Building Leadership Excellence

# Creating Functionality on Paper Using Novel Roll to Roll Surface Treatment Equipment: Case Studies

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# Outline

- Introduction
- Surface treatment concept
  - Main features and coating methods
- First case study: smoother base for printed electronics
- Second case study: bioactive functionalities on fibre based web
- Conclusions
- Acknowledgements

# Introduction

- Forest-based sector structural changes globally
- Pressure to adapt and make innovations in novel areas

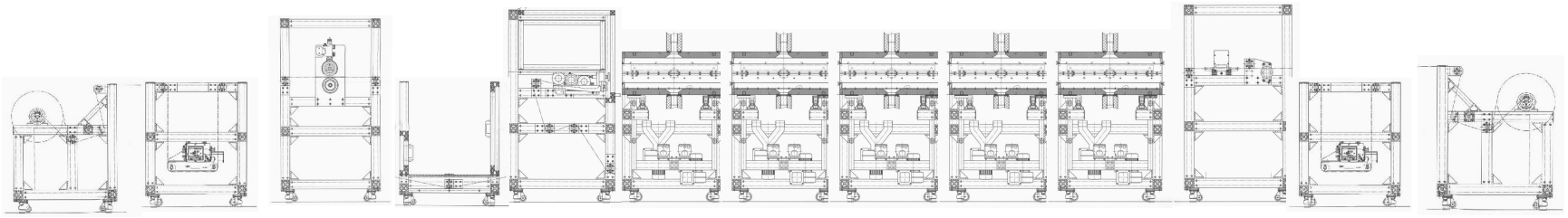
- Forest-based sector challenges
  - Replacement of oil-based products with bio-based (non-food)
  - Special, higher value tailored products
  - Reduced environmental impact
  - EU energy policy vs. energy usage
  - Sustainment of employment
  - Sustainable raw material sources

# Surface treatment concept – extending beyond pigments

- Traditional pigment coating research
  - Mills and pigment companies
- Research for such special applications requires cost effective, flexible research equipment
- SUrface Treatment Concept SUTCO is novel surface treatment line
- Possible end users  and applications across forest-based customer sectors
  - Converters
  - Various surface treatments
  - Printing houses
  - Non-woven materials
  - Treatment of plastics
  - Bio-Barrier development
  - Simple electronics

# Surface treatment concept

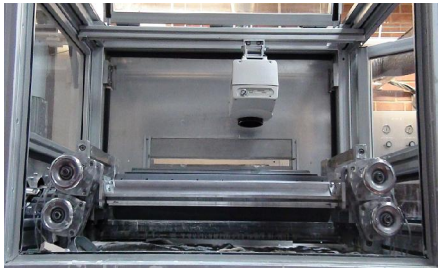
- New revolutionary surface treatment concept for pilot testing & production
- Idea of a fixed process completely discarded
- Single components connected as desired
- Connection of customized components
- Small amount of coating needed
- Sealable coating units & fumes removal during drying
- Fiber based materials and plastics

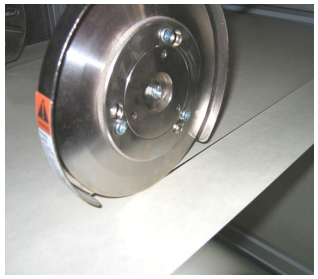


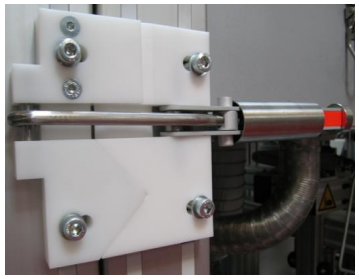
# Surface treatment concept units

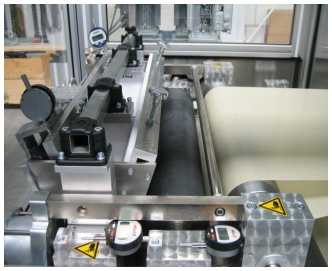
- Un/rewind
- Flexo-type roll coating
- Spray-coating
- Soft-bar coating
- Curtain coating
- Kiss coating
- Air drying units 5 pieces
- IR-drying

