Fraunhofer IVV

Fraunhofer-Institut für Verfahrens-technik und Verpackung IVV

octima

2nd Annual Meeting „Sustainable Food Packaging“

Milan, 27th May 2025

Beyond plastic:

Reimagining fiber-based packaging with an innovative bio-based barrier inspired by nature

Lorenzo Tomei, Fraunhofer IVV

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Fraunhofer IVV – Locations Freising and Dresden

Institute Head Fraunhofer IVV: Prof. Dr. Andrea Büttner (executive) | Prof. Dr.-Ing. Jens-Peter Majschak

Total budget	37.8 M €	Total workforce	332
Operating budget	32.4 M €	Scientists and graduates	201
Investment budget	5.4 M €	Postgraduate students	31

(Status April 2024)

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Fraunhofer IVV – Location Freising

Institute Head Fraunhofer IVV: Prof. Dr. Andrea Büttner (executive) | Prof. Dr.-Ing. Jens-Peter Majschak

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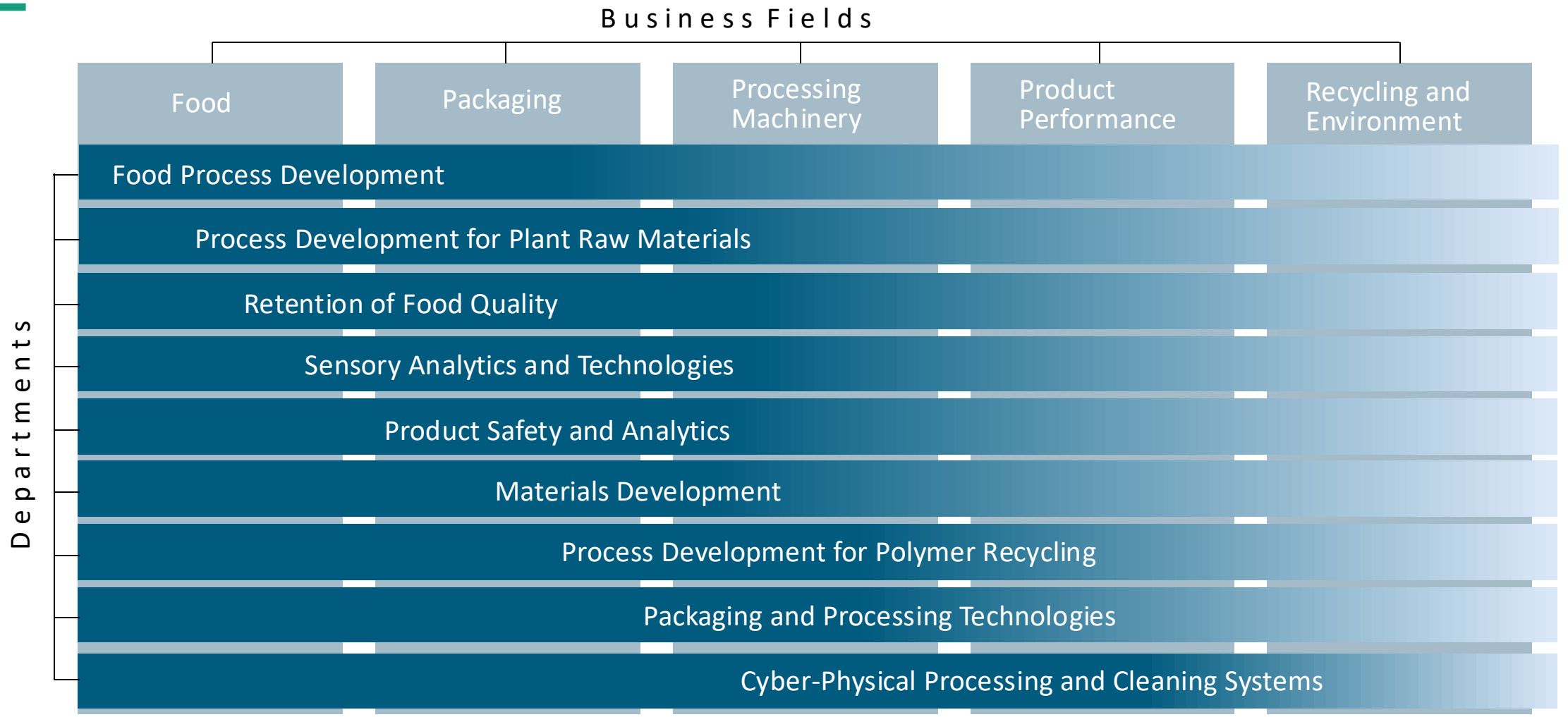
Fraunhofer IVV – Business fields and departments



