



H2020-BBI-JTI-2018

GA 837761

Workshop 2021 – Biobased materials research: advances from ECOFUNCO and BIONTOP European project

Principle of chemical grafting and effect of fatty acid grafting onto whey protein-based films

Online
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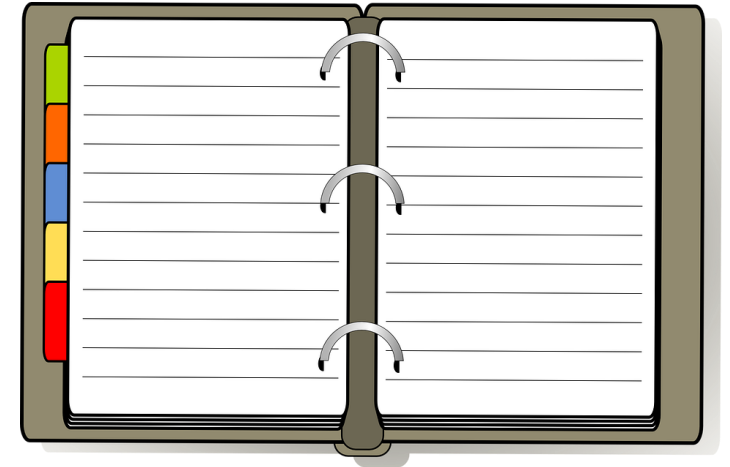
Albstadt-Sigmaringen University



This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 837761.



- **Principle of chemical grafting**
- **Methods of chemical grafting**
- **Research results of chemical grafting**
- **Conclusion**

