Biobased Performance Materials Symposium
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Session: Processing
Presentation by: Chris Smit, *Océ-Technologies*

Title: **BIOPRINT – Developing a Bio-based latex for the printing industry**

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Curriculum:
Chris Smit started his career at Océ-Technologies in 2012 as ink interaction researcher in product development, where he took part in development of the ink released with the Varioprint i300, Océ's first cut sheet inkjet printer utilizing latex ink. He went onto becoming part of the technological development team where he was investigated the next ink release as well as further releases of the inks for the Varioprint i300 platform. After three years he became lead technologist and currently coaches an early phase development group, looking into new (ink) avenues and is responsible for introducing high throughput methodologies in his domain. He takes part in a number of activities taking place between Océ and external parties such as WUR and gives in house courses for Océ employees.

Abstract:
The BIOPRINT project is a consortium between ADM, OCE and Wageningen Food & Biobased Research. The goal of the project is to create a bio-based latex for inkjet printing with desired and competitive properties. The challenges in this project vary from producing a bio-based latex to incorporating the latex into an ink set that is both stable and can form a film in the harsh environment that inkjet printing is. A summary of activities that have taken place within the BIOPRINT project will also be presented

During the projects it also became clearer how to not only look at developing a bio-based ink, but to also how to increase the chance of the bio-based ink becoming a successful application, which will be the closing remarks of the presentation.

BPM 2 – **BIOPRINT**:

Tunable bio-based polymers for digital printing applications

Chris Smit

WAGENINGEN UNIVERSITY & RESEARCH

biobased performance materials

ADM

océ

A CANON COMPANY

R4 - Public

Outline

I. Introducing BIOPRINT
  - Consortium
  - Project goal
  - Printing context

II. Defining BIOPRINT

III. Activities in BIOPRINT and future work

Introducing BIOPRINT

BIOPRINT consortium partners

Bio-based
Monomers
Source

Introducing ADM

ADM: A History of Biorefinery Innovation

- $61B in net sales FY17, 300 processing facilities, 44 innovation centers, 31k employees
  - Headquarters in Chicago, IL
  - Founded in 1902 as a linseed crushing operation
- Stable earnings from a broad product portfolio
  - Four traditional business product platforms: Food, Feed, Energy, Industrial

	MT/day
Oilseed Processing	~154,000
Corn Processing	~76,000
Agricultural Services Processing	~29,000

ADM

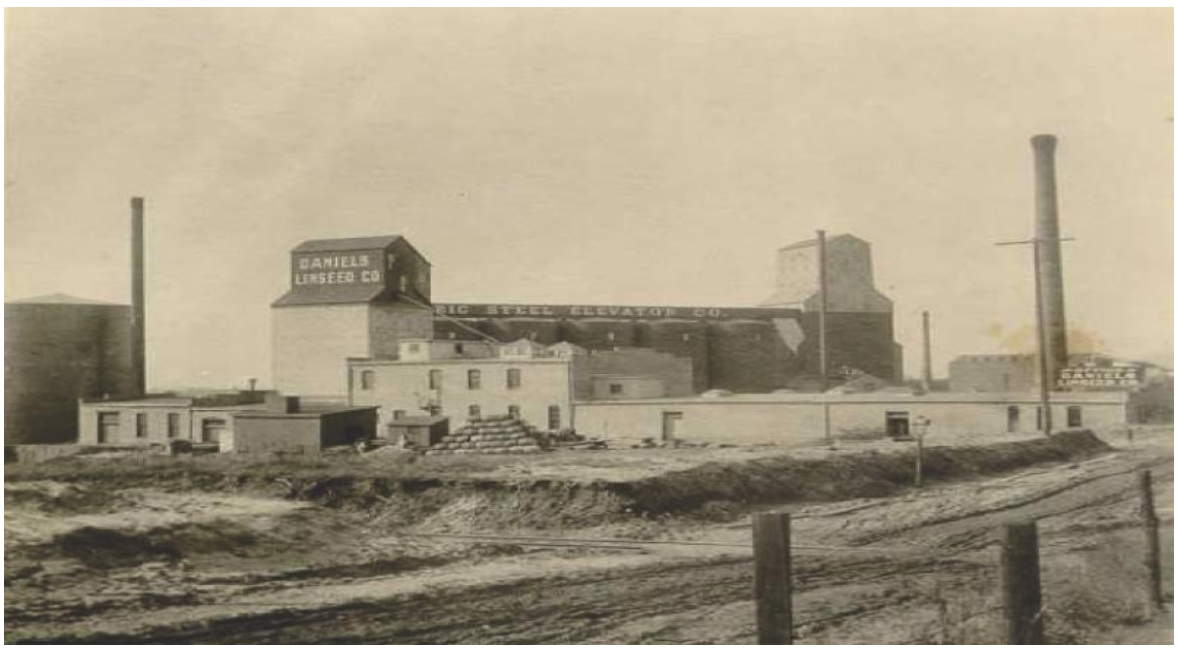
current

ADM
Supermarket to the world

(1962-2001)

