



## Coating of PVOH/NFC blend to develop a barrier packaging board: from lab to pilot scale

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## Introduction

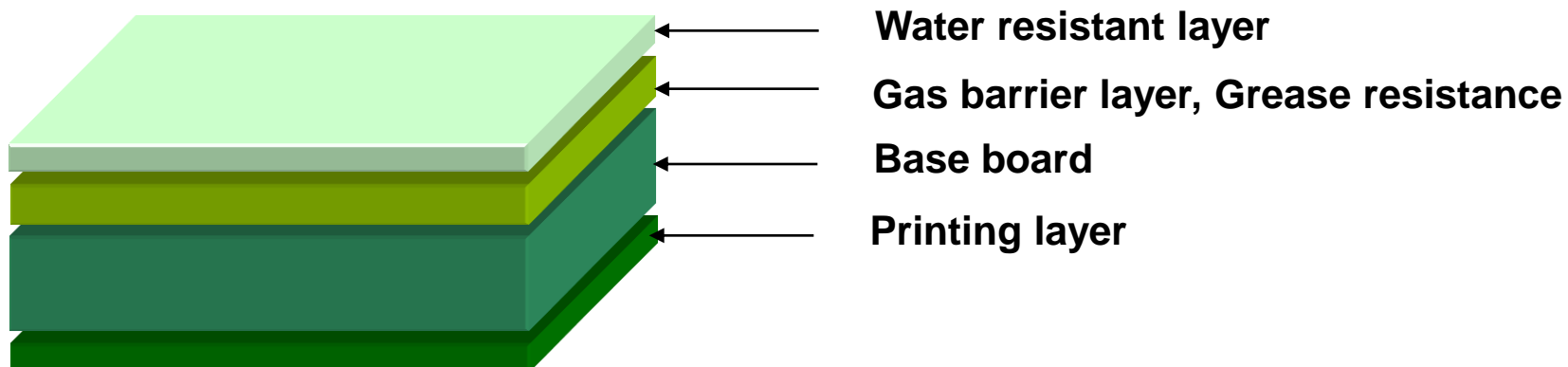
- In Europe
  - 46.4 millions tons of plastics converted in 2010
  - 39% used in packaging materials ([www.Plasticseurope.fr](http://www.Plasticseurope.fr))
- Major drawbacks
  - Cost index linked to oil price
  - Poor recyclability
  - Negative environmental impact



→ To replace petrochemical polymers  
with materials derived from renewable resources

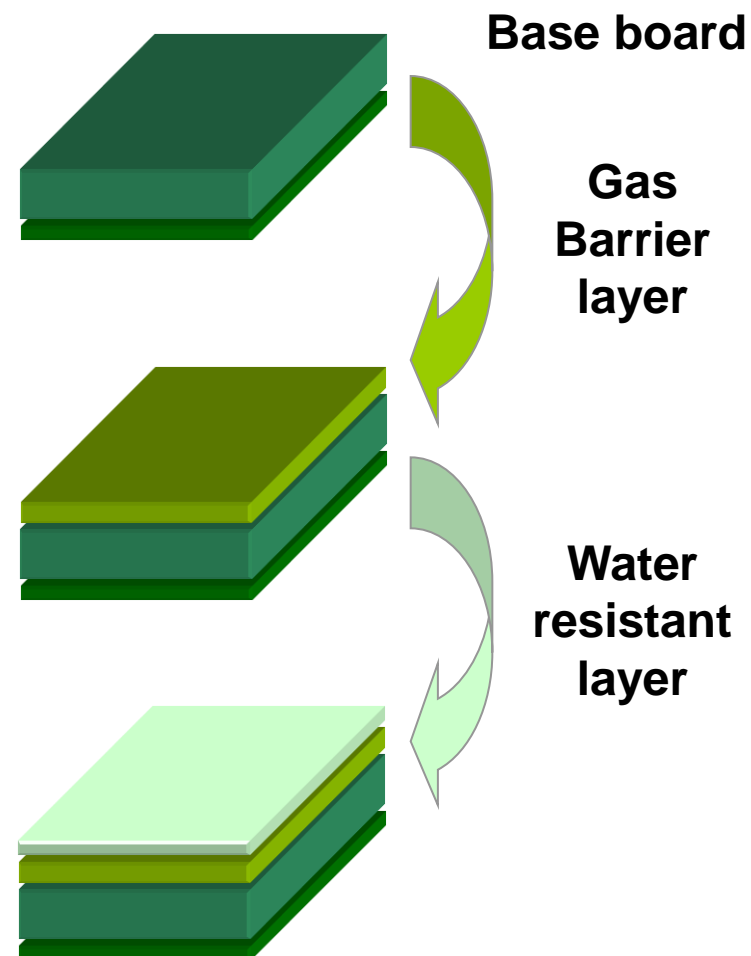
## Introduction

- Motivation
  - Micro- and nano-fibrillar cellulose (MFC/NFC)
    - Promising barrier properties
    - Good mechanical resistance
- Objective
  - Development of barrier packaging board using NFC

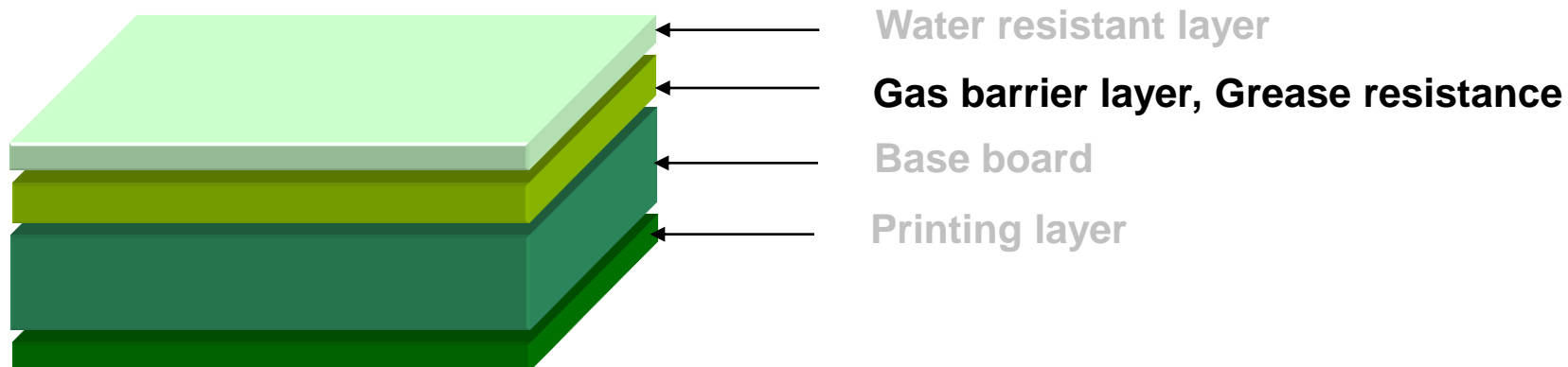


## Outline

- Development of PVOH/NFC barrier layer
  - Preliminary studies
  - Up-scaling
  - Pilot coating trials
  - Characterisation of pilot trials samples
  
- Improvement of water resistance
  - Pilot coating trials
  - Characterisation of pilot trials samples

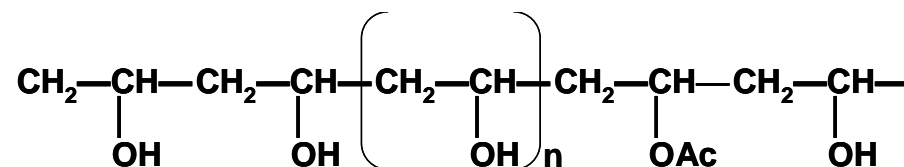


## Development of PVOH/NFC barrier layer



## Preliminary studies

- Gas barrier layer
  - NFC-CTP suspension characteristics
    - low solids 2%
    - high viscosity
    - Problems for use with coating processes
  
- Use of PVOH matrix
  - Excellent oxygen barrier properties
  - Good grease resistance
  - But water sensitive



## Preliminary studies Coating colour preparation

- Protocol development
  - To reach the highest possible solid content
  - Cooking of the PVOH matrix directly in the NFC suspension



- Homogeneous blend
- High viscosity (Brookfield 100 rpm: 1200 mPa.s for a ratio 90/10)

