NEW TRENDS IN THERMOPLASTIC FOAM PRODUCTION

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FOAM EXPO EUROPE 2024

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ABOUT US

Our strength is the combination of a team of highly qualified scientists and facilities specially designed to develop and validate innovative ideas.

Created more than 10 years ago, in 2012, CellMat Technologies is a spin-off company from the CellMat Laboratory of the University of Valladolid focused on developing high-quality R&D in all the topics surrounding polymeric foams.

The company is comprised of scientists with a high level of expertise in all the different topics surrounding these materials.

SOLUTIONS FOR THE INDUSTRY

SERVICES FOR THE WHOLE VALUE CHAIN

Pilot Plants
Small-scale foam production plants

Understanding Foaming
Evaluation and quantification of foaming mechanisms

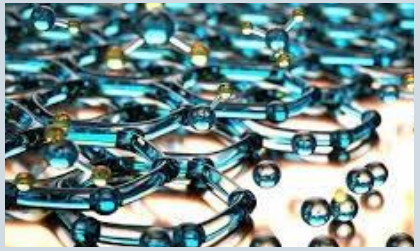
Characterization and Validation
Conventional and advanced characterization techniques

AutoCell
Specific software for advanced foam analysis

Sustainable Solutions
Innovation in materials and processes to drive it

Training Courses
Increasing your competitiveness

On-Site Assessment
We will be wherever you will need us



Advanced Products and Processes
Development of novel products and processes. Upscaling.

VISIT US AT

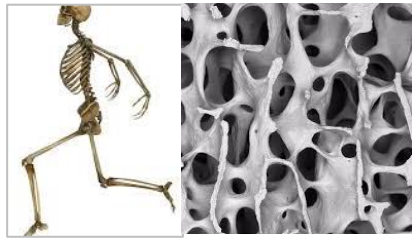
BOOTH 324

INTRODUCTION

FOAMS, 100 YEARS … OR MORE …

Nature created foams

80 Million Years B.C.



1849 — The basis for foam development
Wurtz and Hoffman reported for the first time a reaction between an isocyanate and a hydroxy compound

1920 — Latex Sponge
Precursor of Latex foam made by Dunlop method in 1928

1937 — Otto Bayer and PU Foams
Polyester-based Urethane polymers became essential items during WWII due to the need to replace nylon

1942 — Extruded Polystyrene
With CFCs

1945 — Phenolic Foams

1954 — Expanded Polystyrene
Suspension Polymerization

1958 — Extruded Polyethylene

1961 — PolyIsocyanurate Foams

2024 — $109 Billion
CAGR to 2035: 4.9 %

Sustainability

- Montreal Protocol
- PCRs
- Lightweighting
- Reach (FRs, Blowing Agents, …)
- Circular Economy
  - Rubbers
  - PVC
  - PET
  - Crosslinked Polyolefins
  - …

INTRODUCTION

THE CURRENT SCENARIO

Sustainability triggering innovation in technology and materials

COMPRESSION MOLDING

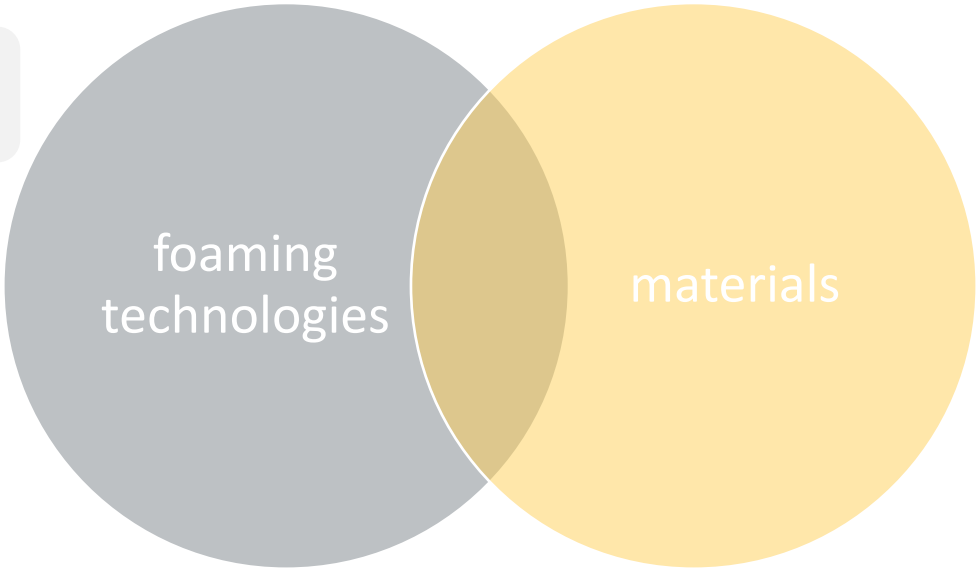
EXTRUSION FOAMING

REACTIVE FOAMING

INJECTION MOLDING

BEAD FOAMING

GAS DISSOLUTION FOAMING



POLYMERIC MATRICES

BLOWING AGENTS

ADDITIVES

COMPRESSION MOLDING (MIDSOLES)