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Our business fields and core areas of expertise

Food

High-quality, healthy and convenient foods and ingredients

Packaging

Safe, customer-friendly and recyclable packaging materials

Processing Machinery

Optimized production and cleaning processes and digital solutions for Industry 4.0

Product Performance

Holistic sensory optimization of raw materials and market-ready products

Recycling and Environment

Innovative recycling technologies, bio-based additives and environmental analysis

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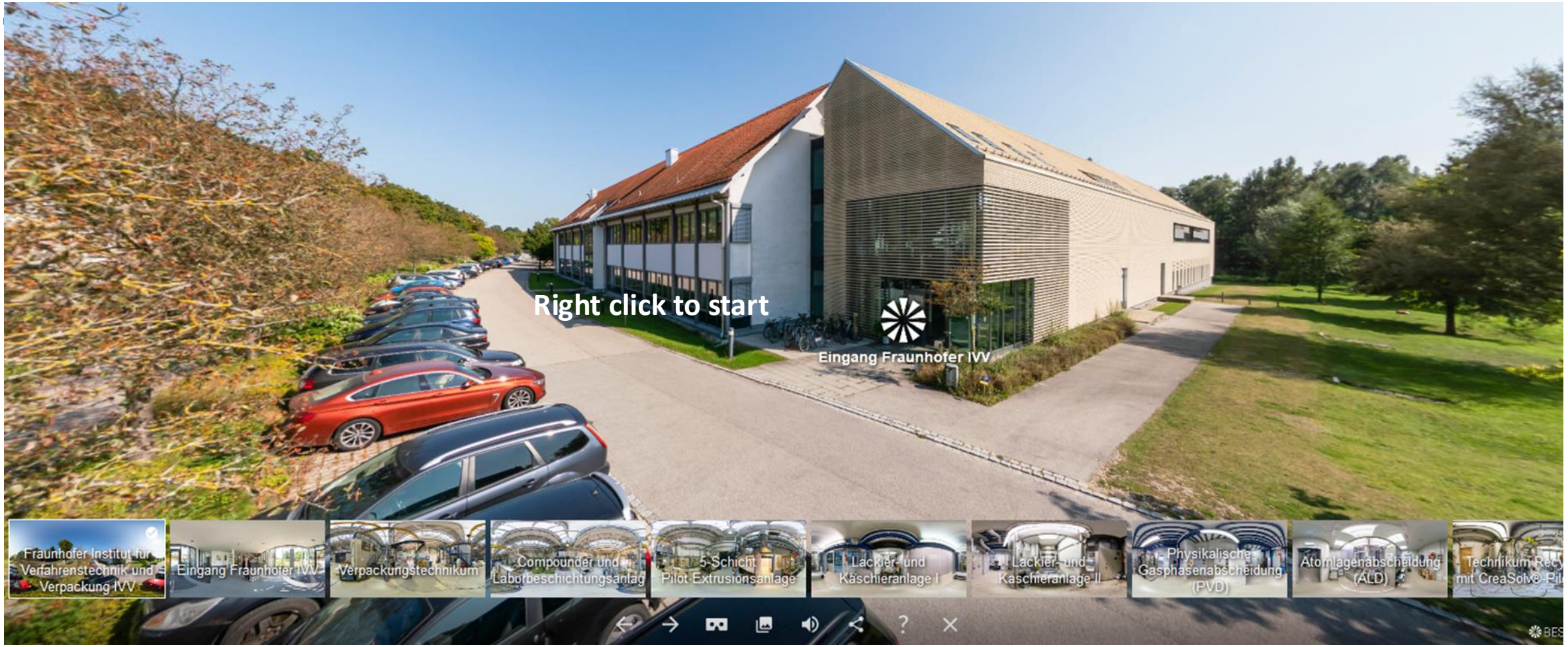
Virtual 360° tour through our pilot plant facilities



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Beyond plastic

From man-made to natural materials: protecting packaged goods and the environment

