

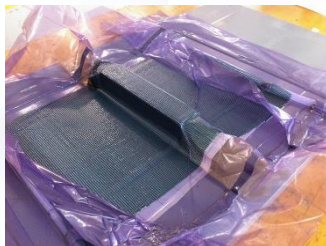
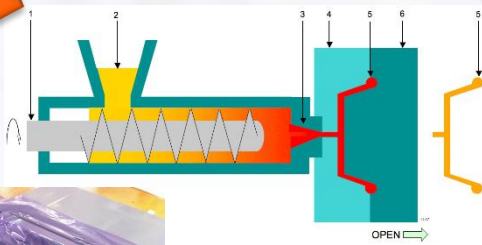
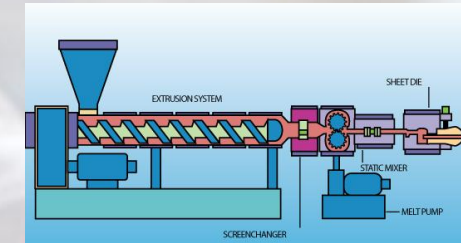
Lightweighting Techniques for Thermoplastic Polymers

by Maria Rosa Contardi, Maria Teresa Scrivani

K12 Midterm conference, May 18th 2017



Proplast
private R&D centre,
representing the «actors» of
polymer and composite materials and
processing industry



Our Premises



**C/O Politecnico di Torino
sede di Alessandria**

Academic training (Politecnico di Torino)

proplast
servizi
specialistic training
lifelong training
personnel recruitment

proplast
basic and fundamental research
(performed in cooperation with Universities)

1998



**new premises
C/O Parco tecnologico - Rivalta Scrivia**

proplast
technical services for SMEs
Product engineering
process engineering
materials engineering
technology transfer
applied research
ecodesign
international cooperation

2008



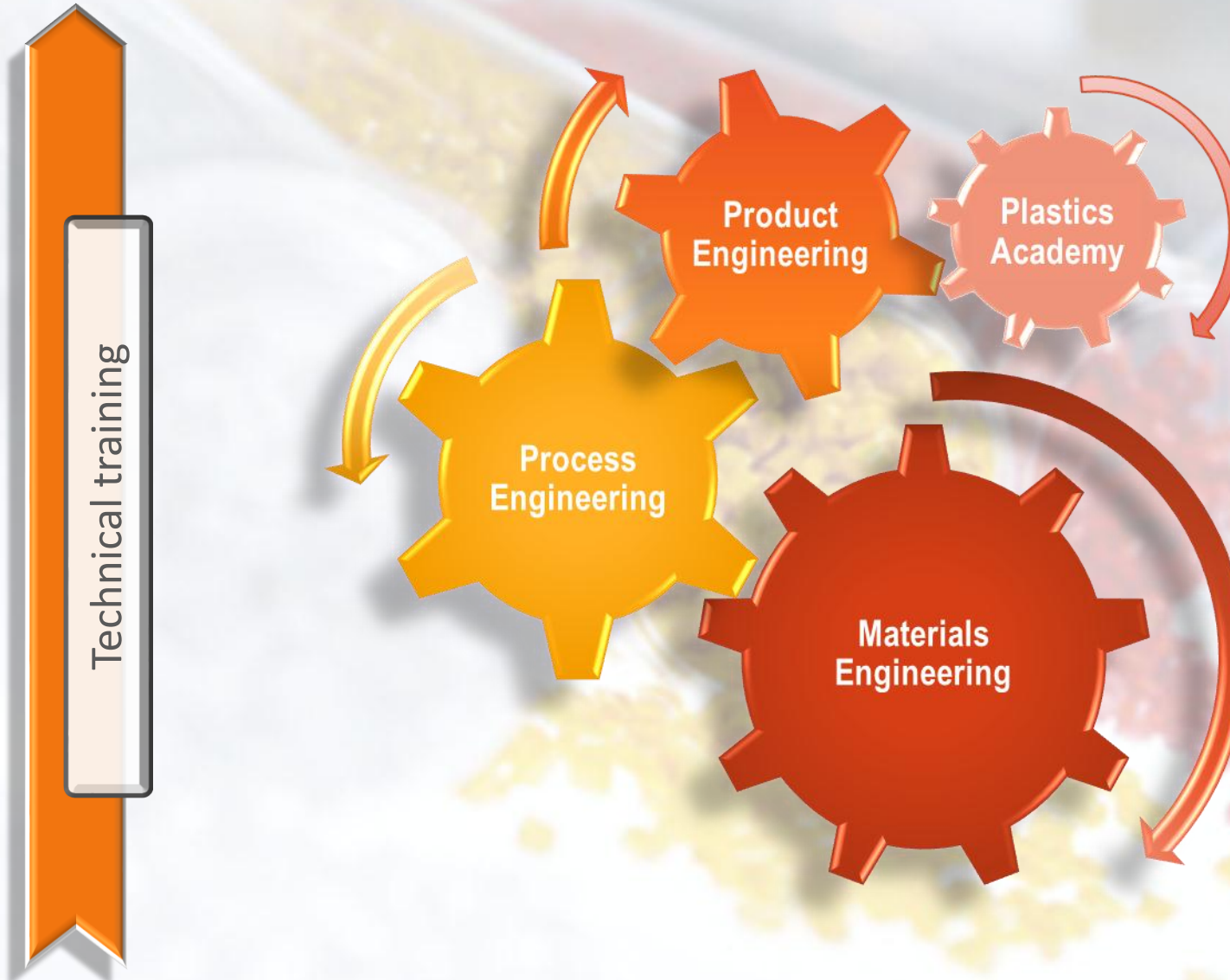
Sedi in Provincia di Palermo

(S. Flavia e Bagheria)

proplast
basic and fundamental research
(performed in cooperation with Universities)

2013





EU collaborative research projects

PLASTICIRCLE

Improvement of the plastic packaging waste chain from a circular economy approach (H2020)

FIRE-RESIST

Developing Novel Fire-Resistant High Performance Composites (FP7)

