

BioFoam®

'PLA particle foam expanding in Europe'

Purac Lactide Plant Ground breaking

Synbra Technology

By J. Noordegraaf



- Company introduction;
- BioFoam® project overview;
- PLA polymerisation;
- BioFoam® processing:
 - PLA foaming;
 - PLA molding;
- BioFoam® properties:
 - Energy requirements and carbon footprint;
 - Mechanical and thermal properties;
 - Drop test results;
- Conclusions.

Company introduction



SYNBRA is the leading producer and converter of Expanded Polystyrene ('EPS')

- with about 1.500 employees;
- with a turnover of about € 300 million;
- focus on Sustainable Insulation Systems (SIS) and Industrial Products & Solutions (IPS);
- innovative and vertically integrated through cluster Technology & Innovation;
- Dutch holding co-ordinates 6 Clusters and has 26 production locations in 6 countries.

Broad range of EPS applications



Sustainable Insulation Systems (SIS)

Markets

End products

Roof insulation

Pitched, flat



Wall insulation

Cavity, exterior



Floor insulation

Boards, systems



Civil engineering

Road construction



Industrial Products & Solutions (IPS)

Markets

End products

Industrial/ Technical

Technical parts, Electronics



Food

Fish, Meat, Produce



Horticulture

Seed trays



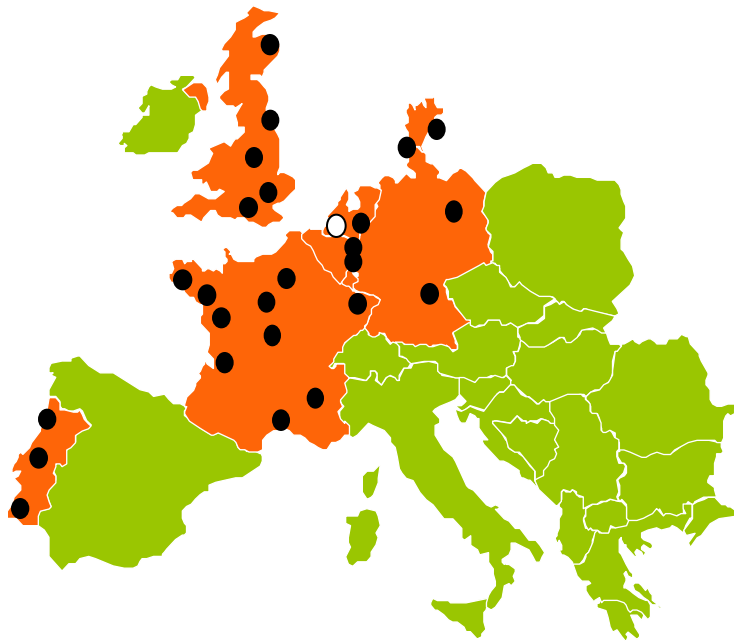
Water filtration

Biostyr®



Synbra's European coverage

- In general, transportation of EPS > 250 km is not profitable
- Majority of the business is local



- Synbra Technology supplies businesses with EPS beads
- Local BUs convert the beads into products
- Local BUs invest in product and application innovations
- Synbra Technology supports with material innovation

BioFoam® project overview



History BioFoam® project



- Formal project started April 2006;
- R&D with Wageningen University WUR;
- Starting point: use Synbra EPS pre-expansion & moulding;
- Use Polylactic acid (PLA);
- Best results blowing with CO₂;
- Shape moulding with biobased coating;
- Patents 2007 (coatings) and 2008 (processing);
- Trade mark BioFoam®: www.biofoam.nl

1. Polymerisation:

- GMO free PLA based on lactide;
- Making unexpanded BioBead;
- Cooperation with Sulzer Chemtech and Purac Biochem.
- Making sc-PLA compounds

2. Foaming and moulding:

- Upscaling impregnation and moulding;
- Cooperation ATO Wageningen.

3. Marketing:

- BioFoam: through Synbra downstream clusters
Synprodo, Styropack UK, Isobox, Dansk Styropack
- Sc-PLA: through Synbra Technology

PLA polymerisation



PLA production



- PLA can be obtained in two ways:
 - 1) Direct polymerization of lactic acid will mostly result in low molecular weight poly(lactic acid), PLA;
 - 2) Polymerization of lactide (= dimer of lactic acid) can create high molecular weight polylactide, PLA.
- Synbra's PLA plant will use recently developed technology by Sulzer Chemtech and Purac Biochem based on the second route.

- Technology from Purac Biochem and Sulzer Chemtech:
 - Synbra Technology as first user;
 - First European PLA producer: 5000 t/yr;
 - Growing to remain market leader in EU.
- BioBead polymerisation:
 - Cooperation with lactide market leader Purac;
 - Acces to D lactide: high temperature PLA possible;
 - Is a business opportunity in itself
 - Startup Q2-2010.