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Introduction

Bio-based raw materials and packaging

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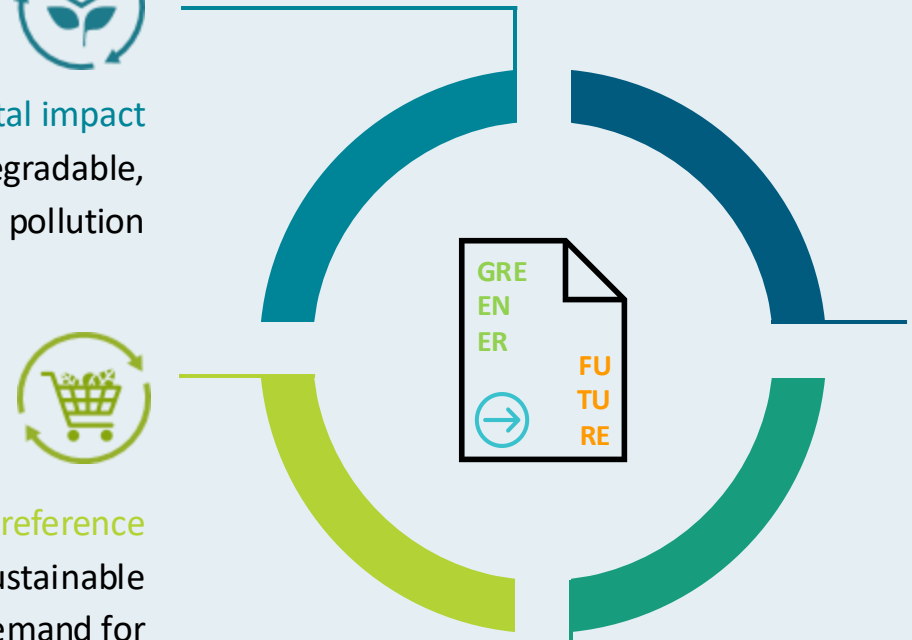
Why paper packaging?

A possible alternative for a greener future

INNOVATION DRIVERS



Environmental impact

Paper is recyclable as well as biodegradable, which helps reduce environmental pollution

Consumer preference

Consumers increasingly prefer sustainable products, which also increases demand for sustainable packaging alternatives

Conservation of resources

Natural materials such as paper come from renewable raw materials and reduce dependence on fossil resources

Innovation potential

Technological advances enable the production of both more sustainable and more functional packaging solutions

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Which challenges are we still facing?

Where R&D can make an important contribution

Bio-based and functional
fiber-based packaging materials

Natural barrier from oak cork

Project BioBarrier4Fiber

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Innovative barrier from nature

How tree barks provide a protective packaging solution

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BioBarrier4Fiber

Multifunctional bio-based water vapor barrier coatings for fiber-based packaging materials

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BioBarrier4Fiber Fraunhofer IVV

Innovative barrier from nature

How tree barks provide a protective packaging solution

The research team

Process Development for Plant Raw Materials

Lorenzo Tomei

Materials Development

Dr. Marie Föllmer

Paula Goderbauer

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Innovative barrier from nature

How tree barks provide a protective packaging solution

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IVLV Industrievereinigung für Lebensmitteltechnologie und Verpackung e.V.

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MARMARA UNIVERSITY

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SAKARYA ÜNİVERSİTESİ

TÜBİTAK

START
June 2023

Project duration

END
May 2025

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Innovative barrier from nature

How tree barks provide a protective packaging solution

THE PROBLEM

- Increasing demand for **sustainable, alternative packaging**
- Fiber-based packaging substrates **require an effective barrier coating to be functional**
- A **100% bio-based and functional water vapor barrier** for fiber-based packaging materials is not available on the market

OUR MISSION

- Developing a **unique coating material** with the following **Unique Selling Value**

Bio-based | **Water vapor barrier** | **Heat sealable** | **Processable** | **Flexible** | **Food conform**