Phos-Istos

Development of biophotonic device based on flexible light emitting textile dedicated to the monitoring and treatment for dermatologic diseases and carcinoma (FP7)

multiHYBRIDS

Innovative sensor-based processing technology of nanostructured multifunctional hybrids and composites (FP6)



Innovative process and solutions to reduce the weight of PET containers and boost the diffusion of the green (Life+)

GreenFactory4Compo

Green Factory for Composites
(Regione Piemonte - Piattaforma «Smart Manufacturing»)



Veicoli urbani stradali su gomma ecologici, ergonomici, economici, sicuri ed interconnessi, per il trasporto di persone e/o merci (Ministero per lo sviluppo economico – Bando «Industria 2015»)



Sistemi e Componenti per il recupero dell'energia e l'efficienza energetica di autoveicoli (Regione Piemonte - Bando «Piattaforma Automotive»)

DIATEME

Dispositivi ad alto contenuto tecnologico per il settore biomedicale (progetto PON, "Ricerca e Competitività 2007 – 2013" Regioni Convergenza)

POLILED

Materiali polimerici per LED ad alta efficienza (Regione Piemonte - Bando «Poli Innovazione»)

WIN-STREET

Water IN: STReet design with Environmental Engineering Technologies (for urbanized areas) (Regione Piemonte - Bando «Poli Innovazione»)

FILGREEN

Studio di fattibilità di FILati a base GRafenE per l'immagazzinamento di Energia (Regione Piemonte - Bando «Poli Innovazione»)

3D Filter

Stampa 3D per miglioramento di membrane per filtrazione di gas
Regione Piemonte - Bando «Poli Innovazione»)

- **Classes for graduated students**
 - post University specialization degree in Polymer Science and Technology
- **Classes for high school graduates**
 - injection molding
 - mold maintenance
 - CAD for plastics
- **Classes for people working in the plastics sector**
 - more than 30 different theoretical and practical classes on plastics materials and processing technologies held every year
 - training courses designed upon specific company needs



Seminars and conferences
about new materials and new technologies

Events examples:

- Heat & Cool Technologies
- Conductive Polymers
- Technical conference on Mucell® technology
- Energy management for the plastic processing industry
- Polymers compounding
- Scientific moulding
- Fiber reinforced composites

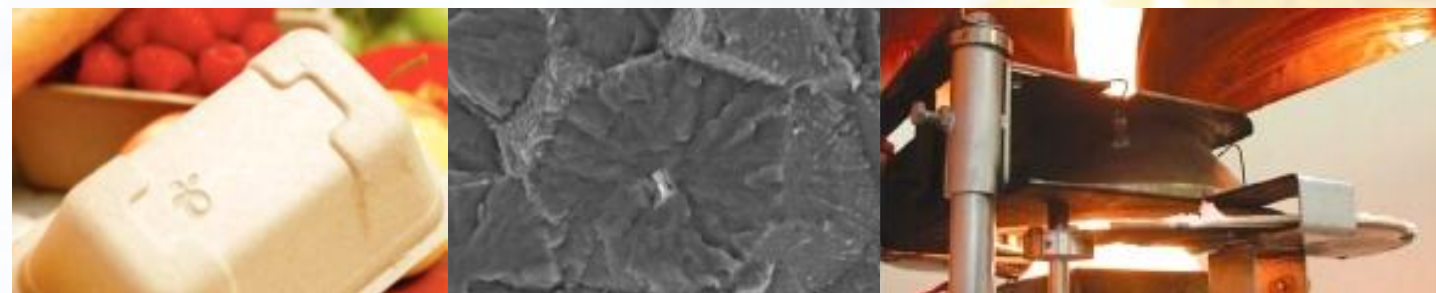


8-9-10
November
2016

ECCP
European Conference on thermally and
electrically Conductive Polymers and
composites
FROM LAB TO MARKET

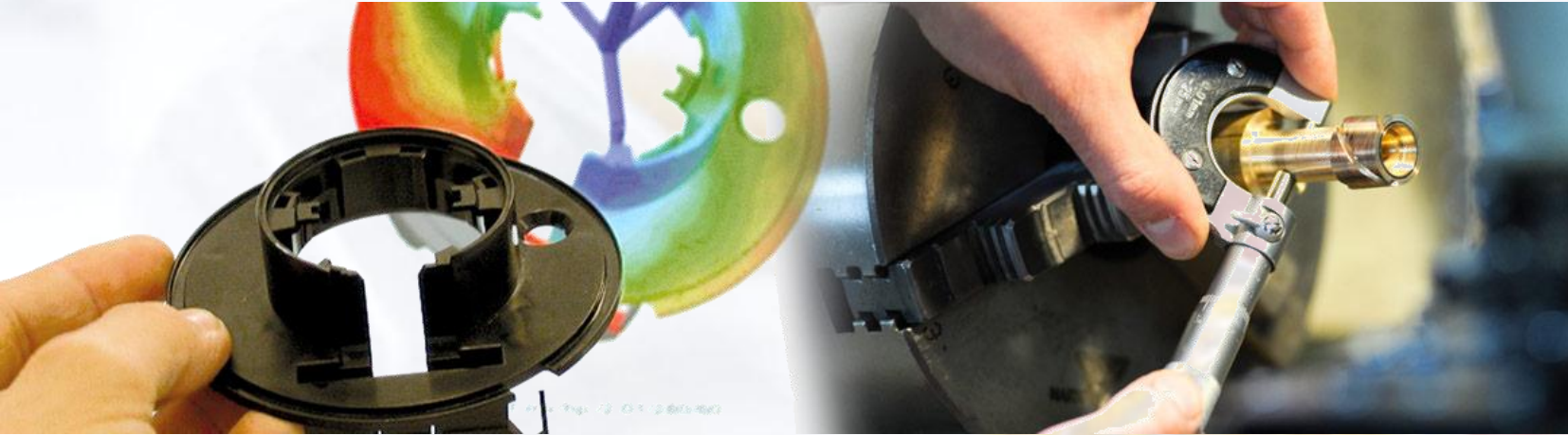


- **Tailoring of formulations vs. the final application by the means of different technologies**
(compounding, melt blending, reactor and solid state polymerisation)
- **Explorative and feasibility studies about new polymers and additives**
- **Environmental sustainability:**
 - biopolymers
 - polymers for green applications (photovoltaics, membranes)
 - recycling of post-consumer waste
- **Development of high-performance polymeric materials:**
 - flame retardant materials
 - nanocomposites
 - high stability polymers (vs. aging, weathering, stress cracking)
 - metal replacement
 - thermoplastic polymers
 - adhesive polymers
 - food packaging materials
 - conductive plastics