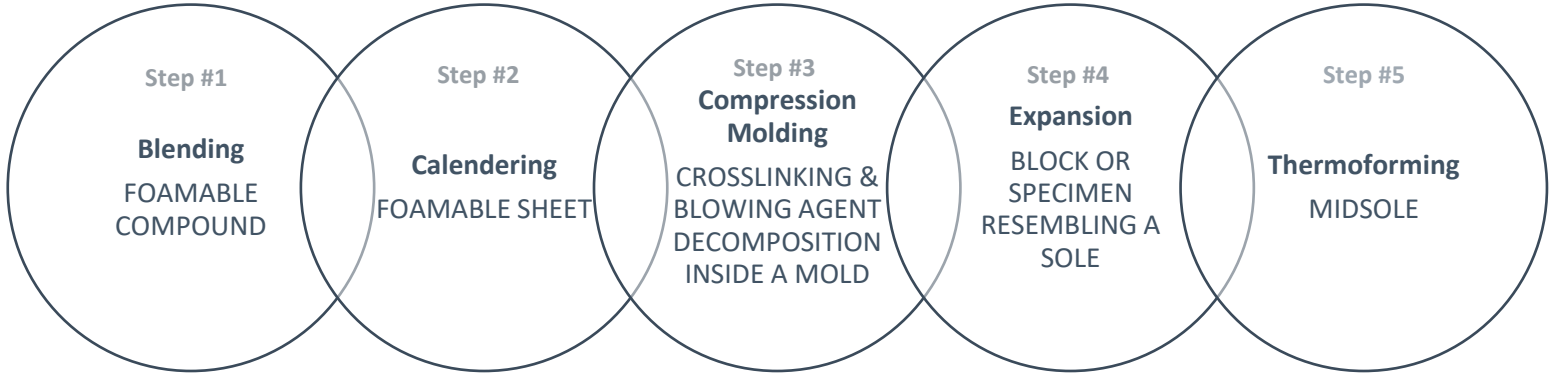
THE TRADITIONAL SCENARIO

The Formula

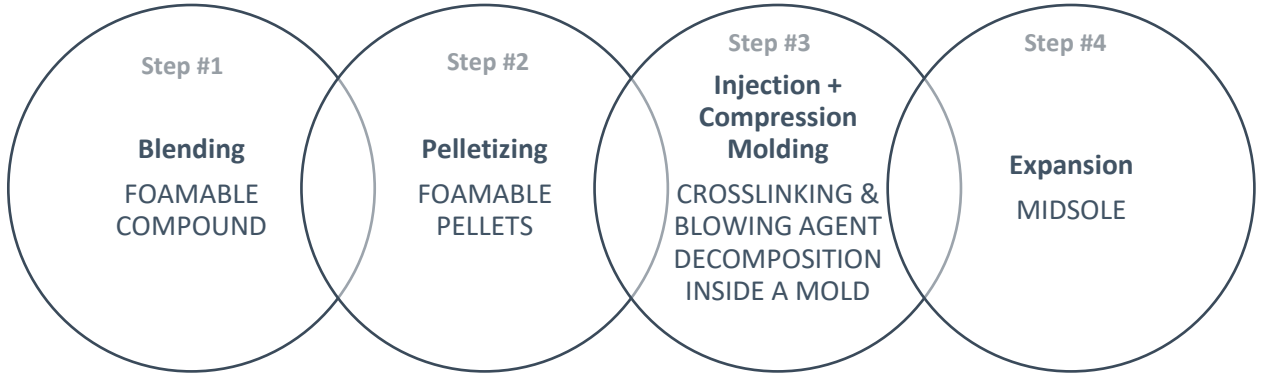
Components – Traditional Formula Midsole
Polymer(s) (EVA, POE, LLDPE)
Crosslinking agent (BIPB, DCP)
Blowing agent (Azodicarbonamide)
Catalyst BA (ZnO, ZnSt, Urea)
Catalyst XL agent (TAC, TAIC)
Processing aids
Pigments
TiO2
Fillers (CaCO3)

The Production Routes

COMPRESSION MOLDING + THERMOFORMING



INJECTION MOLDING



COMPRESSION MOLDING (MIDSOLES)

THE ALTERNATIVES

The Formula

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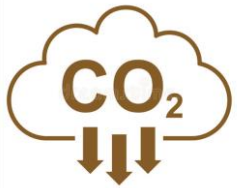
Fillers (CaCO3)



- Low sustainable raw materials
- Crosslinked solutions (poor, challenging, expensive recyclability)
- Large amount of residues

KEEPING THE CURRENT TECHNOLOGIES BUT MOVING TO MORE SUSTAINABLE BLOWING AGENTS

ALTERNATIVE CHEMICAL BLOWING AGENTS

alve-one®

SOLVAY

Progress beyond

COMPRESSION MOLDING (MIDSOLES)

THE ALTERNATIVES

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TiO2
Fillers (CaCO3)

- Low sustainable raw materials
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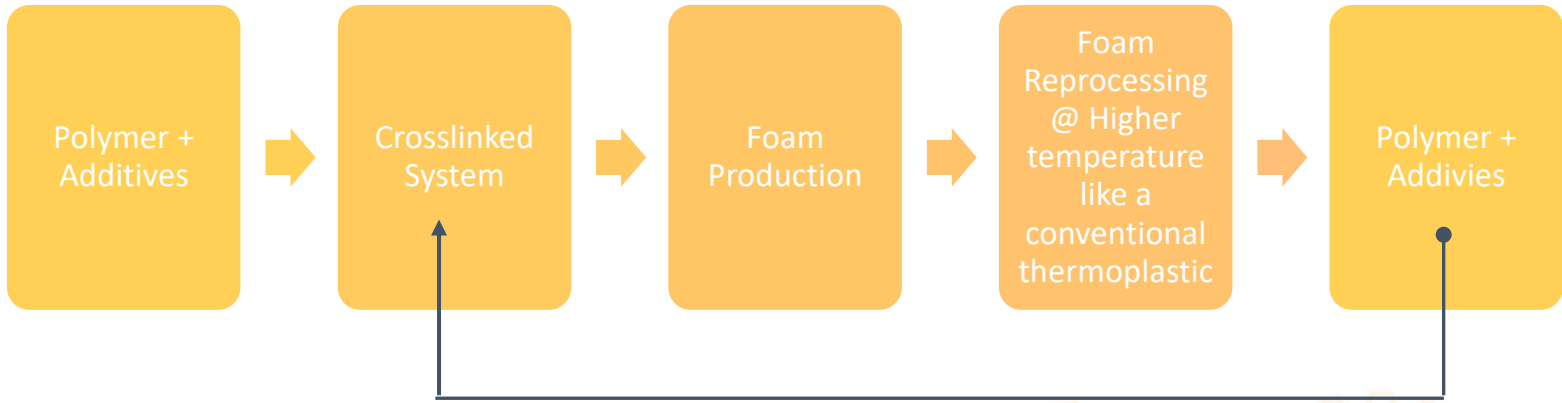
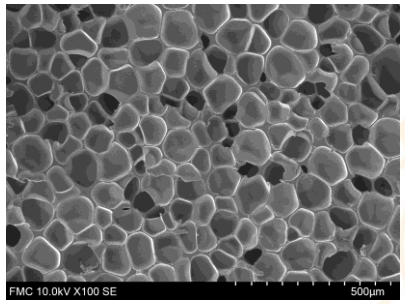
ALTERNATIVE CROSSLINKING ROUTES

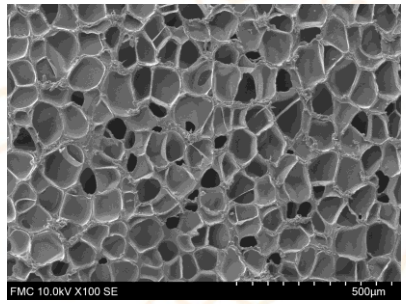
DYNAMIC CROSSLINKING

Combining the traditional polymeric matrices with additives creating covalent bonds that are capable of exchanging or switching between several molecules