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Suberin

A promising bio-based material for fiber-based packaging coatings

Up to 50% by weight of cork oak bark

Plant-based hydrophobic biopolymer

Protective barrier

1. Process development for suberin extraction and refinement

2. Development of functional coating formulation and application process on fiber-based packaging

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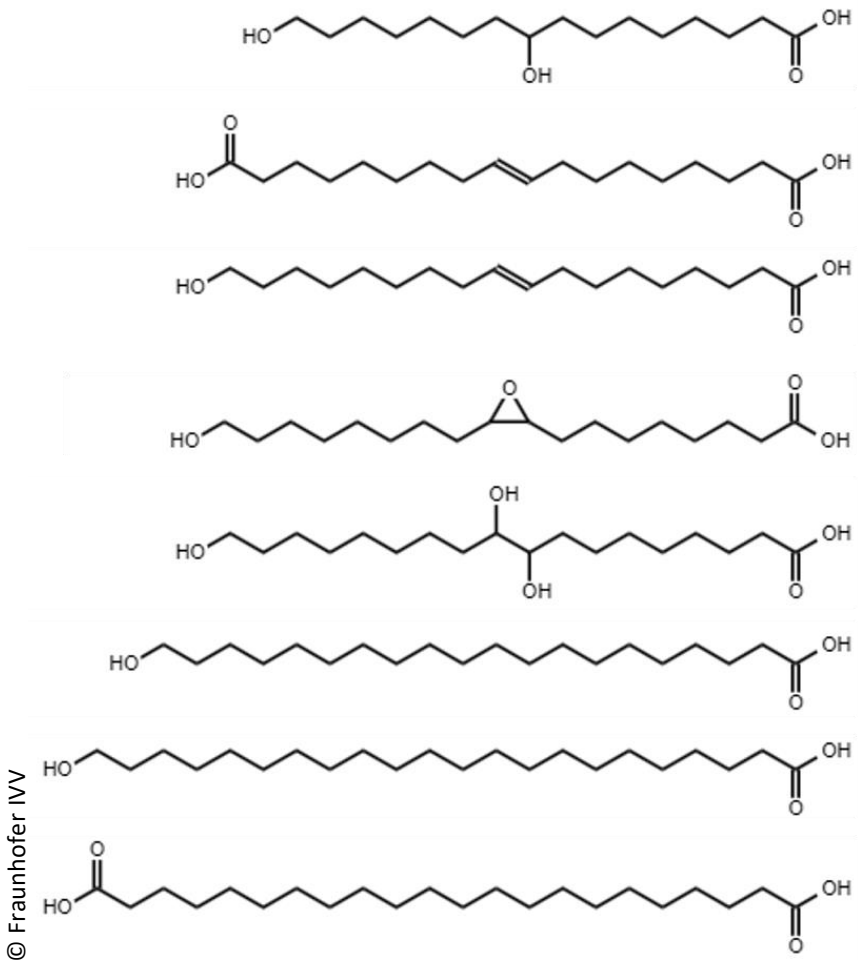
Suberin fatty acids

Functional, hydrophobic, long-chain molecules

Jargon corner

SFA: *Suberin Fatty Acids*



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1. Direct extraction of suberin from cork oak bark is not possible due to its highly complex structure
2. Suberin is first chemically depolymerized into its components, the suberin fatty acids (SFAs)
3. SFAs are then extracted in suitable solvent systems, separated from the remaining biomass, and purified
4. The SFAs obtained are then formulated for the development of the coating and their functionality is tested

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Suberin fatty acids

Functional, hydrophobic, long-chain molecules

4 Further scale-up to pilot extraction plant (300 l) at Fraunhofer IVV for technology transfer validation

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Coatings from SFAs

Bio-based water vapor barrier

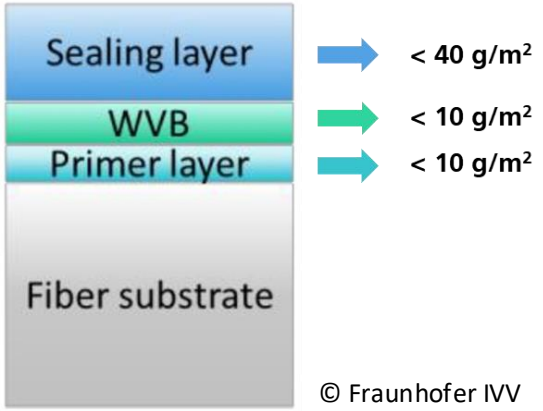
Jargon corner

WVB: ***W**ater **V**apor **B**arrier*

1. Development of liquid coating formulations of SFAs (and additives)

2. Development of coating formulations on packaging paper first at lab scale with further plan to transfer them at pilot scale