PLA thermal properties

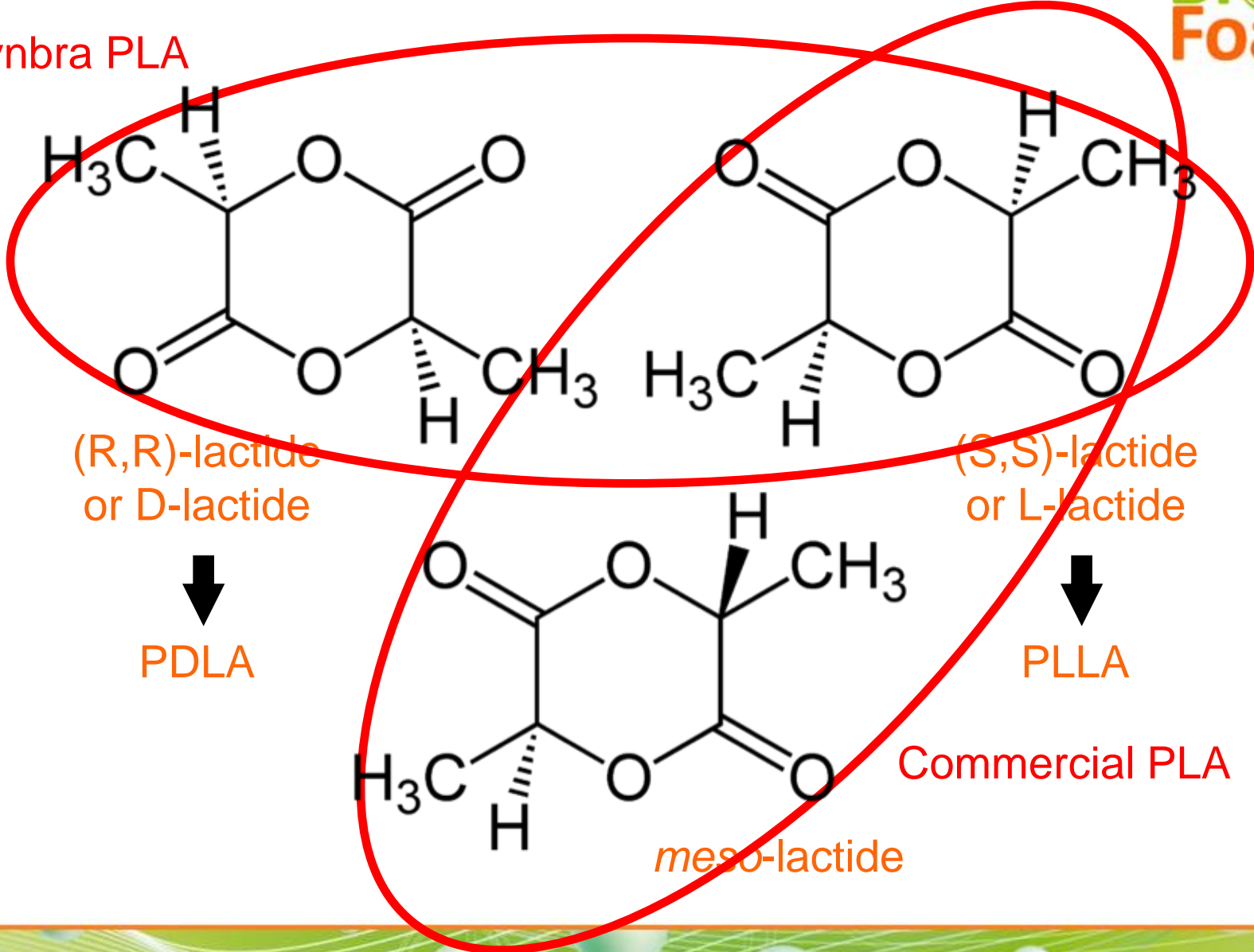


- PLA is a semi-crystalline polymer with a low T_g (55 °C) and a high T_m (140-180 °C);
- Heat resistance can be a major issue in solid PLA and X-PLA;
- By controlling recipe and crystallization heat stable BioFoam® (up to 80 °C) can be achieved;
- Further improvements possible by stereo-complex technology (use of D-lactide);

