Hochschule für Technik, Wirtschaft und Kultur Leipzig
Leipzig University of Applied Sciences

iP³ Leipzig – Institute for Printing, Processing and Packaging

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On the Penetration Behaviour of Paper in Terms of Printability

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cooperative PhD Program

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HTWK Leipzig I Faculty of Media **I** Field Materials and Material Testing

Characterization of surface properties of substrates in terms of processability in printing and packaging processes using spectroscopic methods and dynamic penetration measurements

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Agenda

1. Motivation and Challenge
2. Influences on ultrasonic signal changes
3. Paper Model of Dynamic Penetration Measurements
4. Statistical Analysis

1. Motivation and Challenge

How is the manner of interaction of paper and ink?

Which measurement techniques can be used to identify these interactions?

Dynamic Penetration Measurement with Ultrasound
time-resolved detection of all wetting phases

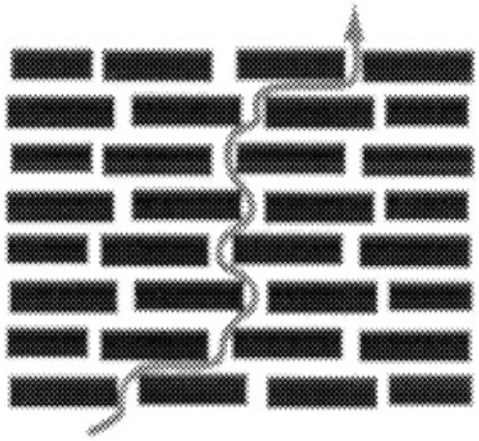
IR-Spectroscopy
static, local-resolved detection of chemical ingredients

Characterization of substrates in terms of relevant ink transfer properties

Improving the predictability of the printing process

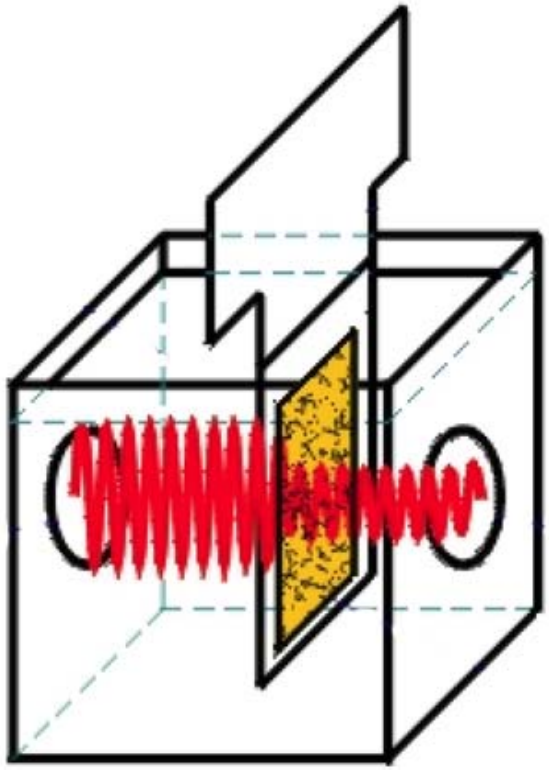
Substrate Paper

- Paper is a complex, porous and inhomogenious material with swellable plant fibres
  - Important characteristics:
    - Porosity
    - Tortuosity