TRADITIONAL XL
(Peroxides)
200 kg/m3
90 microns





DYNAMIC XL
180 kg/m3
95 microns

INTRODUCTION

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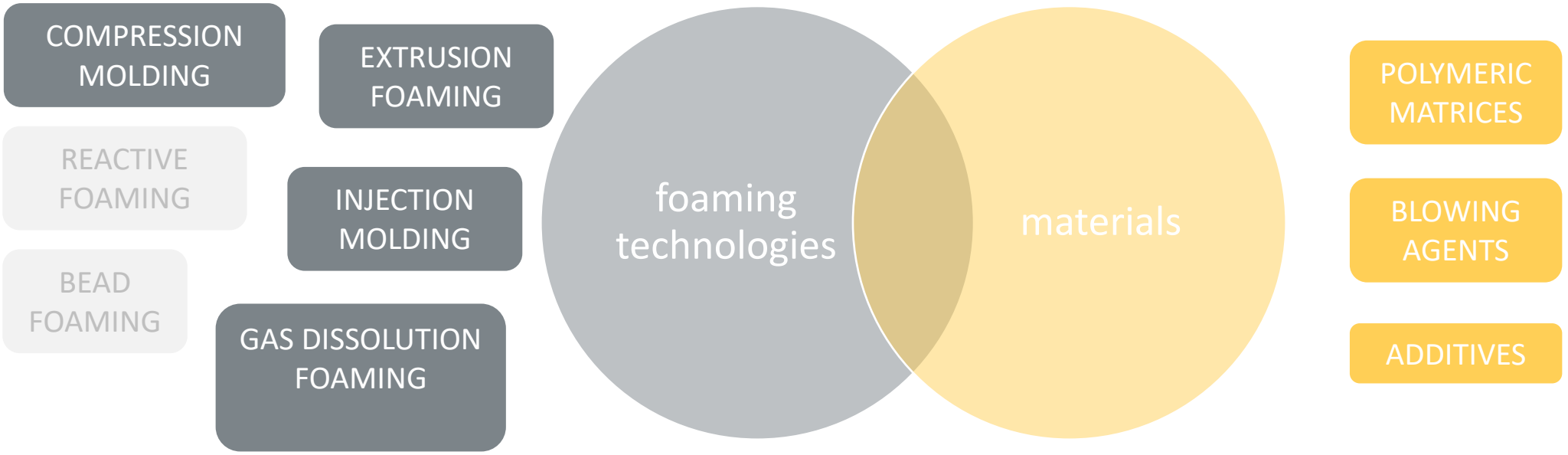
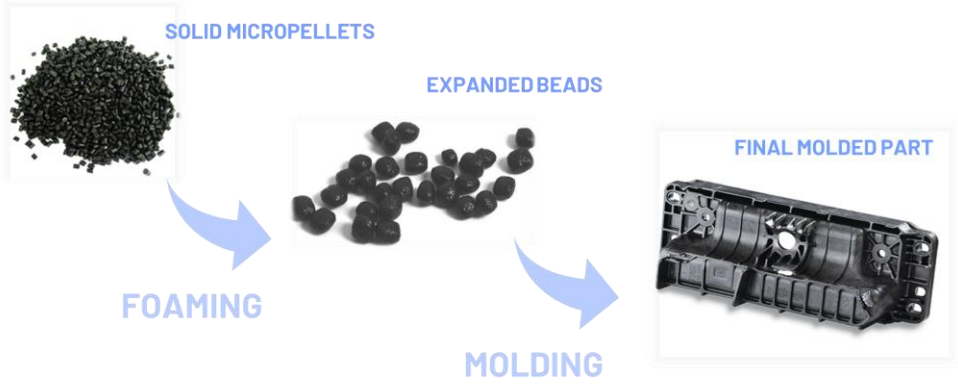
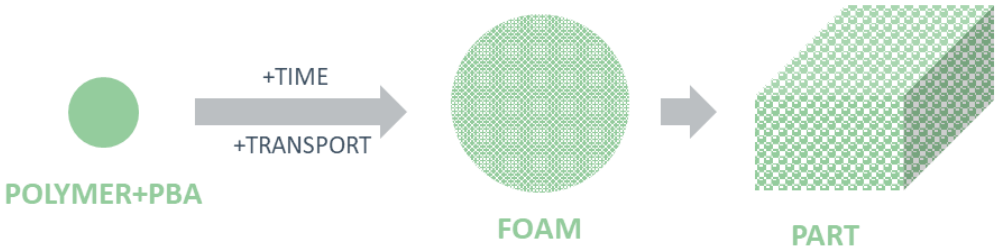


THE KEY TECHNOLOGIES

BEAD FOAMING

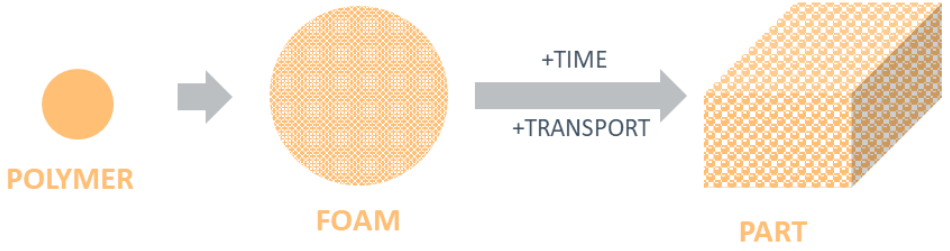


EXPANDABLE BEADS



- Non-expanded polymer granules with a blowing agent dissolved (example: expandable PS beads).
- **ADVANTAGES:**
  - ✓ Material can be transport in the solid state and the expansion can be done in the facilities of the end user.
  - ✓ Very low-densities can be achieved, since the beads expand during molding.
- **DRAWBACKS:**
  - x Hydrocarbons are used (flammable).
  - x Not all the polymers allow to keep the blowing agent dissolved for a long time.