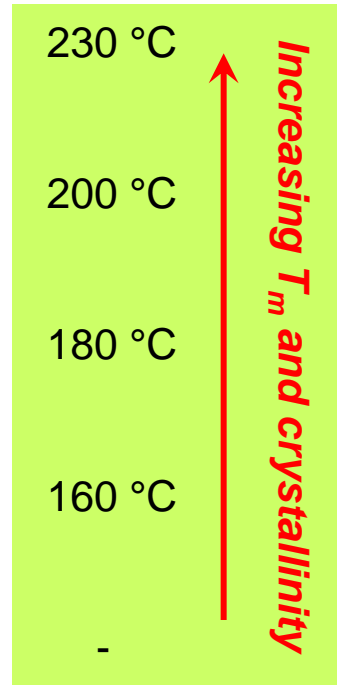
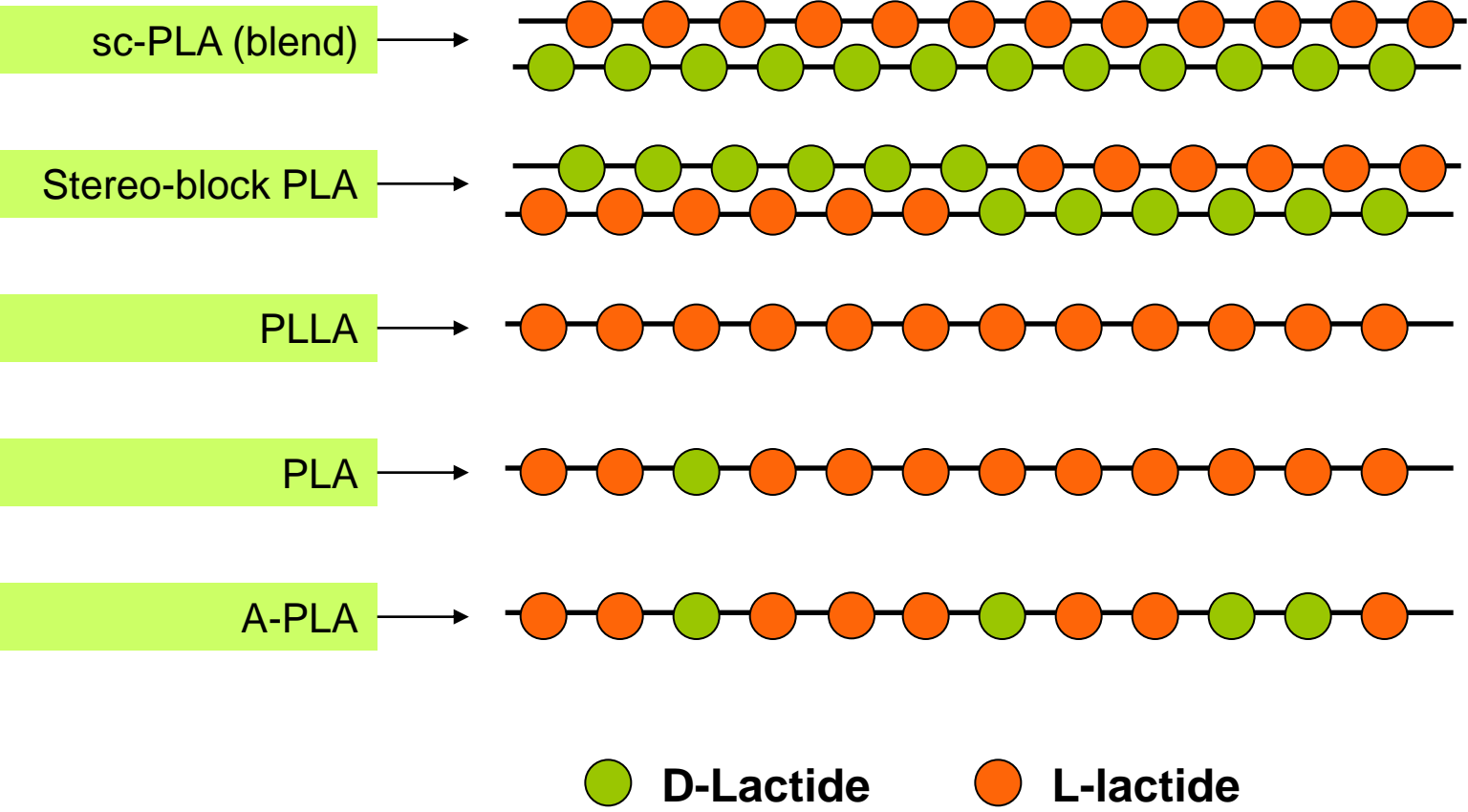
PLA structure



Synbra PLA



PLA structure



>10% D in PLA
Amorphous (no T_m)

Stereocomplex-PLA improves Heat Resistance (HDT)



Now



Coffee
70°C



*Future with
sc-PLA??*



By mixing 40 % PDLA with PLA cups are made that can be used till 190°C without distortion.