## From Lab scale to Pilot scale

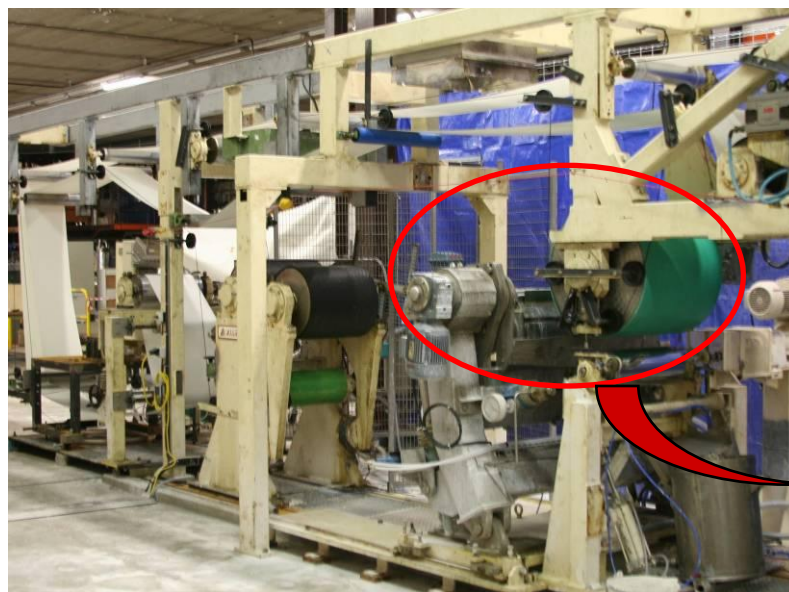
- Lab Scale



**Endupap:** Rod coating - sheets



- Pilot Scale



**Pilot Coater:** Rod / Blade - reels



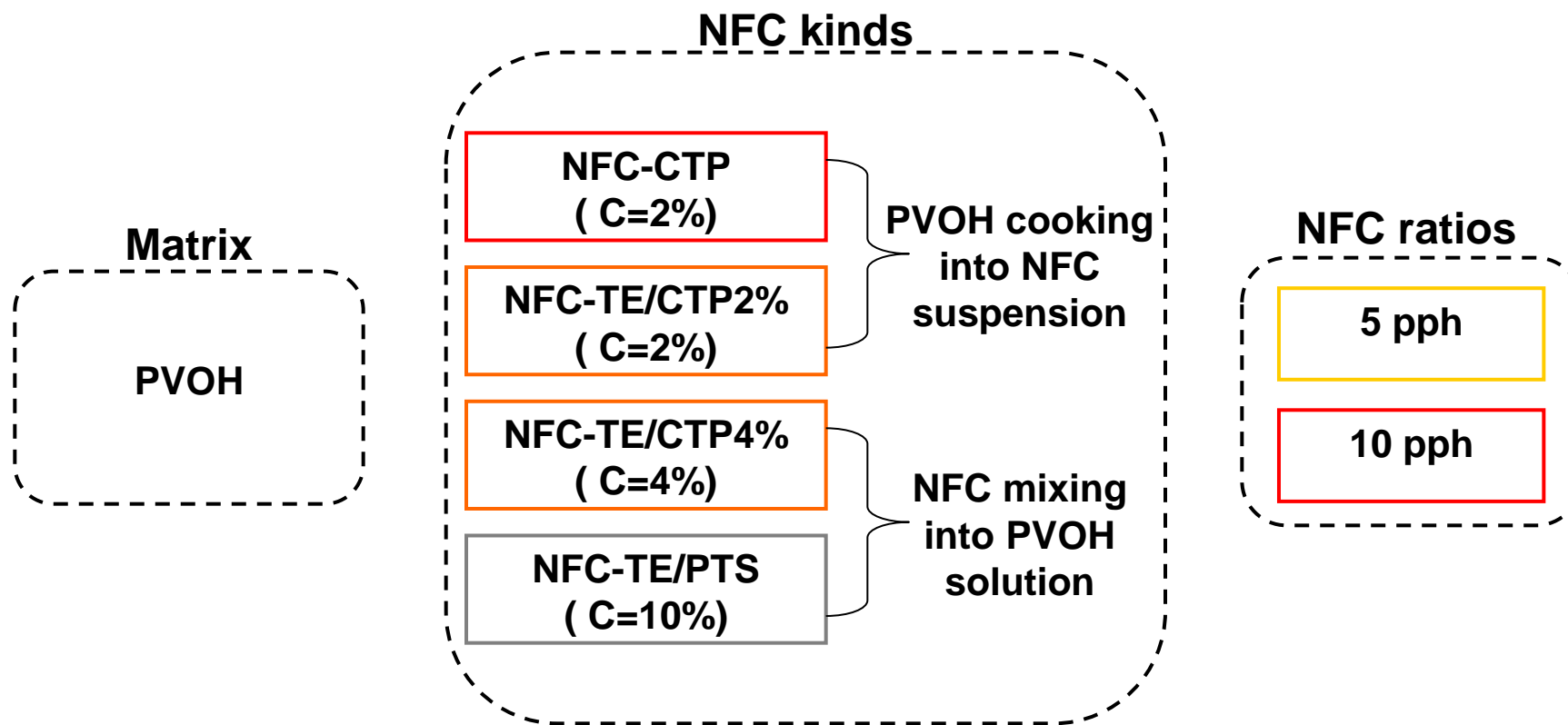
## From Lab scale to Pilot scale

	Lab scale	Pilot scale
Cooking of PVOH in NFC suspension	Water bath	Direct steam injection
Rheology of coating colour	Large viscosity range	Viscosity adapted to the equipment (pumping, coating system)
Coat weight	Several passes possible	Machine speed, Blade parameters
Drying behaviour	Long drying time possible	Machine speed

# Pilot trials

## Introduction of NFC in a PVOH matrix

- Coating colour



## From Lab scale to Pilot scale Coating colour preparation

- Cooking of PVOH in NFC suspensions



- Up scaling validated ✓

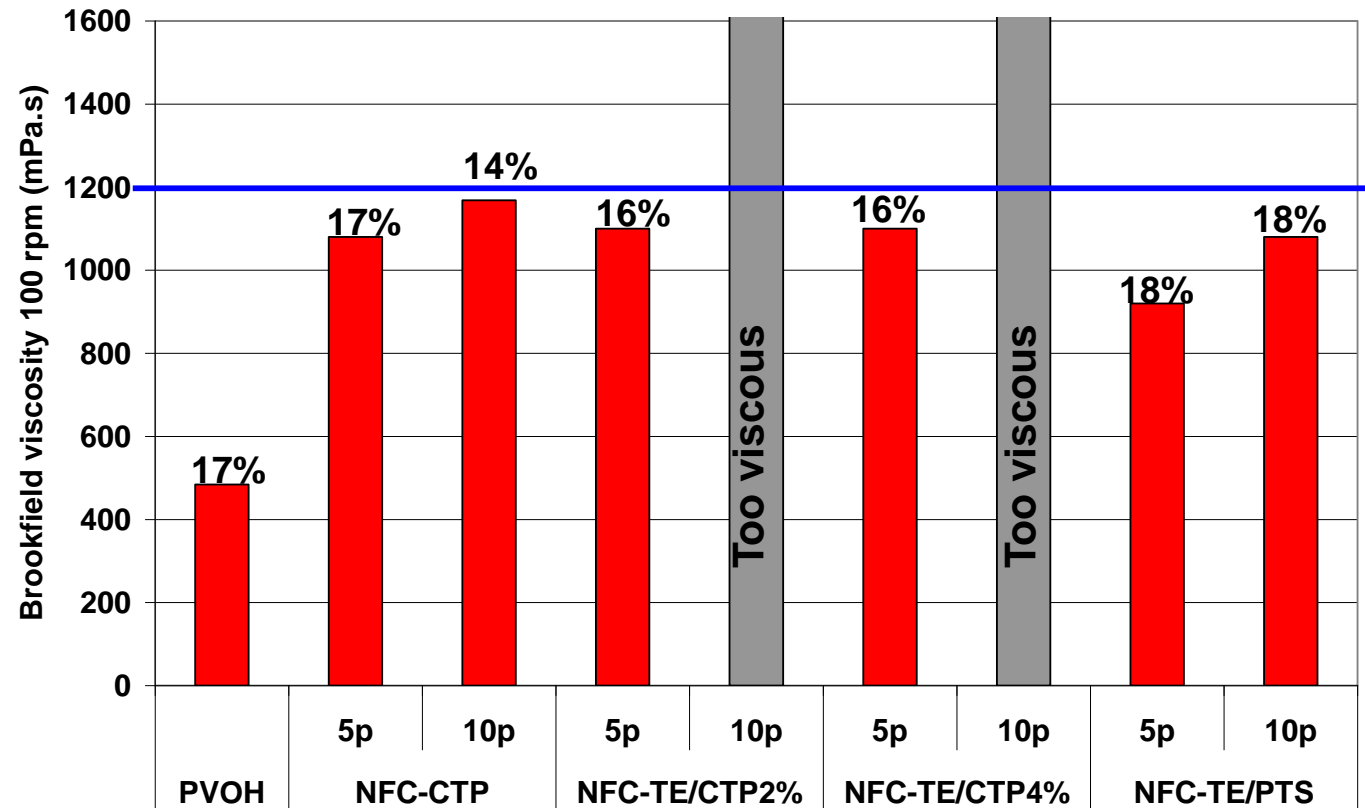
## From Lab scale to Pilot scale Optimization of coating colour viscosity

- Back flow problems

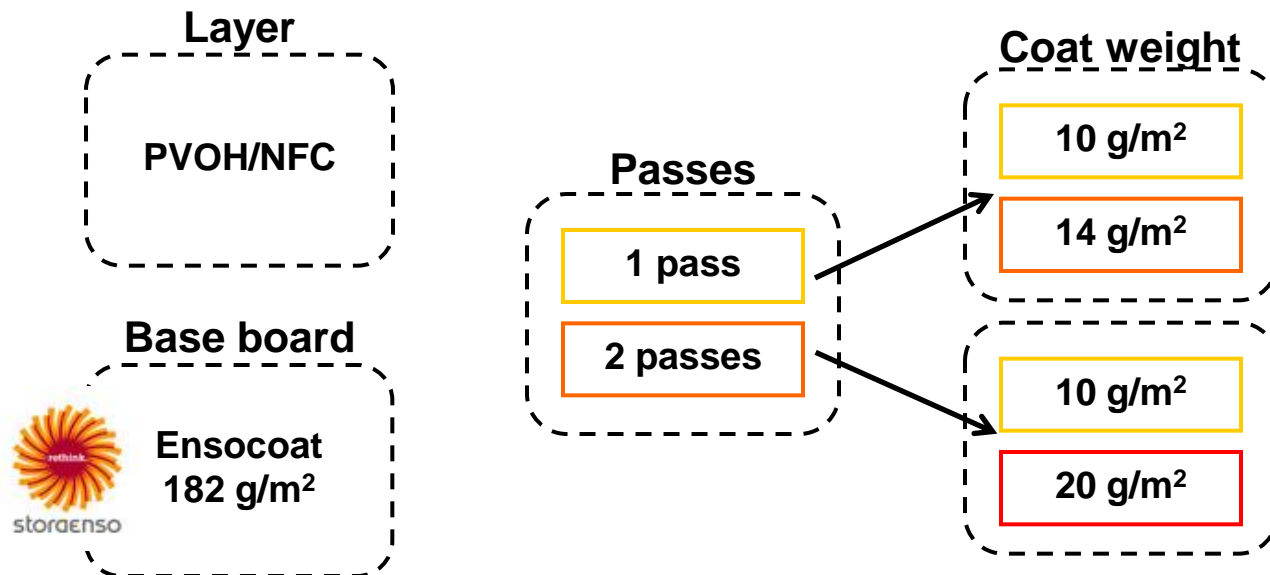


## From Lab scale to Pilot scale Optimization of coating colour viscosity

- Back flow problems → Upper limit in viscosity: 1200 mPa.s
- Minimum coat weight → Lower limit in solids: 14%



## Pilot trials



- Coating: SoftTip blade
- Drying: electric IR + Forced hot air
- Speed: 70 m/min