EXPANDED BEADS

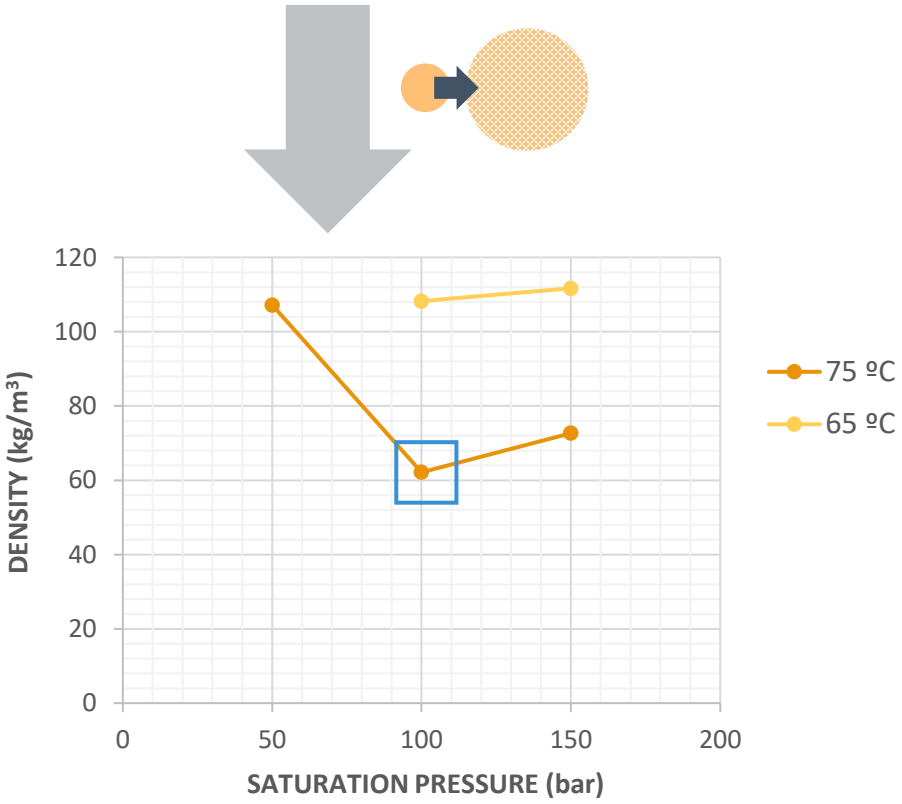


- Expanded polymer granules (example: expanded PP beads).
- **ADVANTAGES:**
  - ✓ Carbon dioxide can be used as the blowing agent (non-flammable, cheap solution).
  - ✓ This strategy can be applied to any polymer, regardless its nature.
- **DRAWBACKS:**
  - x Inefficient transport of low-density beads.
  - x It is challenging to achieve low-densities due to the densification process during the molding.

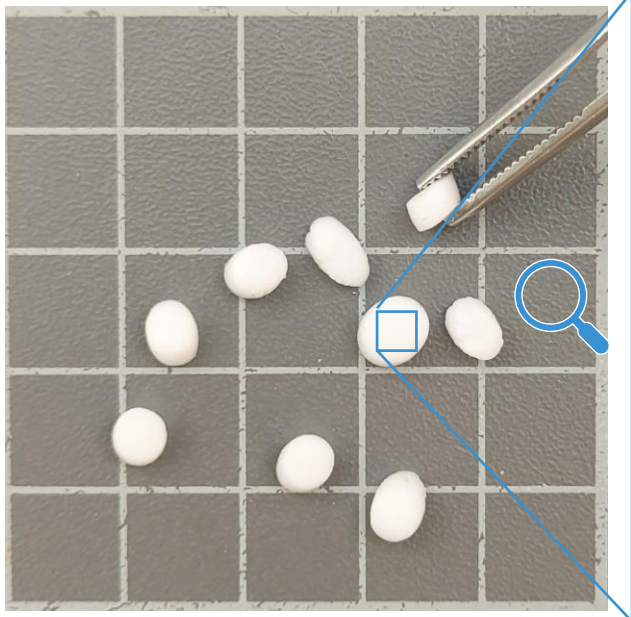
THE BEAD FOAMING TECHNOLOGY

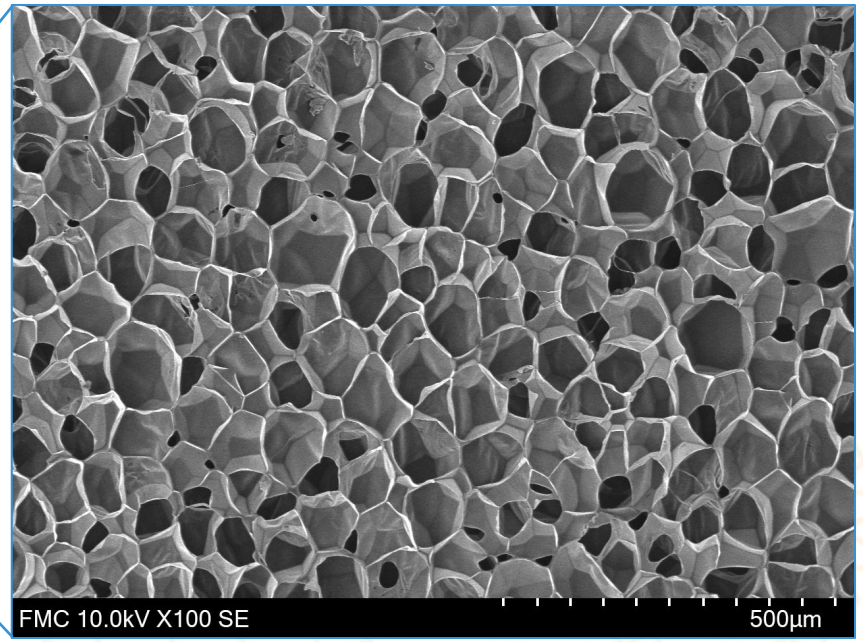
E-EVA

- **Formulations** designed for bead foaming
- **Optimization of the foaming process** using CO_2 as the blowing agent



