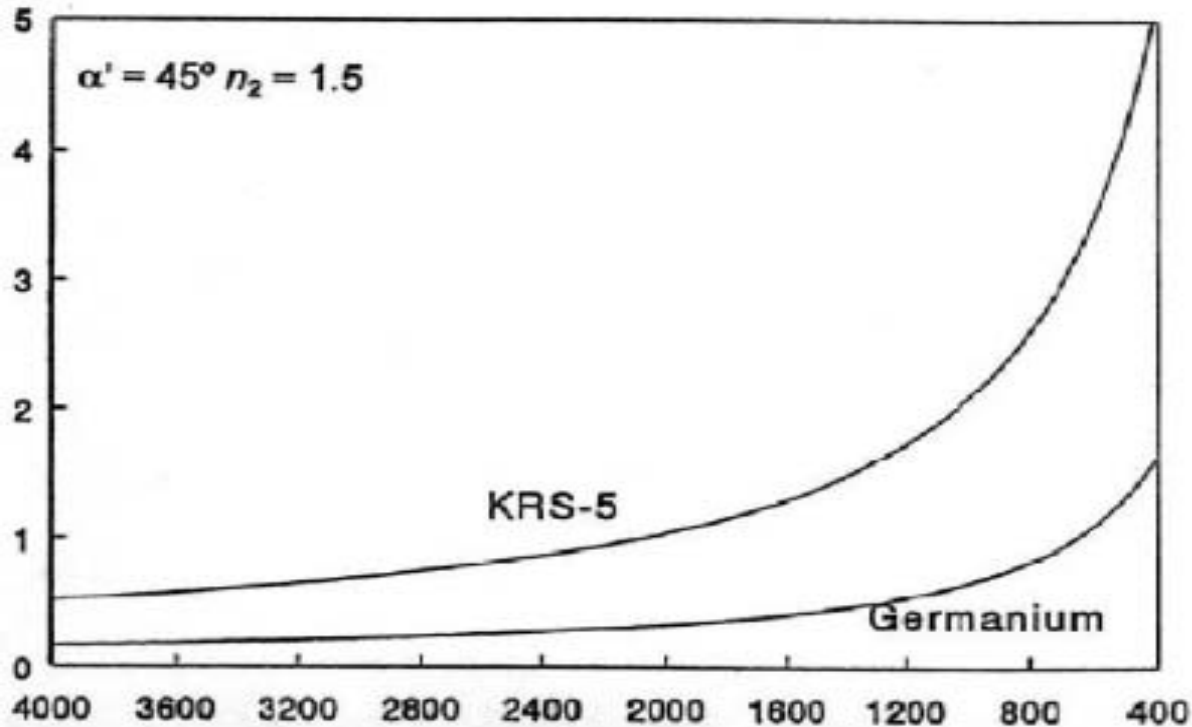
# IR-spectrum of SB-latex



# ATR-IR surface measurement from the paper



# Penetration depth in ATR-IR-analysis



source: Urban, M.W.,  
ATR Spectroscopy of  
Polymers  
Theory and Practice,  
(1995)