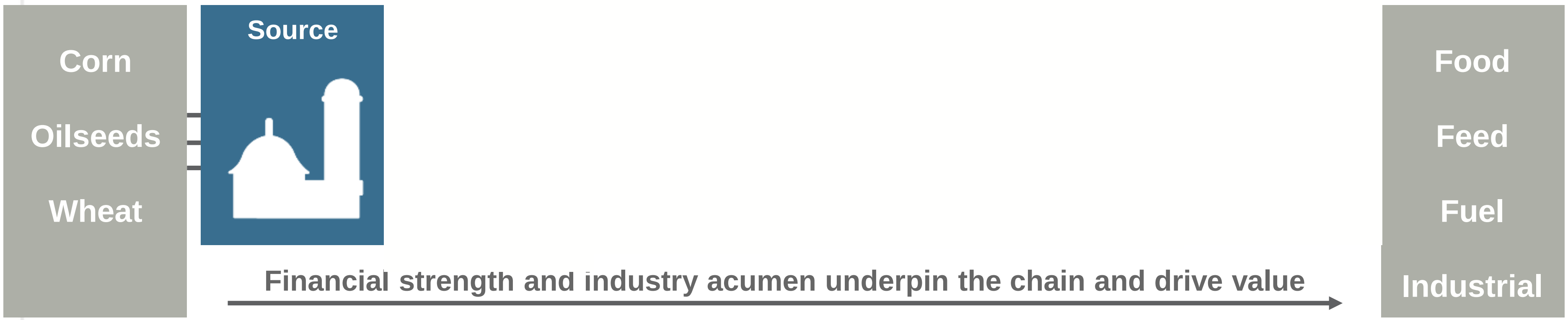
Archer-
Daniels-
Midland

(Before 1962)



ADM

ADM's Proven Core Model



Setting the competitive standard

Capture value across the chain

ADM Chemicals Development

Direct Replacements

- Majority of Development Efforts
- Meet specifications and must be competitive in current markets
- Lower GHG footprint in comparison to petroleum analogs
- Example: *Propylene Glycol, Acrylic Acid, Adipic Acid, HMDA*

Bioadvantaged Molecules

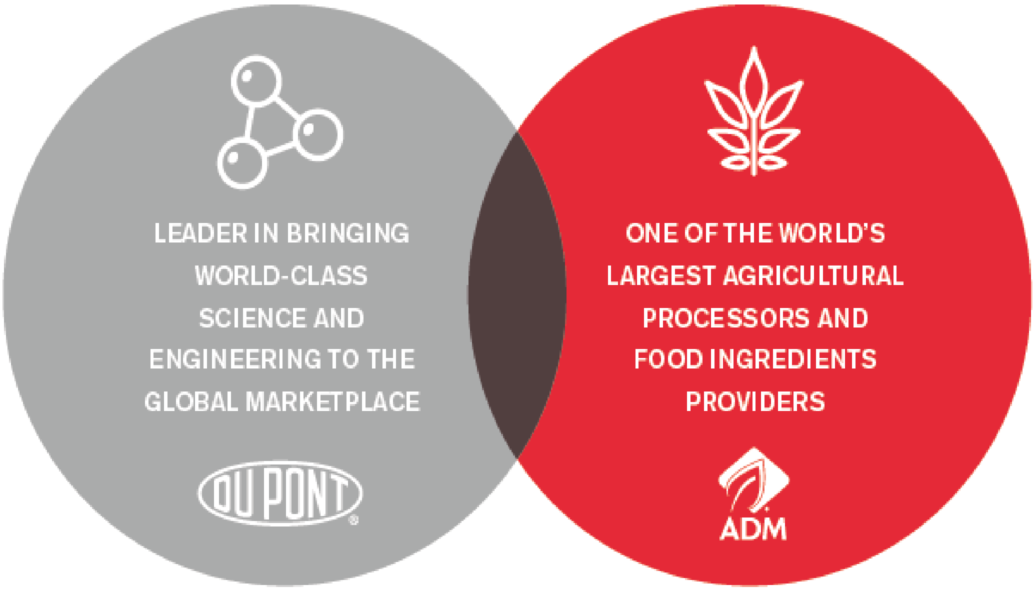
- New intermediates not readily accessible from petrochemical routes
- **Must have additional performance or environmental/health attributes**
- Examples: *FDME, Glucaric Acid, Isosorbide*