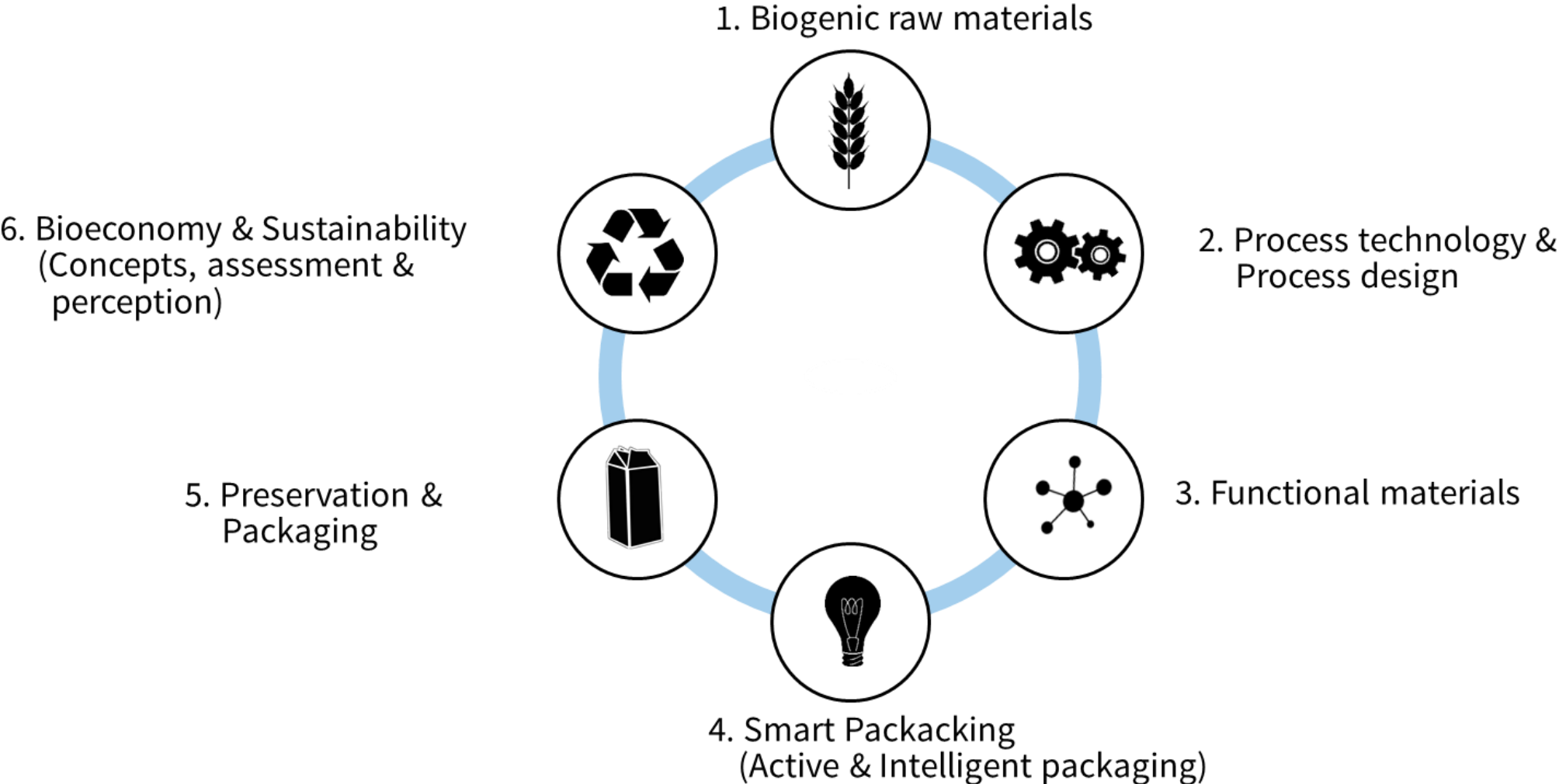




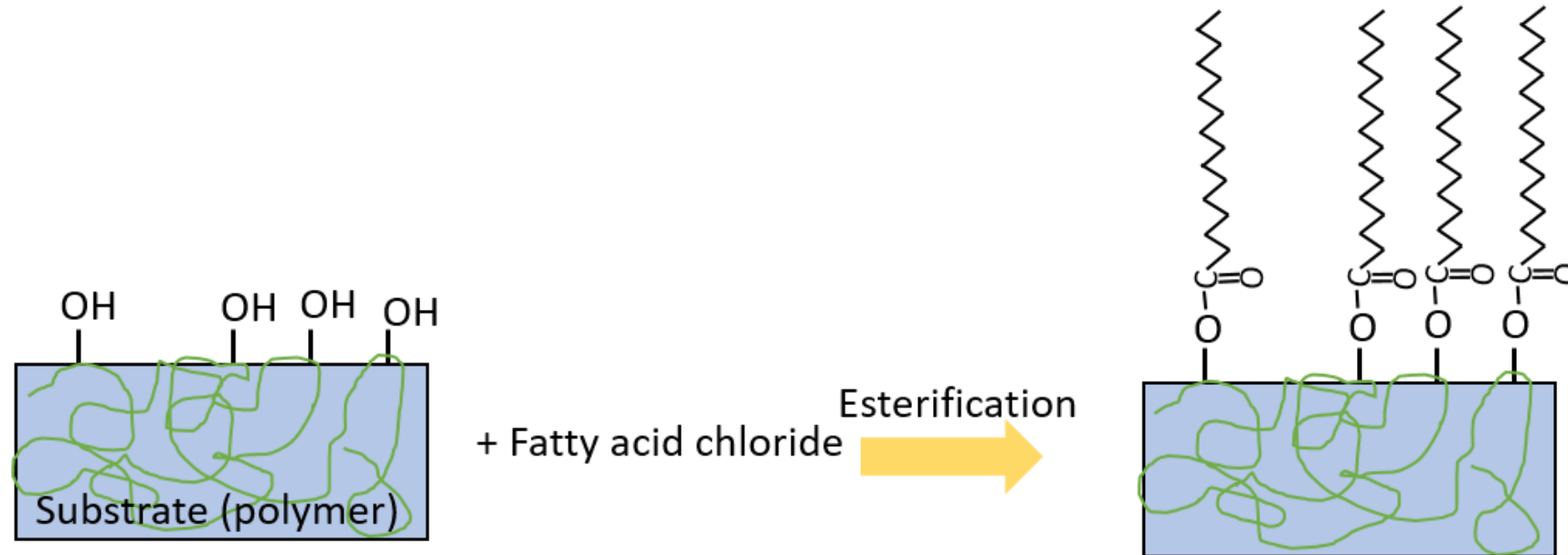
As part of the faculty of Life Sciences, the **Sustainable Packaging Institute**, short **SPI**, delves into research & teaching in six subjects areas.

Main research focus on **sustainable packaging concepts** for the entire Life Sciences industry.





Chemical grafting process for improved barrier properties



Characteristics:

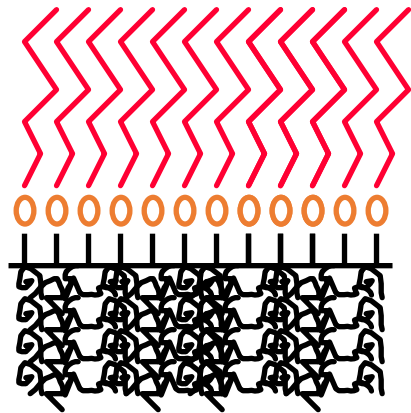
- Closed layers
- Biodegradable
- High oxygen barrier (Wheylayer)

Motivation:

- Fast reaction
- Material efficiency
- Hydrophobic surface
- Higher water vapour barrier
- Less humidity sensitive OTR

Chemical grafting process

Water



← Barrier effect

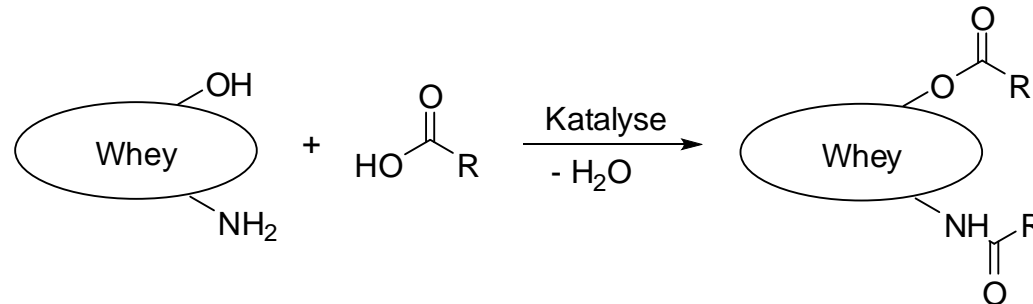
← Grafted fatty acids

← Protein-layer

Objective:

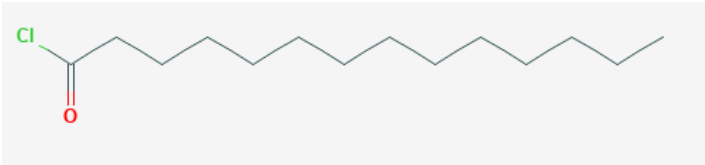
- Nano-scale surface modification → High material efficiency
- To achieve hydrophobic surfaces and a low surface energy → Improved water vapor barrier and repellence properties (e.g. for easy emptying of packaging)
- Maintain biodegradability / recyclability