3. Evaluation of coating weight, water barrier, water vapor barrier, grease resistance, flexibility, and sealability



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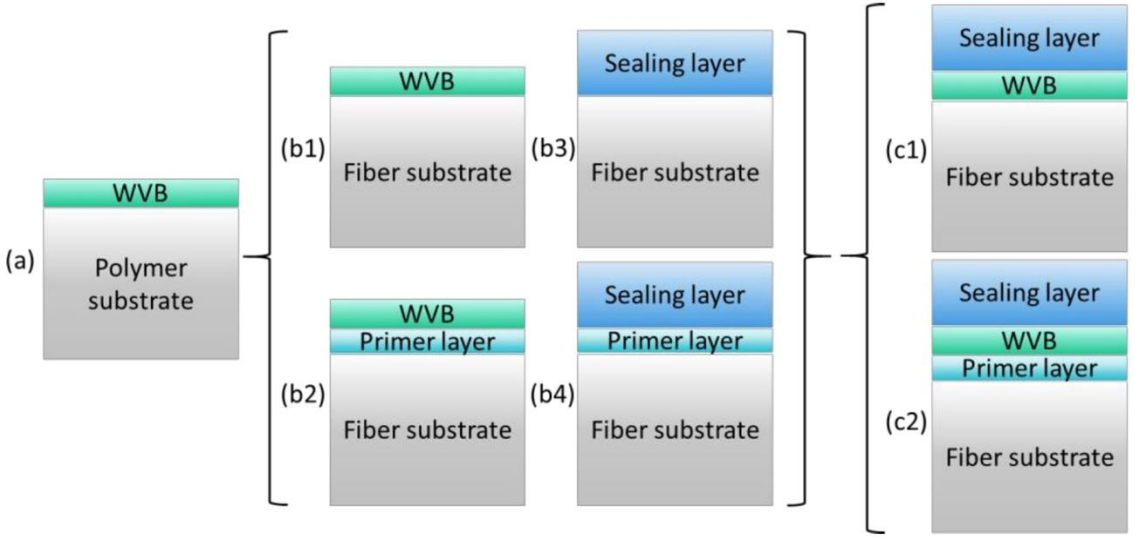

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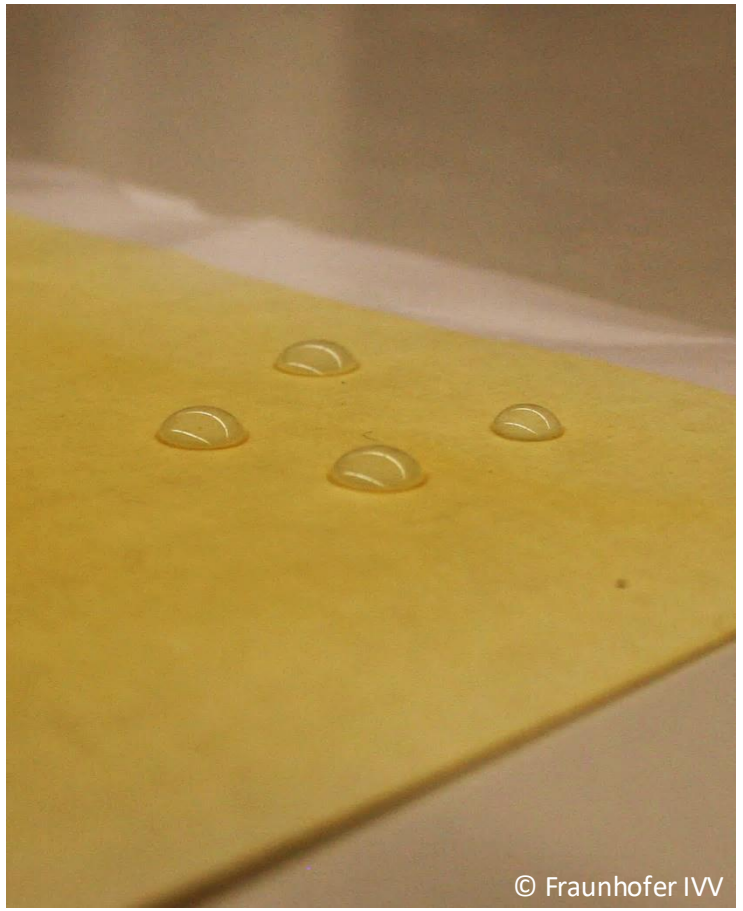
Coatings from SFAs