Goal: Develop transformational technology that enables economically feasible routes to sustainable materials

ADM

ADM and DuPont Announce FDME

A REVOLUTIONARY PARTNERSHIP BETWEEN TWO SCIENTIFIC LEADERS IS BRINGING A NEW MOLECULE TO MARKET

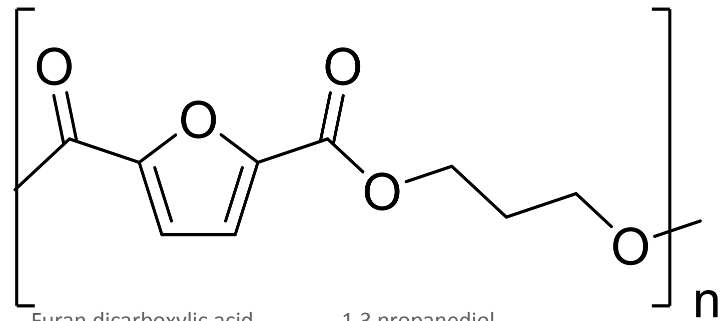


PTF: 100% Renewable Polyester with Superior Barrier Performance

Polytrimethylene Furandicarboxylate (PTF)

A novel polyester made from FDME and

Bio-PDO™ (1,3-propanediol)



Furan dicarboxylic acid (FDCA)

1,3 propanediol (Bio-PDO™)

Superior gas barrier properties	*Provides lightweighting and smarter packaging*
Recyclable polymer	*More packaging with recycled materials*
100% renewable polymer	*Enables use of more sustainable materials*

10x improvement in barrier properties compared to PET

ADM and DuPont Commission Pilot Plant

Pilot Plant commissioned April 30, 2018 in Decatur Illinois

Introducing WFBR

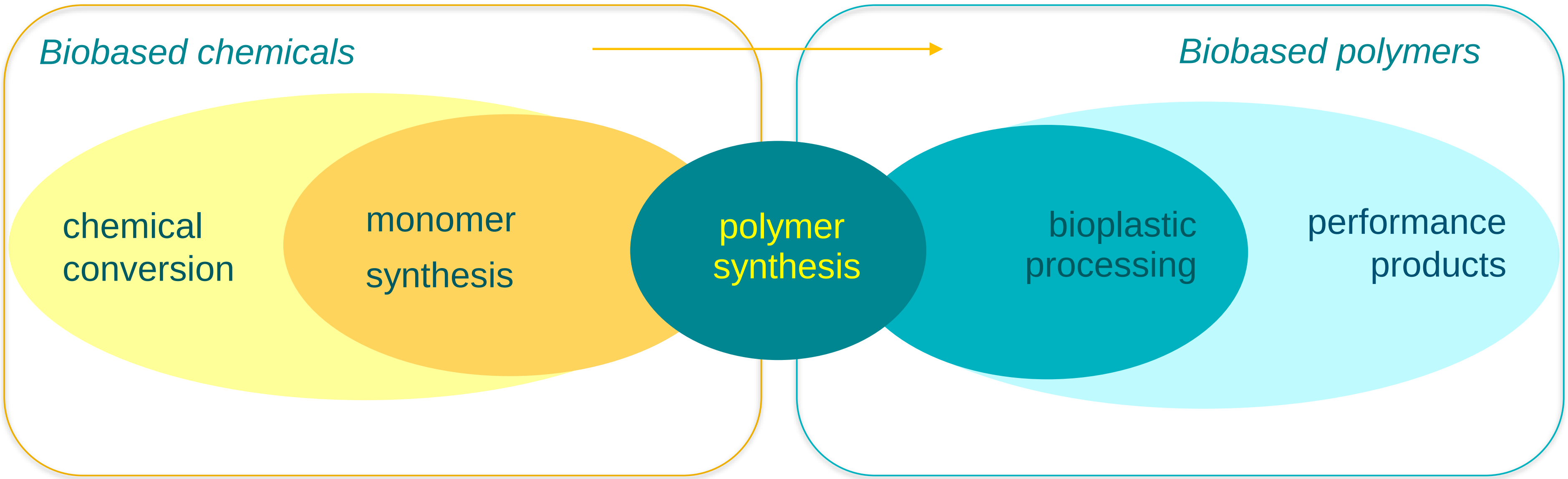
Wageningen Food and Biobased Research (WFBR)

Healthy & Delicious Foods

Sustainable Food Chains

Biobased Products

WFBR Biobased Products



Carbohydrates
Lipids
Lignin
Cellulose
Pectins
Alginates
etc.

Furans
Isosorbides
Aromatics
Diols
etc.