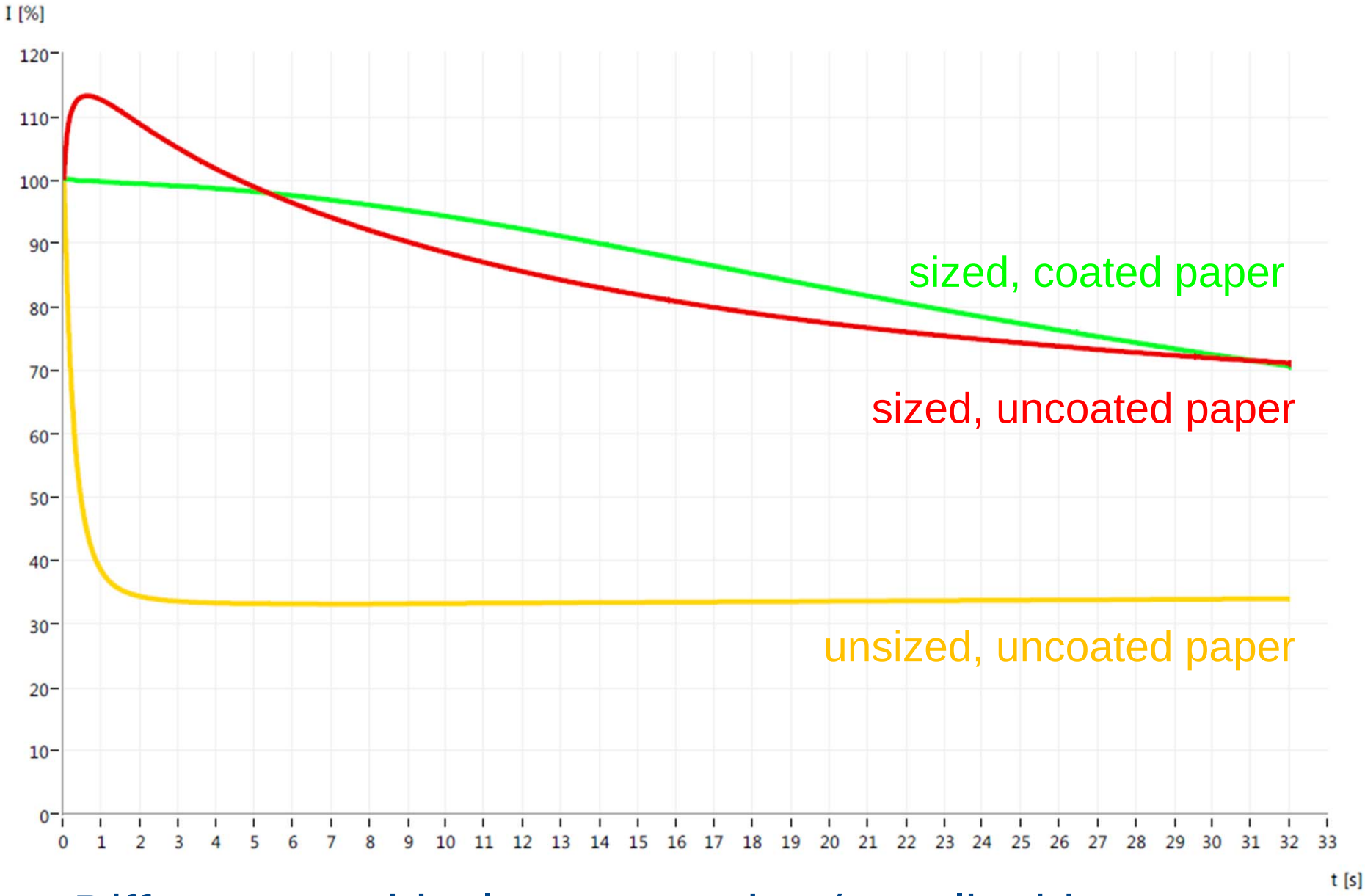


Source: PTS-FB
IW 081047

Measurement Device



source: emtec



Different graphical paper grades / test liquid: water

2. Influences on ultrasonic signal changes

Hypothesis:
Because of swelling processes small air bubbles are generated in the fiber structure on which the ultrasonic signal is scattered and therefore attenuated.

Which processes are responsible for the attenuation of ultrasound?

Is the main reason really captured air in the fibre network?

Is it possible to remove the air out of the paper?

SEM images of paper cross-sections

Mercury porosimetry of paper

Vakuum tests (Evacuating of Air out of the paper)

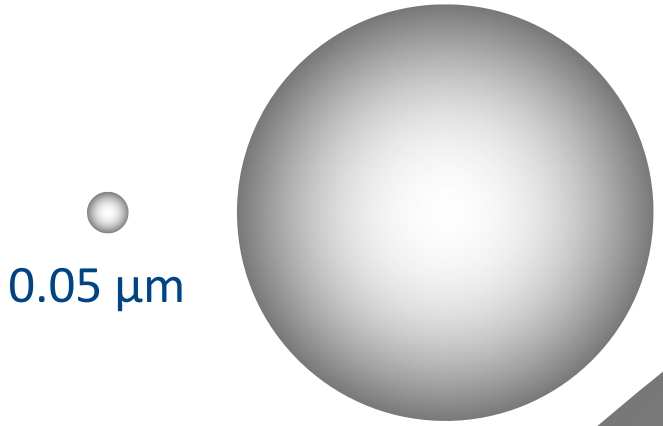
Paper Pores

pore diameters in paper:

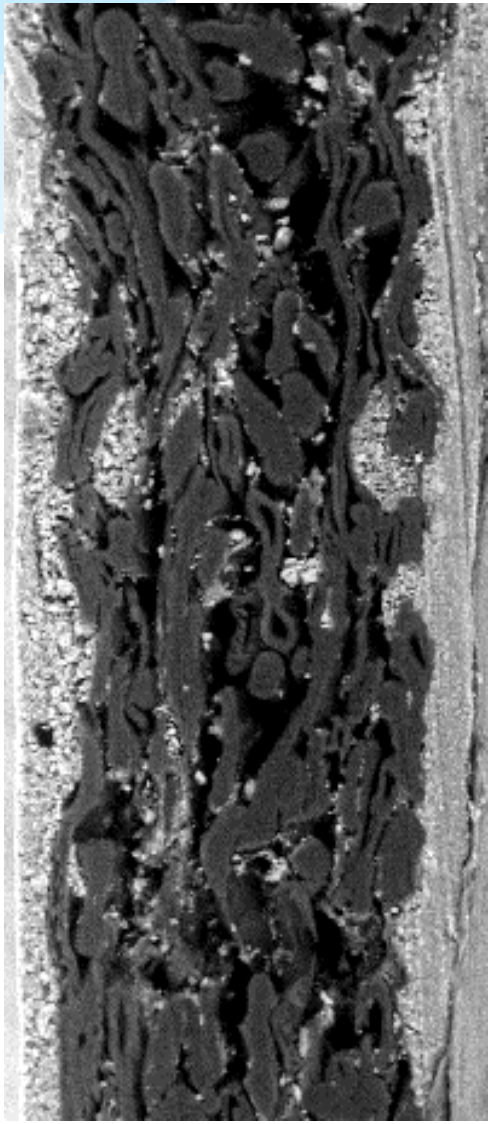
Source: PhD Thesis Dr. Arne Krolle

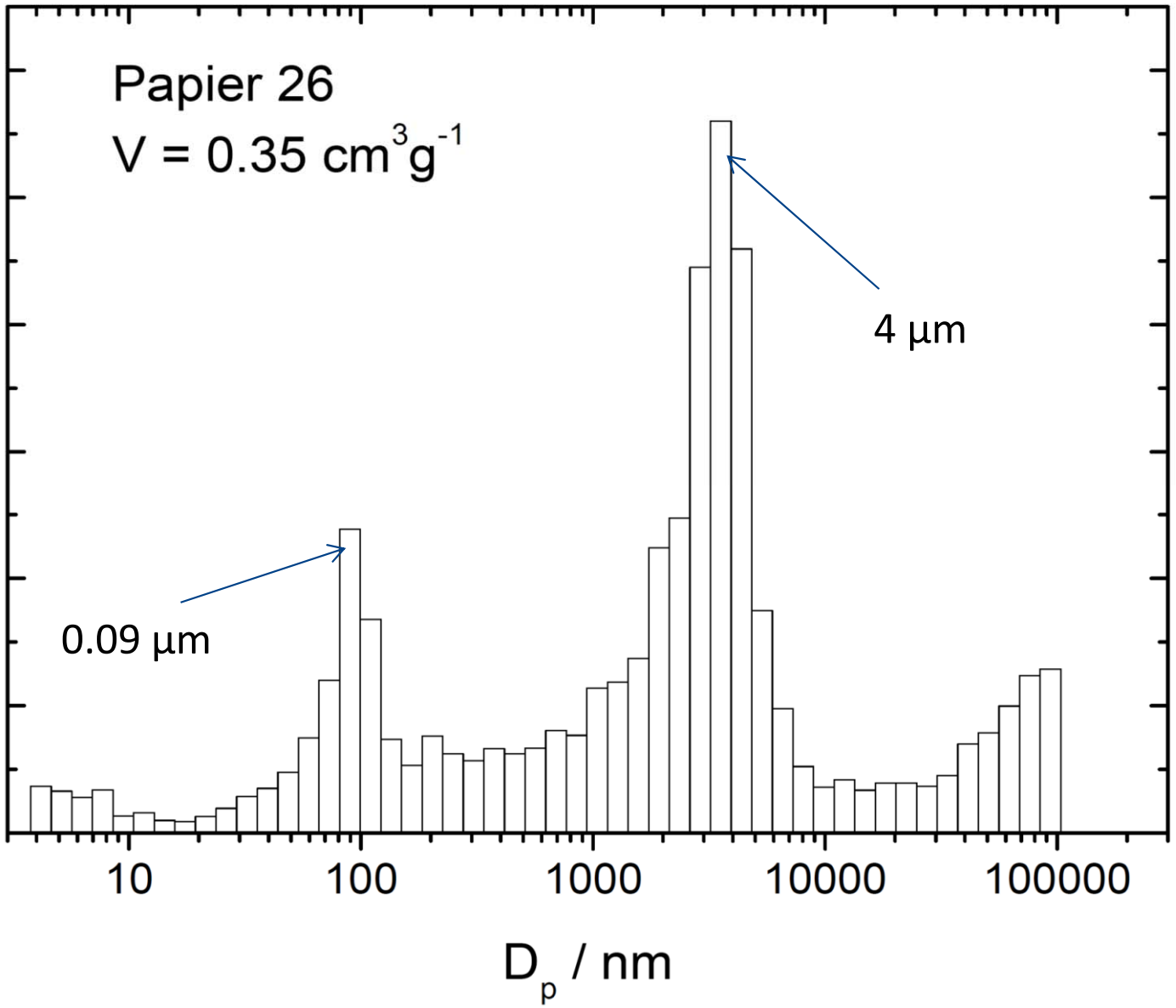
Coating: ≈ 0.05 µm – 0.5 µm

Paper Pores: ≈ 0.5 µm – 10 µm



10 µm



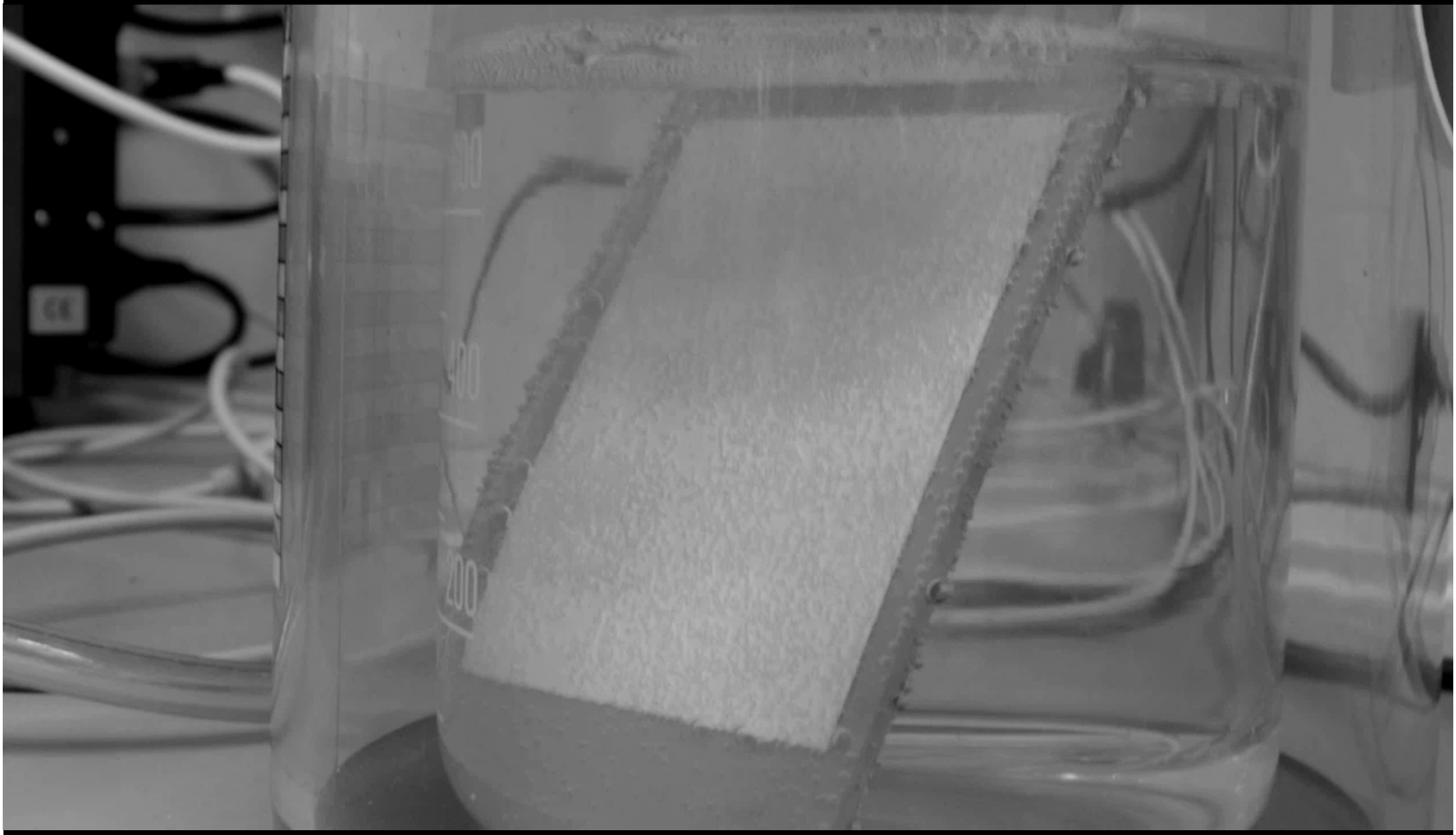


SEM Picture and Mercury Porosity of a sized and coated Papier

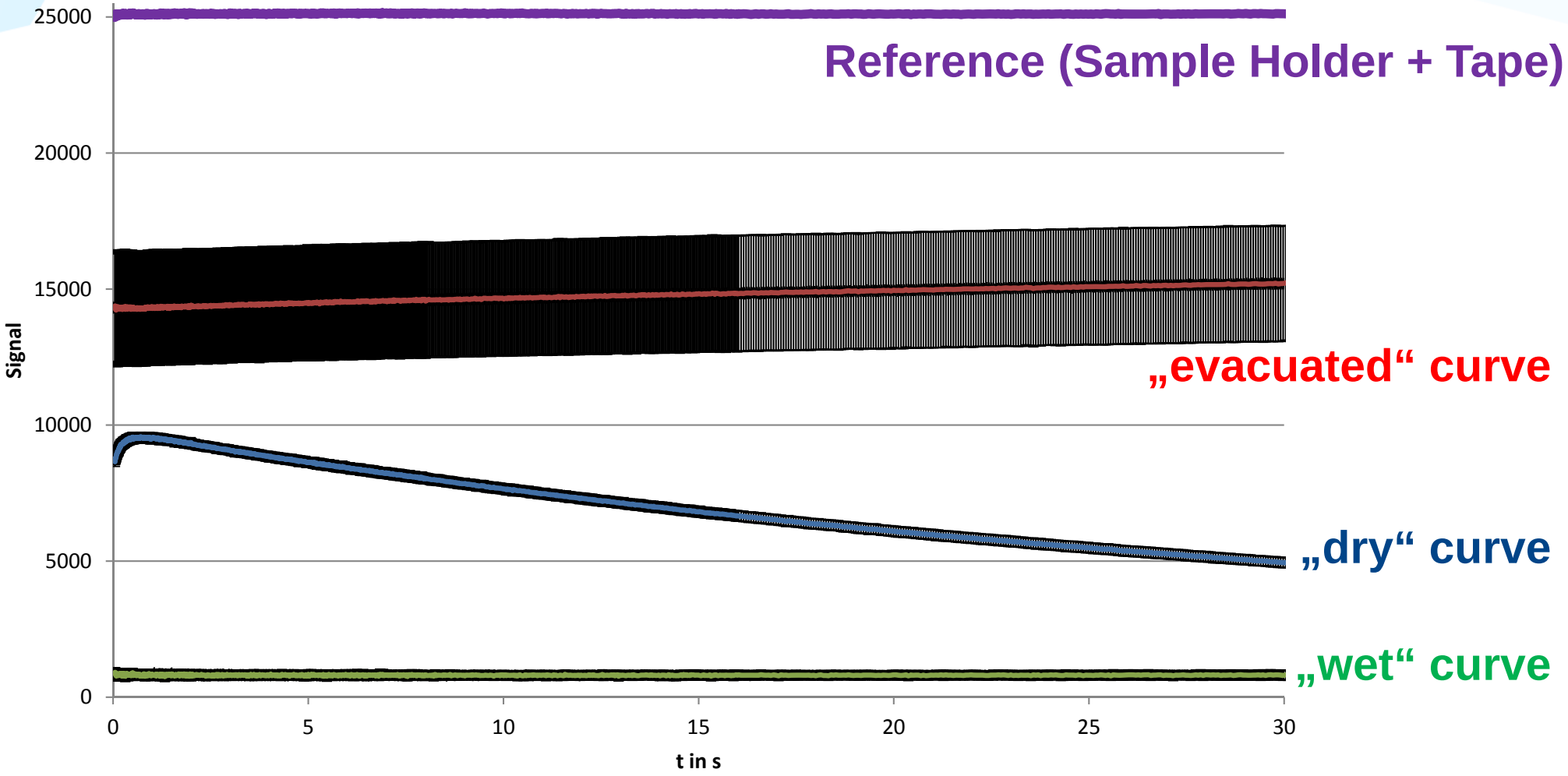
Vacuum Tests / Implementation

„dry“ measurement	„evacuated“ measurement	„wet“ measurement
Conventional DPMU of a paper sample	DPMU of the evacuated paper sample	Comparative measurement of a not evacuated paper sample (10 min „watered“)
measuring time 30 s	evacuation to 100 mbar; 1 min pressure holding time (time of this procedure 10 min); DPMU time 30 s	DPMU time 30 s