- Injection molding (Heat-and-cool, Roctool[®], Mucell[®])
- Pre-series molding
- Compounding
- Film extrusion
- Thermoforming
- Thermoplastics & thermosets composites
- Metal/ceramic injection molding (MIM, CIM)





Product and process engineering

FEM structural simulations

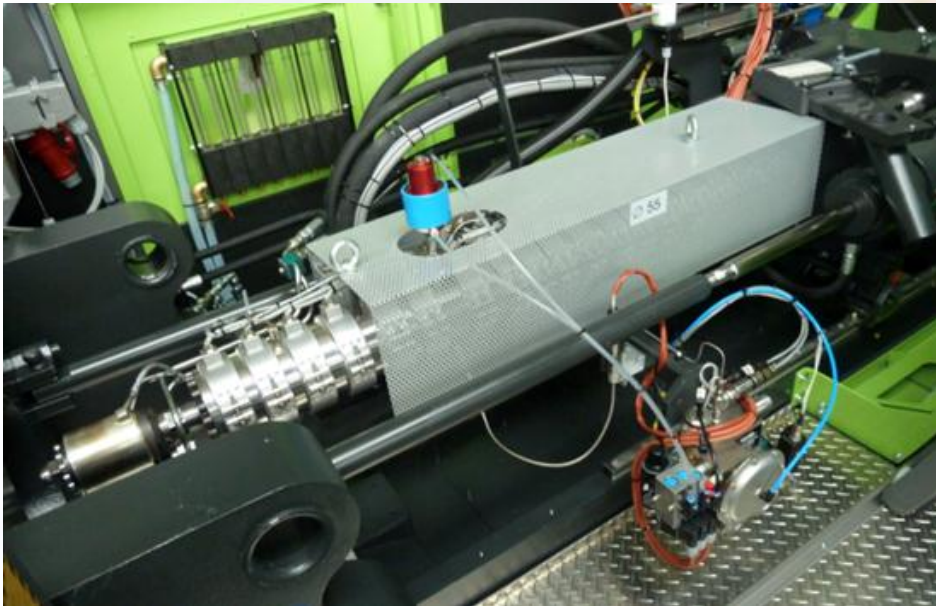
Process simulations

- Development and optimization of new products
- Design and manufacturing of pilot molds
- Rapid prototyping
- Static/dynamic non linear analysis
- Impact analysis
- Modal/vibrations analysis
- Thermoplastics injection molding simulations
- Thermosetting injection molding simulations
- Blow molding/thermoforming simulations
- Thermal analysis

Lightweighting in injection molding: the MuCell® technology

The two key elements of MuCell technology:

1. Lowering of the viscosity of thermoplastic resins by controlled feeding of gas (either N₂ or CO₂) into the melt
2. Creation of a microcellular structure in the part core by gas expansion in the cavity



Proplast demo line

Installed on Engel injection machine - 180 tons, 55 mm screw

100-500 grams typical part size

CO₂ or nitrogen

ENGEL

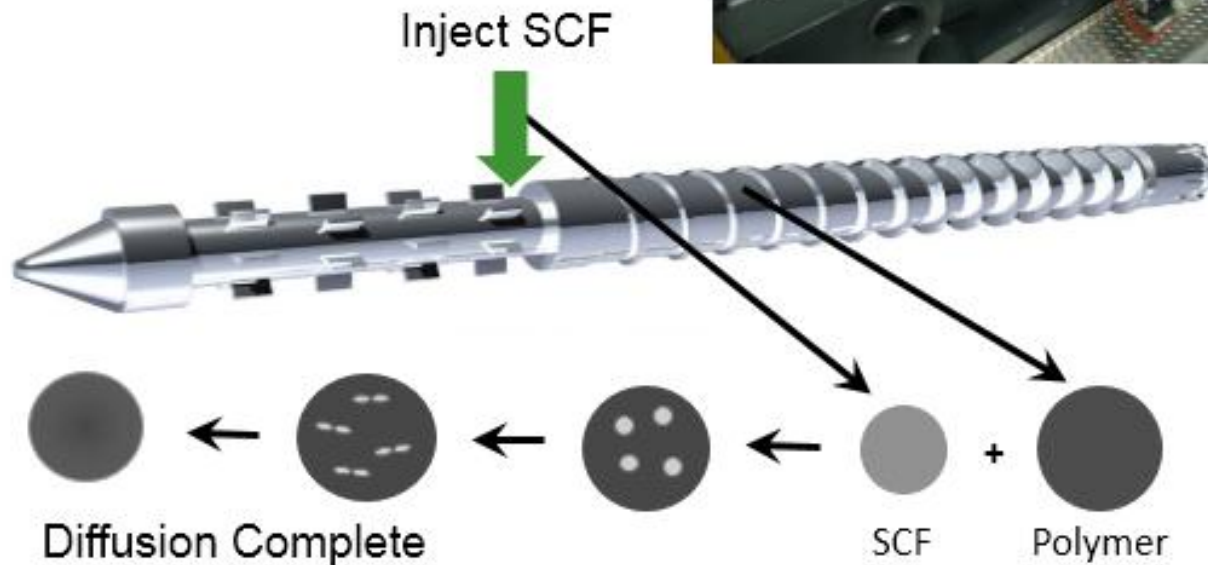
MuCell Processes
TREXEL INC.

TREXEL INC.