➔ Barrier is depending on grafting density

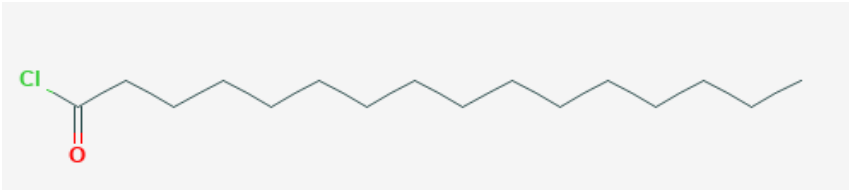


Fatty acid chlorides

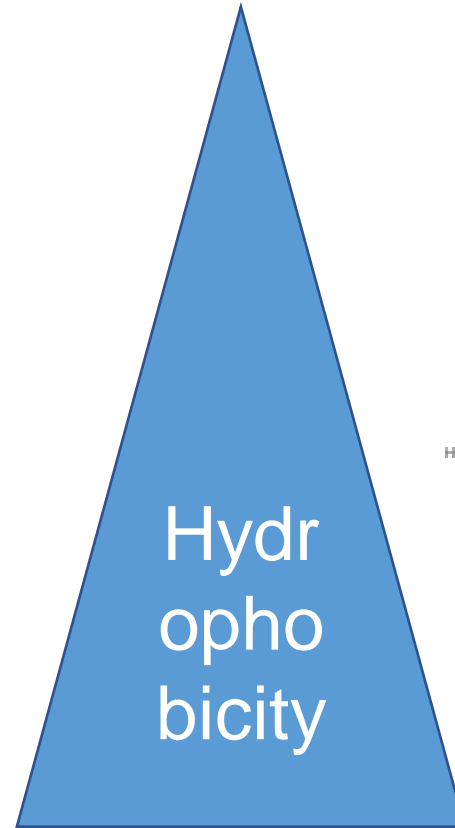
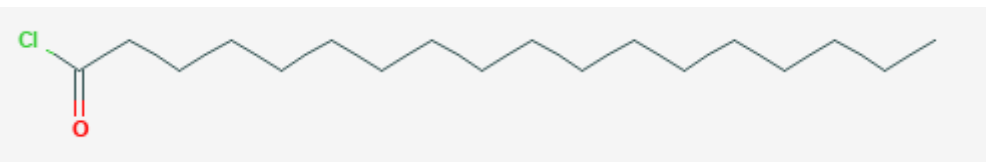
Myristic acid chloride