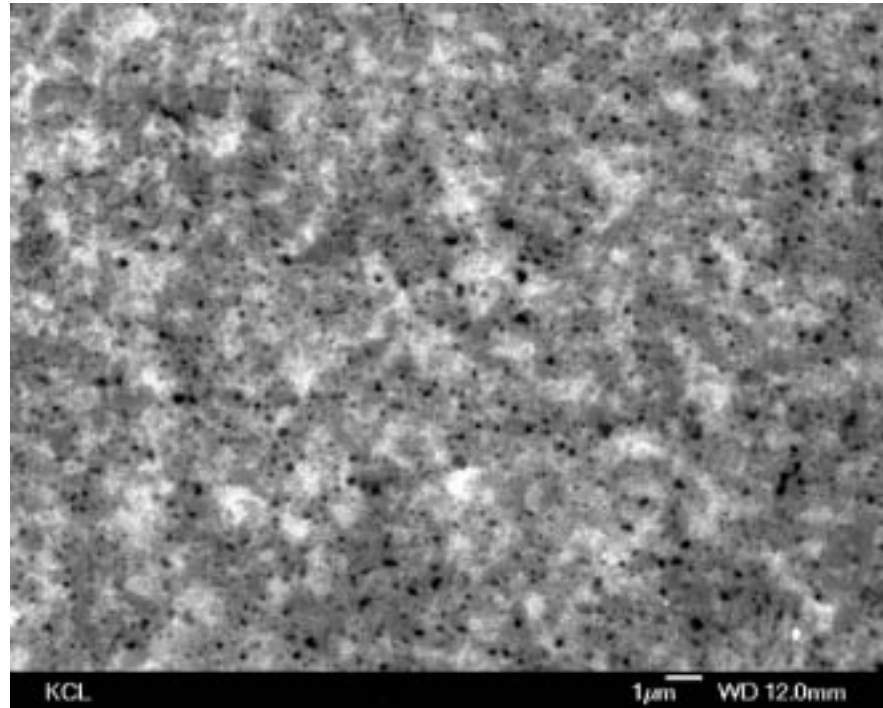
penetration depth  $\sim 1\mu\text{m}$



# SB latex ATR-IR analysis from coating layer

- A few micrometers thick surface layer is analysed
- Main coating components can be identified and latex-pigment ratio quantified
- Detection sensitivity depends on the chemical nature of compounds studied
- Mapping to study the evenness of surface composition

# Surface SEM image



100 % Calcium carbonate +SB  
BSE mode

# ATR-IR analysis with DurasamplIR accessory

- **Sample surface is pressed against a diamond crystal**
- **Good contact between crystal and sample**
- **ATR-IR spectrum is measured**





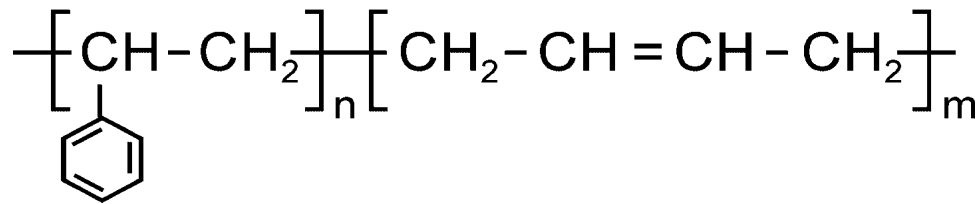
# Contact of diamond crystal in DurasamplIR ATR



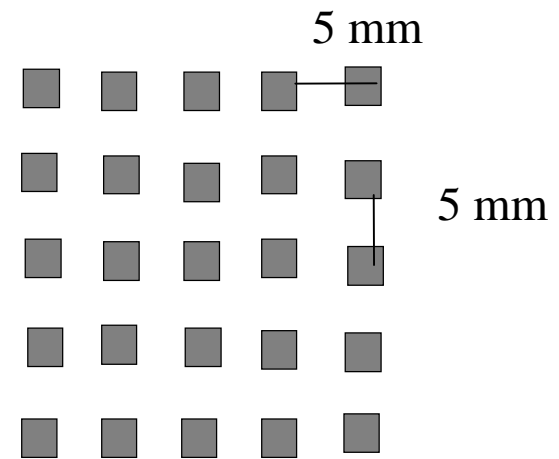
contact repeated 10 times on carbonate coating (Setacarb)



# SB-latex mapping analysis with ATR-IR



- Spectra are measured from several points on coating surface
- Styrene /pigment ratio is calculated from IR-spectra