$$\rho_{real} = 62\ kg/m^3$$
$$\rho_{app} = 30\ kg/m^3$$



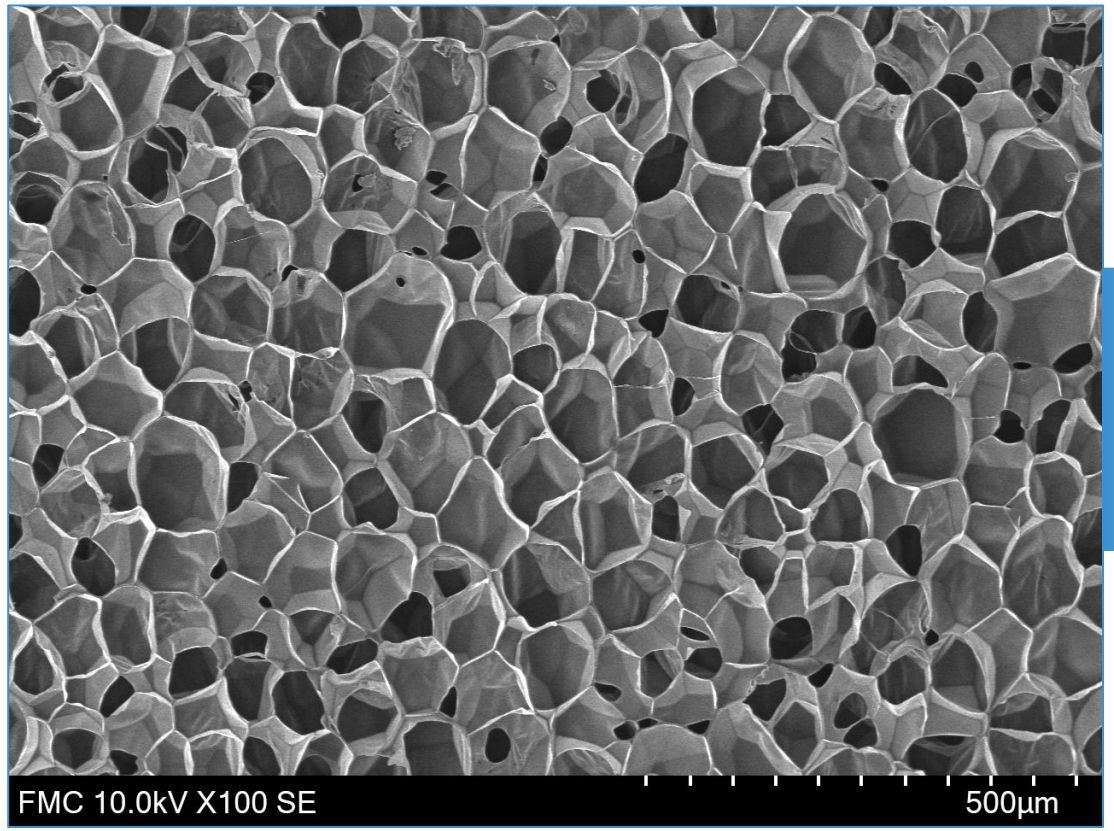


Low-density
Non-crosslinked
Closed cell structures

THE BEAD FOAMING TECHNOLOGY

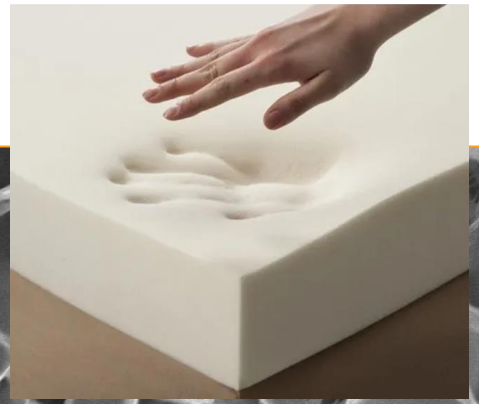
E-EVA

Low-density
Non-crosslinked
Closed cell structures



TUNING THE PROCESS

New applications!



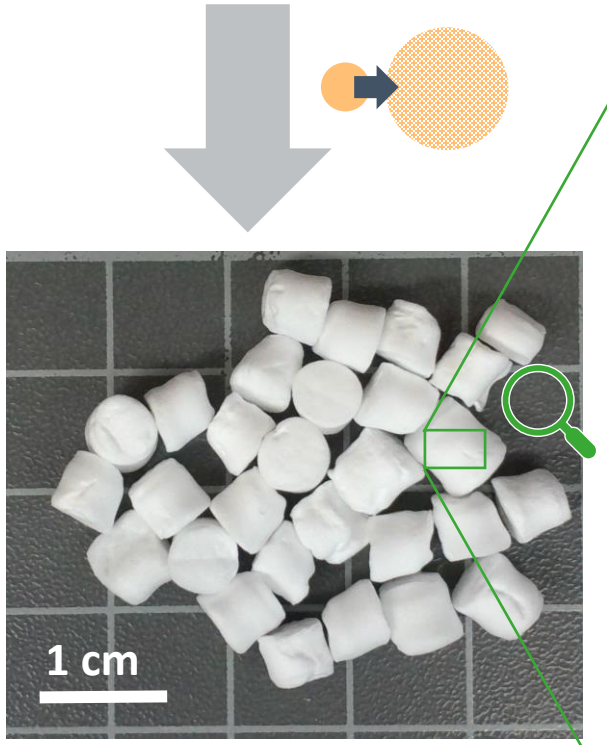
Microcellular (< 5 µm)
Non-crosslinked
Open cell structures

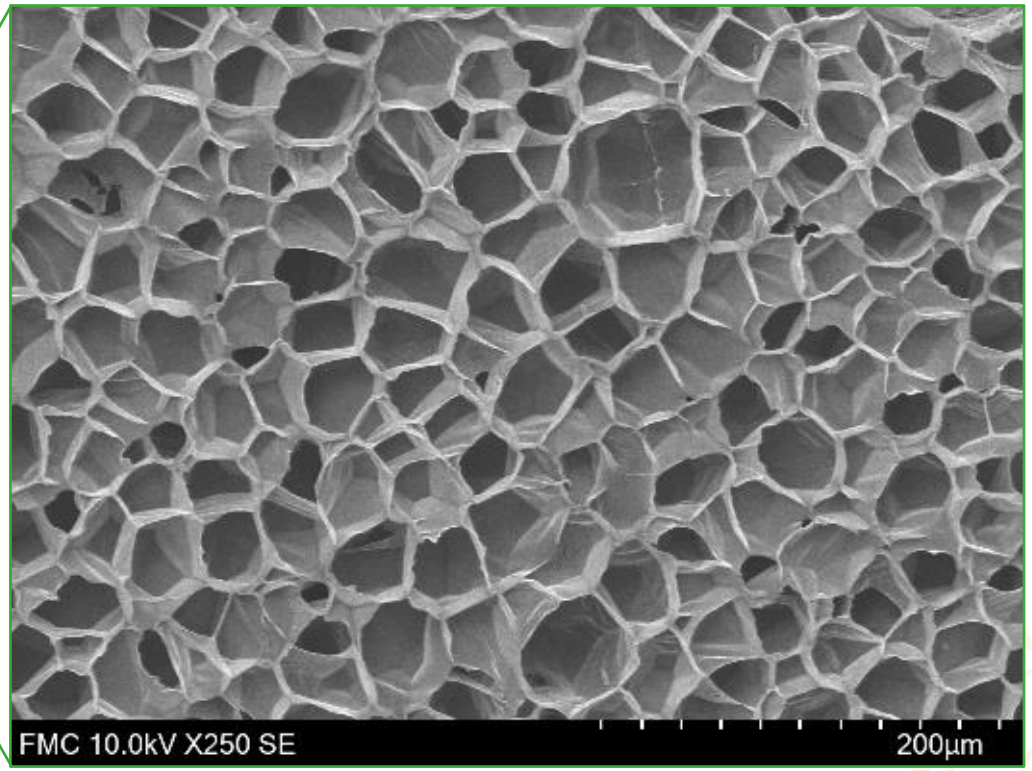
THE BEAD FOAMING TECHNOLOGY

BIOPOLYMERS

E-PBS (POLYBUTYL SUCCINATE)