Palmitoyl chloride



Stearoyl chloride



Palmitoyl anhydride

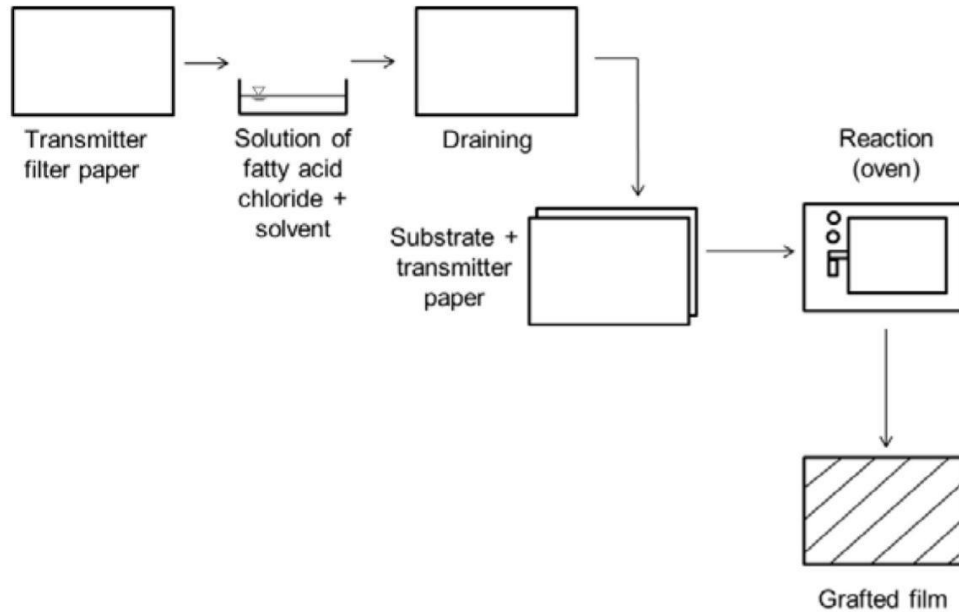


Common source: nuts, fruits, seeds

Methods for fatty acid grafting

Transfer method via transmitter paper

Fatty acid chlorides/anhydride (2%) dissolved in petroleum ether



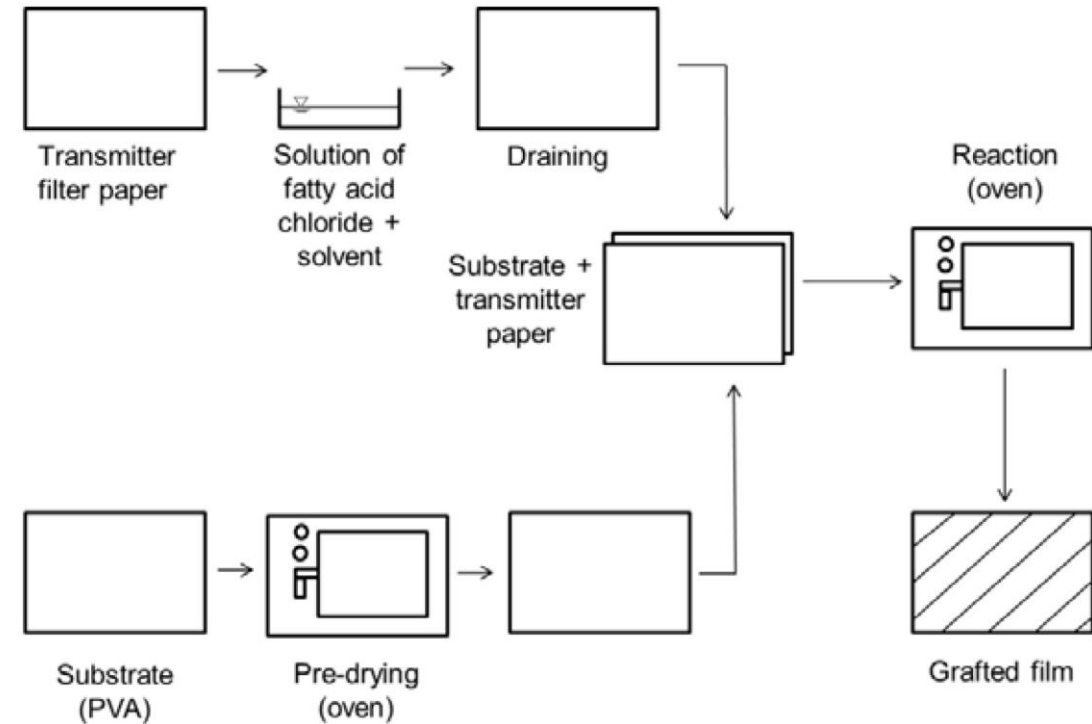
Gravure printing (Upscaling of FA grafting process)

Fatty acid chlorides/anhydride not diluted/dissolved





Schematic representation of the grafting process



Main varying parameters:

Fatty acid chloride: molecular weight, concentration, solvent

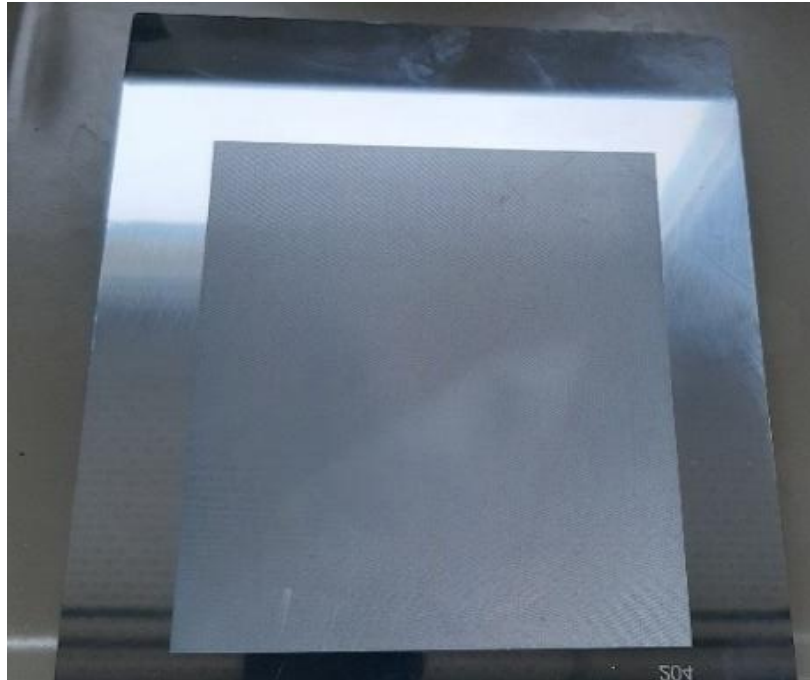
Type of substrate

Grafting parameter: temperature, time

Gravure printing technique

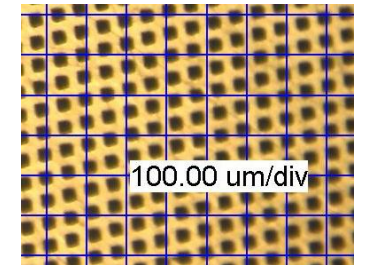
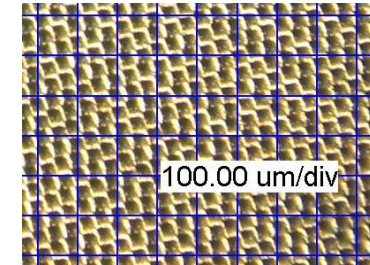
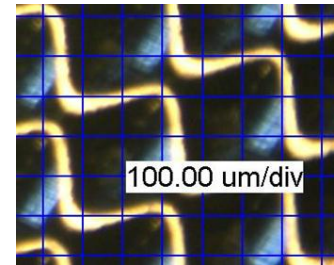
Upscaling of FA grafting process

Fatty acid chlorides/anhydride not diluted/dissolved in contrast to transfer method