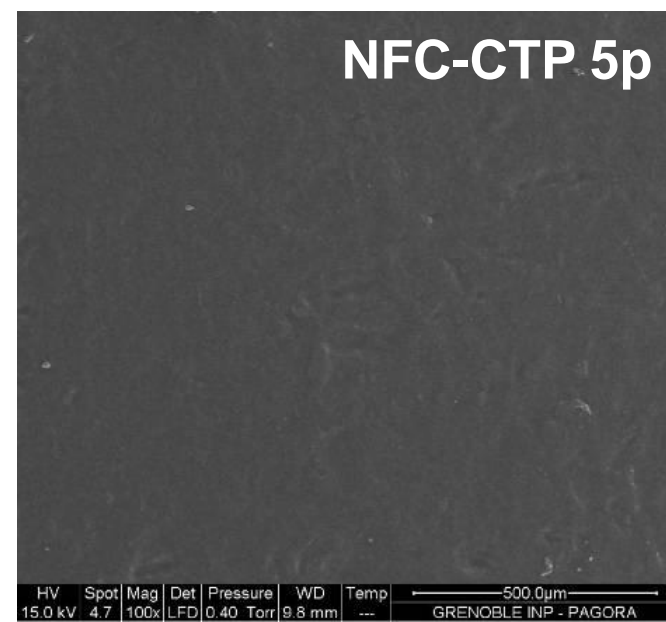
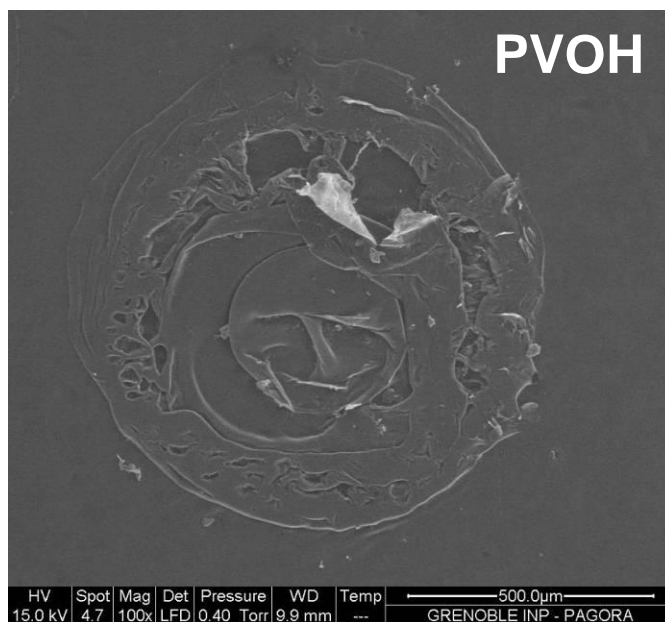
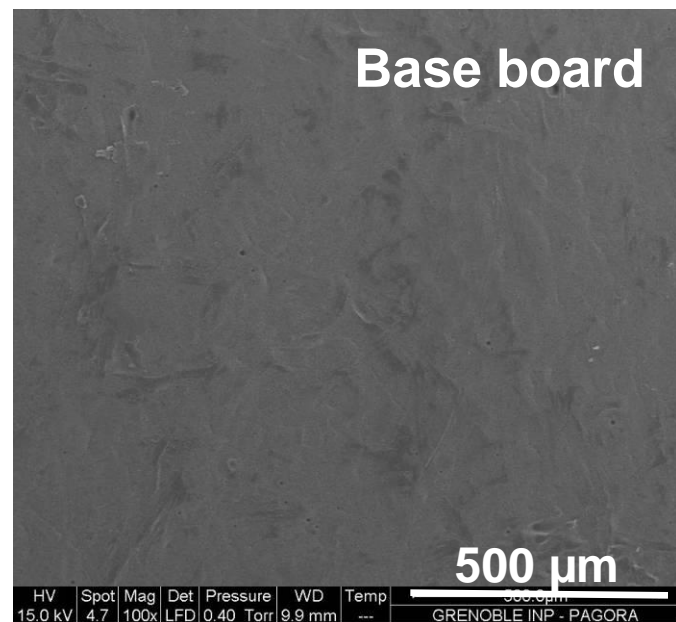
## From Lab scale to Pilot scale Drying behaviour

- Importance of drying strategies
  - PVOH
    - Very film forming
    - Appropriate drying strategy very hard to find → blistering
    - Samples very difficult to produce
  - PVOH/NFC
    - Better behaviour
    - Great improvement of the layer drying → quite no more blistering
    - Possible increase of the coat weight