Solution
Emulsion
Suspension
Reactive extrusion

(Co)polyesters PEF, PPF, PBF, PIIF
Polyamides
Polycarbonates
Polyurethanes
(co)-PLA and stereo-complexes
PBS, PHA
etc.

Films
Foams
Composites
etc.

Equipment at WFBR

Polymer synthesis

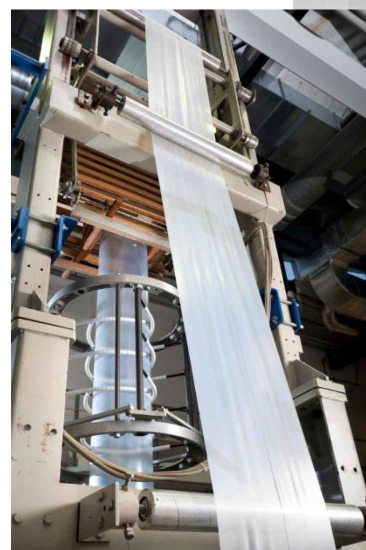
(1 g - 1.5 kg)

- 2 L double walled reactor
- impellor stirrer
- for solutions, emulsions and suspensions
- Bottom drain valve (product collection)

- 1.5 kg melt polymerization reactor
- anchor stirrer
- Torque, temperature, pressure monitoring on-line
- Max temp: 320°C
- Bottom drain valve

Polymer processing

(0.5 - 100 kg/h)



film blowing

injection molding

extrusion

Introducing Océ

Products & solutions

- Cameras (compact & interchangeable-lens)
- Printers for home and office
- Digital production printers
- Video equipment
- Network cameras
- Medical equipment
- Semiconductor-manufacturing equipment

Leader in consumer & professional imaging

197,776 employees worldwide

2017 revenues €30.23 billion*

Ranked 3rd among U.S. patents in 2017

** Translated from yen at 31 December 2017 rate of 134.96 JPY = 1 EURO*

Products & solutions

- Large format printing technologies
- Continuous feed printing technologies
- Cutsheet printing technologies
- Sheetfed printing technologies
- Workflow software
- Business services

océ

A CANON COMPANY

A Canon innovation center

2017 revenues €1.77 billion

3,900 employees in Océ innovation centers

12,000 employees in Canon sales & services

Top 10 R&D investor Netherlands

The printing industry in perspective

Global industry revenues 2016 (Billions €)

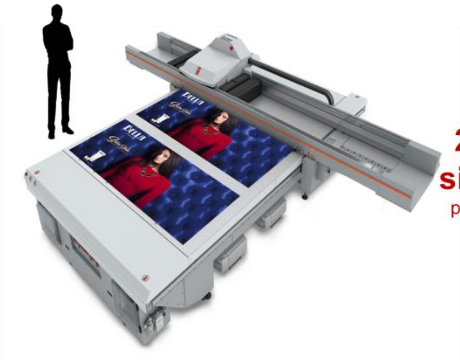
Music | Video games | Consumer electronics | Printing

19

Sources: Pira: The future of Global Printing to 2020

Océ Portfolio

Océ Arizona 6170 XTS



200 signs per day

Océ ColorWave 700

500 posters per day

Océ ProStream 1000

Latex

Up to **425,000 direct mail pieces** per day

Océ VarioPrint i-series

Latex

100,000 brochures per day

Océ Colorado 1640

Up to **600 banners** per day

Sustainability

Océ Sustainability Mission Statement

Océ enables its customers to manage their documents **eco**-efficiently and **eco**-effectively by offering innovative print and document management products and services for professional environments, **while acting as a responsible corporate citizen.**

Sustainability Vision

Océ wants to be best in class regarding minimizing its environmental footprint and maximizing the well-being of people. Océ shows the world that documents can be managed **eco**-efficiently and and ultimately **eco-**effectively.

Sustainability strategy structured in five Focal Areas, four are product related:

Canon philosphy

"All people, regardless of race, religion or culture harmoniously living and working together in the future"

lies at the heart of the Canon brand, business and sponsorship activities
It shapes our mission and our values, the way we treat our people and conduct our business.