BioFoam® processing

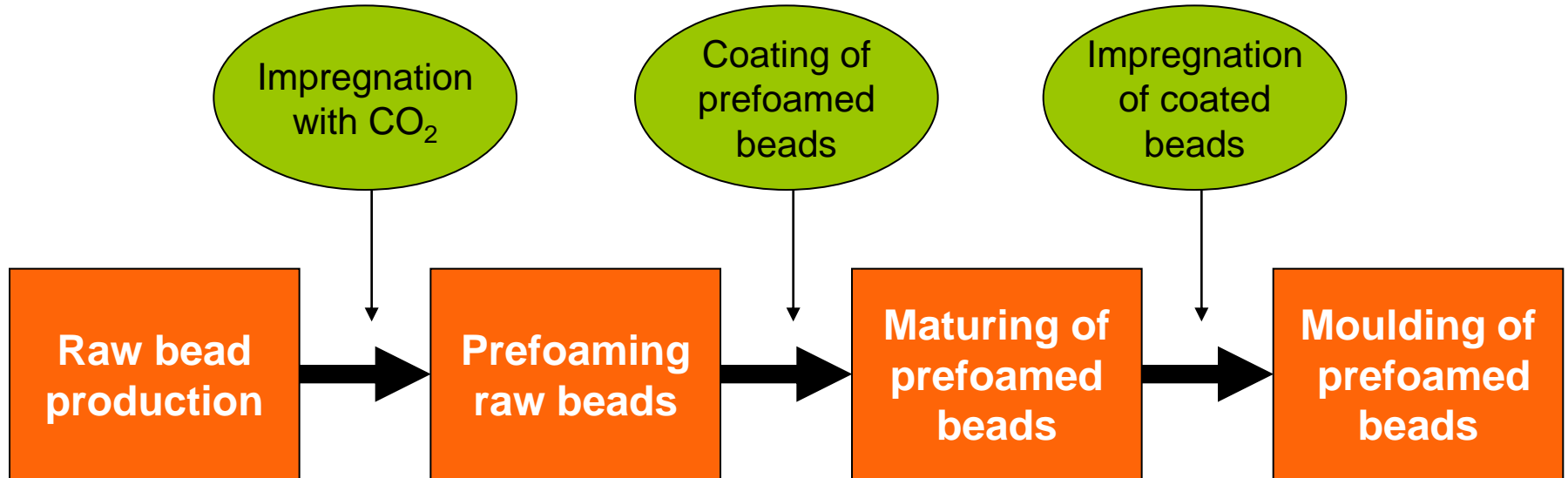


Status foaming and molding

- First production facility in Etten-Leur;
- Roll-out 2011 to other BU's;
- Pre-marketing samples available.



PLA foaming



PLA foaming

- Prefoaming is done on a commercial EPS prefoamer;
- Density 30 g/l in one prefoam step (< 30 g/l in two steps).



Compared to EPS:

- Lower temperatures;
- Shorter cycle times.

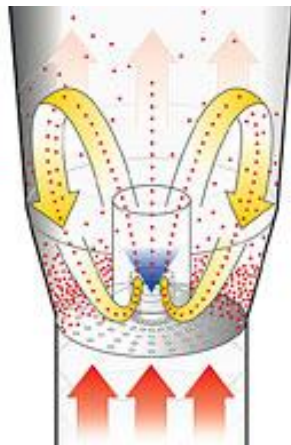
Difficulties:

- Low density foam;
- CO₂ evaporates easily;
- Heat stability of PLA.

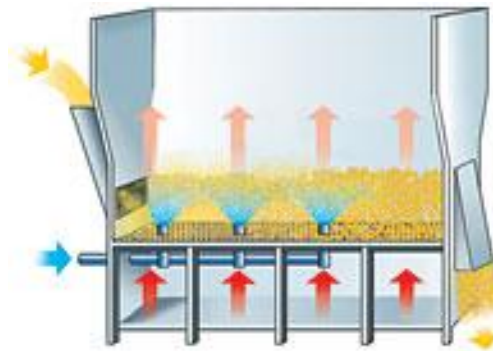
PLA molding



- A special coating is applied to the prefoamed BioBeads to improve adhesion during moulding;
- Patented technology: WO 2008130226.



Batch fluid bed coating unit (Wurster coating)



Continuous fluid bed coating unit (Glatt fluid bed)

PLA molding

- Moulding is done on a commercial EPS moulder;
- Similar process as with common EPS grades.