Bio-based water vapor barrier

WHERE WE SUCCEEDED

1. Coating weight[1]: **8,0-12,7 g·m^{-2}**
2. Seal strength[2]: up to **1,4 N/15 mm**
3. WVTR[3,*]: down to **9,6-15,0 g·m^{-2}·d^{-1}**



[1] DIN 53104
[2] DIN 55529
[3] DIN 53122-1, 23 °C, 85 % RH
* value normalized on a coating weight of 10 g·m^{-2}

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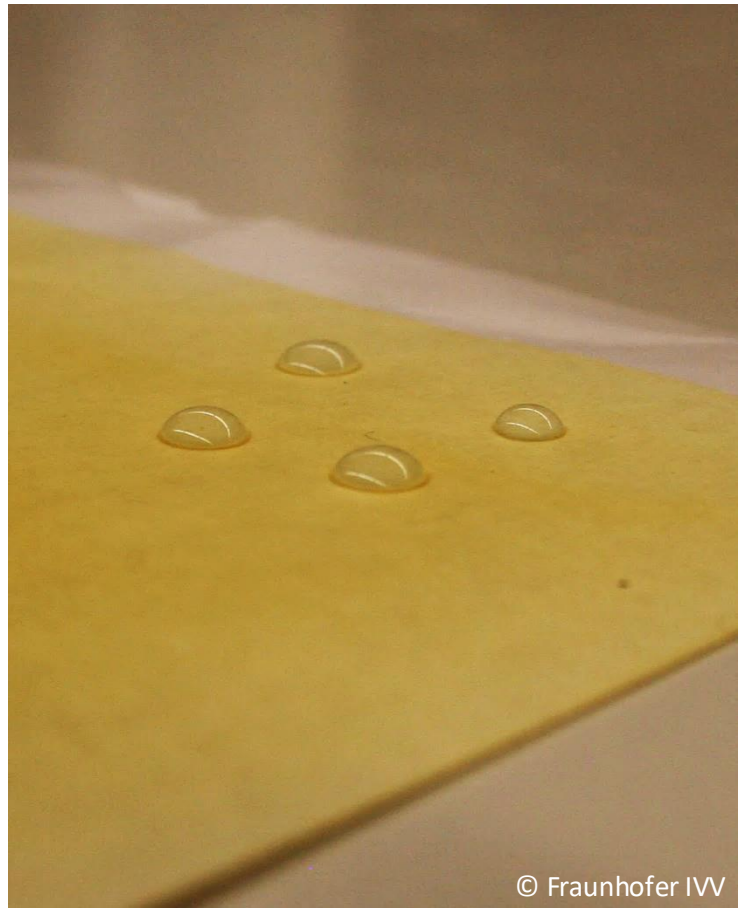
Coatings from SFAs