→ Great improvement of runnability and productivity  
with the use of NFC

## Good coverage of coated board

- SEM photos of PVOH and PVOH/NFC coated board



- Blistering



## Barrier properties of coated boards

### Oil and grease resistance

- Cobb index 24H with coloured peanut oil

Base board

NFC-CTP 5p / 10 g/m<sup>2</sup>



**Cobb index: 200 g/m<sup>2</sup>**

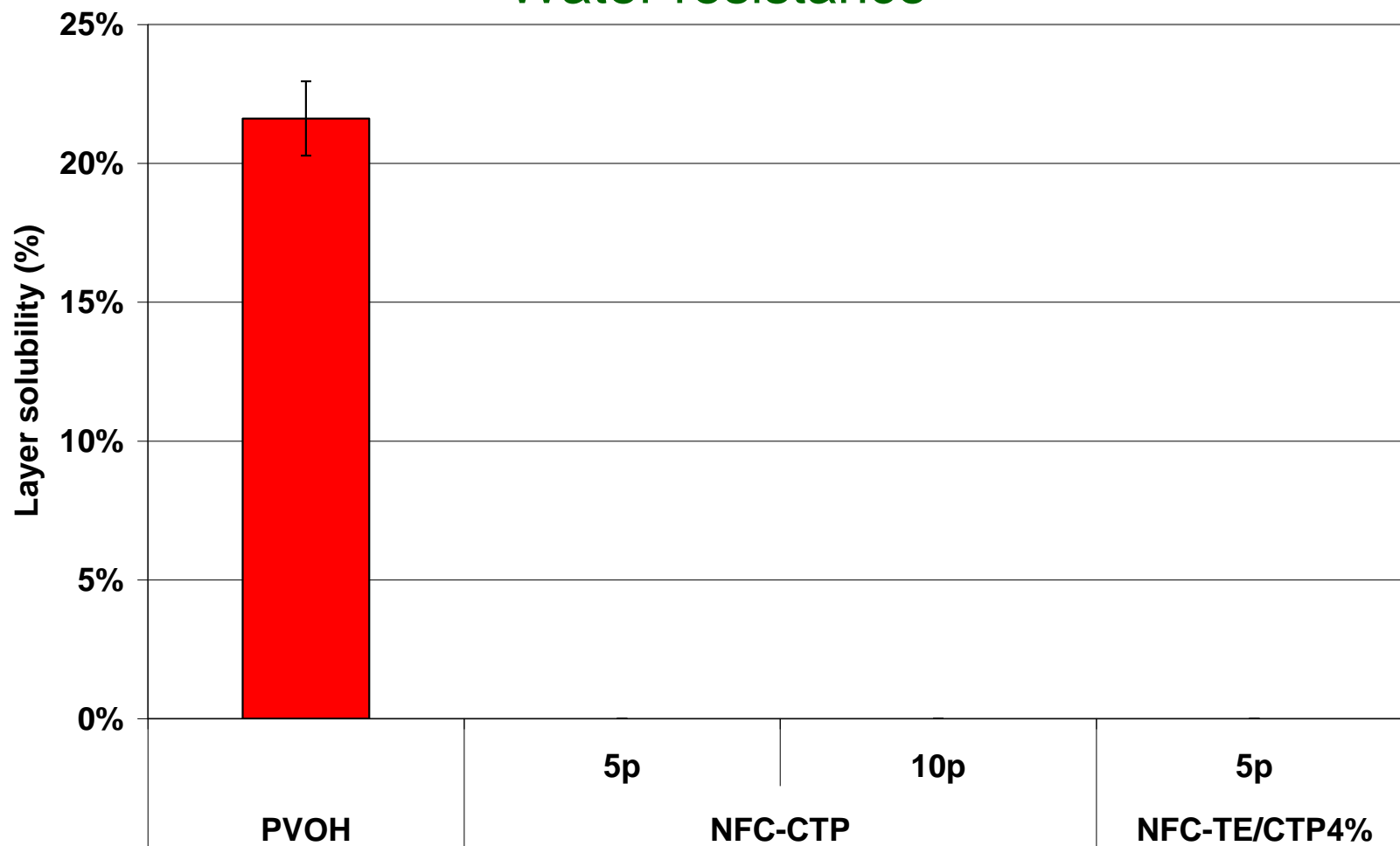
**Cobb index: 2 g/m<sup>2</sup>**

## Barrier properties of coated boards

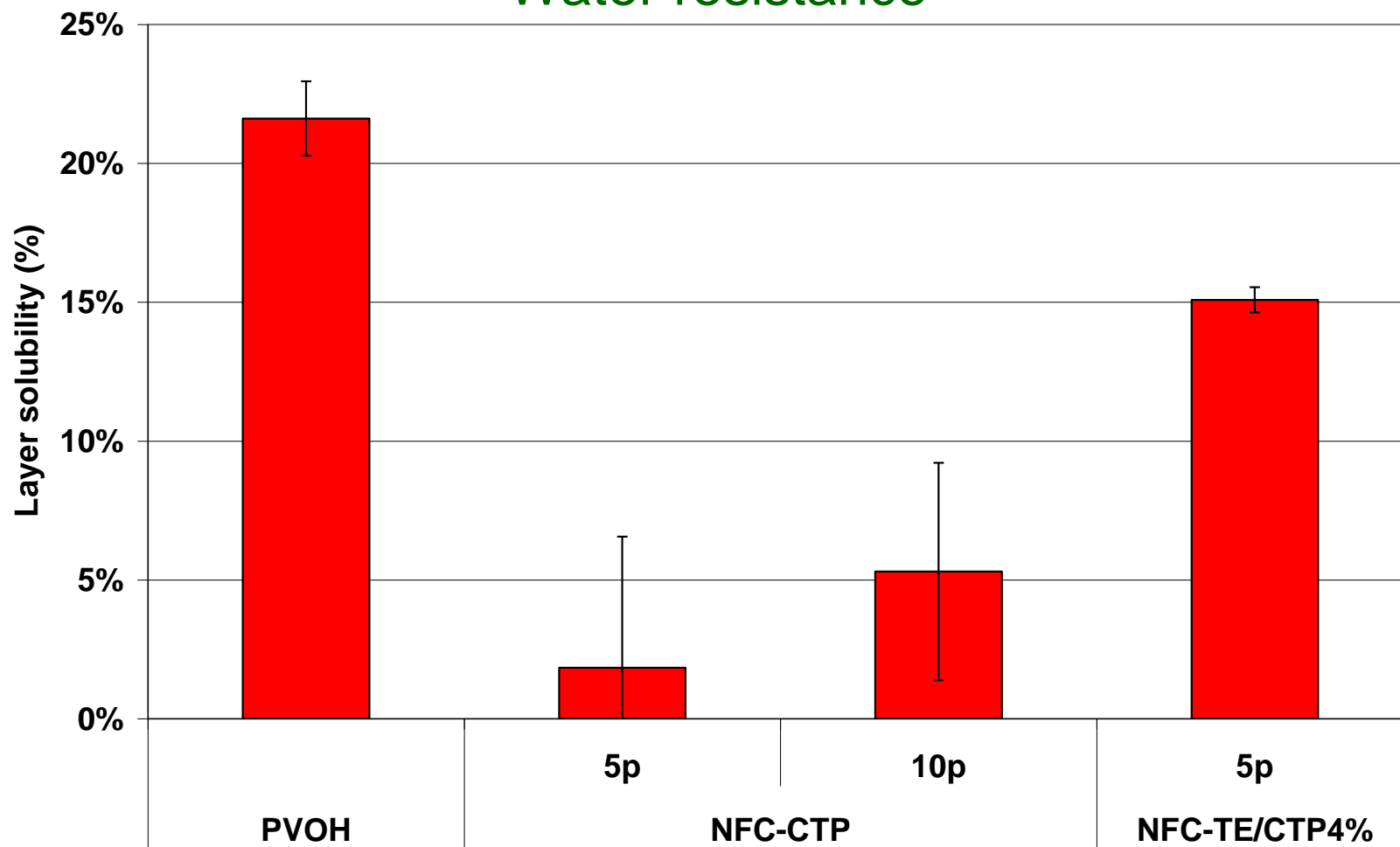
### Water resistance

- Specific Cobb60 Measurement due to layer solubility
  - Classic Cobb measurement of the sample
  - Dry grammage measurement of the sample analysed
  - Solubility calculation
  - Calculation of the Cobb\* index taking into account the solubility of the layer