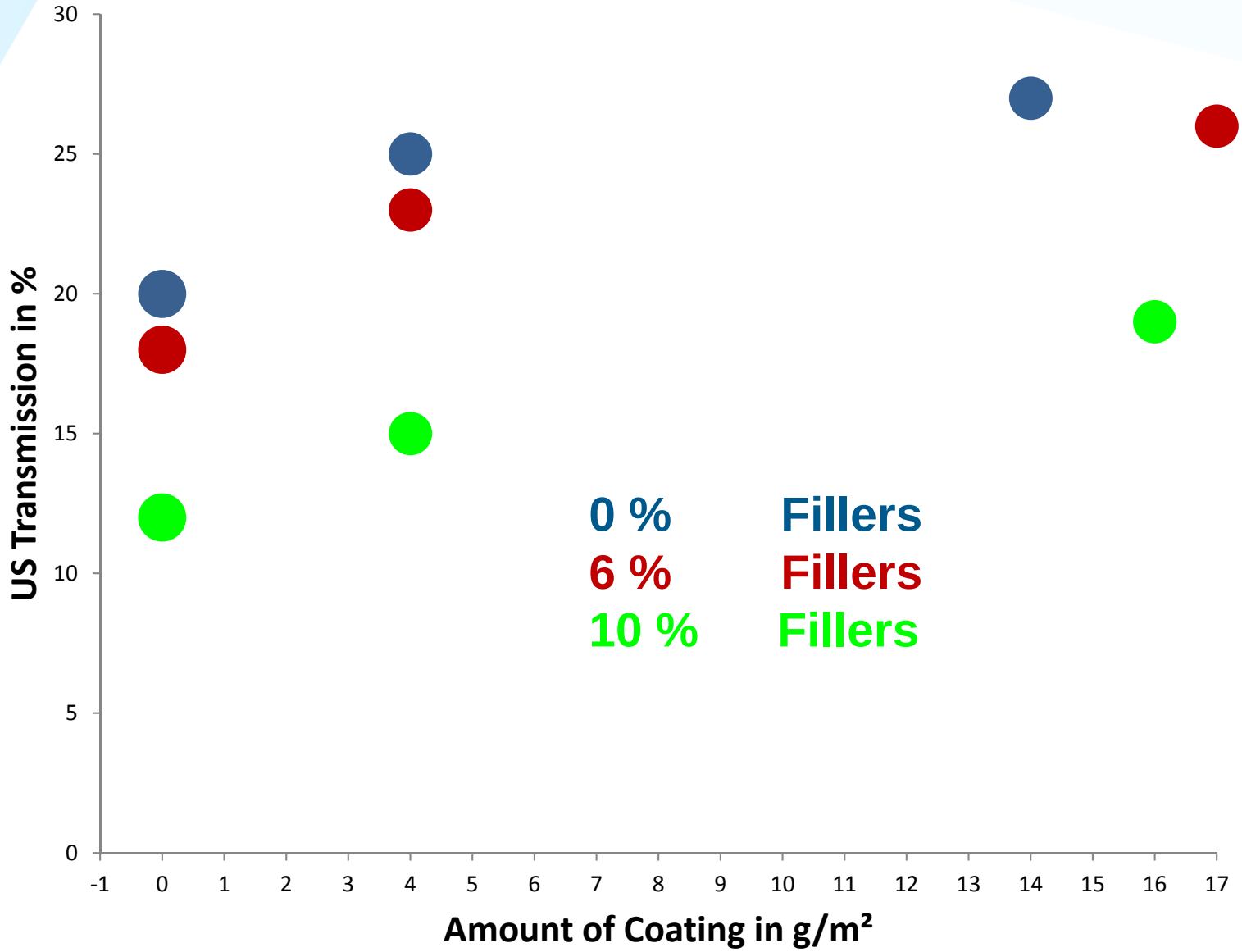
Vacuum Test / Evacuation



Vacuum Tests / measurements of the sized, uncoated paper

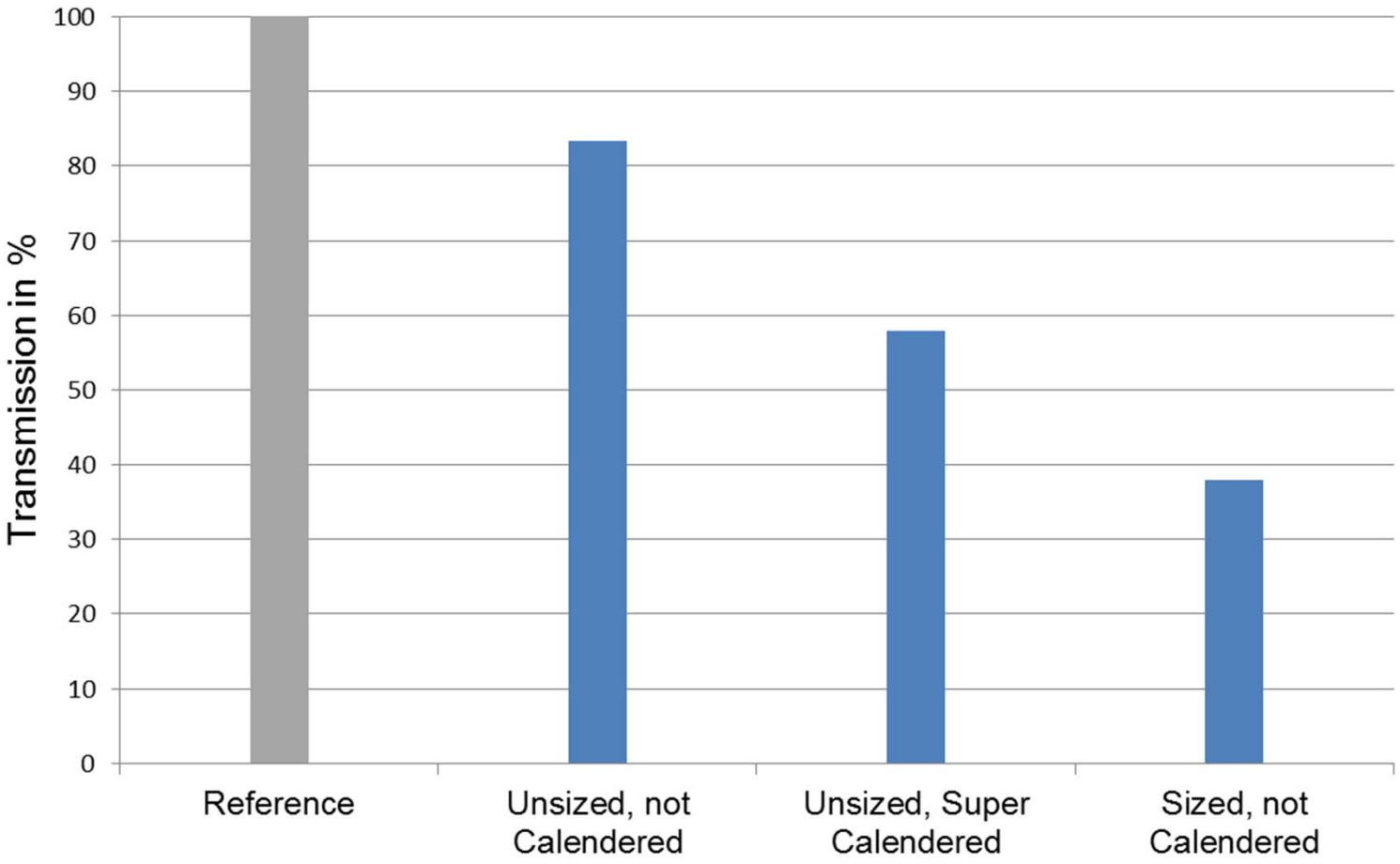


Vacuum Tests / Results of the „dry“ measurements