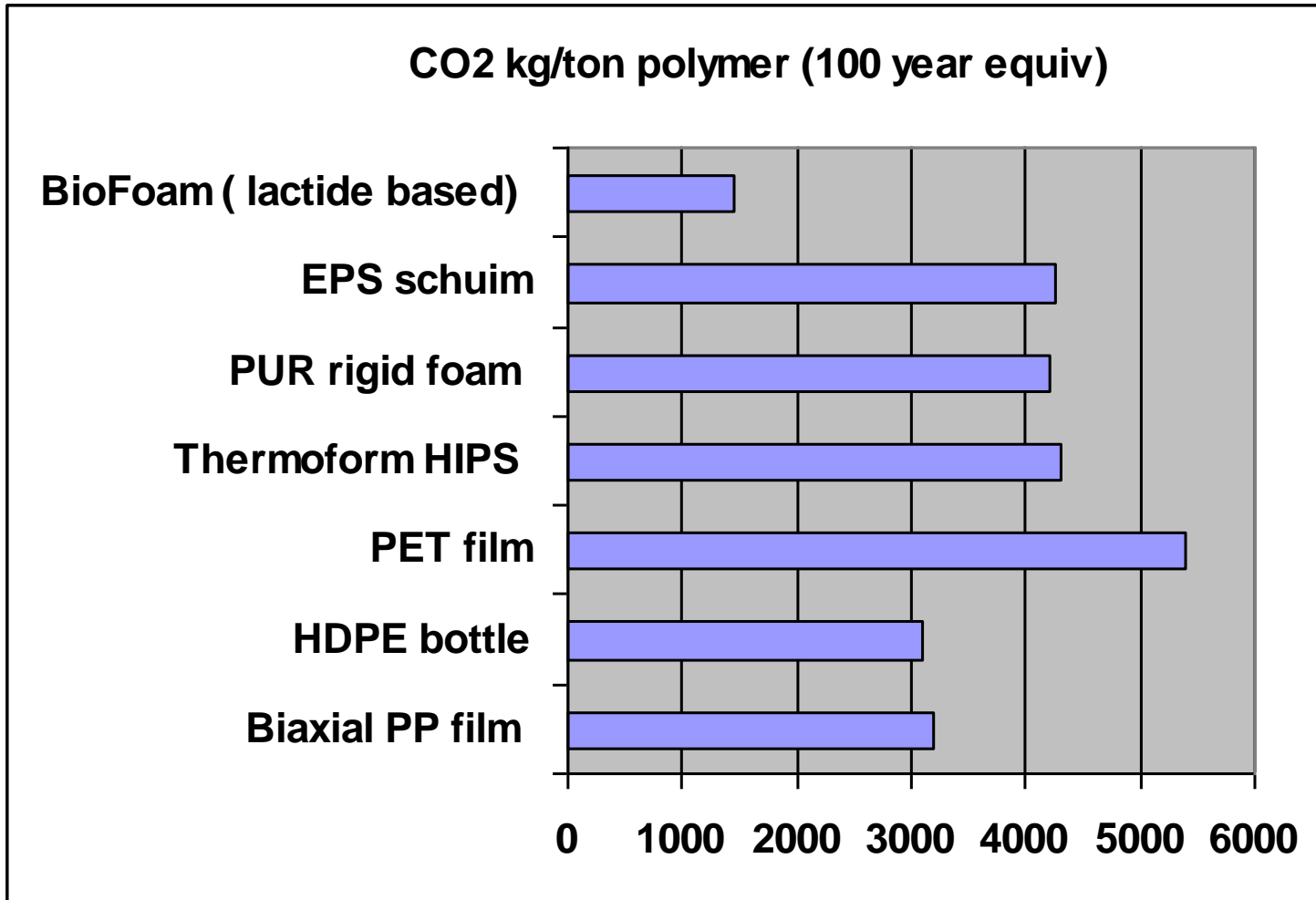
Compared to EPS:

- Lower temperatures;
- Longer cooling times.
- Difficulties:
 - CO₂ evaporates easily;
 - Heat stability of PLA.