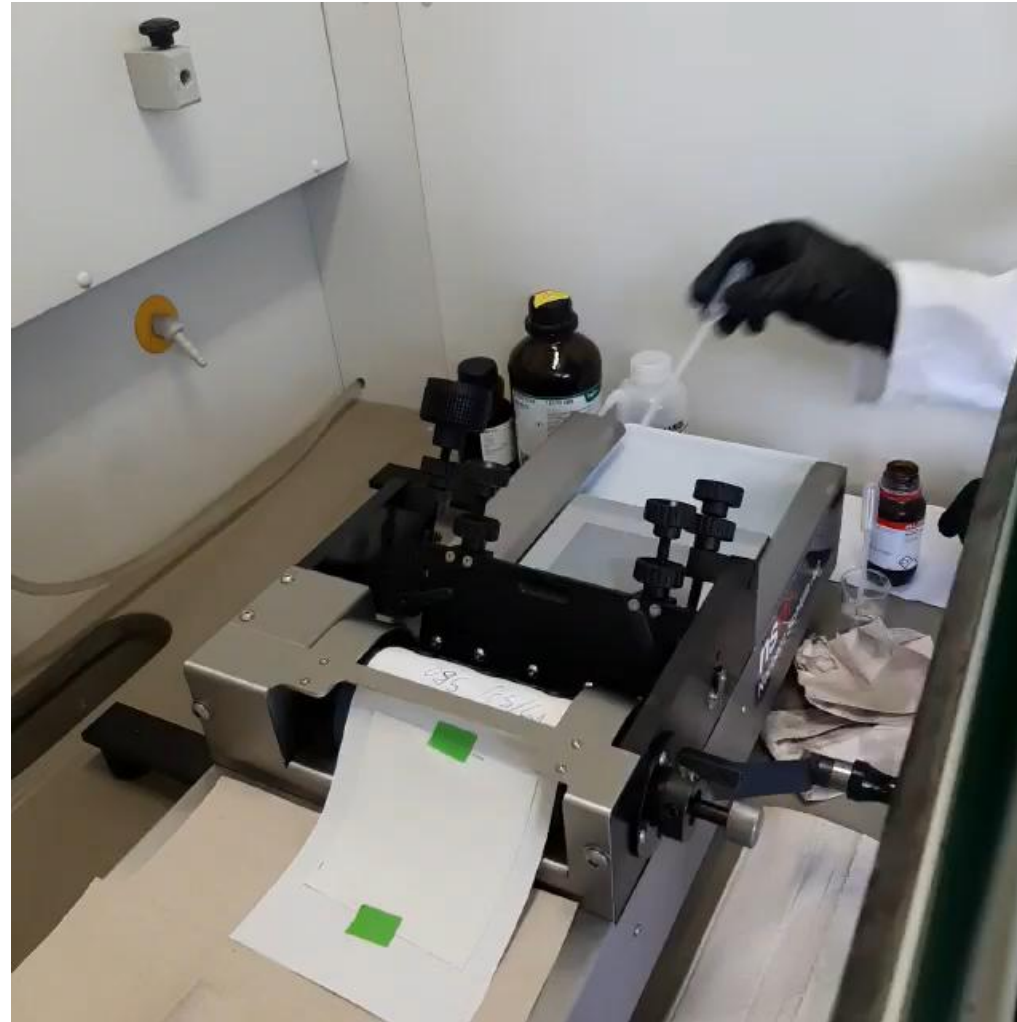
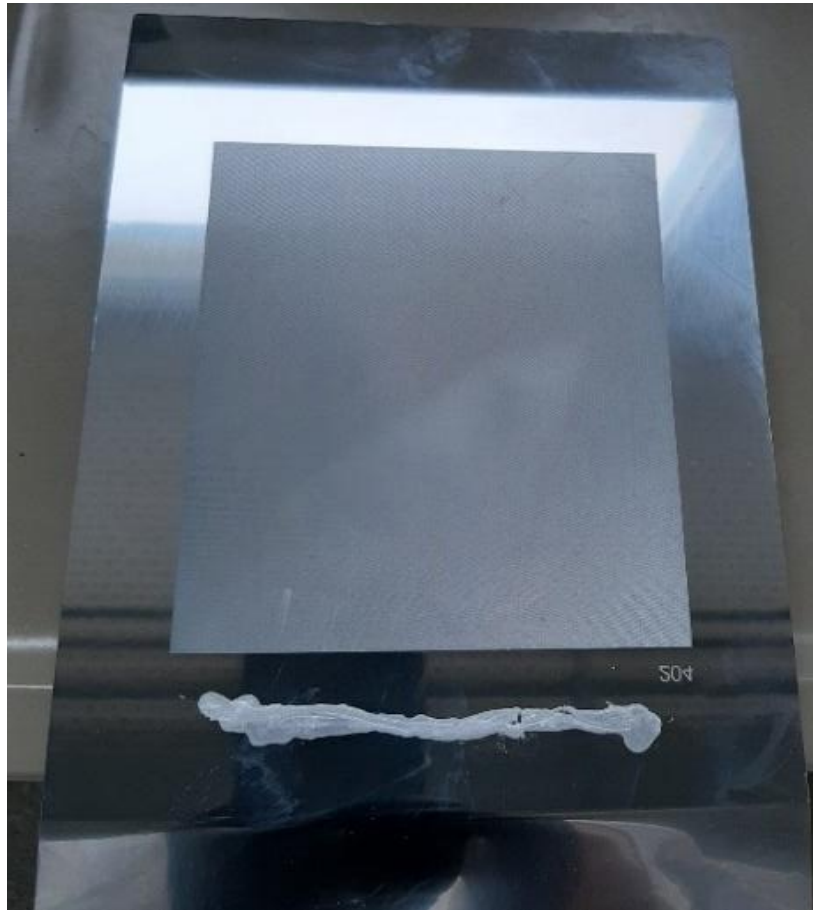
Microscopic view of different printing plate used

