Title: Biobased performance materials in a circular economy

Author: Christiaan Bolck

Contact details:
Christiaan Bolck
Program Manager Materials
Wageningen Food & Biobased Research
P.O. Box 17
6700 AA Wageningen
The Netherlands
T +31 317 480229
E christiaan.bolck@wur.nl

Curriculum:
Christiaan Bolck, is director of the Biobased Performance Materials research programme and as such is coordinating the Biobased Materials R&D activities within the Dutch top sectors. Christiaan has over 15 years of experience in product and market development regarding materials and products from biobased and recycled (re-)sources. As programme manager renewable materials within the applied research institute Wageningen Food and Biobased Research, he is currently responsible for the research and development activities at Wageningen Research in the field of biobased and circular materials, such as plastics, textile, paper & pulp, and building materials. In addition, he is a member of the “Expert group Biobased Products” of the European commission (since 2008), Advisory Board member of the lectorate polymer technology at the Windesheim polytechnic (since 2008), member of the advisory committee on (green) taxation scheme of packaging waste (since 2008), and Consultant “governmental policy on the biobased economy” for the Dutch ministries of Economic Affairs and Agriculture (since 2004).

Abstract:
The Biobased Performance Materials Program is a research program that has been running since 2009 and focuses on the development of high performance materials based on biomass. BPM is a PPP within which industry and knowledge institutions collaborate and which also has a coordinating role within the Dutch top sectors in research and development in this field. Through a chain approach, technology is developed from various primary raw materials such as sugar beet and potatoes for the production and processing of new or substantially improved biobased polymers for applications in the packaging, electronics and automotive industries. The current BPM program has come about through a “market-oriented” approach, based on the requirements of the materials and where the wishes of companies have been leading. In the new tranche Wageningen Research wants to give more attention to the reuse of materials and the interaction of materials with the environment (litter, plastic soup). Hence the new name Circular and Biobased Performance Materials.

For the 3rd tranche of (C)BPM an important research direction remains the creation of biobased materials based on new building blocks, with its own unique structure and associated unique properties. For this, on the one hand the available biomaterials will have to be improved and on the other hand completely new biopolymers have to be developed. Another research track is the direct use of available natural polymers such as cellulose, starch, chitin and lignin. This concerns both natural polymers that are currently being underutilized such as residual or secondary streams, as well as industrially produced natural polymers. The aim is, among others, to develop plastics by means of the functionalization of, for example, lignocellulose, and to develop processes by which these polymers can be extracted from waste without loss of functionality. A third research track is specifically
aimed at reusing consumer waste. The following research directions will be considered: (1) Design of materials that can be recycled using available collection and processing processes, (2) Consumer behaviour: for prevention of litter and collection of waste it is important to keep substances really well separated or to separate them afterwards (3) influence of so-called disturbances from residual and waste products. These must be separated as much as possible from the main product, so that new, qualitatively good new products can be made with clean recyclate and (4) each residual and waste stream has its own, unique functionalities that we must retain as well as possible in the reuse process.
PPP coordinating R&D activities in the Netherlands on Biobased Performance Materials

Initiated by Wageningen Food and Biobased Research

Fills an important gap in research that catalyzes the biobased economy

Is unique in its construction: industrial partners participate actively from all parts of the value chain

Start in 2010 & 2nd tranche 2015

Sponsored by the Dutch Government
Goal & Scope

Cost competitive biobased performance materials with substantially improved properties profile

- Using functionality in biomass
- Using unique structures available in biomass
- Low temperature transformations (wherever possible)
- No biocrude or syngas
- With focus on Products, Materials, Polymers, Monomers
- Circular approach
Output

- New building blocks, polymers, compounds and end products
- Patents, scientific publications, posters, etc.
- Books on plastics, composites, building materials, chemical building blocks and sustainability of plant derived oil products
Projects 1st tranche

- NOPANIC
- PLA St IC
- FEASIBLE
- SUSTAIN
- ChitoSmart
- MOBIOSOL
- ACTION
- HIPLA
- BIOCRES
Projects 2nd tranche

- MAGIC : Rail fastening systems : Edilon Sedra, Croda
- HIPPIE : High performance polymers from isoidide : ADM, DuPont, HCA
- SPECIFIC : Starch PE films with Improved barrier : AVEBE, Sabic
- DISCOVER : Covering materials for Roofing : Icopal, Stichting DAKlabel
Projects 2nd tranche

- **Glue Reed**: Renewable boards
  DSM, Natuurmonumenten

- **MethaForm**: Biobased itaconic acid and methacrylic acid
  ADM, EOC, Van Wijhe (Wydo)

- **APPS**: Applications for PBS
  Reverdia, Promens, Teamplast

- **FOAMEX**: Extrusion foaming
  Synbra (BEWi), Nomacor, Sulzer Chemtech
Biobased performance materials in a circular economy

Christiaan Bolck – Director BPM
7th BPM symposium – 14 June 2018 – Campus Wageningen
Wageningen Campus inspires

University and research
- 9,000 BSc and MSc students
- 1,700 PhD students
- Over 100 nationalities
- 6,500 employees
- Extensive international network

Interaction with companies
- Contract research
- Stimulate & support entrepreneurship
- Incubators
- Sharing research facilities
- Lifelong learning
- Flexible business accommodation options
- Expat centre

Perfect base for interaction and innovation

To explore the potential of nature to improve the quality of life
Total use via (bio)refinery

Strategic themes:
- Circular & Biobased Economy
- Resource Use Efficiency

WR Vision

The Biobased Economy Value Chain
Waste: a valuable resource for materials

Preconditions:

1. Materials must be designed in such a way that they can be recycled with the available collection and processing methods.