Influence of the filler and the amount of coating on the US Transmission

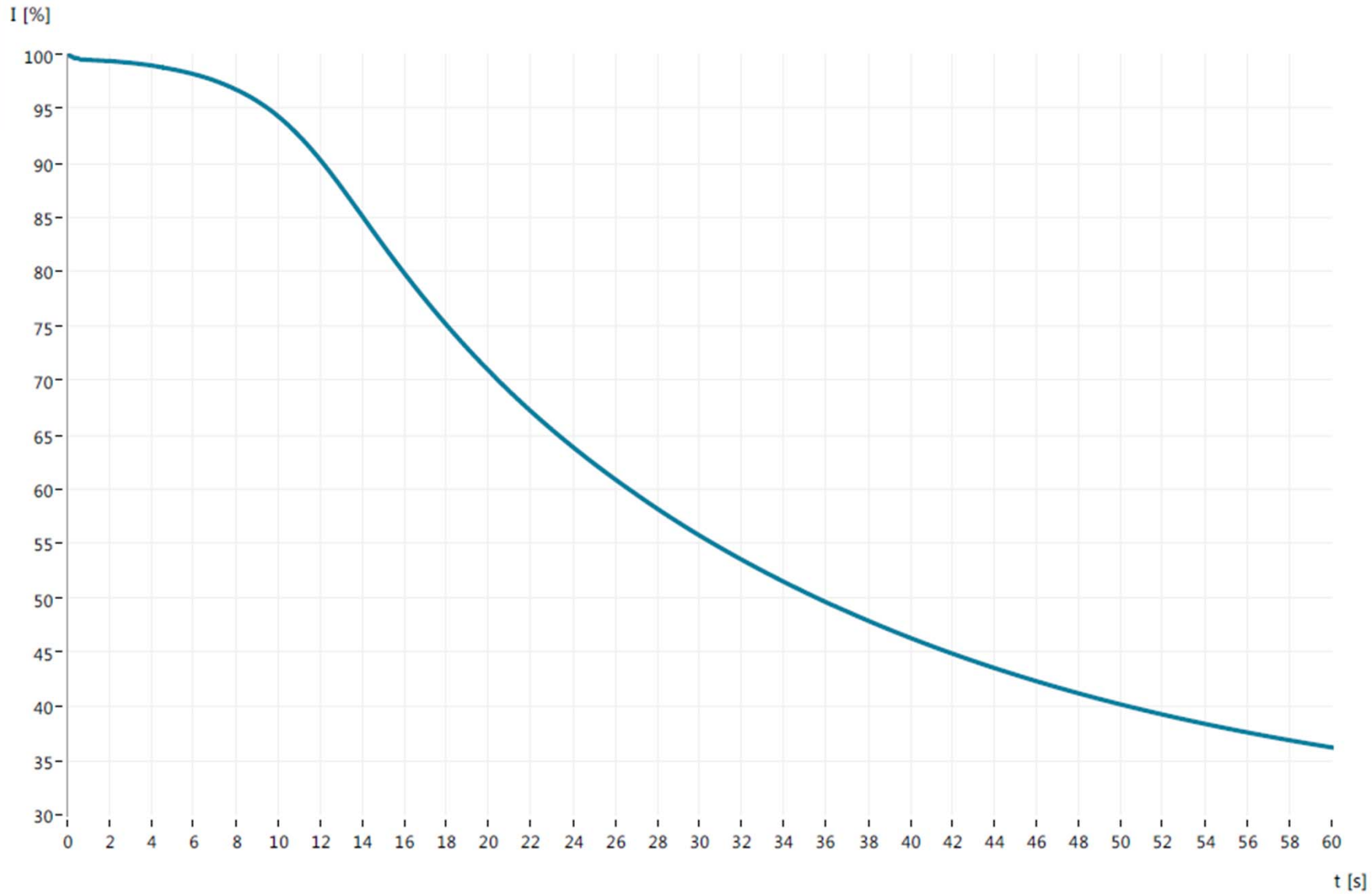
Vacuum Tests / Results of the „evacuated“ measurements