Lightweighting in injection molding: the MuCell® technology

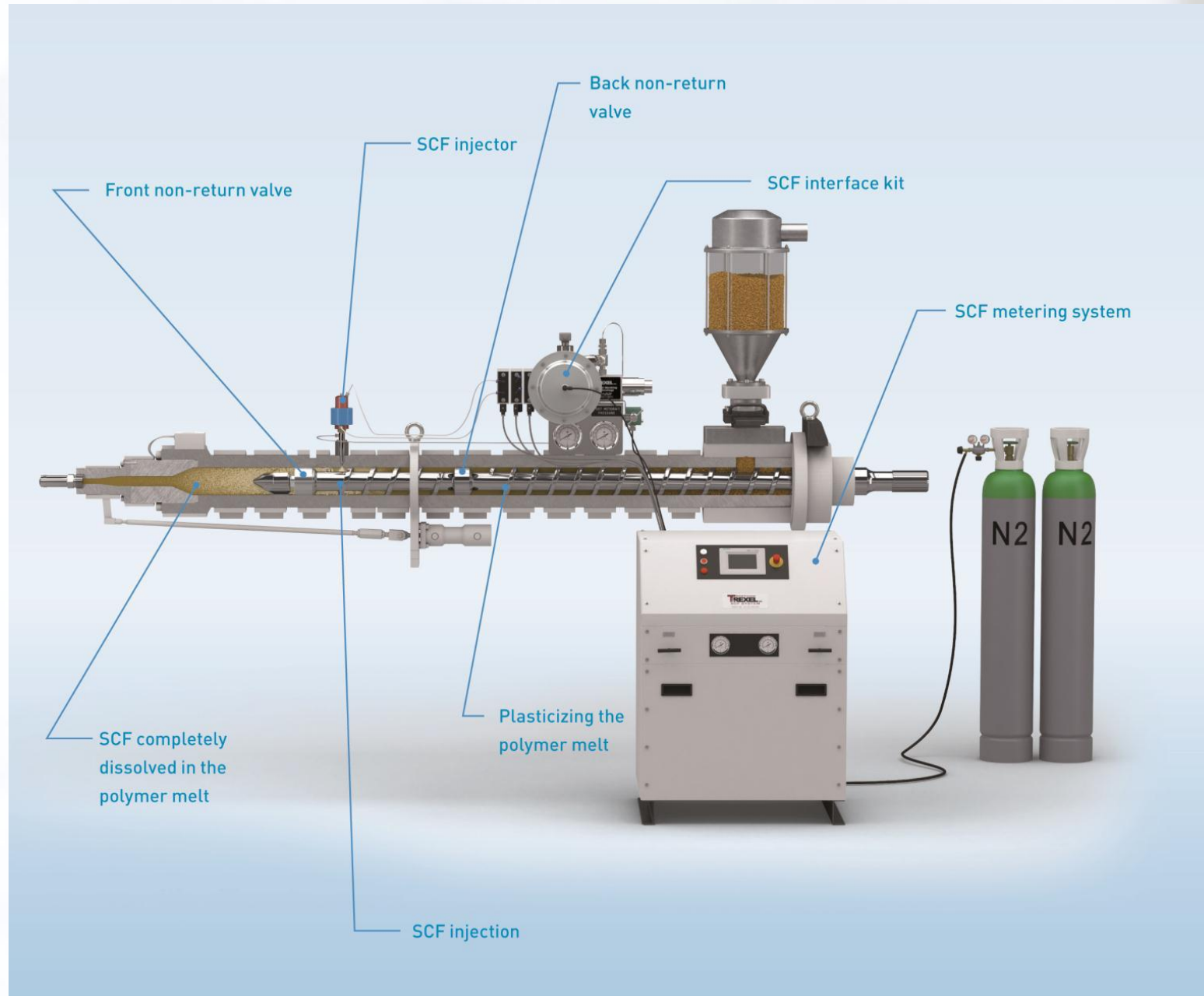
Dissolving SCF into the melt

- ⇒ Screw flights break-up SCF stream
- ⇒ Mixing flights cause SCF to divide into smaller bubbles and then dissolve



A single phase solution is created by injecting the SCF (super critical fluid) into the thermoplastic melt during screw recovering