## Barrier properties of coated boards Water resistance

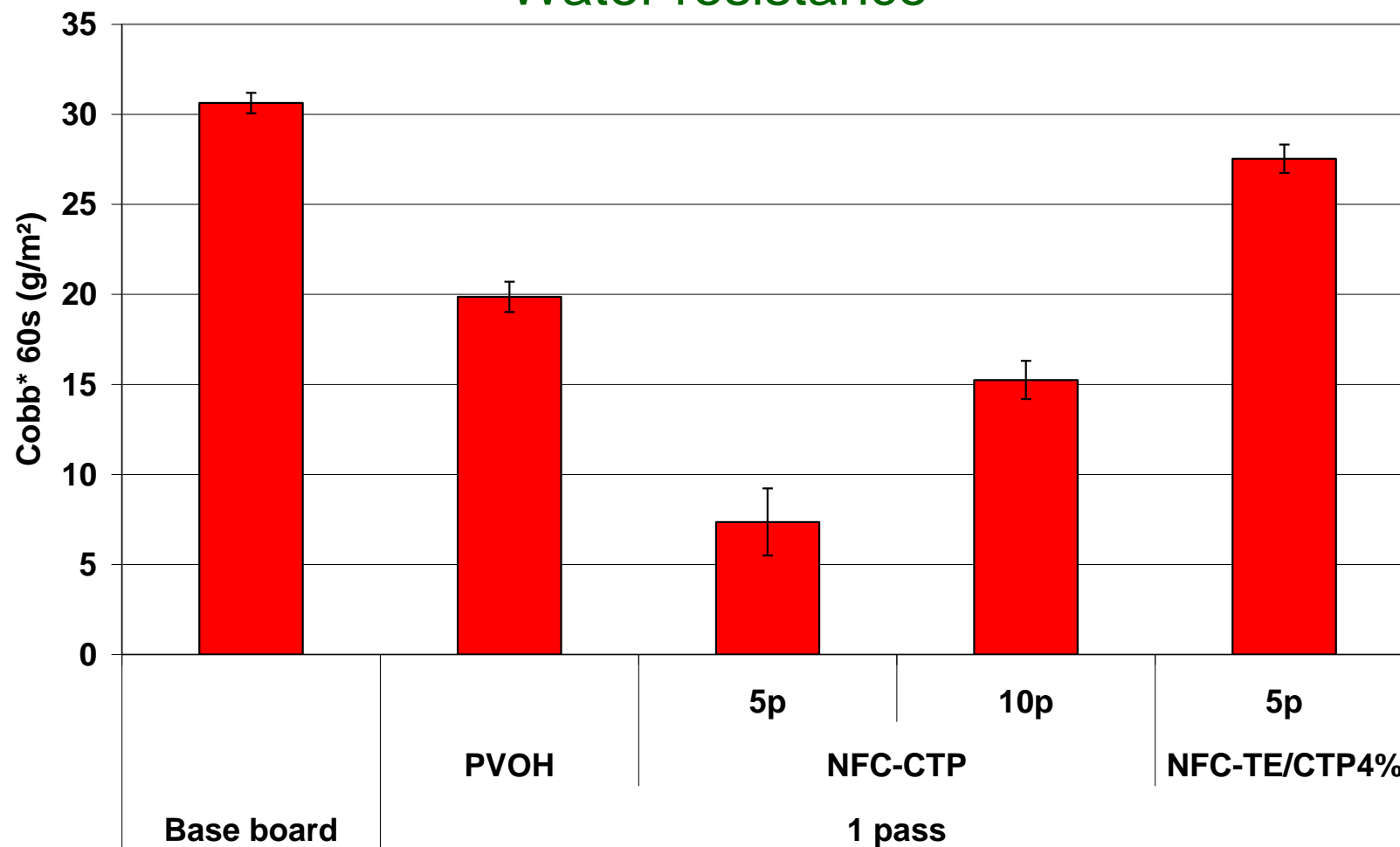


## Barrier properties of coated boards Water resistance



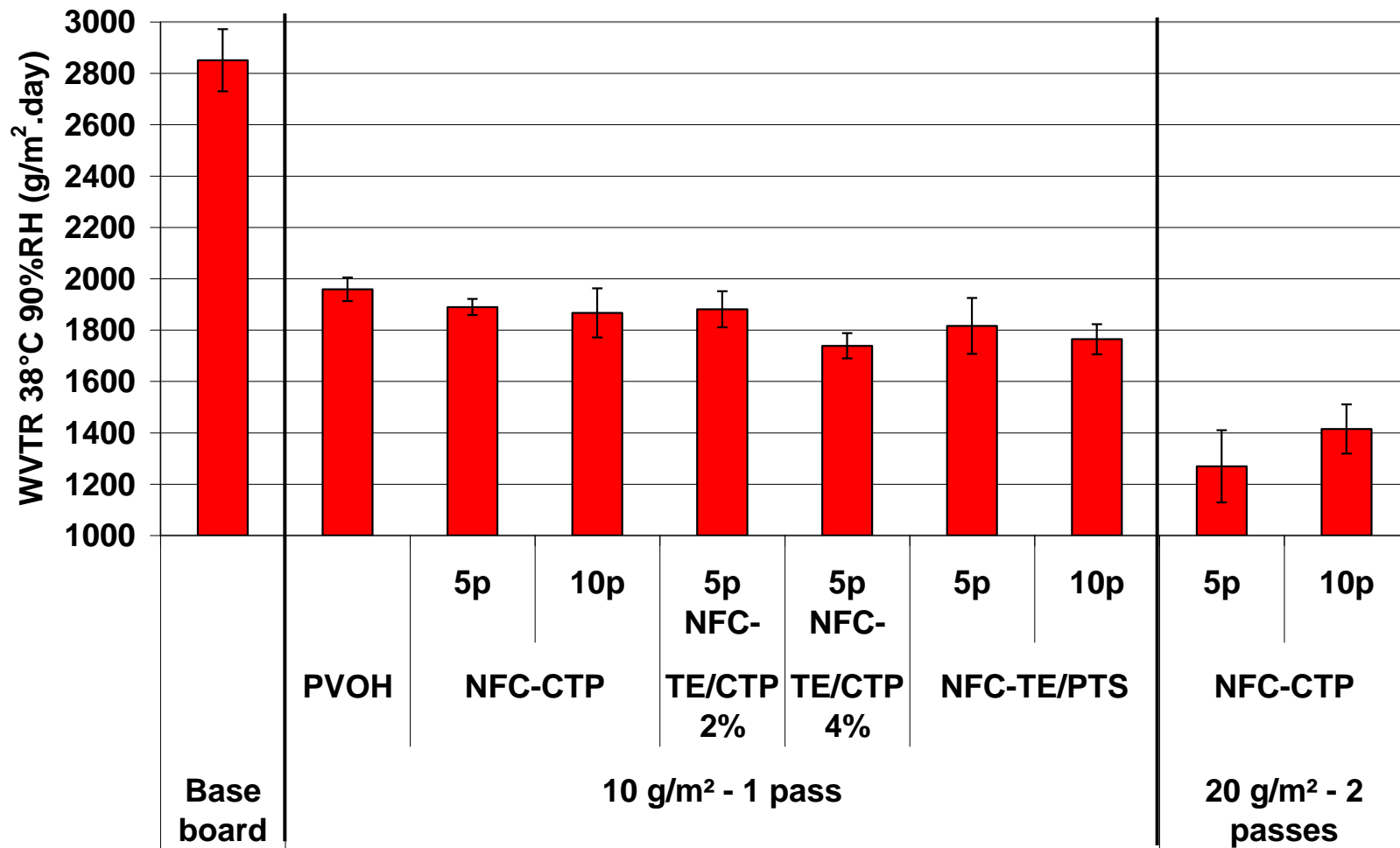
## Barrier properties of coated boards

### Water resistance



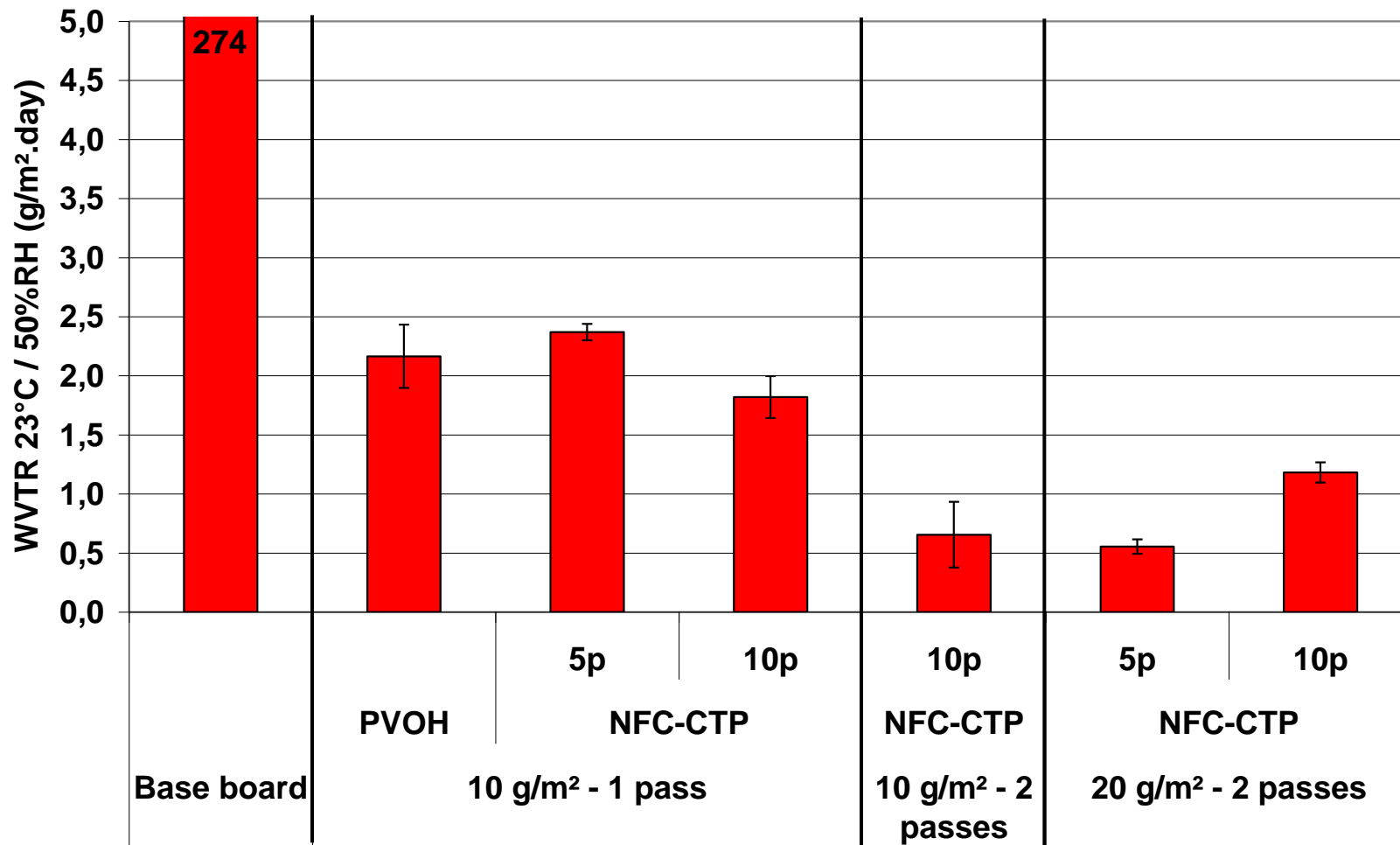
## Barrier properties of coated boards

### WVTR at 38°C 90%RH



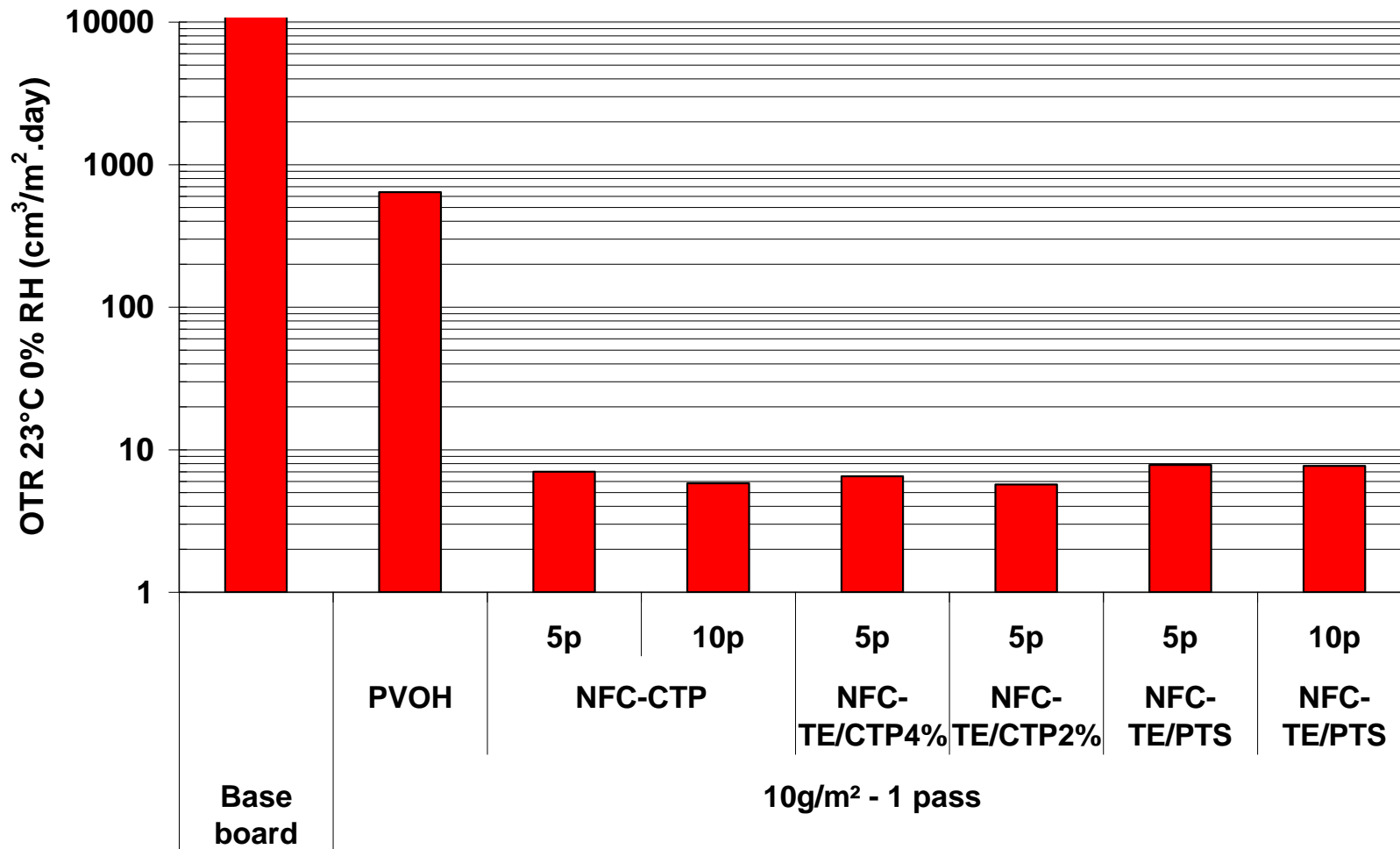
## Barrier properties of coated boards

### WVTR at 23°C 50%RH



## Barrier properties of coated boards

### OTR at 23°C 0%RH



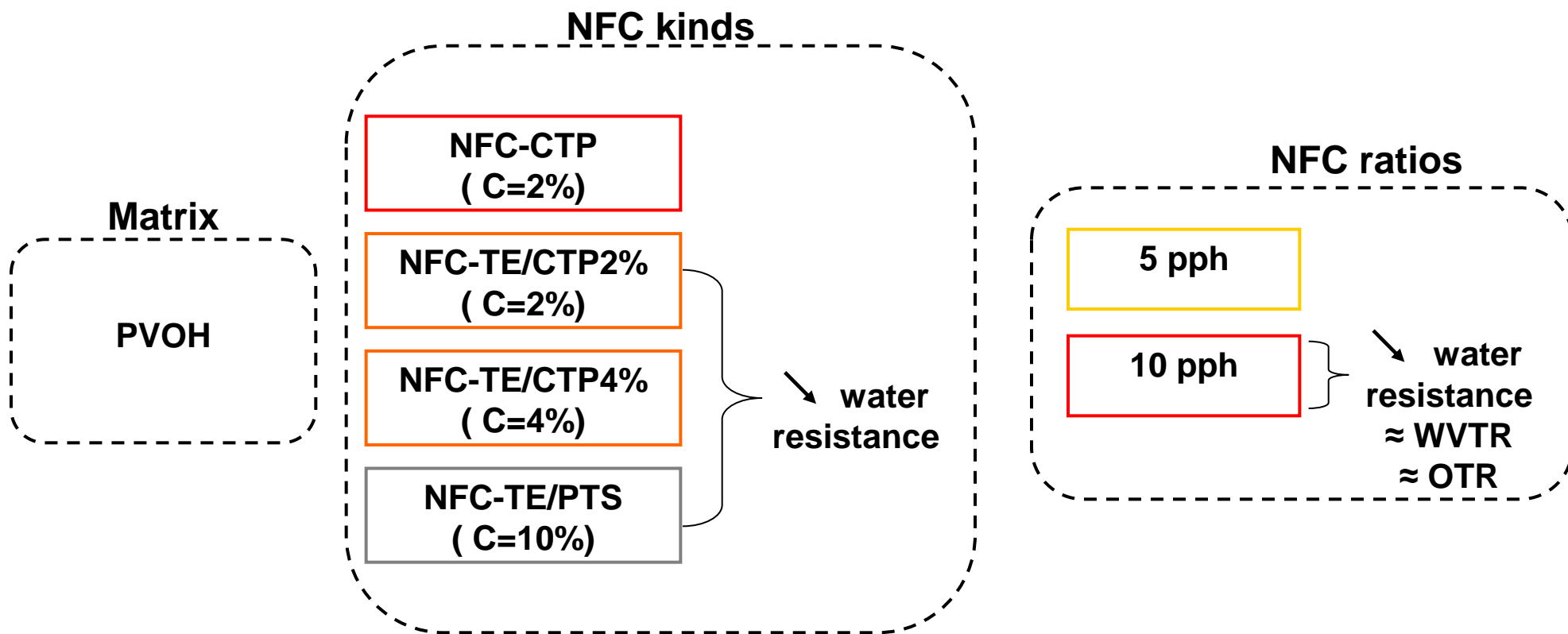


## Conclusions

- Successful upscaling of
  - PVOH/NFC blend preparation (PVOH cooking into NFC suspension)
  - PVOH/NFC layer coating
    - High viscosity
    - Low solids
- Improvement of the layer drying with the use of NFC → Improvement of runnability and productivity
- Good barrier properties of samples produced at pilot scale
  - Grease resistance
  - WVTR
  - OTR