BioFoam® properties

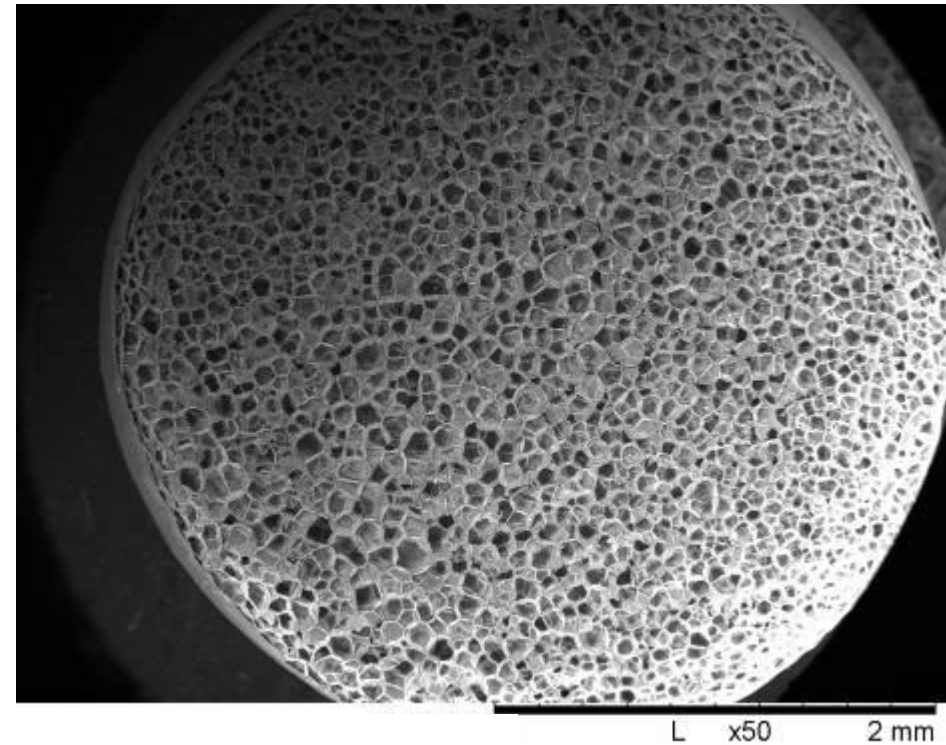
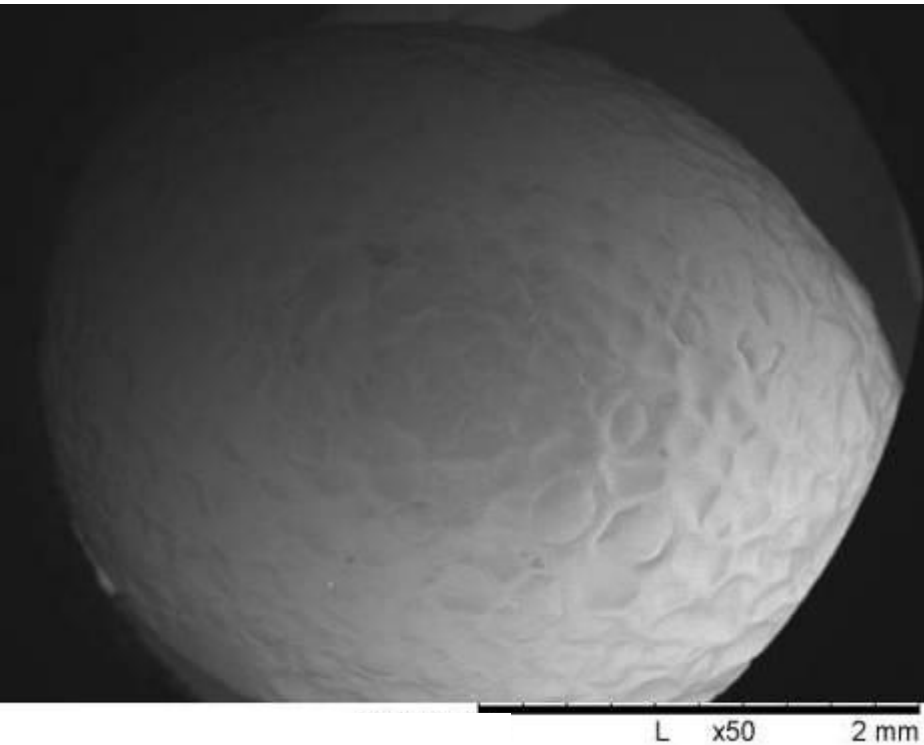