- Corona
- Plasma ($N_2$-Ar )
- UV
- Egde guidance
- Spreading roller
- PLC-guidance
- Offline calender
- Winder







# Two case studies

- Goal: demonstrate versatility of the surface treatment line
- First case study: to create smoother base for printed electronics
  Demonstrative product: printed conductive pattern
- Second case study: to create bioactive functionality on paper
  Demonstrative product: simple biosensor

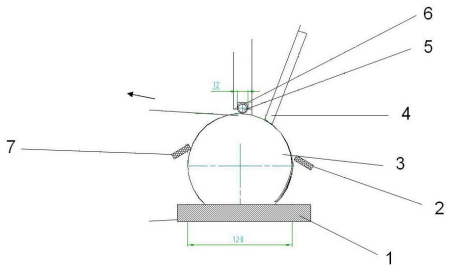
# First case study: smoother base for printed electronics

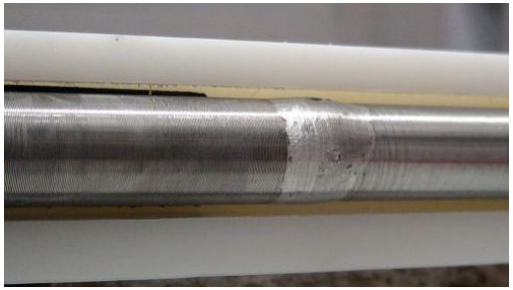
- Goal: smoother base for printed electronics
- How: three different surface coating materials chosen
  1. Kaolin
  2. Flexo-laquer
  3. Thermoplastic starch

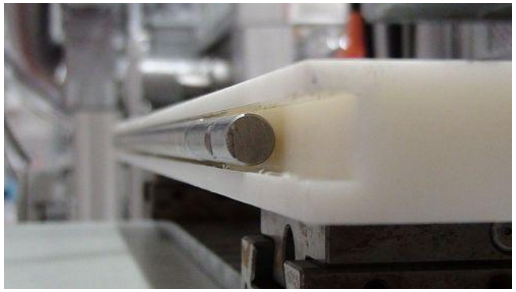
- Implementation
  - Base material: precoated (blade) fine paper
  - No pretreatments of web
  - No multiple layers of different coatings
  - Soft bar (rod) coating with selected coating material
  - Calendering

# First case study: smoother base for printed electronics

- Development work done
  - Soft bar coating method developed
    - Similar to rod coating

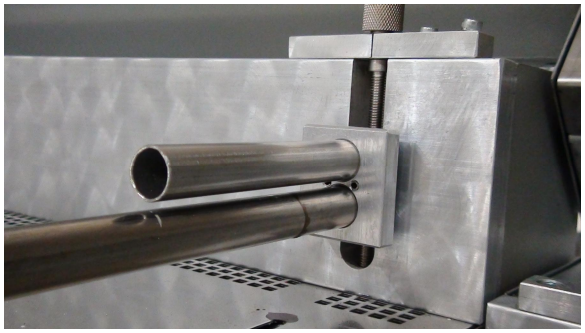


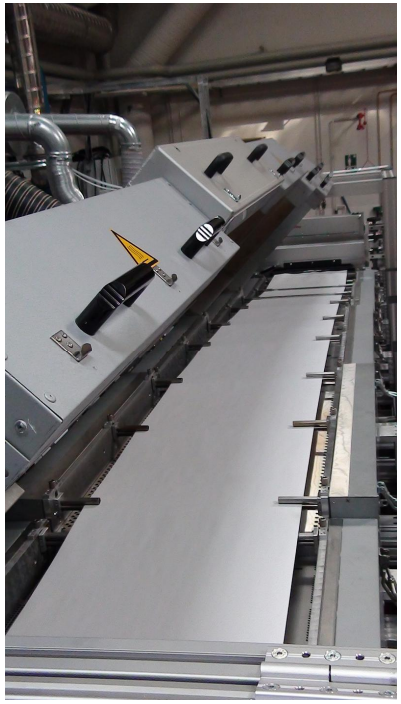





# First case study: smoother base for printed electronics

- Development work done
  - Drying section modified
    - Horizontal drying section vs. edge curling