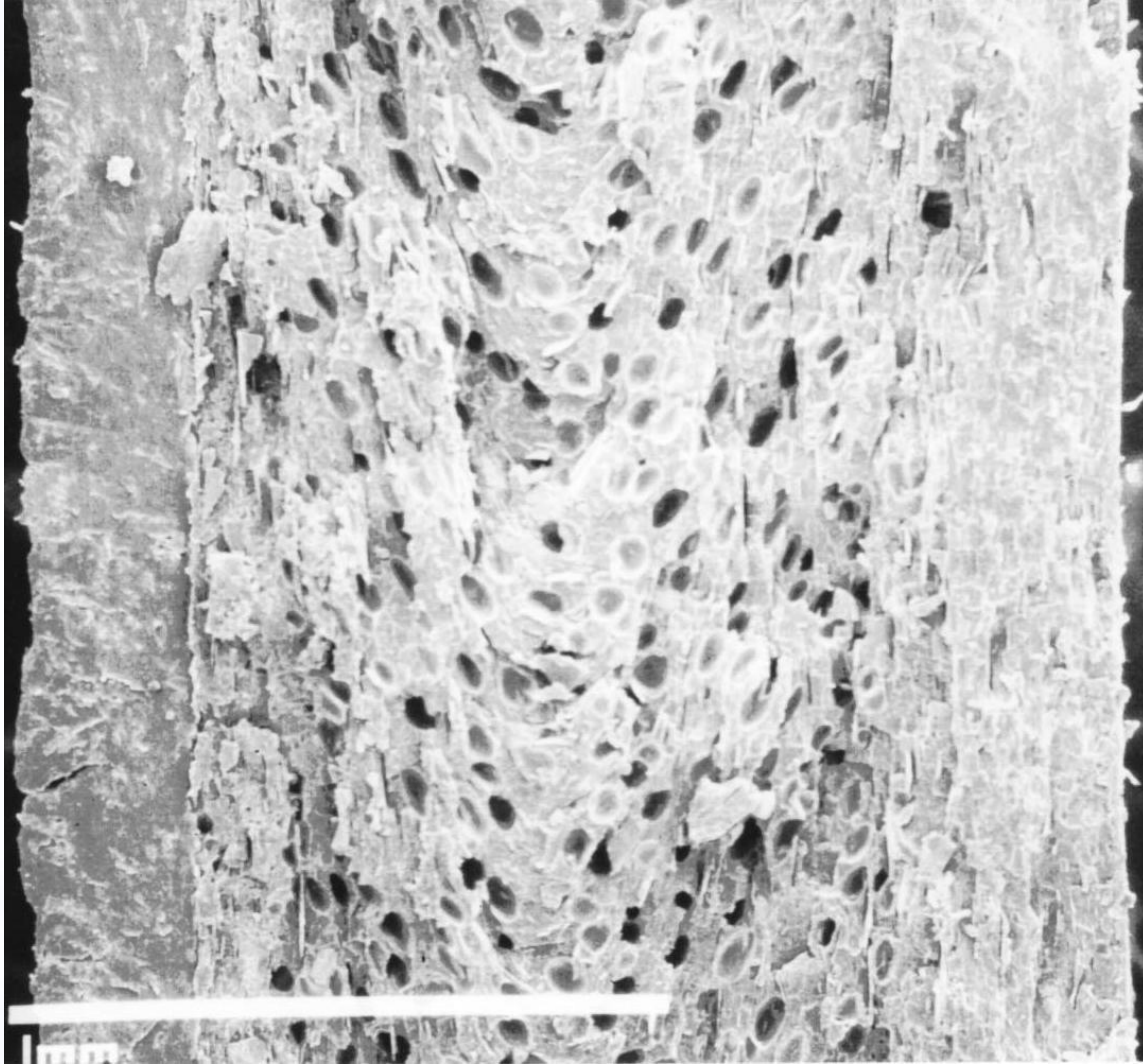
Lightweighting in injection molding: the MuCell® technology



MuCell line typical layout



Lightweighting in injection molding: the MuCell® technology



Typical 'sandwich' structure of MuCell parts:

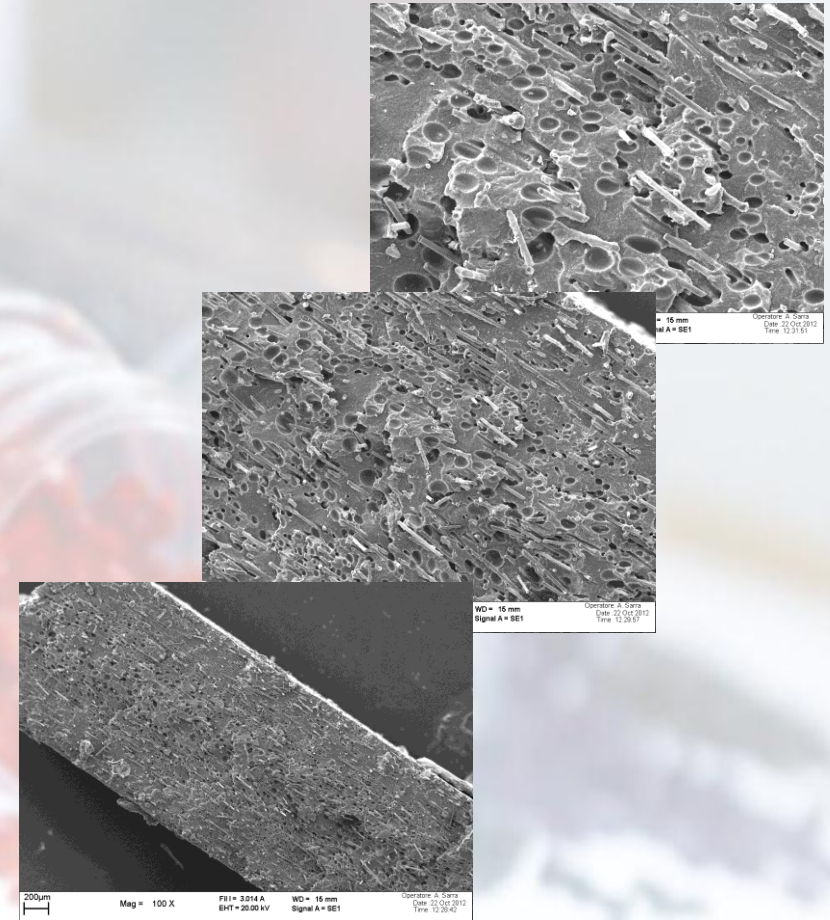
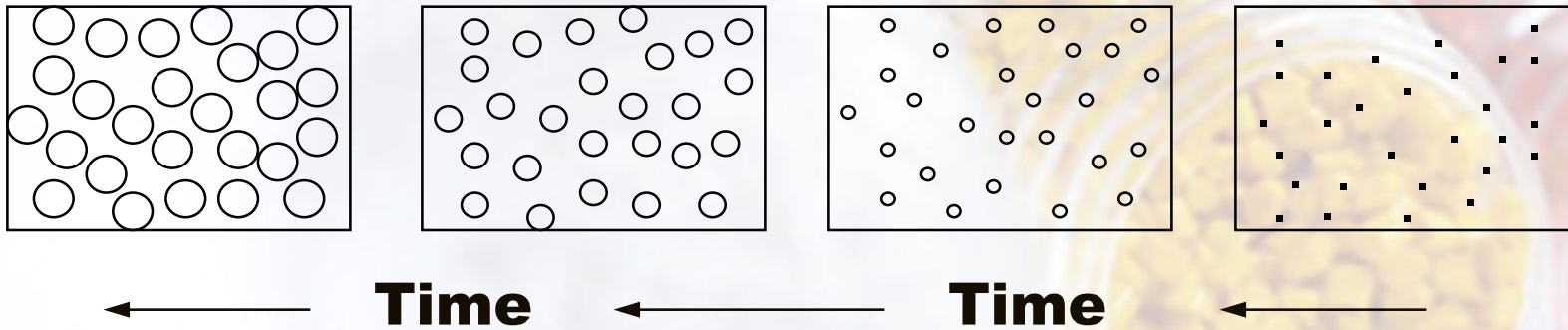
Compact skin - Foamed core - Compact skin

MuCell Processes
REXEL INC.