- **Formulations** designed for bead foaming (**without chain extender**)
- **Optimization of the foaming process** using CO_2 as the blowing agent





Real density: 60 kg/m³
Apparent density: 30 kg/m³
Micrometric cells (< 50 µm)
Closed cell structures
Flexible foam

THE BEAD FOAMING TECHNOLOGY

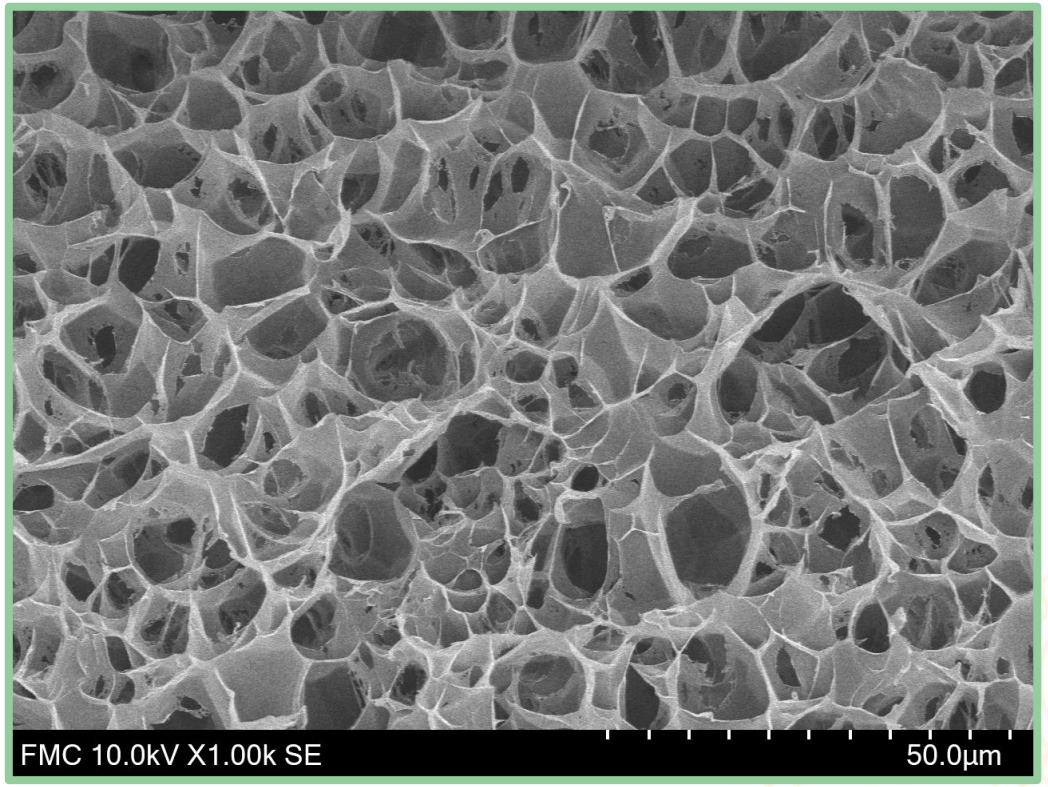
BIOPOLYMERS

E-PLA/STARCH

PLA-based formulation
10% Starch (biodegradable, cheap)

foaming

$$\rho_{real} = 150\ kg/m^3$$
$$\rho_{app} = 75\ kg/m^3$$



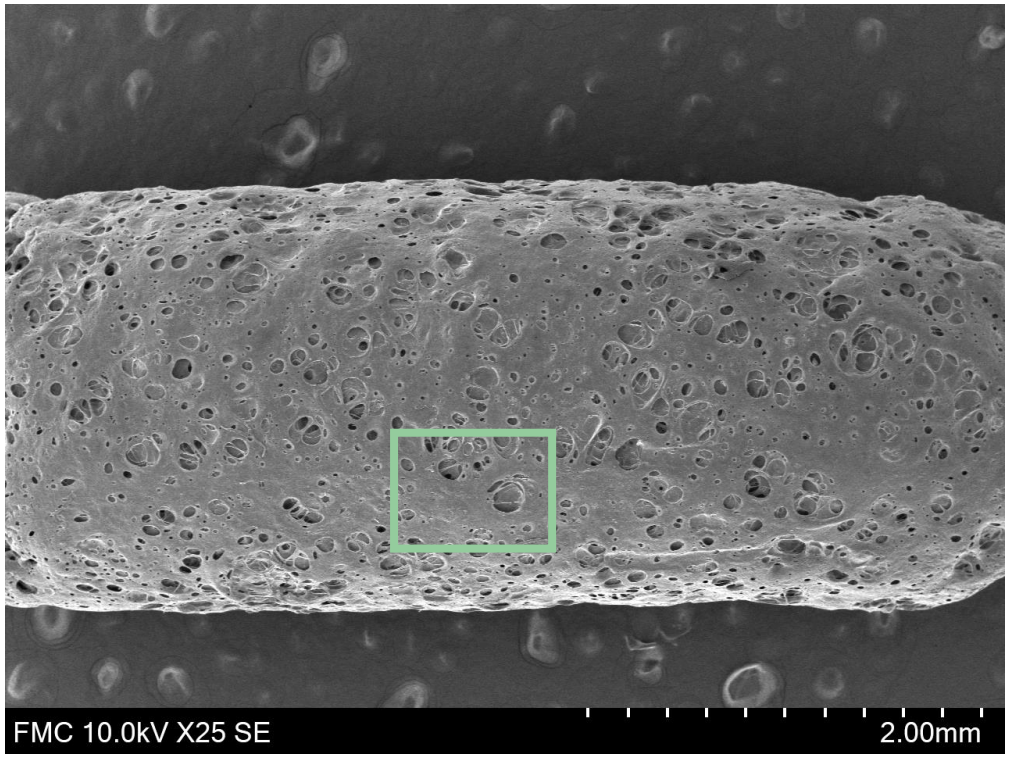
Low density
Open cell structure
Micrometric cells
(< 10 microns)