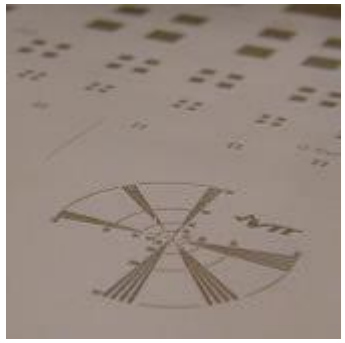


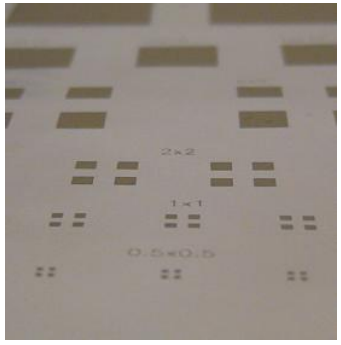


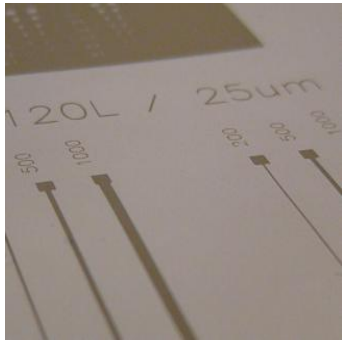
# First case study: smoother base for printed electronics

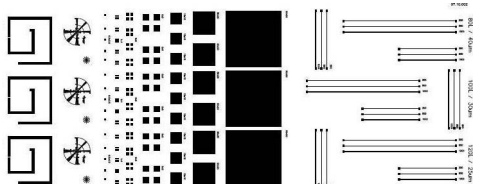
- Enhanced smoothness was produced compared to trial point
- All surfaces smooth enough to print conductive pattern
- Kaolin coated sample produced lowest roughness
- Electrical resistances follow roughness values

| | Thickness, µm | Bendtsen roughness, ml/min | Roughness $R_{a,}$ µm | Roughness $R_{q,}$ µm |
|---|---|---|---|---|
| Thermoplastic starch | 64 ± 2 | 0 | 1,96 | 2,5 |
| Kaolin | 60 ± 2 | 0 | 1,42 | 1,78 |
| Flexo-laquer | 70 ± 1 | 10 ± 1 | 1,57 | 1,97 |
| Lumiflex Ref | 95 ± 2 | 13 ± 1 | 1,96 | 2,43 |







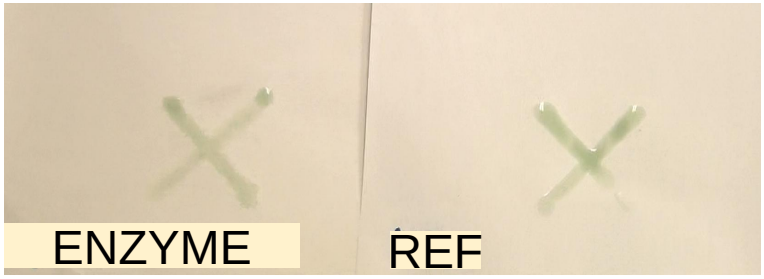
# Second case study: bioactive functionality on paper

- Goal: bioactive functionality on paper as simple biosensor
- How: Enzyme solution sprayed on kaolin precoated base paper
  → adding substrate solution creates color reaction

- Implementation:
  - Base material: precoated (blade) fine paper
  - Spray-coating with fine mist
  - Delicate drying on drying section

# Second case study: bioactive functionality on paper

- Application of substrate on enzyme coated web created a color reaction successfully
- Enzyme stayed active during the process of spray application and drying
- Technique developed later used for similar applications




After application of substrate solution


10 seconds after application of substrate solution

# Conclusions

- First case study
  - new coating method developed and implemented successfully
  - Coating trials followed by calendaring produced even enough surface to print conductive patterns
  - Surface roughness not as low as the surface roughness of plastic
  - Attempts to produce smoother base for printed electronics will continue
- Second case study
  - Simple concept for creating bioactive biosensor created
  - Knowledge from biotechnology and surface treatment combined successfully

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