BEXEL INC.

Lightweighting in injection molding: the MuCell® technology

Foaming occurs during injection into the mold



- ⇒ Low pressure in the mold cause SCF to form cells
- ⇒ Cells grow until the material freezes or the mold cavity is full

Lightweighting in injection molding: the MuCell® Process

MuCell benefits

•Cavity

foaming process instead of post pressure
lower clamping force

•Injection unit

lower viscosity, leading to better filling behavior and lower pressures
better filling behavior
new part design and gate positioning possible
potential temperature decrease

•Part

integral structure
lower part weight
less warpage
no sinkmarks



Without MuCell



MuCell

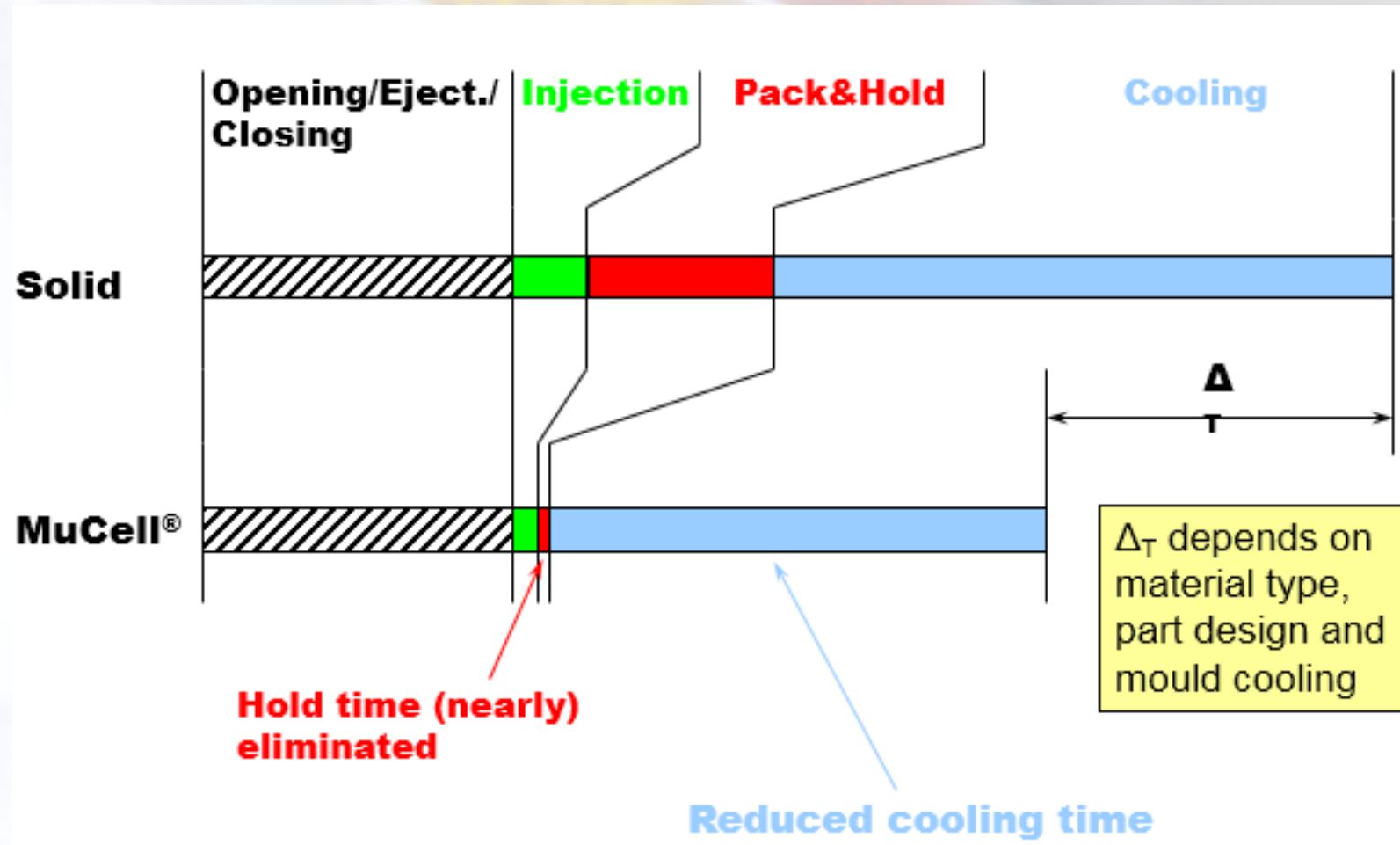


MuCell + Heat & Cool



Lightweighting in injection molding: the MuCell® Process

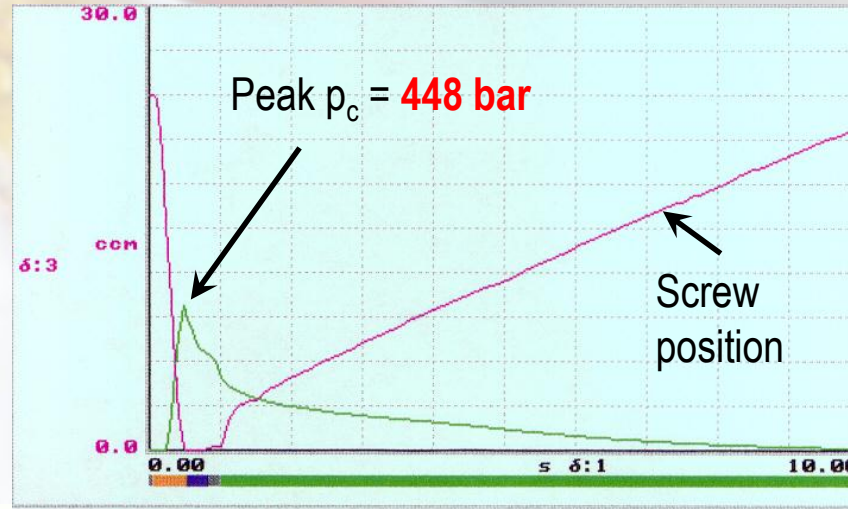
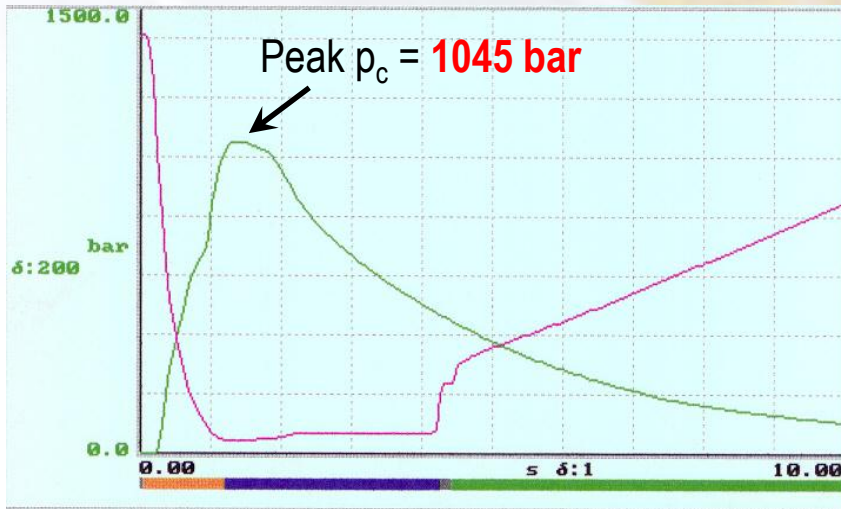
Productivity improvement: overall cycle time reduction



Productivity improvement: reduction of hydraulic pressure