decreasing volume of grafting reagent on surface

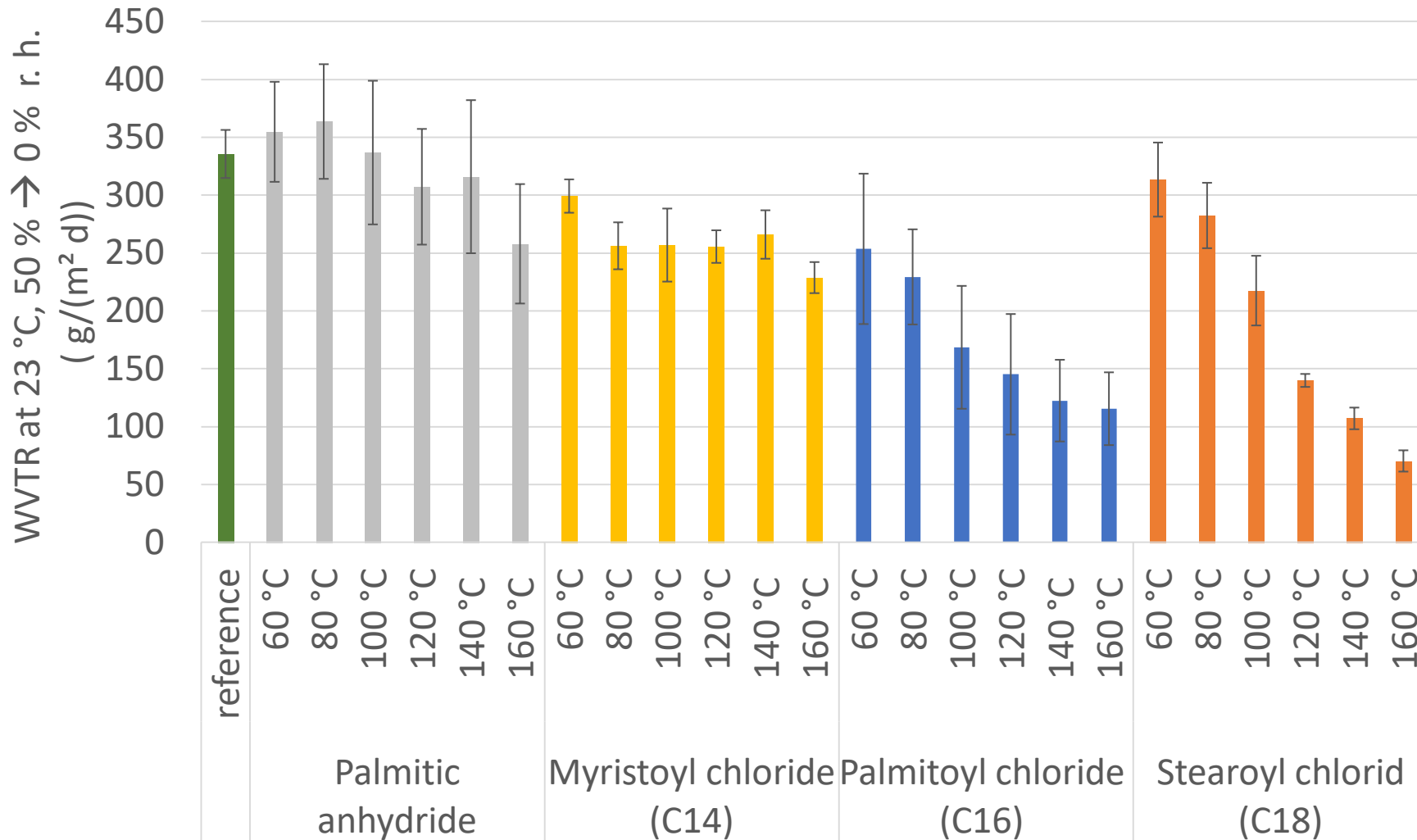


Gravure printing technique

Upscaling of FA grafting process



WVTR of grafted WPI castfilms – Transfer method

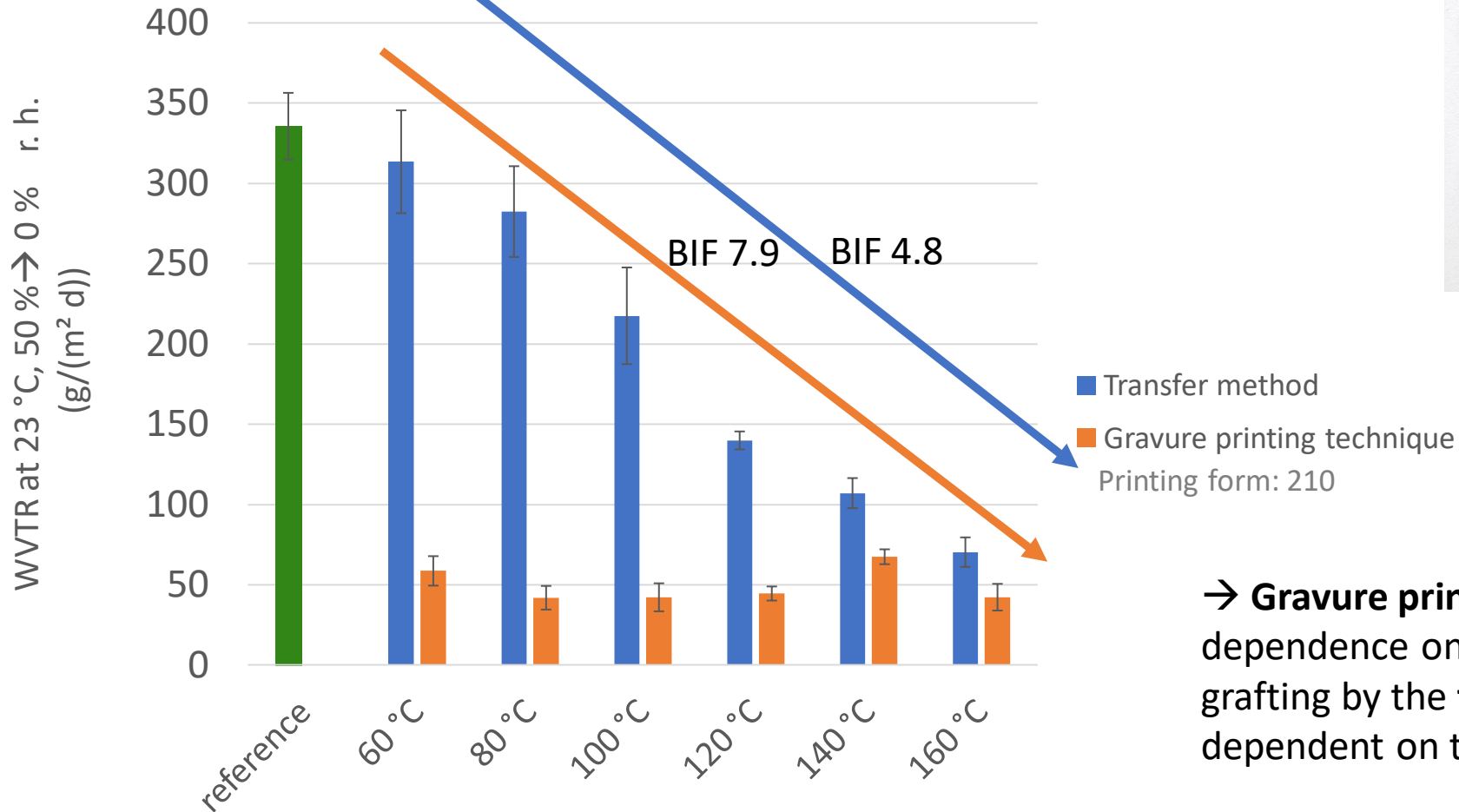


Fatty acid	BIF