Defining BIOPRINT

Vision

- A key driver for the growth of the latex market has been the reduction of VOCs in the **paint** industry. Conceptual understanding of synthetic "latex film formation" lifted–off in the *1990s.*

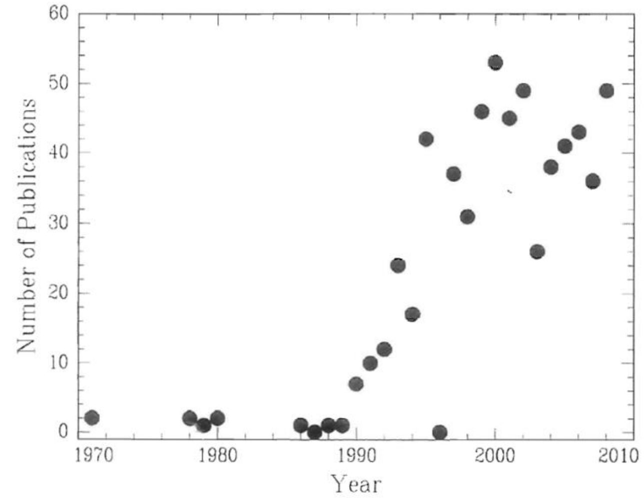


Fig. 1.13 Number of publications, by year, on the topic of 'latex film formation' according to a keyword search on the ISI Web of Knowledge[SM] database.

Fundamentals of Latex Film Formation (2010)
Joseph L. Keddie, Alexander F. Routh

- Vision Océ: **Inkjet** is the future. Water-based latex is a key technology. Transition to inkjet has been confirmed at Drupa *2016**.

  * *"http://whattheythink.com/articles/80798-drupa-future-of-inkjet/"*

- Vision BIOPRINT: Fashioning a Latex from biobased monomers to enable the formulation of a sustainable water-based **latex ink**.

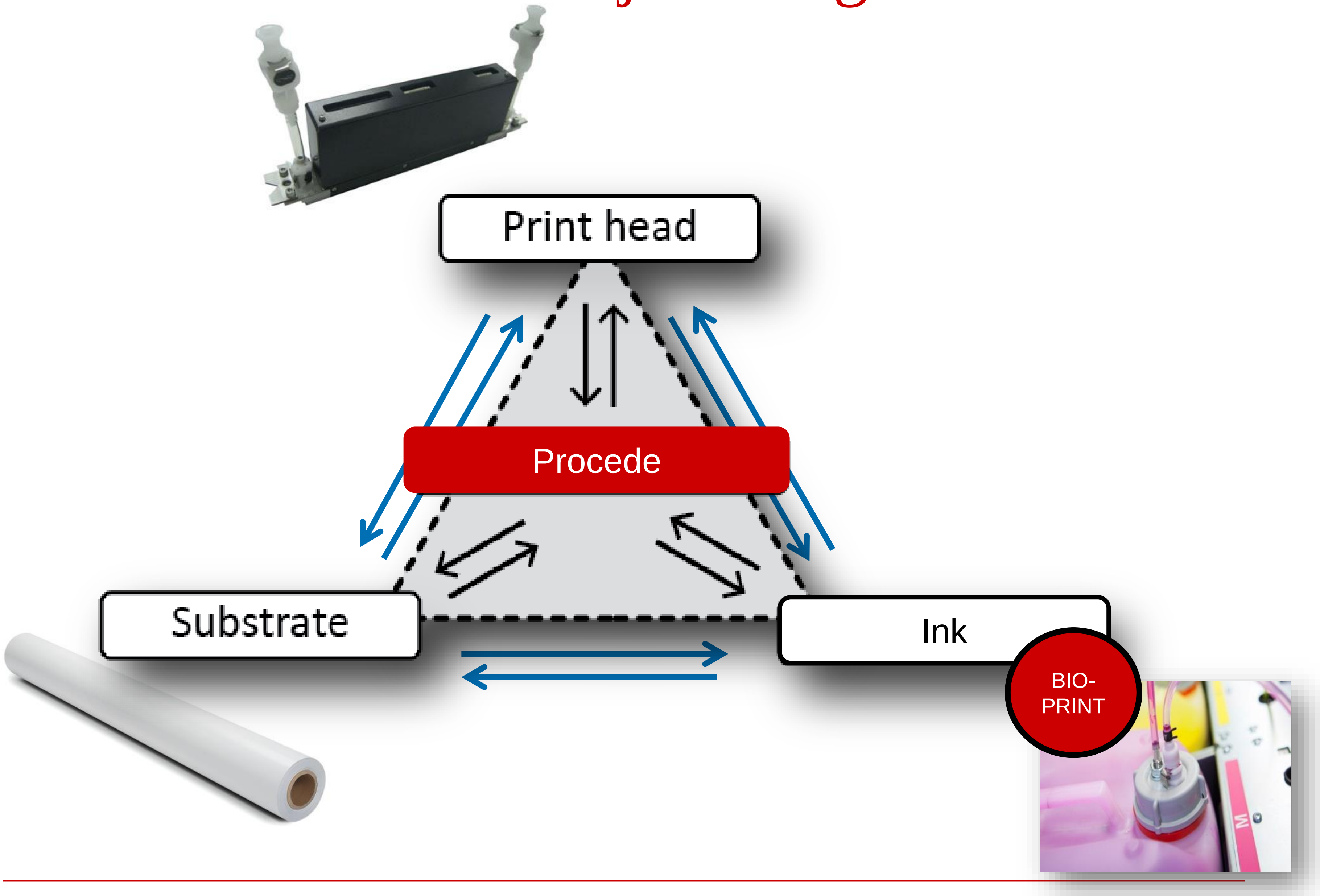
Project Goal

➢ Creating a bio-based latex for inkjet printing with desired and competitive properties