Solid

MuCell®



Data Com Connector, PBT 30 % GF

- ➡ 57 % reduction in peak cavity pressure
- ➡ Due to viscosity reduction, less resin volume, no pack & hold pressure
- ➡ Longer tool life

Lightweighting in injection molding: the MuCell® Process

Case History #1 : Cam Cover

elringklinger



Achieved benefits:

- 👉 30% reduced machine size (350 instead of 500 ton for conventional molding)
- 👉 Improved cycle times, allowing for simultaneous production and assembly process
- 👉 Lighter part
- 👉 Improved flatness

MuCell Processes
REXEL INC.

REXEL INC.

Case History #2 : Dual fan shroud



MuCell Processes
TREXEL INC.



BEXEL INC.

Achieved benefits

- Typical weight reduction 7-10%
- Machine size reduction from 1000 tons to 500 tons
- Cycle time savings of 25-40%
- 200% improvement in fatigue resistance
- Cpk values improved by 50%



Processing: injection molding - RocTool

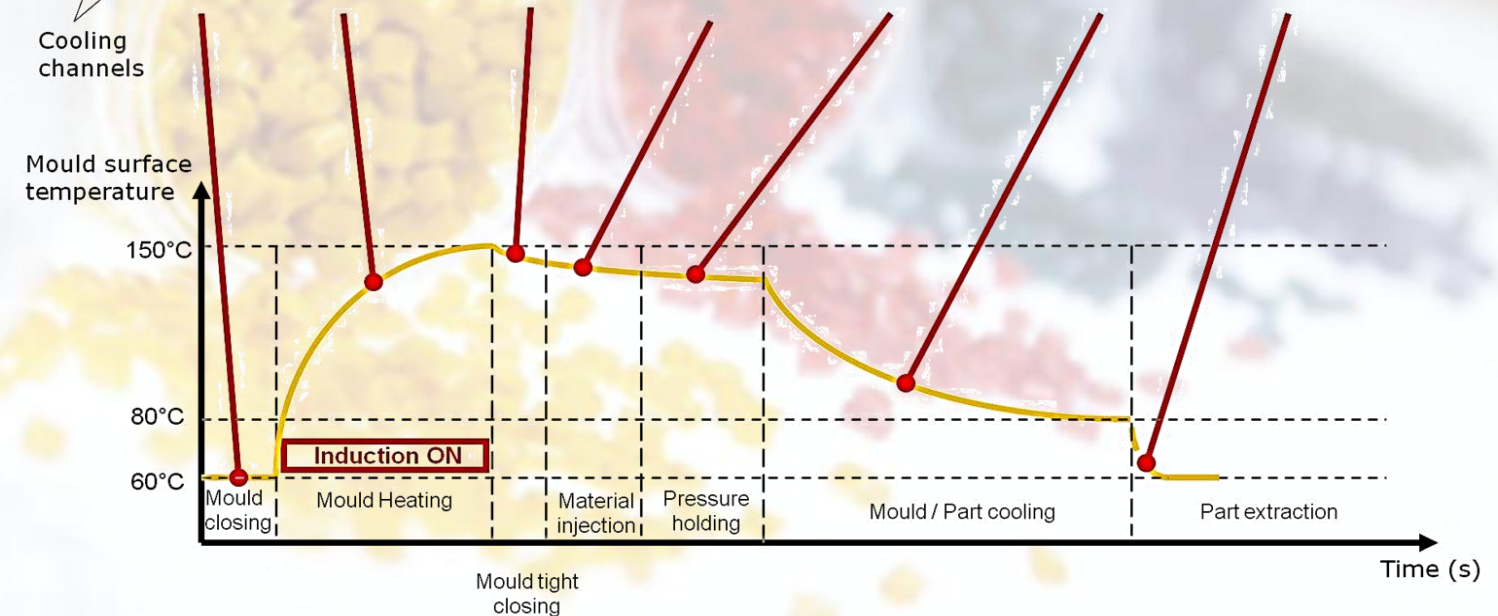
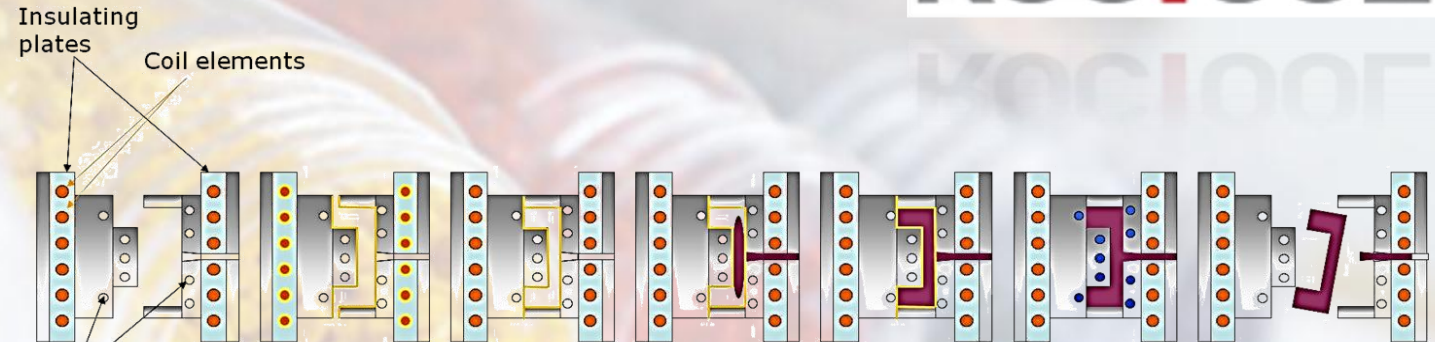
RocTool Processes