Global warming potential of various polymers



Per Kg BioBead 28% CO₂ compared to average of oil based polymers

PLA cell structure



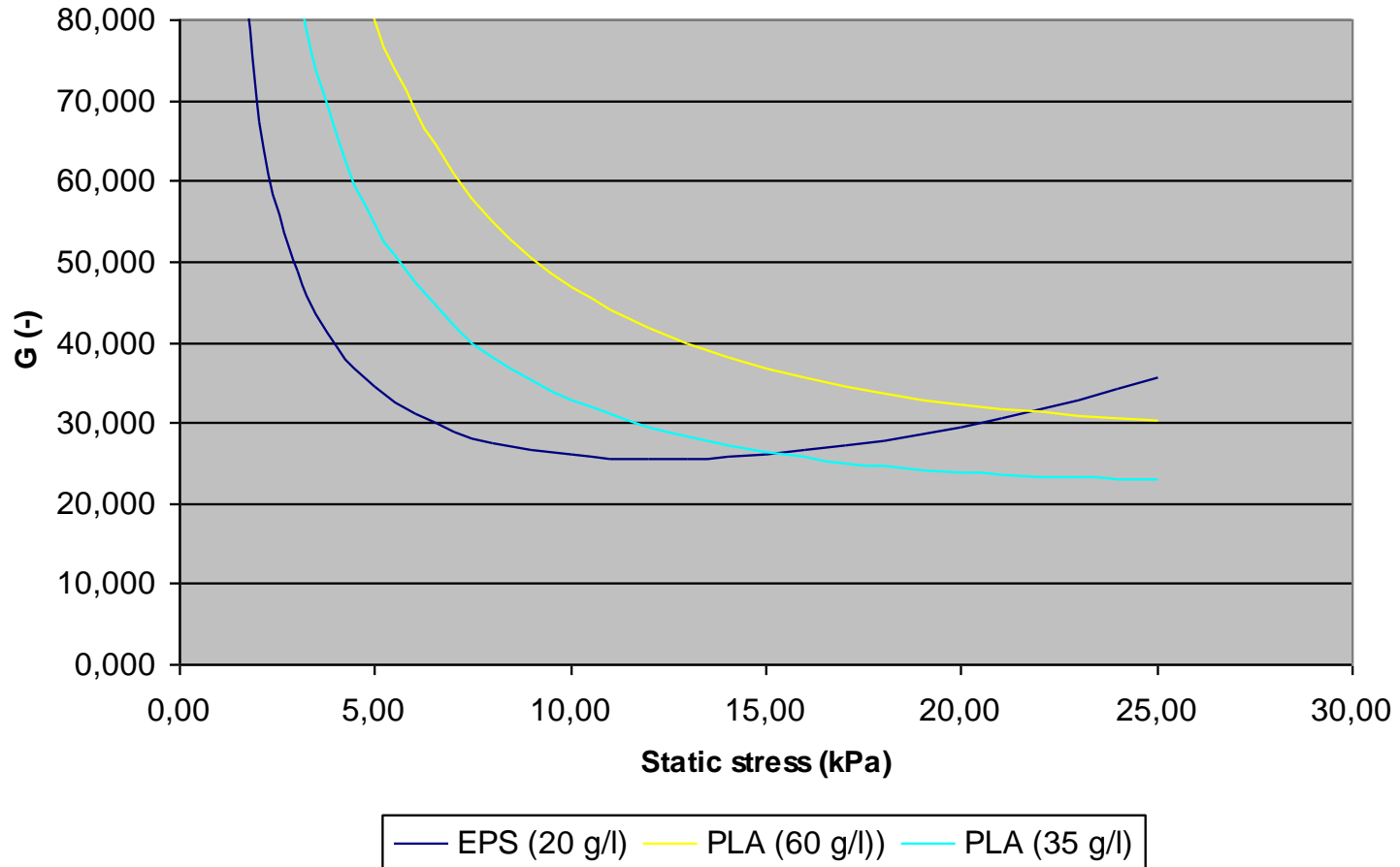
Structure looks very similar to EPS

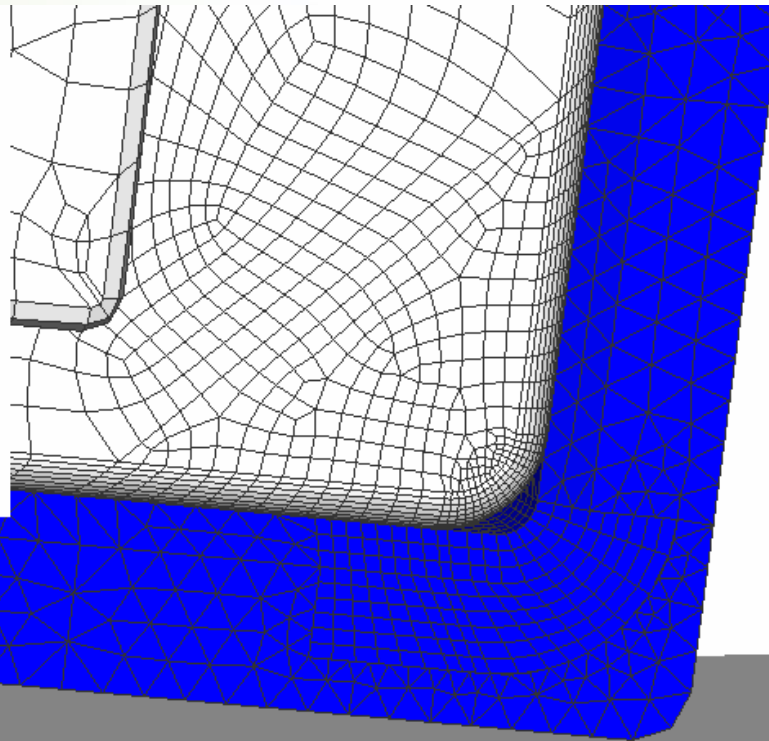
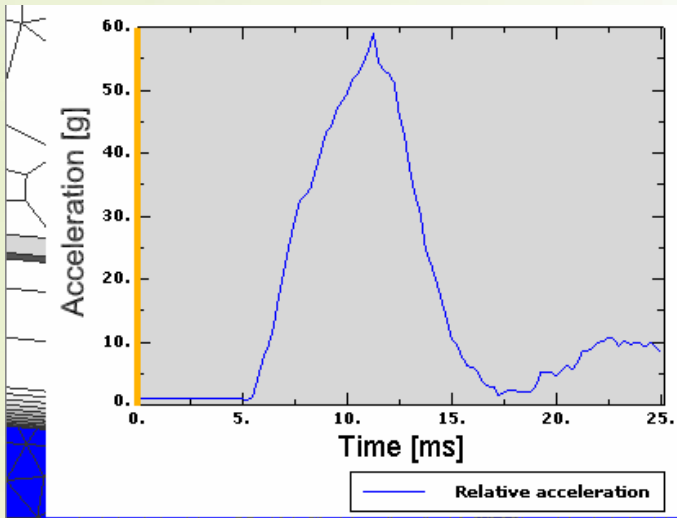
	BioFoam®		EPS	
Thermal conductivity (MW/m·K)	35 g/l	34	33	30 g/l
Bending strength (kPa)	35 g/l	300	300	30 g/l
Compressive stress @ 10% deformation (kPa)	40 g/l	200	200	30 g/l
Compressive modulus (MPa)	40 g/l	4.0	3.0	30 g/l
Shear strength (kPa)	35 g/l	140	250	30 g/l
Shear modulus (kPa)	35 g/l	2.7	3.1	30 g/l
C-value (-)	35 g/l	2.6	2.7	30 g/l