Requirements of the ink:

- Stable during storage
- Stable jetting behavior
- Resulting in a robust ink layer

Interactions in the inkjet triangle



An ideal situation

The BIOPRINT latex can directy replace an existing latex

Idealy....

- No ink-recipe optimisation should be needed to secure:
    - Stability
    - Jetting perfomance
    - Level of ink robustness
- Costprice should stay similar or be reduced
    - (Including R&D costs)
- Easy to produce
    - prefferable within existing facilities

The real situation

Every ingredient has an impact on the resulting product

→ Replacing an ingredient in the recipe leads to a new (different) product

Positioning BIOPRINT

Option 1:

- Starting from an existing product, replace existing latex with the BIOPRINT latex.
  - Recipe is fixed
  - Extremely difficult to predict behavior of the latex

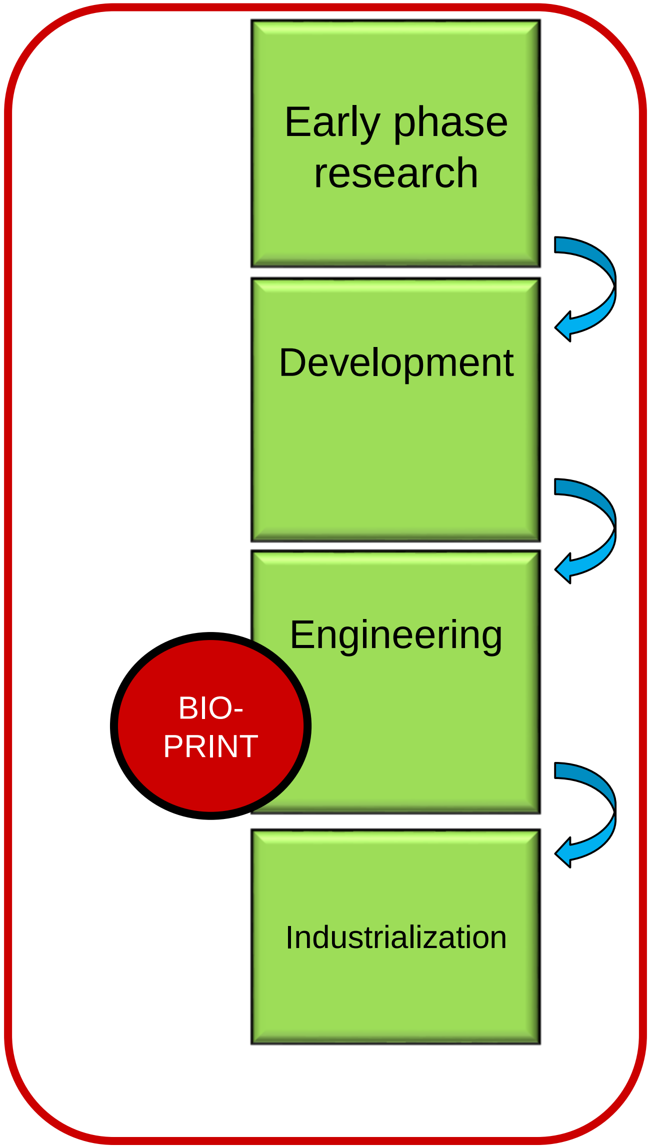
Option 2:

- Start with BIOPRINT latex and build the Ink-recipe around it
  - Focus on Latex properties
  - Latex can be “helped” with other ingredients
  - Ink recipe needs to be developed

Selected R&D location:

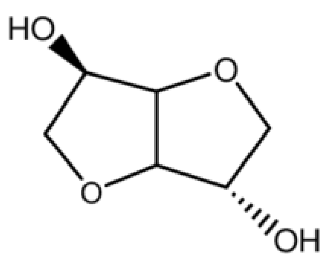
- BIOPRINT moves to early phase research
  - “Feeding ground” for new products