Myristoyl chloride C14	1.5
Palmitoyl chloride C16	3.0
Stearoyl chloride C18	4.8
Palmitoyl anhydride C16	1.4



WPI Castfilm

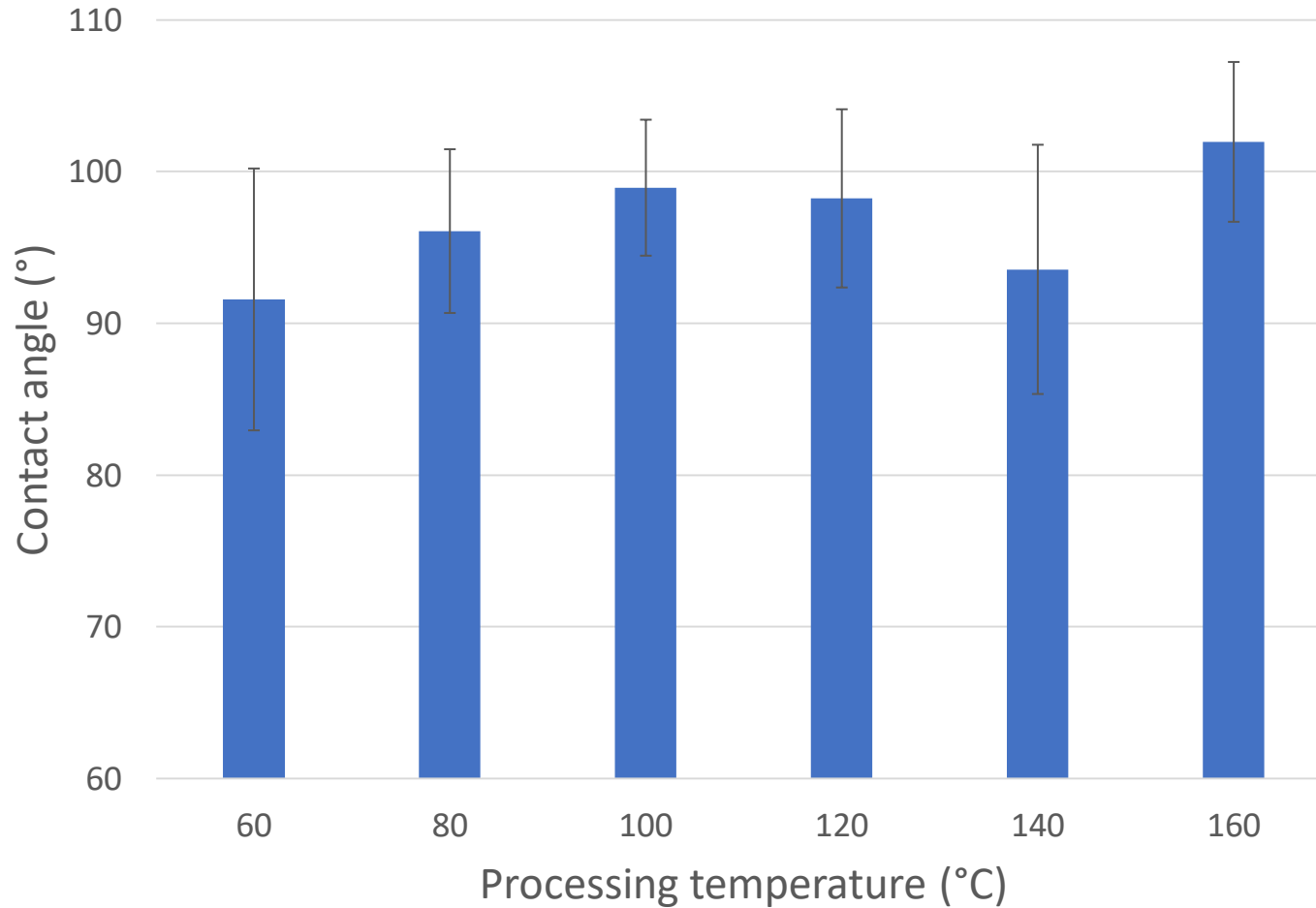
WVTR of grafted WPI castfilms with stearoyl chloride (C18) – Comparison transfer and gravure printing method