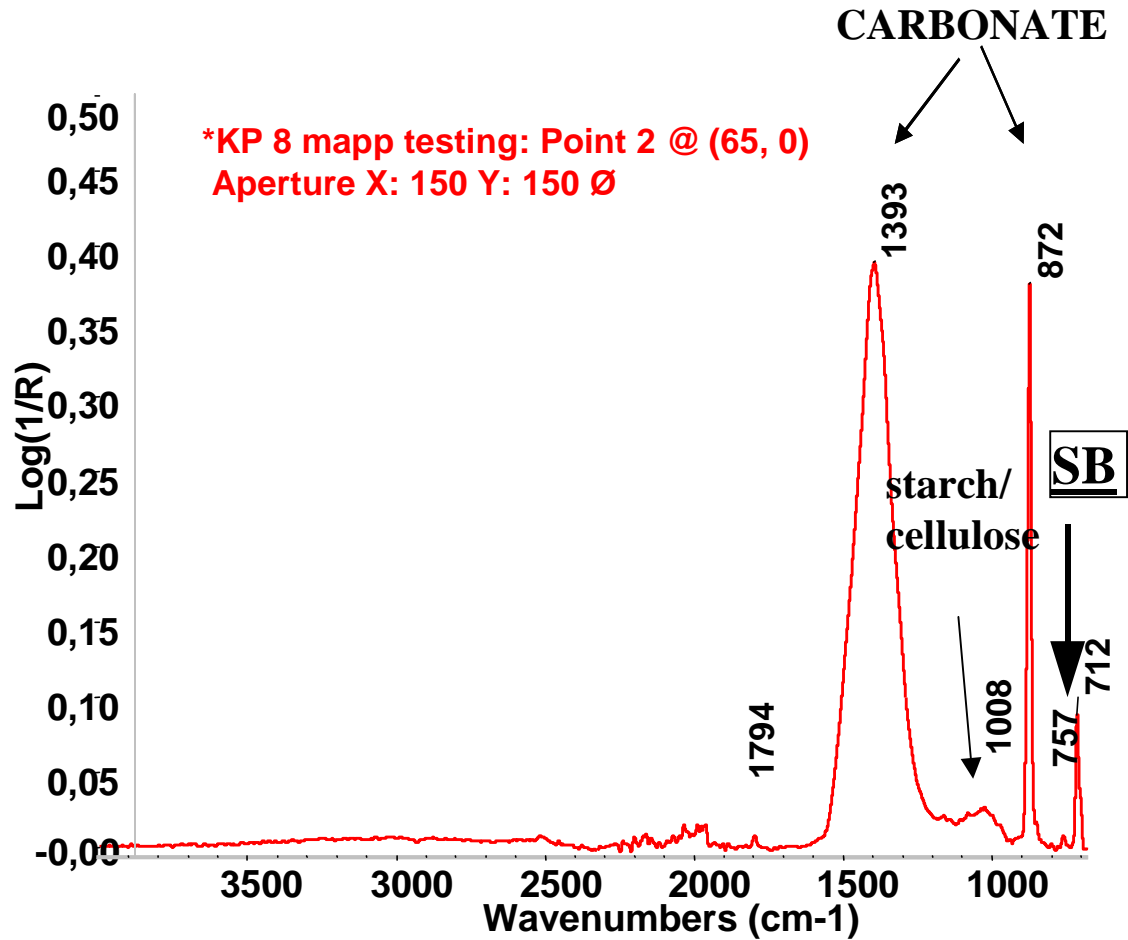
Mapped area 20 x 20 mm<sup>2</sup>

# ATR-accessory in FT-IR measurement