➢ **Biobased polymer inks can show their own strength and benefits**

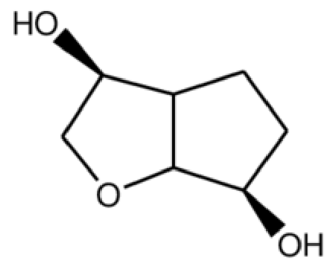


Prior art

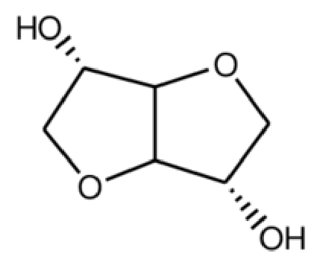
- Co-polyester: isohexide, aromatic dicarboxylic acid or a cycloaliphatic dicarboxylic acid and an aliphatic diol



isosorbide
1



isomannide
2



isoidide
3

HOFSTRA, R. and R.W.N. EVERS, *Bio-based polyester latex*. 2014, US 2014/0011931 A1

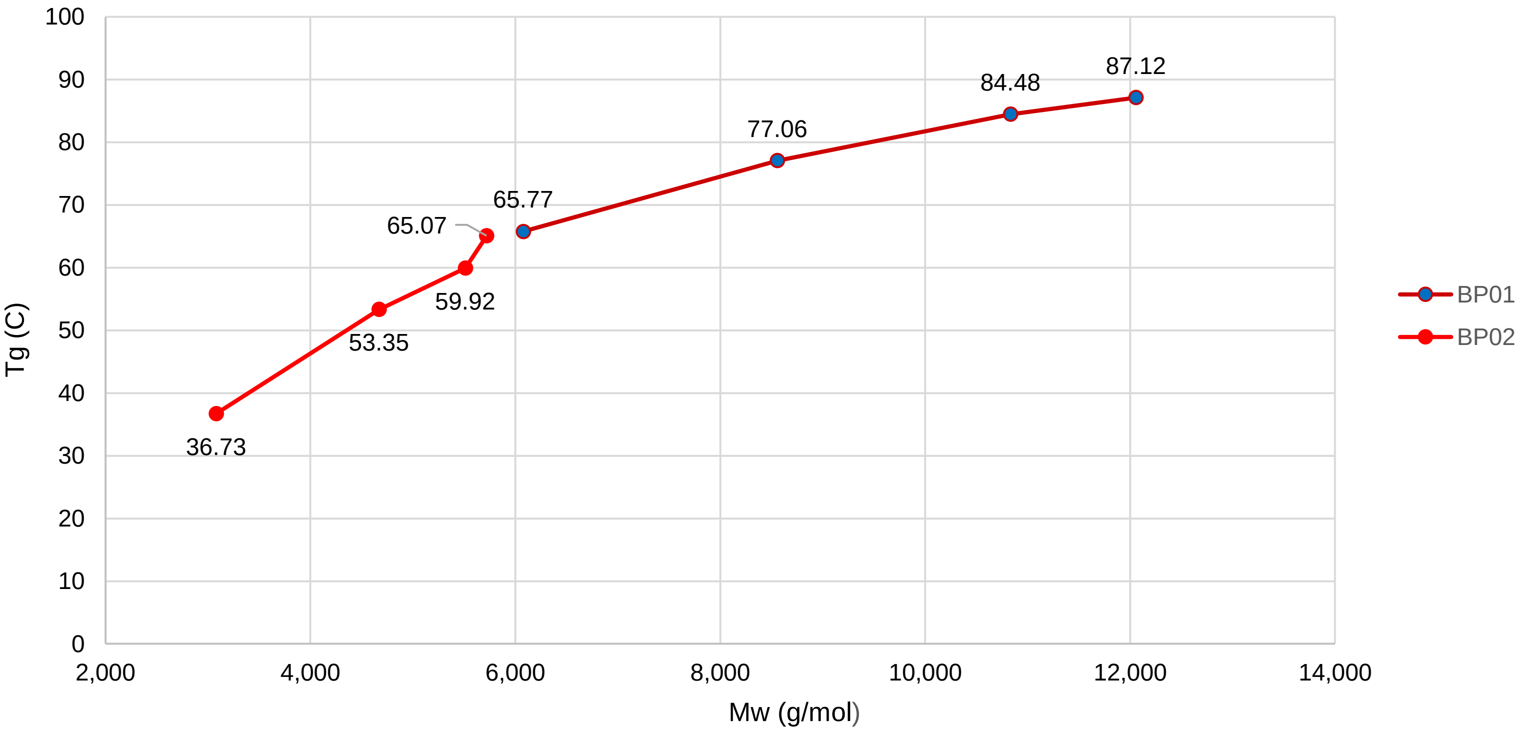
Activities in BIOPRINT

Initial research goals @ WUR

1) Reproduce state of the art ✓
2) Reduce reaction times ✓
3) Establish control over molecular weight ✓
4) Investigate latex stability ✓
5) Improve latex stability ✓
6) Explore new biobased monomers (from ADM) ✓
7) Define a toolbox of monomers for latex properties design ✓