2. When collecting waste, it is important that the components are properly separated, either by consumers themselves or at a later stage.

3. Contaminants in residual and waste products must be separated from the main product to enable the production of good-quality new products.

4. All residual and waste streams have their own unique functionalities which must be retained as best as possible in the recycling process.
Research topics waste2materials

Identifying valuable components:
Use the raw materials concealed in the waste in applications of the highest achievable quality and seek opportunities to use the waste stream as a whole wherever possible.

Recycling processes:
Simulate existing recycling processes in detail and test new recycling processes and pilot setups.

Recycled materials:
Properties and standards: To what extent are recyclates suitable for specific applications and determine which components most affect the quality of the material.

Chemical recycling:
Technology to separate and enable the reuse of waste streams which are difficult or impossible to separate mechanically. Partially or fully break down or dissolve polymers to their original building blocks.

New circular value chains:
How can new circular value chains best be organized? How does the quality and costs from recycling compare to the raw material demand?
Current societal drivers

- Scientific
  - functionality from nature

- Environmental
  - Climate / no fossil carbon
  - Circular

- Social
  - Economy
  - Jobs
Ambitions of the New Plastics Economy

1. Create an Effective After-Use Plastics Economy

- Recycling: Radically improved economics & quality
- Other material streams

2. Decouple plastics from fossil feedstocks

- Drastically reduce the leakage of plastics into natural systems & other negative externalities

3. Design & production

- Biobased

Source: Project Mainstream analysis – for details please refer to the extended version of the report available on the website of the Ellen MacArthur Foundation:
www.ellenmacarthurfoundation.org
Current market drivers

- New unique functional properties: Tg, Tm, gas barrier, UV-stability, water sensitivity, targeted biodegradability, strength, impact
- Non toxic additives and functional ingredients such as plasticizers, fire retardants, anti-fouling, water binders
- Recycling of thermosets, post consumer plastics, textiles, diapers, packaging and foodwaste
- Added value for industrial organic waste like leaves for packaging and sewer sludge for plastics or foodwaste
- Regulation support at NL and EU level: normalization, standardization, certification
Research tracks Circular and Biobased Performance Materials

1. Sustainable packaging
2. New Biobased Polymers
3. Materials from underutilized biomass
4. Closing the loop of consumer waste
5. Plastics in the environment
1. Sustainable Packaging

Example project:
Alternatives for multilayer gas and water vapour barrier materials
2. New Biobased Polymers

- Using biobased building blocs for new non polluting and circular materials
- Taking polymers 2 market: Polymerisation pilot plant initiatives

Example projects:
- Recyclable thermosets en resins
- Biobased Elastomers
3. Materials from under utilized biomass

- Fuelled by the circular economy
- Refinery and materials sciences

**Example projects:**

- Thermoplastic lignocellulose: thermoplastic materials from naturally abundant biopolymers and its derivatives
- Sea2plastics: production of plastics materials based on seaweed and chitin
- Fibrewaste4paper&construction: valorising waste fibres like tomato leaves and reed
4. Closing the loop of consumer waste

Example project

Sustainable chains for supplying sustainable plastic packaging & textiles

Discard → Analyse

Application: Plastic, Coating, Textile, Construction, Papier and Board

Sorting and separation → Improve quality
Plastic recycling

- Improving the properties and value of post-consumer recycled plastics
- Which contaminations have the largest detrimental effect on plastic recyclates
  - Sorting errors
  - Packaging design
  - Packaging content
- Blueprint recycled plastics
  - Standards post use recycled plastics
  - Scope: all applications including packaging
  - Focus large volumes: PP, PE, PET, PS, PVC
Wastexcel: recycling mixed textile

- Recovery of mixed textile from basic natural (cellulose/cotton) and synthetic (polyester and elastan) raw materials
- 6 million tons/y discarded in EU
- Reuse of the cellulosic fractions from mixed textiles would make the EU more resource independent, and makes the textile industry overall more sustainable
5. Plastics in the environment

- CSI Plastics
  - Where are plastics found in the marine environment?
  - How to prevent ...
  - Are biodegradable plastics THE solution?

- Closing the biocycle: triggered biodegradation in soil and sea
| 1 | Sustainable packaging |
| 2 | New Biobased Polymers  |
| 3 | Materials from under utilized biomass |
| 4 | Closing the loop of consumer waste |
| 5 | Plastics in the environment |

**Research tracks 3\textsuperscript{rd} tranche (C) BPM**

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**Kunststoffindustrie roept op tot recyclingrevolutie**

Het recyclingagentschap van kunststoffen in Nederland fungeert onvoldoende. Dat stelt de Federatie Nederlandse Rubber- en Kunststoffindustrie (FKN) in het Masterplan Kunststof Kringloop, dat deze week gepubliceerd wordt. De gerecyclede kunststof - recyclaat - komt teweeg in deeltjes in beperkt aantal producten. Vooral omdat de kwaliteit van de gerecyclede grondstoffen te gering is of de hoeveelheden te klein. Daardoor worden grondstoffen in vooral korteleven in hogewaardige toepassingen als pallets, drukgrobbezen, tussenvellen, lakens en hangels. Dat is duidelijk.

Het recyclaat kan en moet ook worden verwerkt in hoogwaardige producten, zoals in verpakkingen, goed voor 40% van alle geproduceerde kunststoffen, zo meldt het Masterplan Kunststof Kringloop.

Het plan is onder andere onderzoeken van...
Thank you for your attention

christiaan.bolck@wur.nl
+31 317 480229

www.wageningenur.nl/en/fbr

www.biobasedperformancematerials.nl/uk