THE BEAD FOAMING TECHNOLOGY

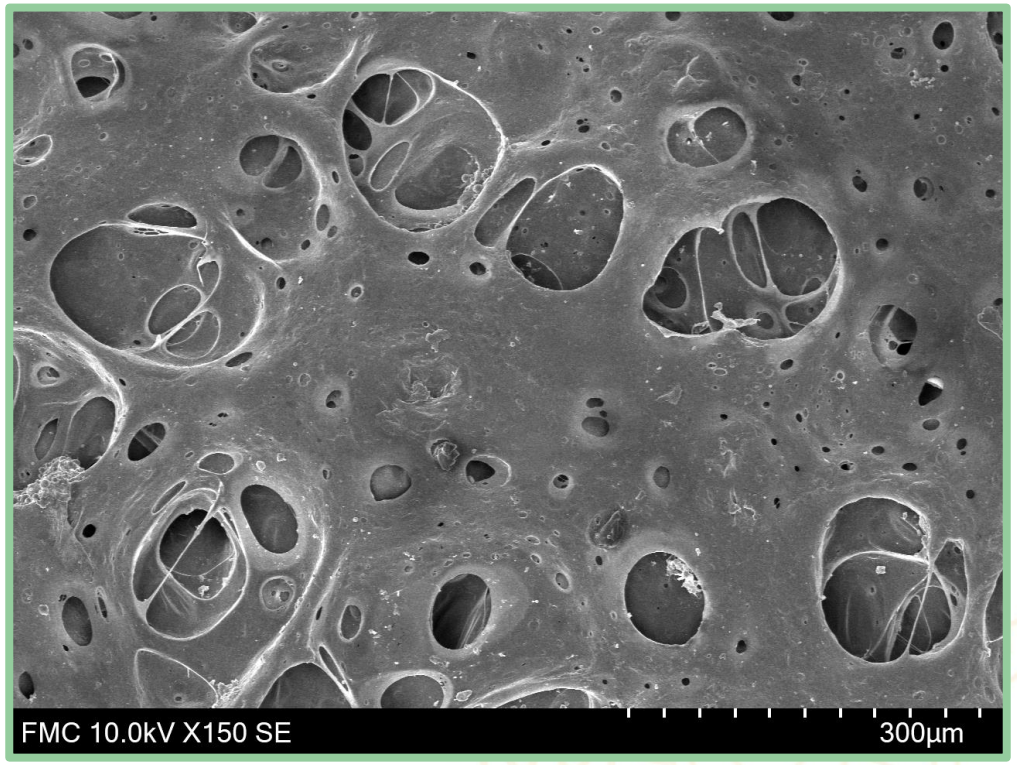
BIOPOLYMERS

E-PLA/STARCH

Surface of the beads



100 % open cell!



Surprisingly, the additives also allow to obtain open pores in the surface instead of the solid skin normal in bead foaming.

THE KEY TECHNOLOGIES

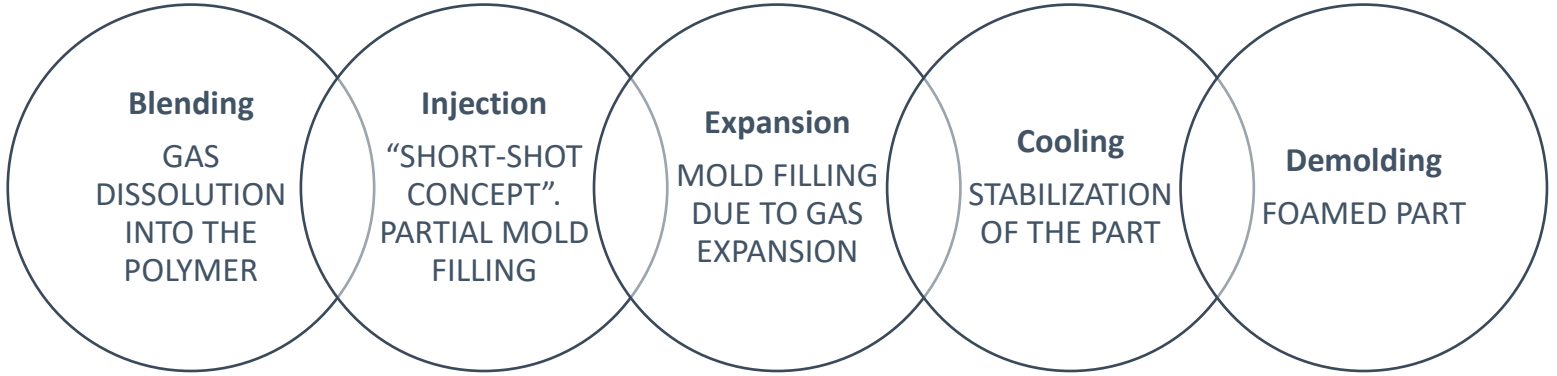
INJECTION MOLDING

The Formula

Components – Traditional Formula Injected Part
Polymer(s) – THERMOPLASTIC ELASTOMERS but transferable to other polymers
Blowing agent – Supercritical PBA (CO2, N2)