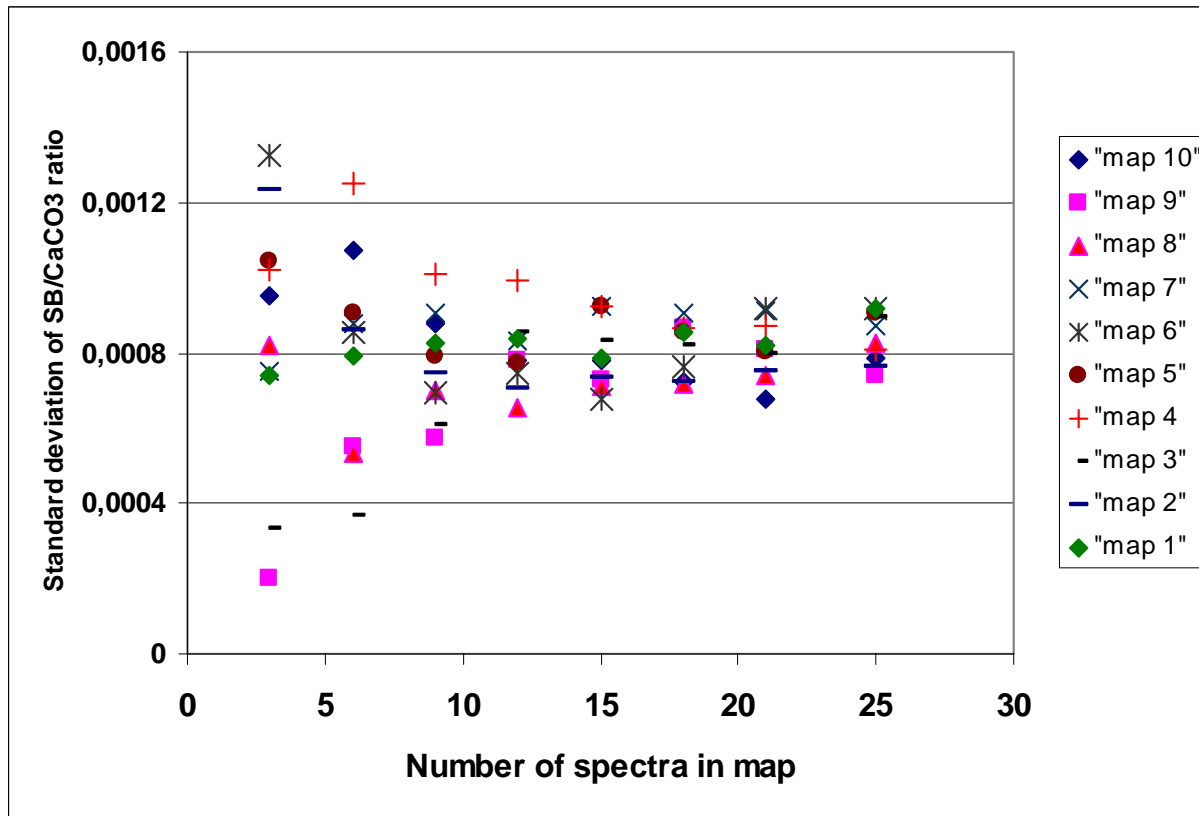
a motorized sample mover is attached to ATR accessory for mapping