Bio-based water vapor barrier

WHERE WE HAVE TO IMPROVE

1. Grease resistance
2. Coating homogeneity and reproducibility
3. Heat sealability



GREATEST CHALLENGE FOR A FULLY BIO-BASED BARRIER SOLUTION

CALL FOR INNOVATION

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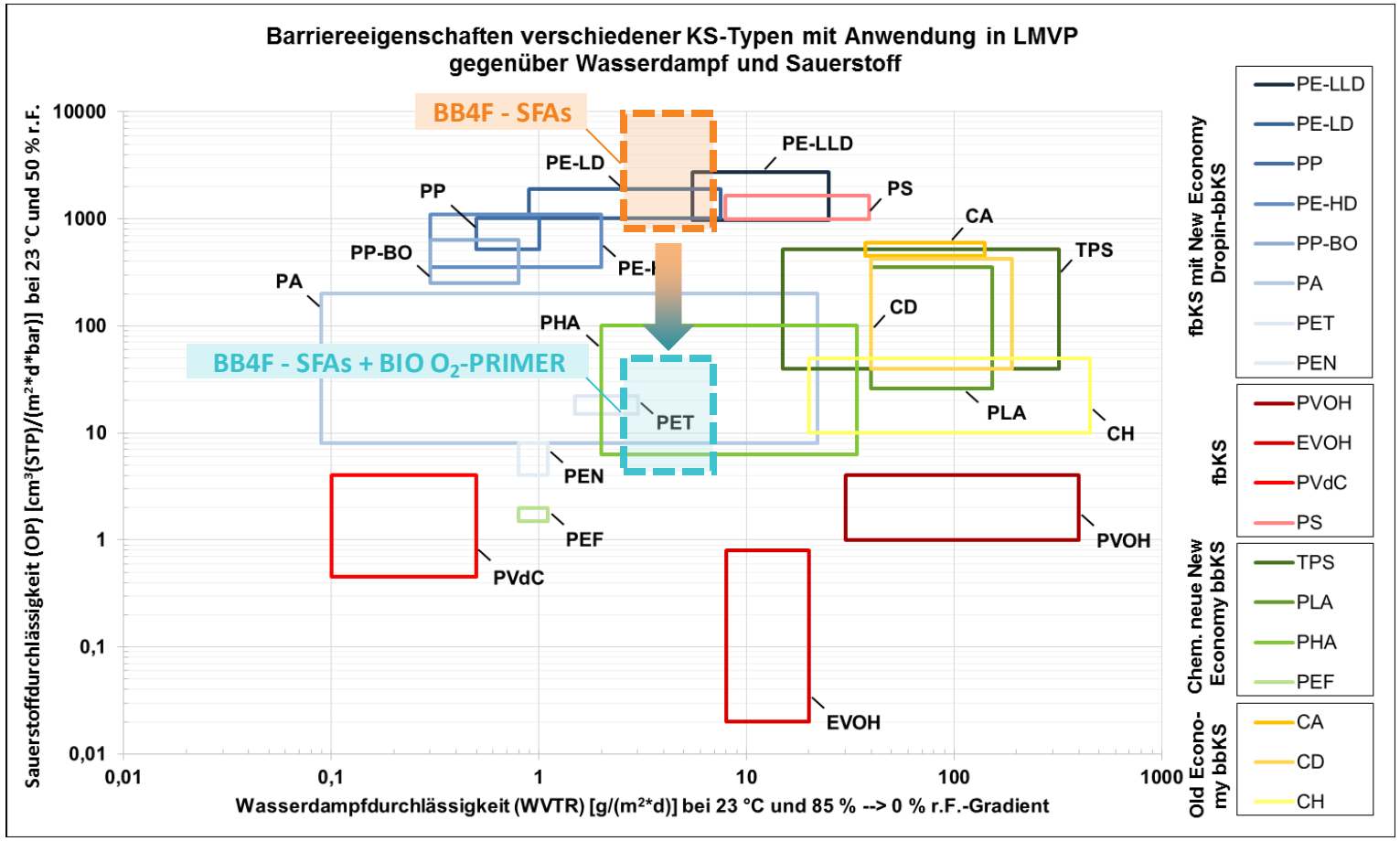
Coatings from SFAs

Bio-based water vapor barrier



Source: Final report of the research project *„Biobasierte Kunststoffe als Verpackung von Lebensmitteln“*, Fraunhofer IVV.
Water vapor and oxygen permeability of various bio-based plastics. All values are normalized to a material layer thickness of 100 µm.

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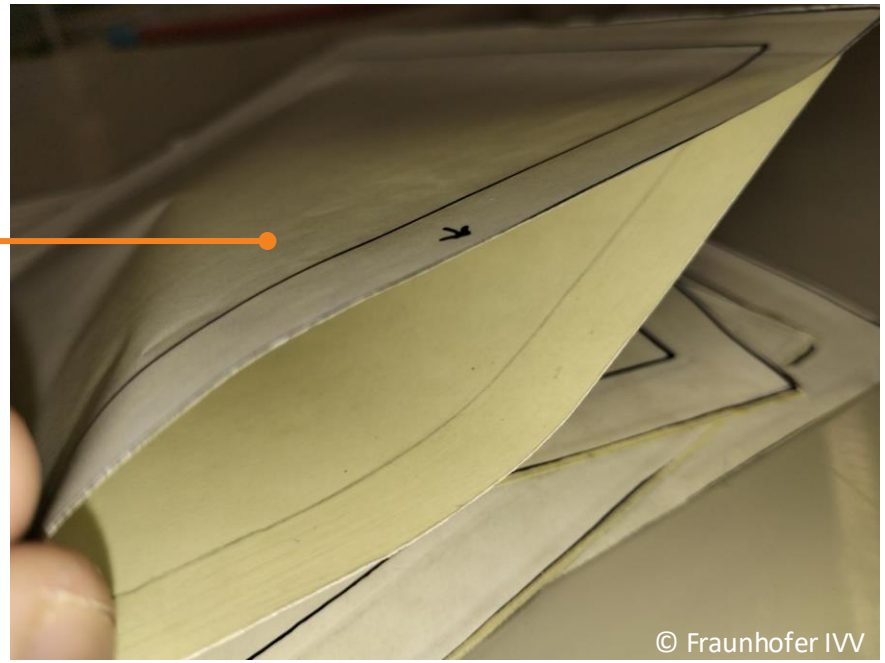
Fiber-based packaging solutions with a natural barrier