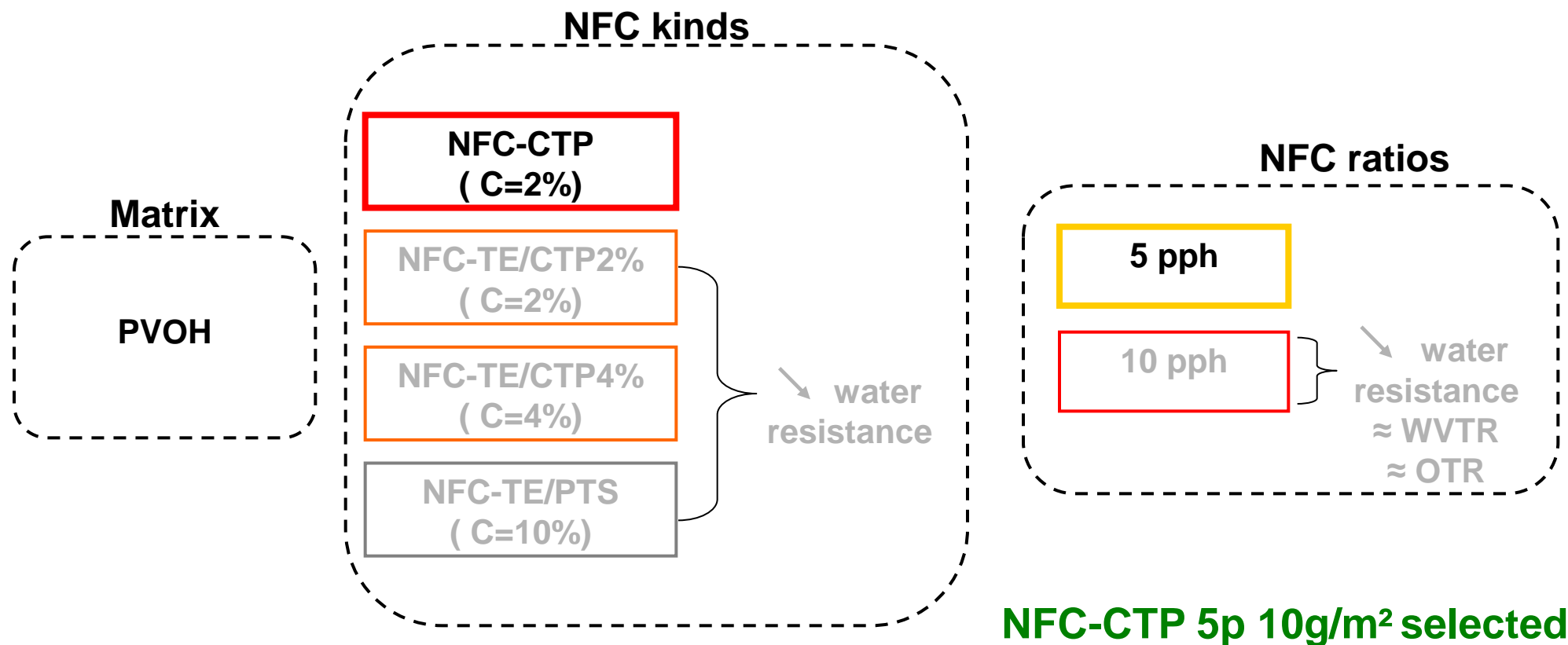
## Selection for the demonstrator

- Coating colour

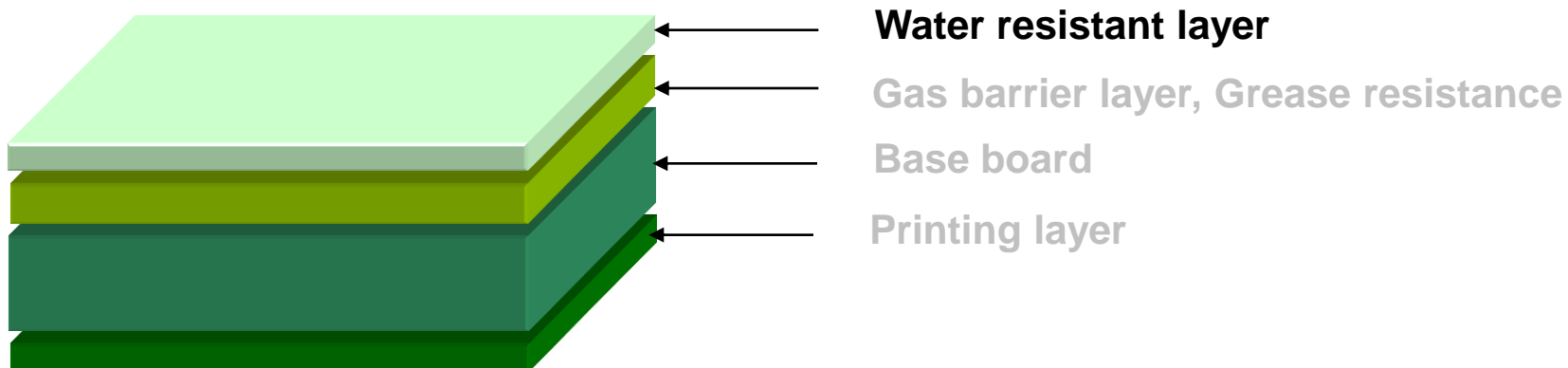


## Selection for the demonstrator

- Coating colour



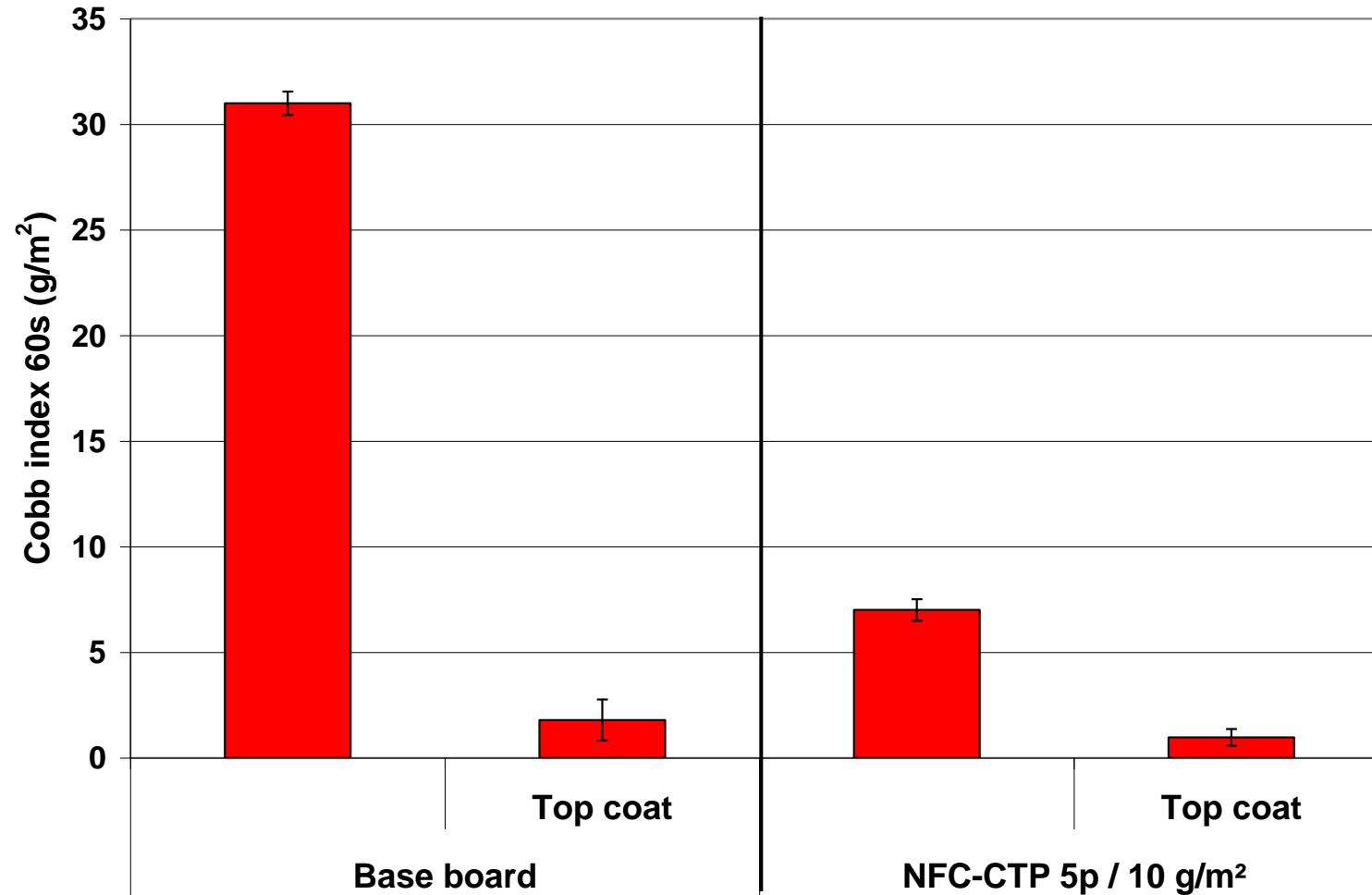
## Improvement of Water resistance



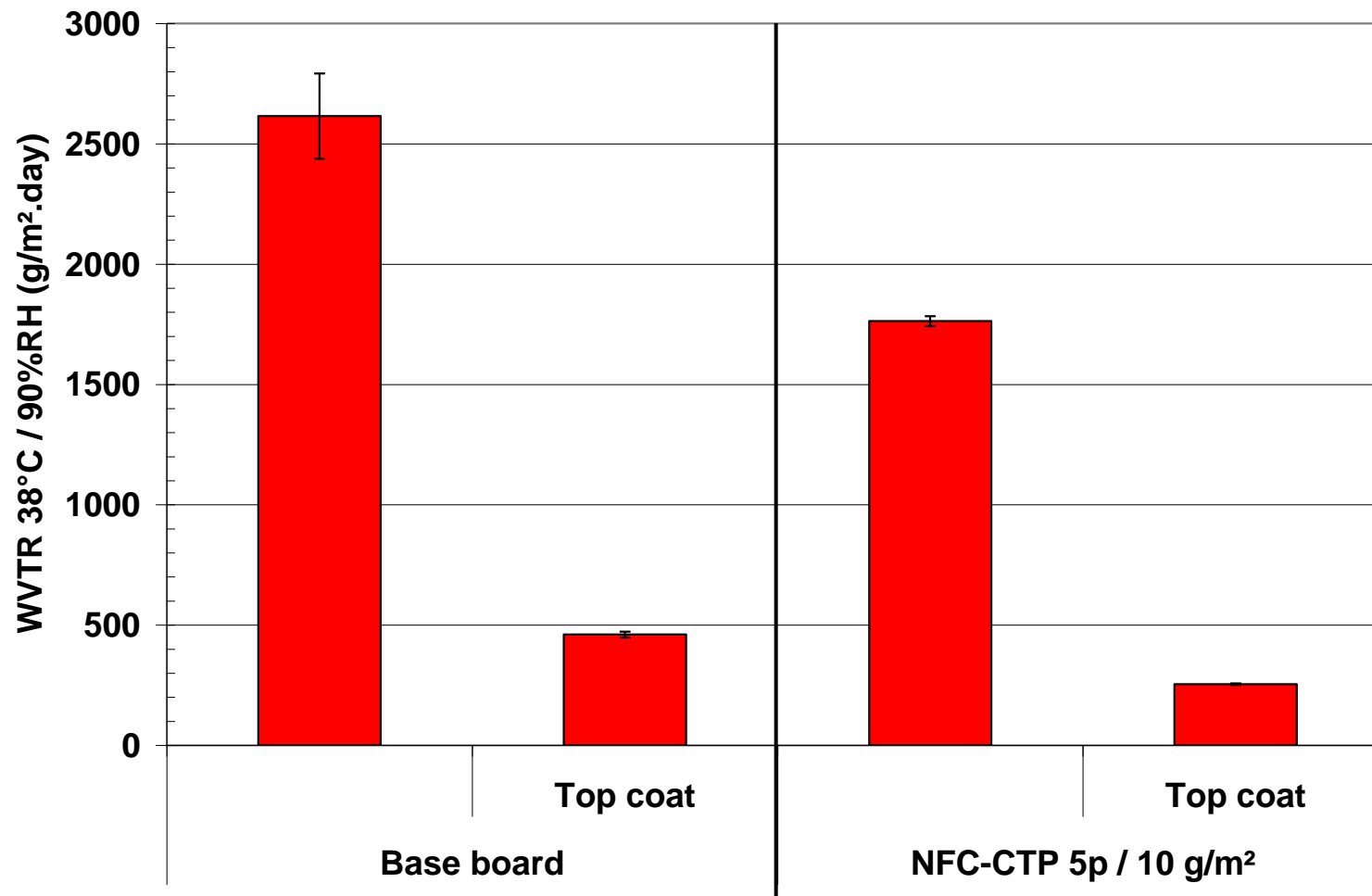
## Improvement of water resistance

- Top coat = Water resistant layer
  - Commercial barrier latex
- Pilot coating trials