The Production Route

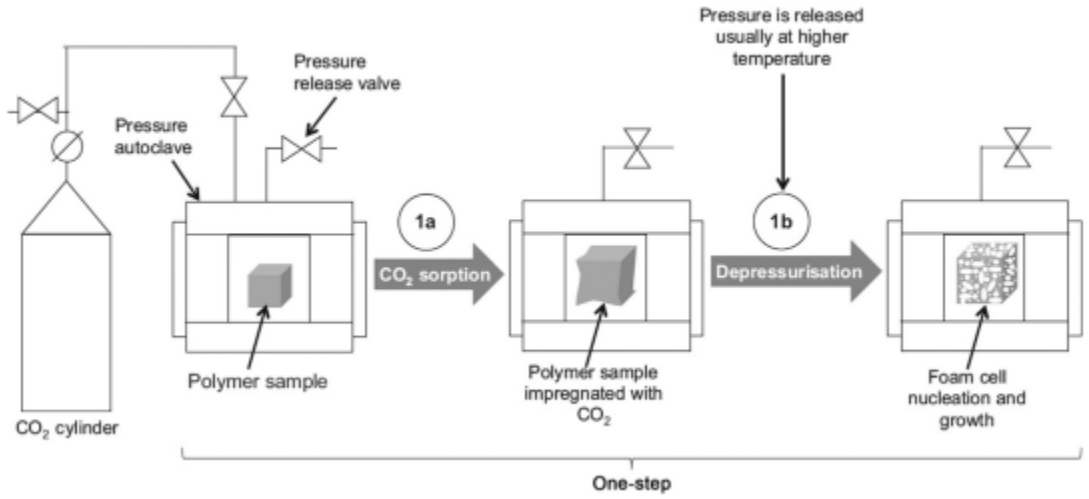
THE LOW-PRESSURE PROCESS



THE KEY TECHNOLOGIES

GAS DISSOLUTION FOAMING

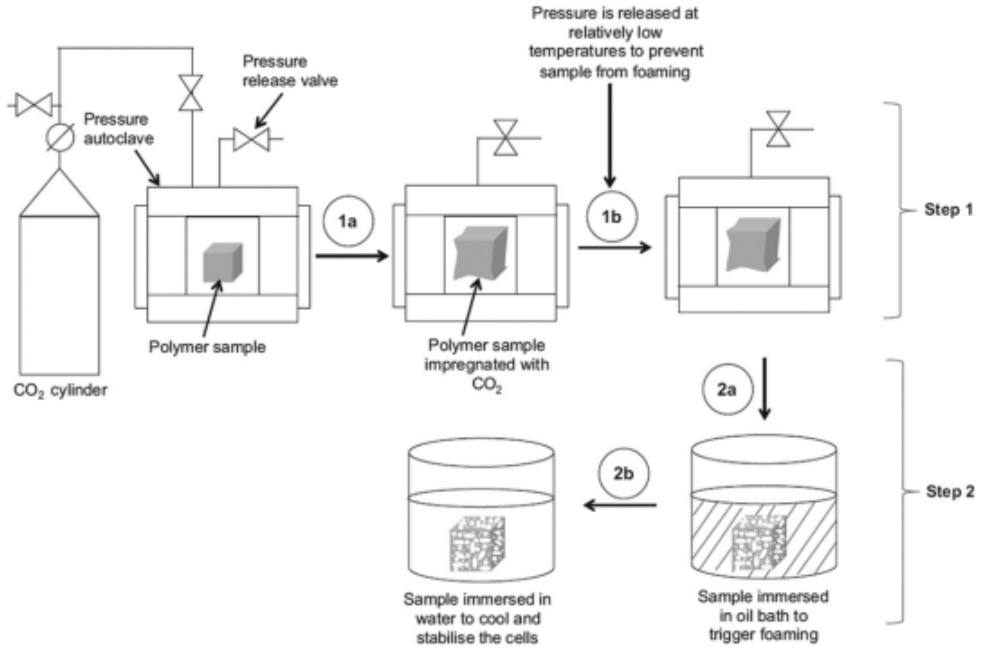
PRESSURE INDUCED BATCH FOAMING (PRESSURE QUENCHING)



- Saturation done close to Tg/Tm (softened polymer)
- Expansion takes place inside the autoclave
- Foamability can be controlled by adjusting the temperature before depressurization

- Massive technology in the scientific literature
- Strong introduction in the market in the last years

TEMPERATURE INDUCED BATCH FOAMING PROCESS



- Saturation done below to Tg/Tm (“solid-state”)
- Depressurization done at a temperature where the material cannot expand
- Foaming occurs outside the saturation autoclave (heating media: bath, oven, another autoclave)
- Gas diffusion starts when the part leaves the autoclave (solid skin)

THE KEY TECHNOLOGIES

GAS DISSOLUTION FOAMING

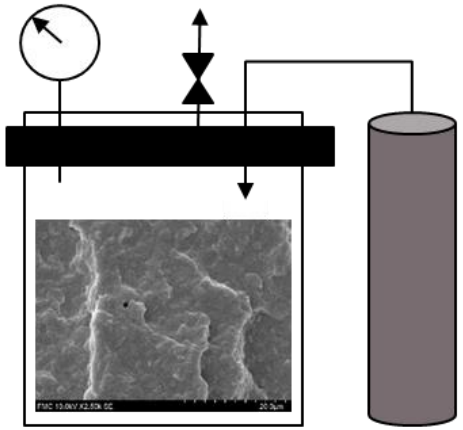
PBAT/STARCH

PBAT + NATIVE STARCH + PLASTICIZERS

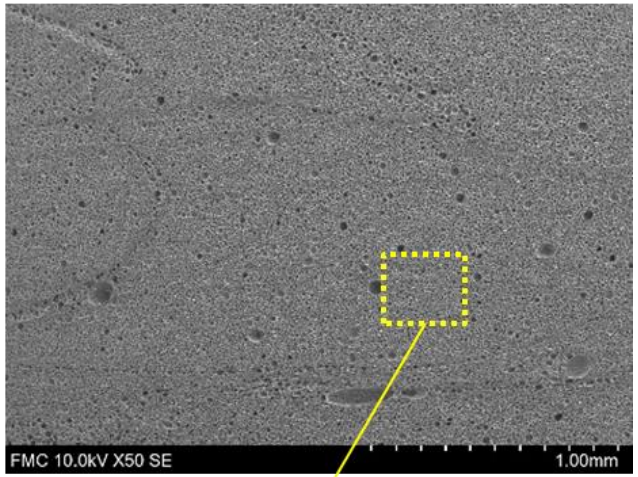
ONE STEP PRODUCTION

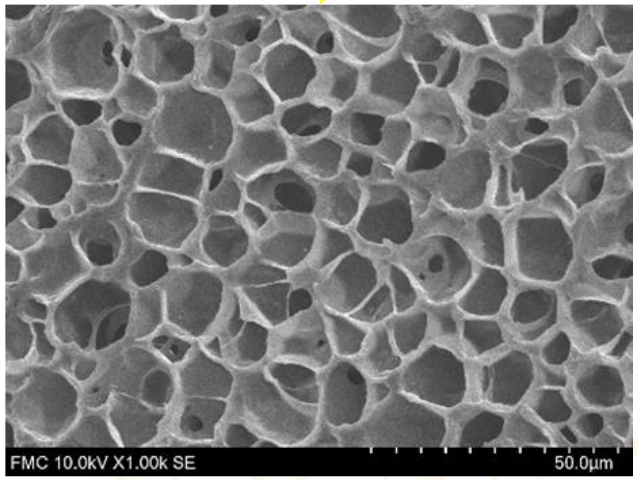
PBAT 60 / TPS 40

Gas dissolution foaming-1 step



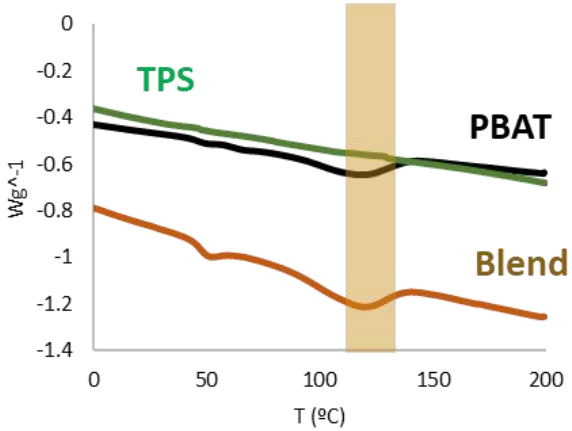
200-300 kg/m3





Approach with PBA → within the melting peak to maximize melt strength

Saturation and expansion temperature



SUMMARY

BEYOND TRADITION

THANK YOU SO MUCH FOR YOUR ATTENTION!

YOU CAN FIND MORE INFORMATION ABOUT OUR ACTIVITIES IN OUR WEBSITE:
www.cellmattechnologies.com

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