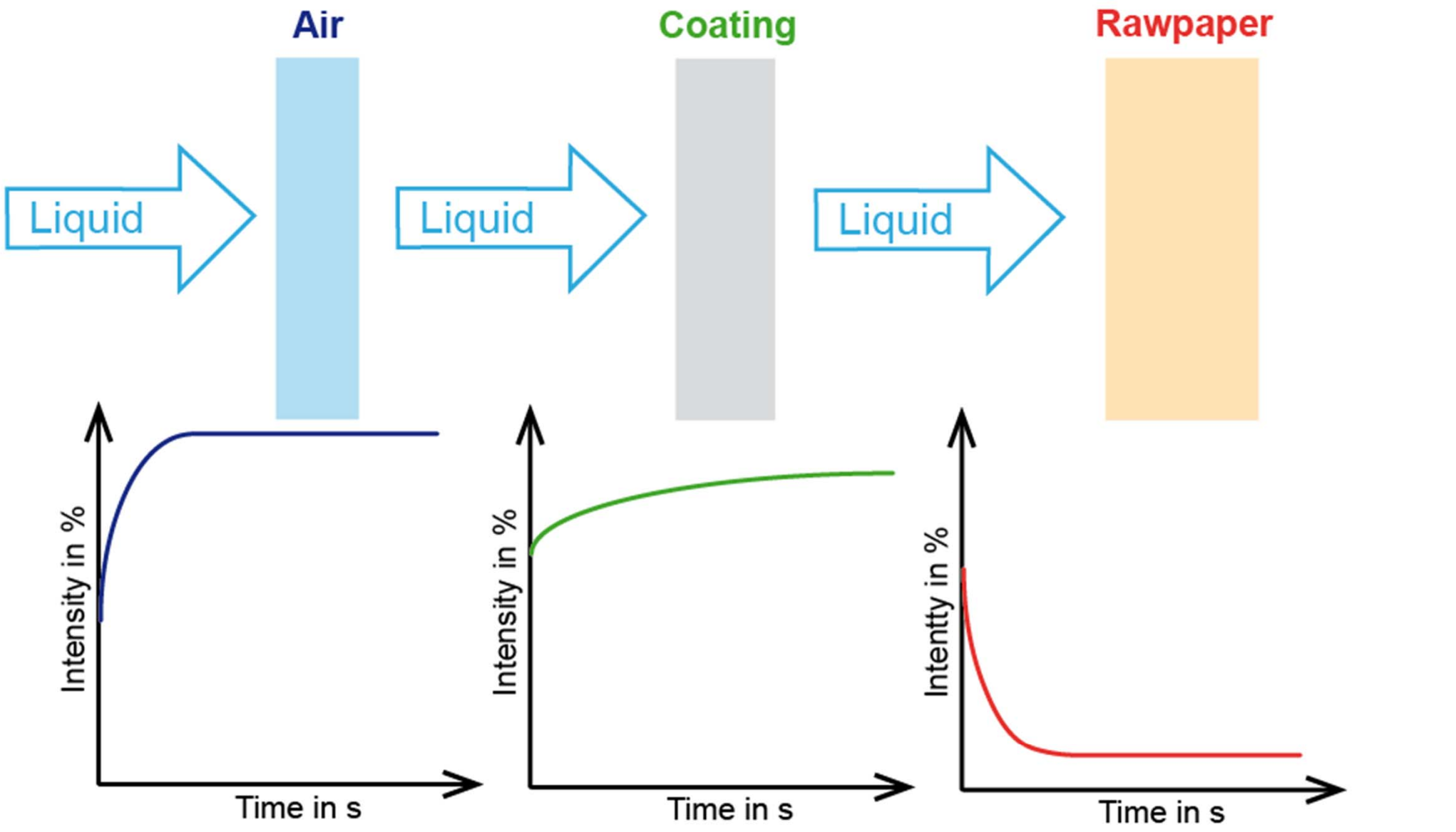
Influences of Sizing and Calendering

3. Paper Model of Dynamic Penetration Measurements

Measured Curve



Paper Model of Dynamic Penetration Measurements



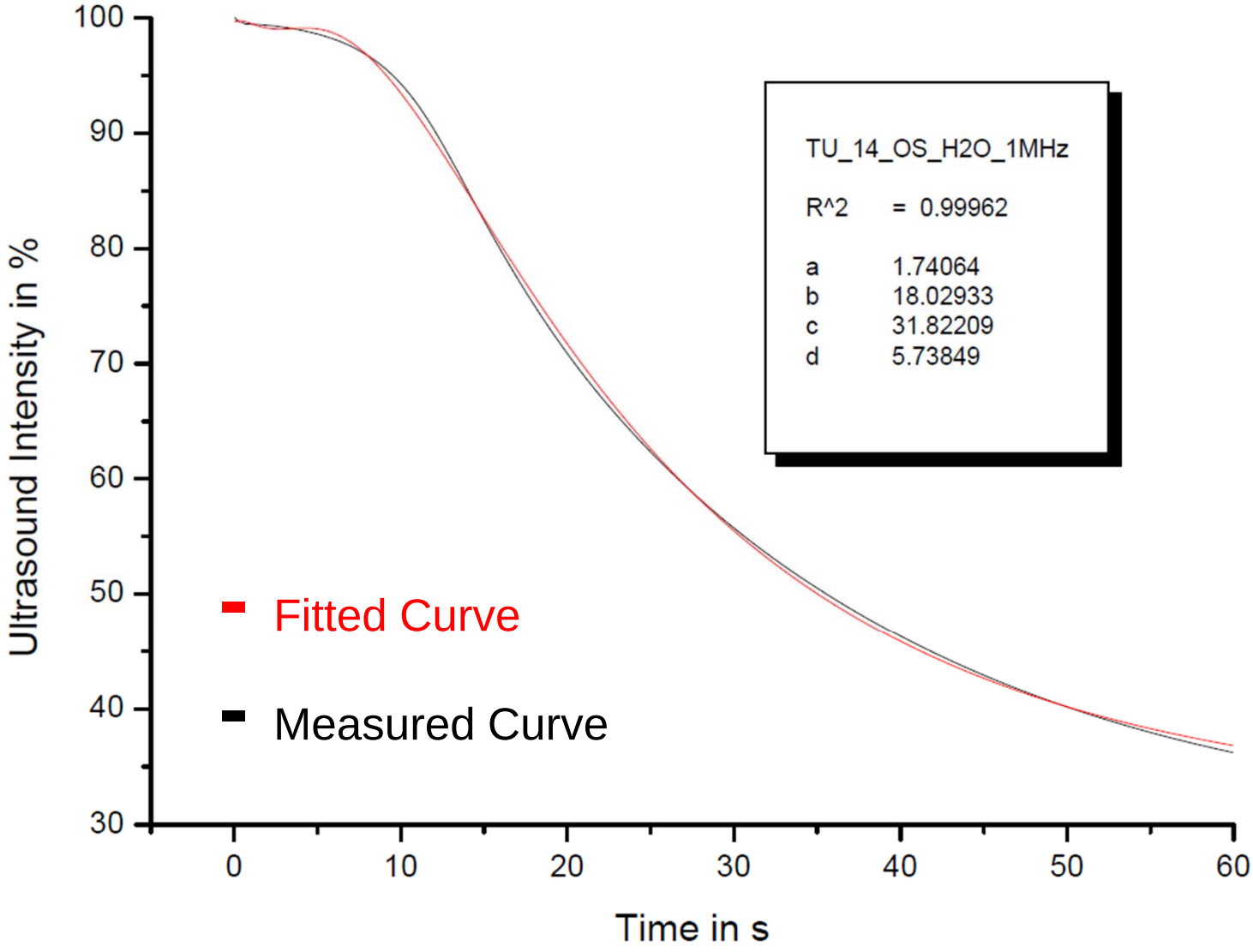
T(t) = Term 1 **Air with a** * Term 2 **Coating with b** * Term 3 **Rawpaper with c**