  - SoftTip blade
  - 5-7 g/m<sup>2</sup> deposition  
onto the barrier layer (NFC-CTP 5p / 10 g/m<sup>2</sup>)
  - Production of flat samples for Demonstration

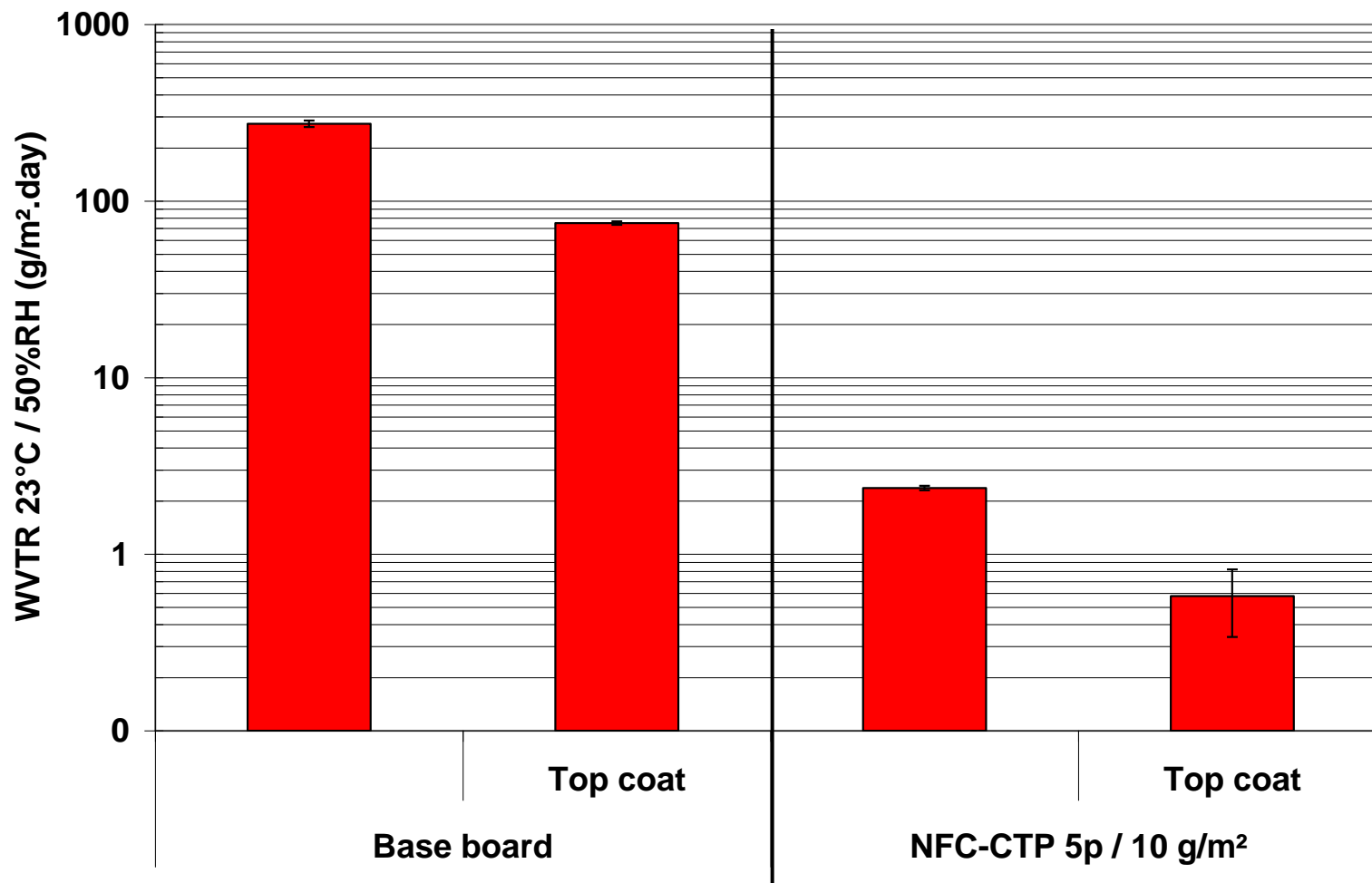
## Barrier properties of Top coated boards Water resistance



## Barrier properties of Top coated boards WVTR at 38°C 90%RH



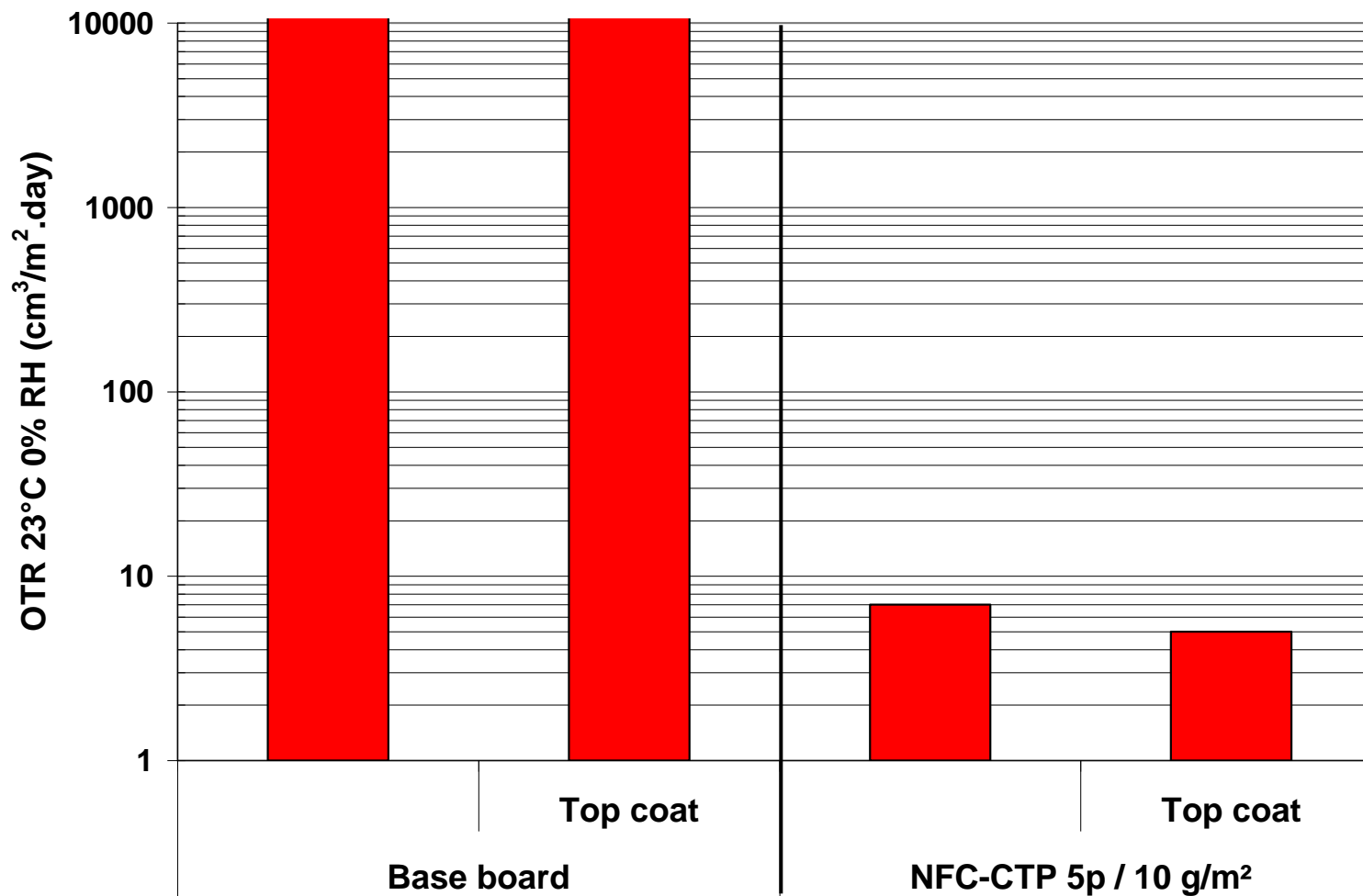
## Barrier properties of Top coated boards WVTR at 23°C 50%RH