# ATR-IR spectrum of SB-carbonate coating

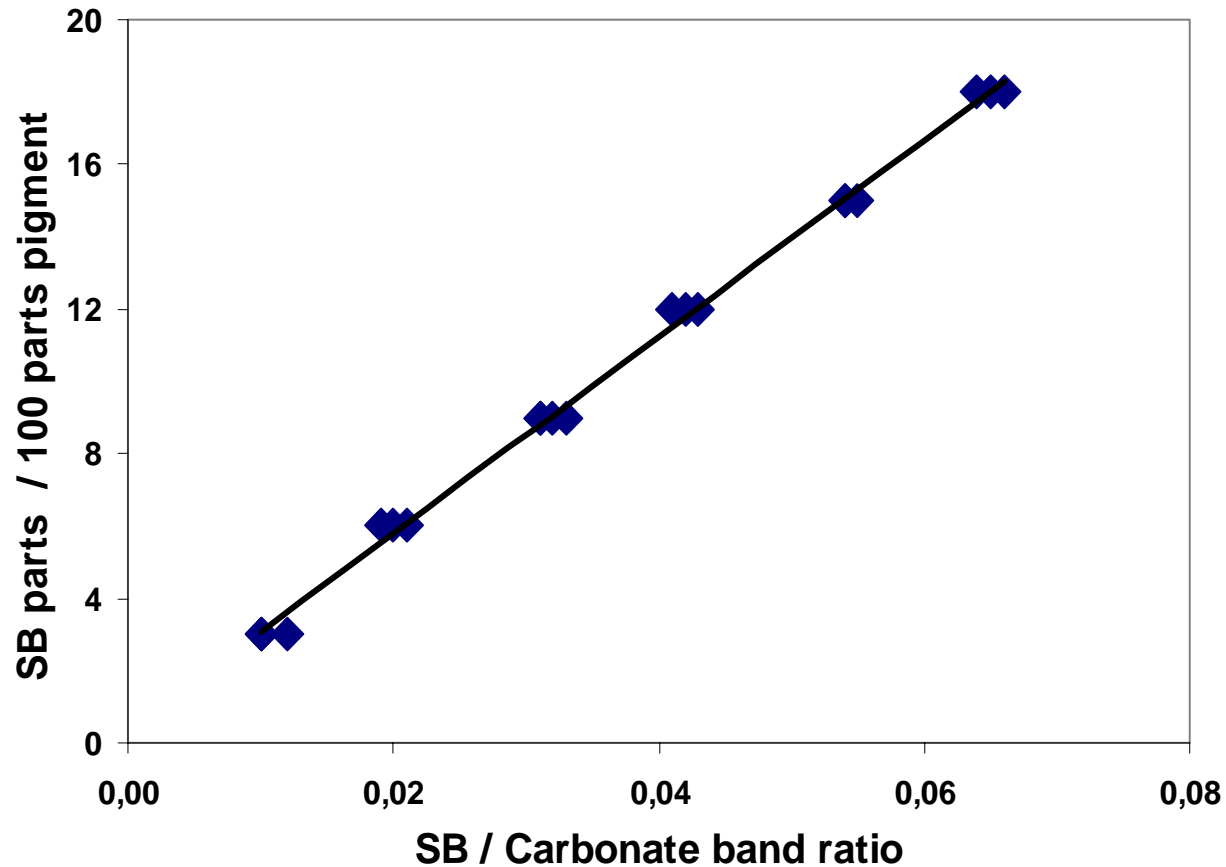




# Number of spectra collected to one map



# Calibration of ATR-IR analysis

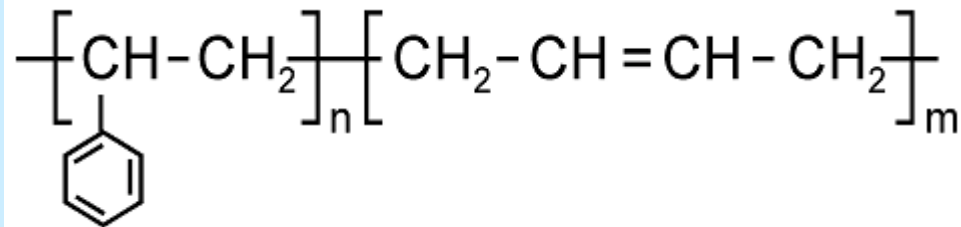


# Conclusions

- ATR-IR mapping is applicable for surface latex uniformity analyses.
- Sensitivity depends on coating composition.
- Pigments have strong signals (carbonate, clay, gypsum, talc), may overlap latex signals.

# Conclusions

- Latex pigment ratio in relative units: to compare coatings with similar composition.
- Calibration with corresponding coating samples is necessary if different types of coatings are compared.



# References

- Lee, D., Whalen-Shaw, M., Fundamentals and strategies in Binder Migration in Paper and Paperboard Coating, ed. Whalen-Shaw TAPPI Press Atlanta, Georgia, 1993, 19-38.
- Bellamy, L.J., The Infrared Spectra of Complex Molecules. Volume One, 3<sup>rd</sup> Edition, 1975, pp 13-94.
- Urban, M.W., Attenuated Total Reflectance Spectroscopy of Polymers, Theory and Practice, *Polymer Surfaces and Interfaces series*, 1996.
- Smith, B.C., Choosing the Right Sampling Technique, Fundamentals of Fourier Transform Infrared Spectroscopy, CRC Press, Boca Raton, FL 1996.
- Kenttä, E., Juvonen K., Halttunen M., Vyörykkä J., Spectroscopic methods for determination of latex content of coating layers, *Nordic Pulp Paper Res. J.* **15** (2000) 579-585.