a... Time of Air displacement

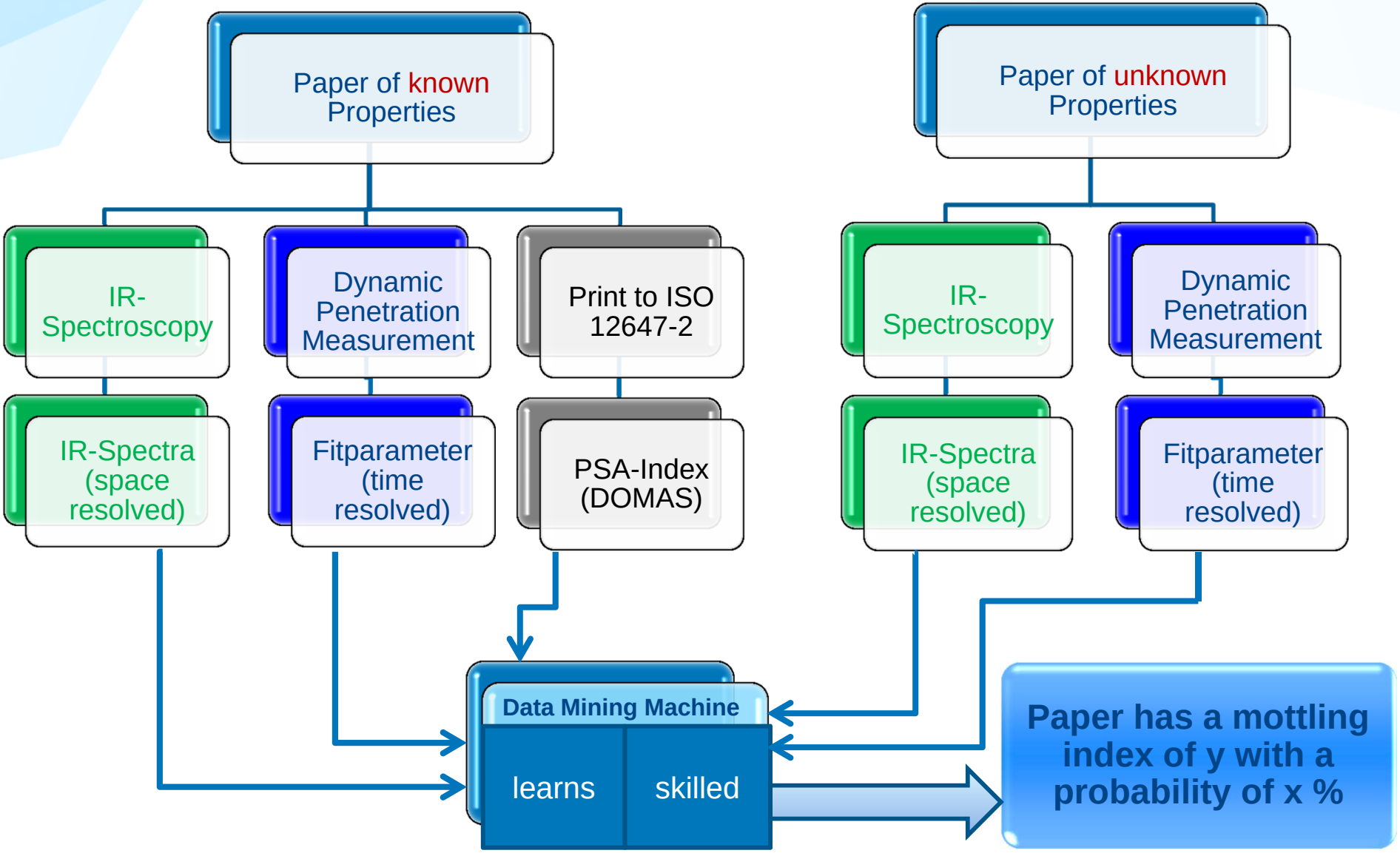
b... Time of Coating Penetration

c... Time of Rawpaper Penetration

Nonlinear Curve Fitting (NLFit)



4. Statistical Analysis


Paper of known Properties
Paper of unknown Properties
IR-Spectroscopy
Dynamic Penetration Measurement
Print to ISO 12647-2
IR-Spectroscopy
Dynamic Penetration Measurement
IR-Spectra (space resolved)
Fitparameter (time resolved)
PSA-Index (DOMAS)
IR-Spectra (space resolved)
Fitparameter (time resolved)
Data Mining Machine
learns
skilled
Paper has a mottling index of y with a probability of x %

Thank You!!!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