Drop test results



1st drop (height/thickness = 10)



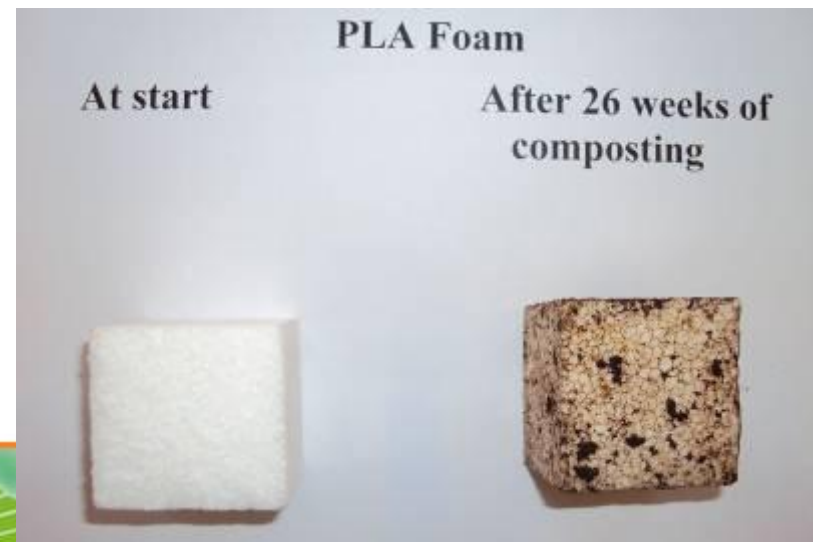


BioFoam 50% Volume saving in Drop testing vs. EPS

Composting results



5 x 5 x 5 cm³ BioFoam® blocks (various densities) disintegrate completely at 70°C within 4 weeks. Not at room temperature



Validation and supporting information

- Fire test Bean Bags Efectis & Moulded NRW-MPA
 - meets BS 5852 (sigaret/match) crib 5
 - meets DIN4102 B1 and B2



- Droptesting at Clemson University (South-Carolina);



- LCA certification by Akzo Nobel;



- Compostability certification EN13432



- C2C certification by EPEA;

Environmental Protection Encouragement Agency



Validation and supporting information



cradle to cradle™
PRODUCT CERTIFICATION
BASIC

IS HEREBY GRANTED FROM NOVEMBER 19, 2009 TO NOVEMBER 18, 2010

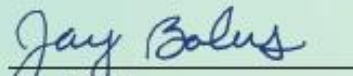
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Synbra Technology bv BioFoam® Expandable Polylactic acid (PLA)

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William McDonough
PRINCIPAL AND CO-FOUNDER


Michael Braungart
PRINCIPAL AND CO-FOUNDER


Jay Bolus
VP, TECHNICAL OPERATIONS



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Validation and supporting information



cradle to cradleSM
PRODUCT CERTIFICATION
BASIC

IS HEREBY GRANTED FROM MARCH 25, 2010 TO MARCH 24, 2011

Synbra Technology bv
PLA BioBeads®

William McDonough
William McDonough
PRINCIPAL AND CO-FOUNDER

Michael Braungart
Michael Braungart
PRINCIPAL AND CO-FOUNDER

Jay Bolus
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VP, TECHNICAL OPERATIONS



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Conclusions



BioFoam® Gen I 30-35 kg/m³:

- Primarily for existing customers;
- Launching customer series Q1-2010.

BioFoam® Gen II 15-25 kg/m³:

- Further improve properties;
 - Intensive R&D by Wageningen University;
- Convert existing equipment;
 - Q1 2011 industrial production.

- Recipe and process development PLA
 - Sc-PLA
 - Cooperation TU Eindhoven
- Development of PLA compounds:
 - Convert existing PS compounding equipment
 - Cooperation TU Eindhoven/Wageningen
- Cooperation with selected customers

BioFoam® / E-PLA:

- Resembles EPS very well;
- Based on GMO-free resources;
- Based on renewable feedstock:
low carbon footprint;
- Biodegradability = additional & sustainable end-of-life option;

Thank you for your attention

Questions?



May-09 Winner of the Frost & Sullivan Technology Innovation Of The Year Award

Jan -09 Gold Medal; Most Sustainable Enterprise NRK Netherlands