WPI Castfilm

→ **Gravure printing** used for FA grafting indicated no dependence on the temperature whereas the FA grafting by the **transfer method** was highly dependent on the temperature

WPI based films grafted with palmitoyl chloride

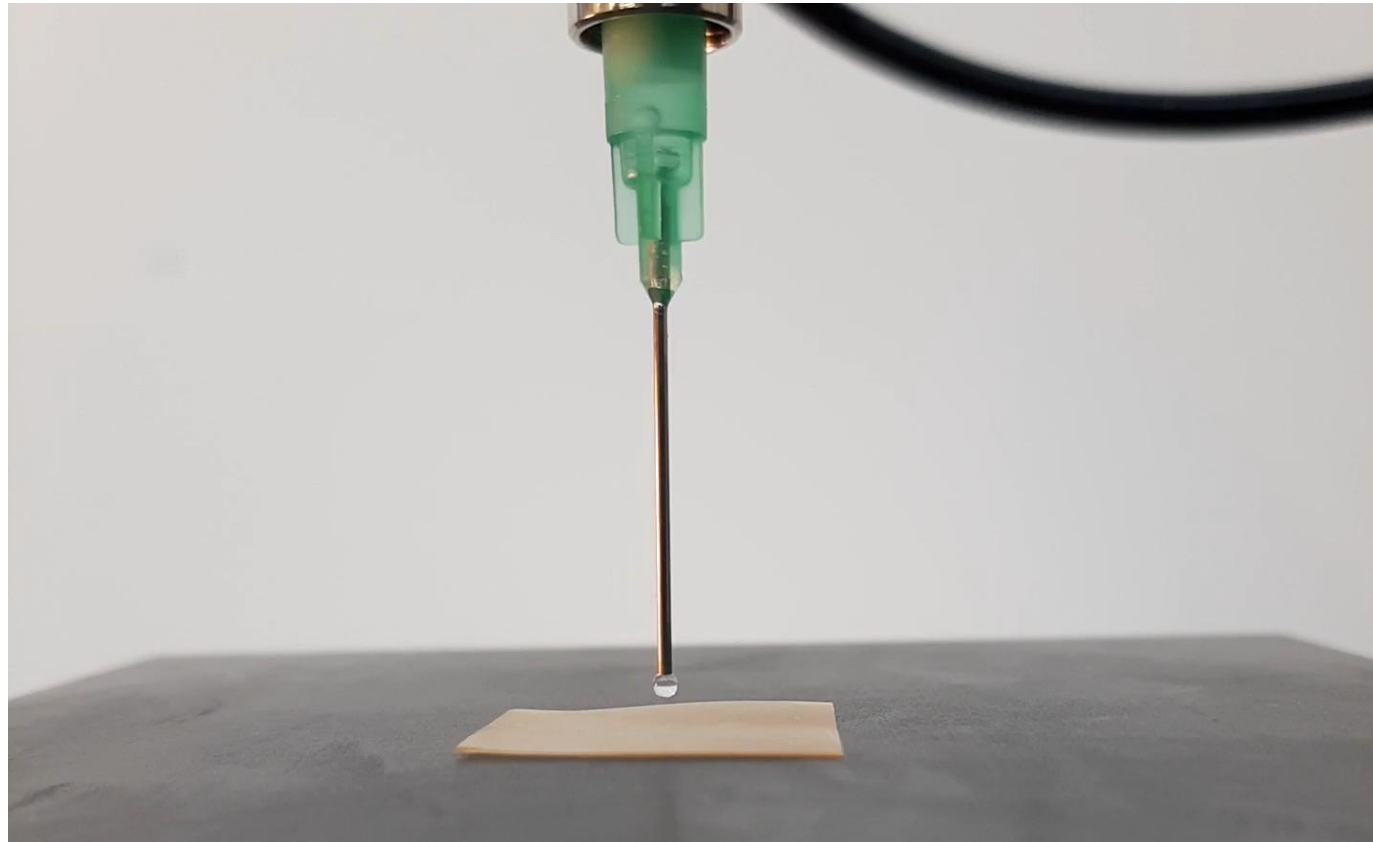


Contact angle of WPI films coated with palmitoyl anhydride and WPI reference could not be measured based on a rapid spreading of the water drop and its penetration into the film

Representative for WPI cast film without grafting or grafted with palmitoyl anhydride

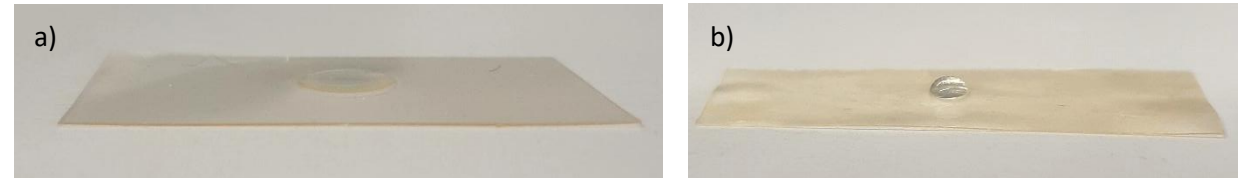


**WPI cast film grafted with
palmitoyl chloride (160°C, 10 min)**



Concluding remarks of chemical grafting onto whey protein-based films

- The FA grafting of WPI films lead to a significant barrier improvement factor for the WVTR using the gravure printing and transfer method.
- Repellent effect of the grafted whey protein-based films with the transfer method and the gravure printing method



Water drop on the surface of a non grafted WPI film (a) and grafted WPI film (160°C, 10 min) (b)

Thank you for your attention!



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