Demonstration phase

1. First lab-scale production of packaging paper demonstrators with SFAs coating
2. Preliminary shelf-life tests with packaged food samples
3. Analysis of product quality and acceptability



SPECS OF PAPER SUBSTRATE

- One-side pre-coated packaging paper
- No effective water vapor barrier
- Suitable for laminating and coating processes

- 80 $g \cdot m^{-2}$ grammage
- Excellent printing properties
- Certified for food contact

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Fiber-based packaging solutions with a natural barrier

Demonstration phase

1. Shelf-life tests performed with cherry tomatoes as food product

2. Panelist acceptability up to 2 weeks shelf-life in SFAs-coated paper pouches

3. Moisture loss is still to be improved via more homogeneous coating layer

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Fiber-based packaging solutions with a natural barrier

Demonstration phase

On 20th test day, tomatoes have lost up to 10 % of their mass

On 20th test day, visible mold growth affects acceptability

On 20th test day, only essicated peel affects acceptability

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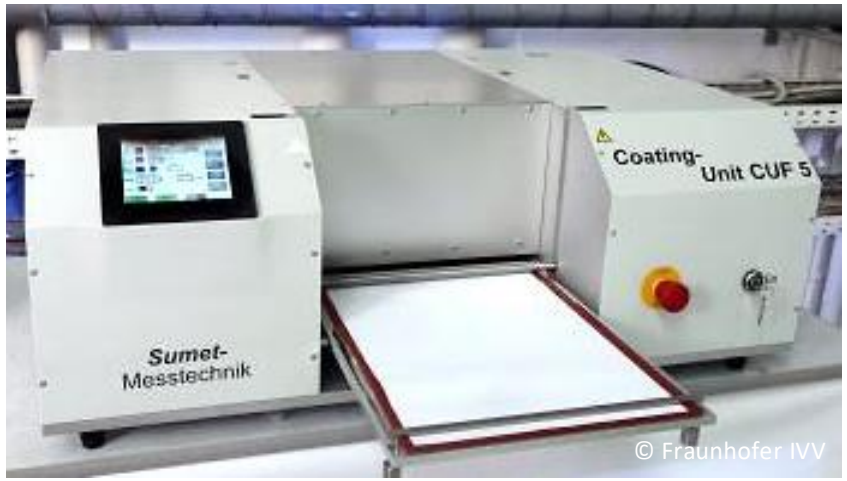
Fiber-based packaging solutions with a natural barrier

Demonstration phase

LAB-SCALE

PILOT-SCALE



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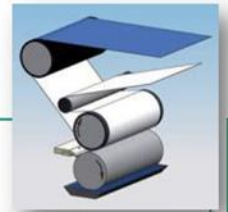
Reverse-gravure coating



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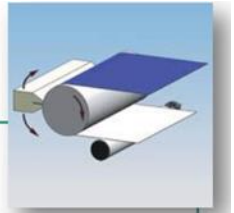
Slot-die coating



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Fiber-based packaging solutions with a natural barrier

Future possibilities

POTENTIAL ADDRESSED APPLICATIONS AND MARKETS

Dry food (pasta, cereal, bread, salt)

Dry detergents (washing powder)

Dry building materials (cement, mortar, plaster)

Fresh food (fruit and vegetables)

What else?

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Can you imagine
your next product protected
by a tree?
We can!

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We look forward to working together with you!

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