Mw and Tg control

Control over Mw leads to control of Tg

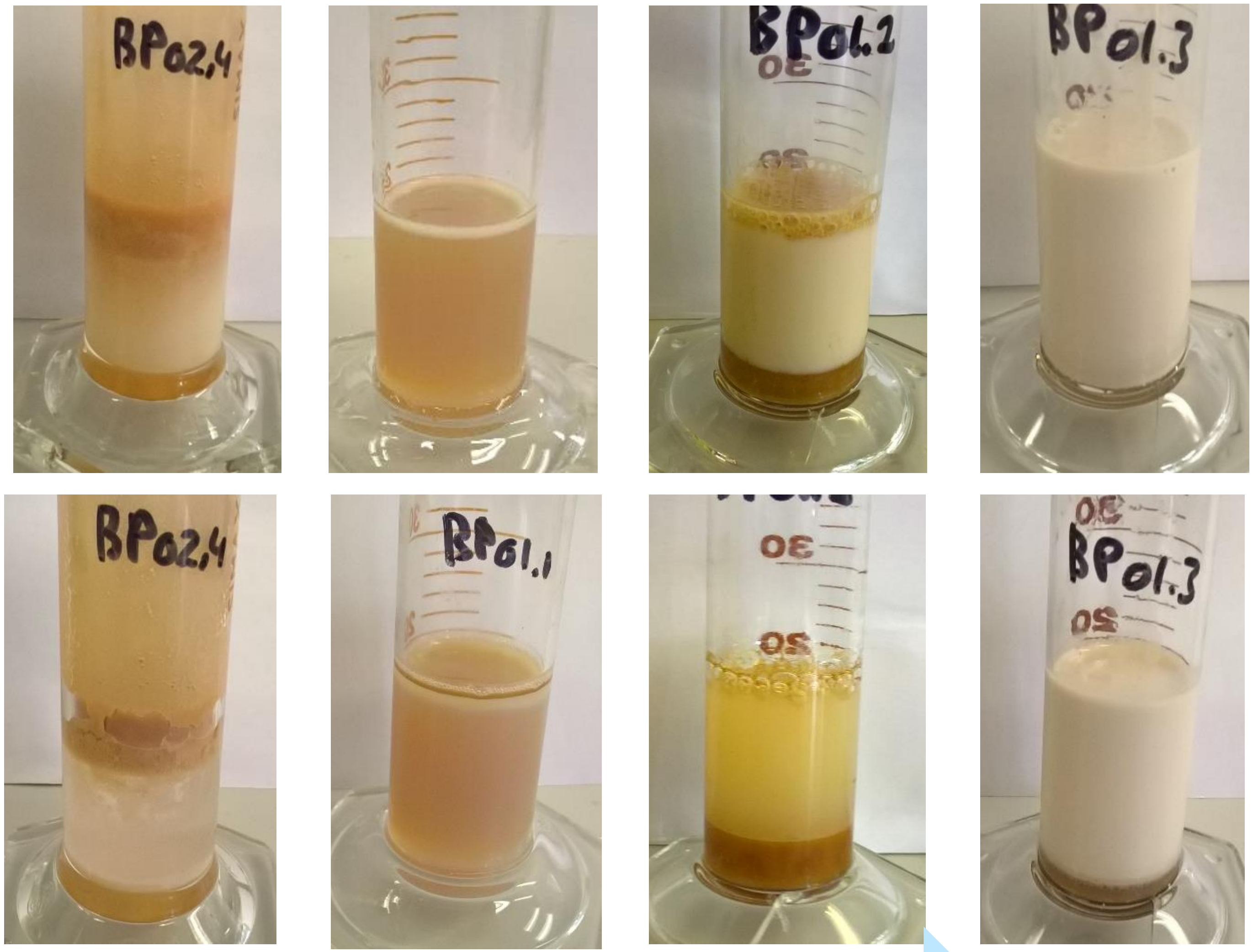


Latex stability

RESTING TIME

2 h

24 h



Molecular Weight

First findings with new polymers

1. Ease in purification steps led to >99+% purity
2. Homogeneous melt obtained in < 1 h during polymerisation
3. Polymerization duration 5.0 h (un-optimized) → 9 fold shorter reaction time
4. Facile fine-tuning of the T_g is possible

Summary

- BIOPRINT latex will be a starting point for ink, instead of a replacement in an ink.
- A synthetic route has been chosen and verified.
- Tg control and stability have been investigated.
- A toolbox of biobased monomers is chosen to steer the polymer properties → desired latex specifications.

Thank you for your attention!

Q & A