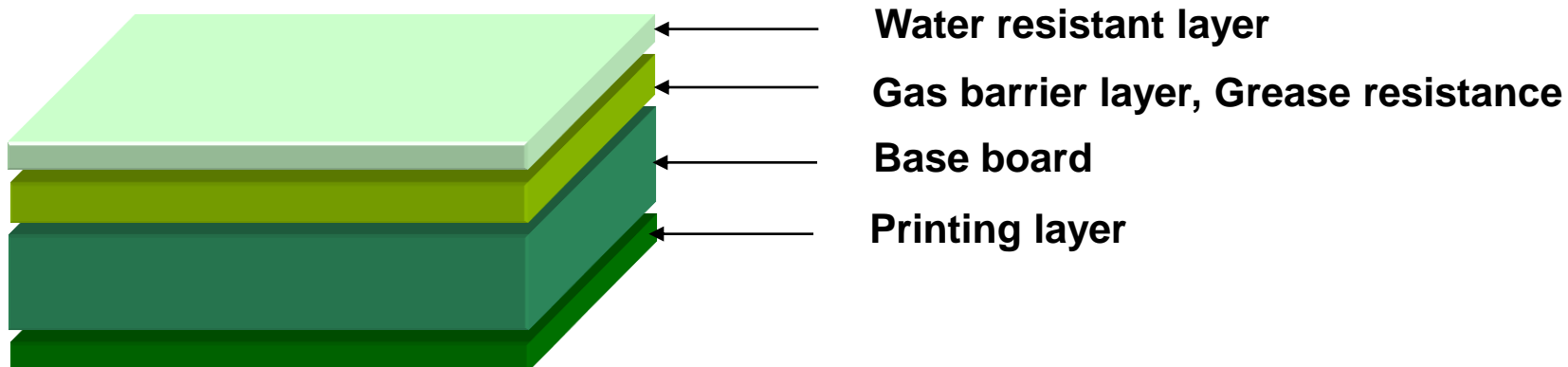


## Barrier properties of Top coated boards

### OTR at 23°C 0%RH



## Conclusions



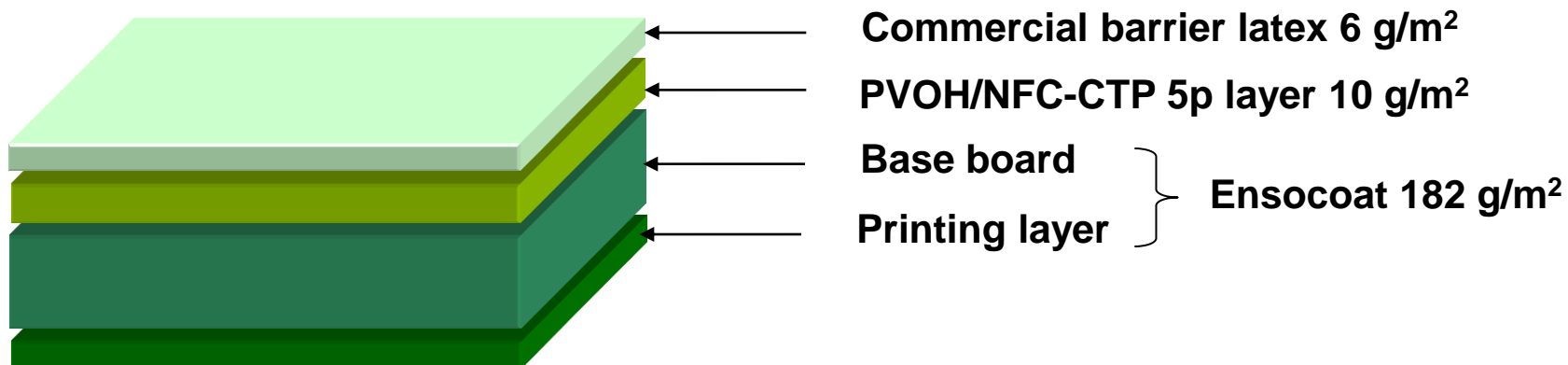
## Conclusions

### Development of a barrier packaging board

- Production of samples at pilot scale
    - Successful up scaling of PVOH cooking into NFC suspension
    - Application Roll/Blade coating at pilot scale without stripes
    - Improvement of the PVOH layer drying with the use of NFC
- Improvement of runnability and productivity with the introduction of NFC in PVOH layers

## Conclusions

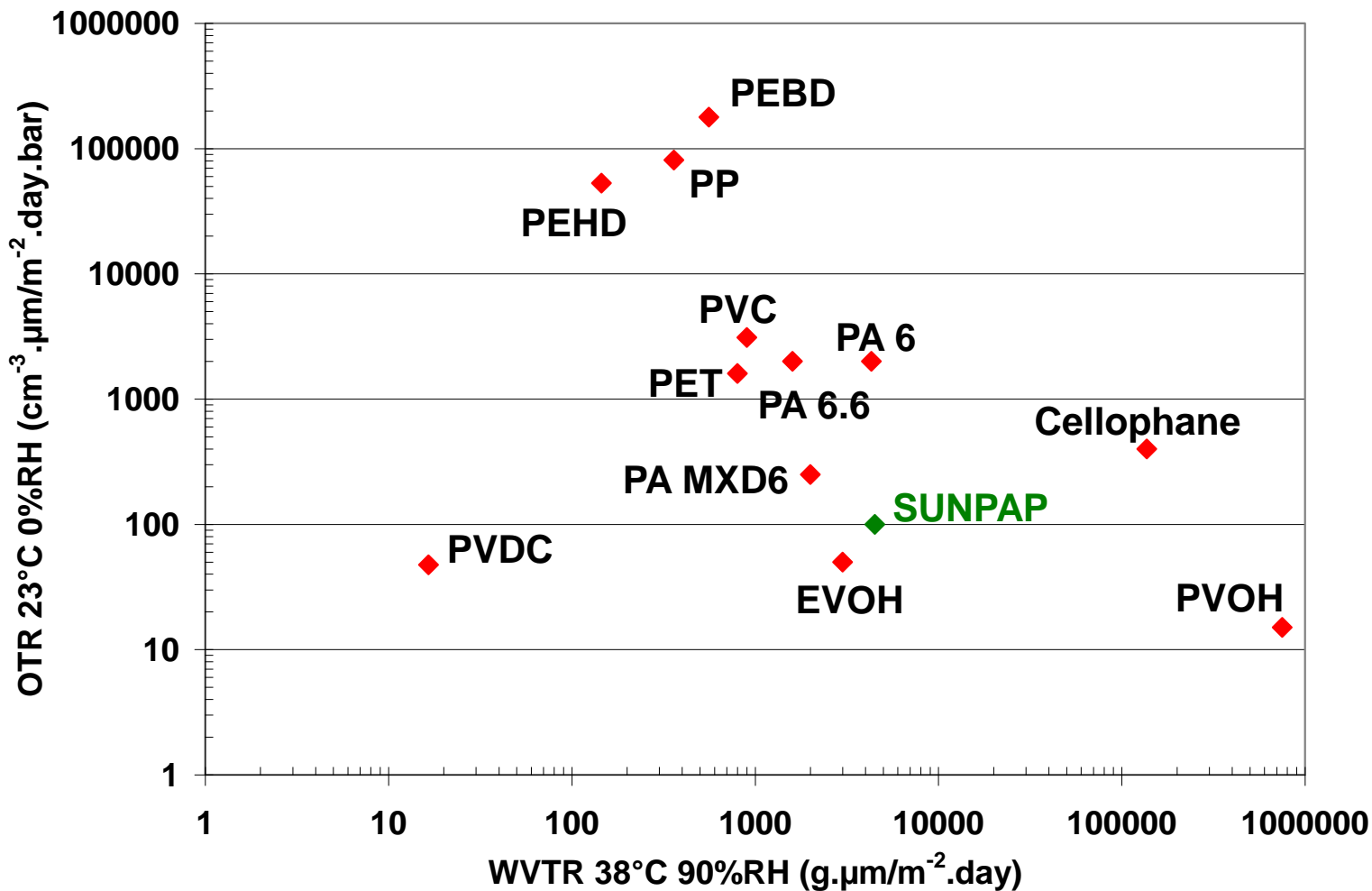
### Development of a barrier packaging board



- Good barrier properties of the demonstrator
  - Grease resistance      Oil Cobb index 24h      2 g/m<sup>2</sup>
  - Water resistance      Cobb index 60s      1 g/m<sup>2</sup>
  - Cobb index 1800s      2.5 g/m<sup>2</sup>
  - Water vapour barrier      WVTR @23°C/50%RH      0.5 g/m<sup>2</sup>.day
  - WVTR @38°C/90%RH      250 g/m<sup>2</sup>.day
  - Oxygen barrier      OTR @23°C/0%RH      5 cm<sup>3</sup>/m<sup>2</sup>.day

# Conclusions

## Comparison with existing materials



**Thank you for your attention**  
**Mille Grazie**

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