Advanced Heat & Cool technology for Composite and Plastic Injection molding by using electromagnetic induction allows to heat a mould in a matter of seconds.



RocTool benefits

- Optimal surface quality: glossy or mat, no visible weld lines
- Thickness reduction is possible
- Mechanical properties increased
- Pressure reduction
- High temperature molding is possible
- Very fast heating of the mold



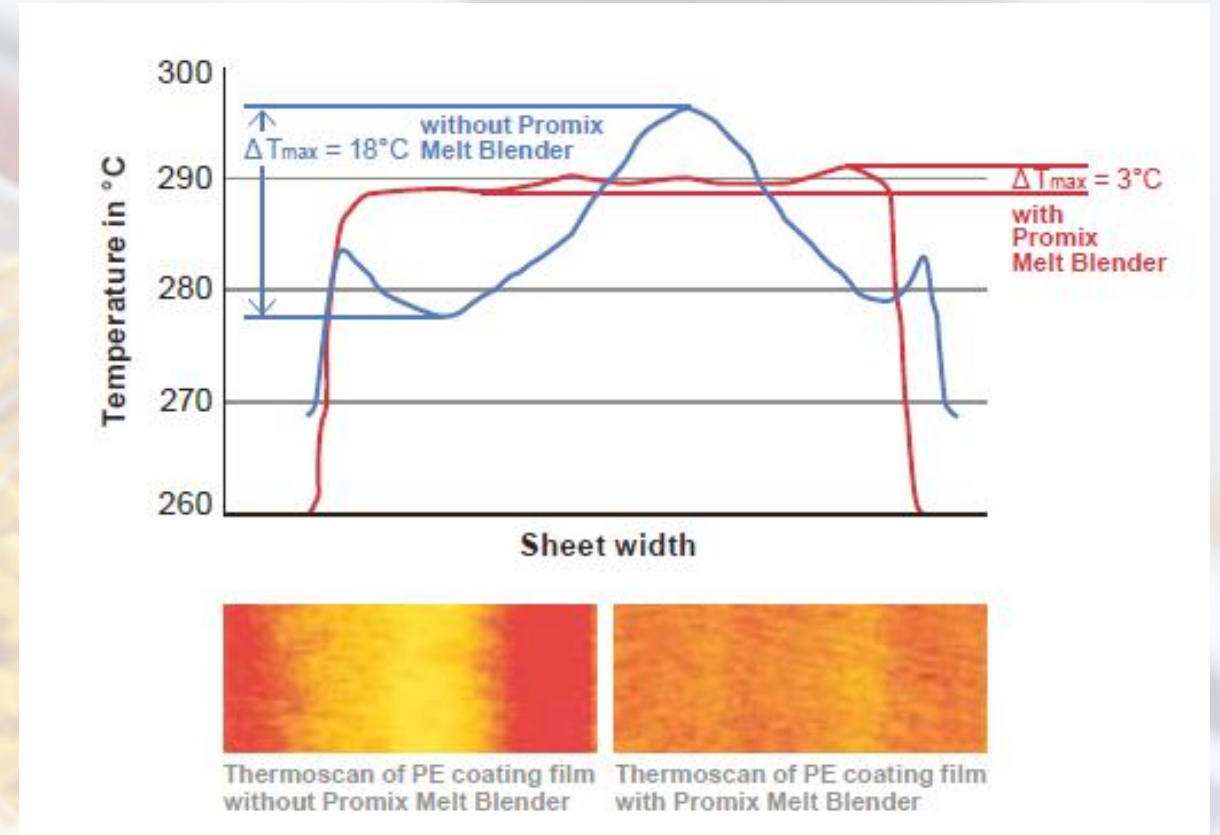
Processing: light weight extrusion - Promix

Promix Solutions

- In extrusion processes temperature differences in the melt are generated by the plasticizing process in the screw, melt pumps, screen changers and even by empty pipe sections.
- Melt Blenders such as Promix blenders efficiently equalize temperature variations over the whole cross section.



Equal melt temperature and velocity are key for high quality extruded products



Processing: light weight extrusion - Promix

In an empty pipe polymer melts will form a laminar profile

Promix melt blenders destroy the laminar profile and create a very effective cross mixing resulting in:

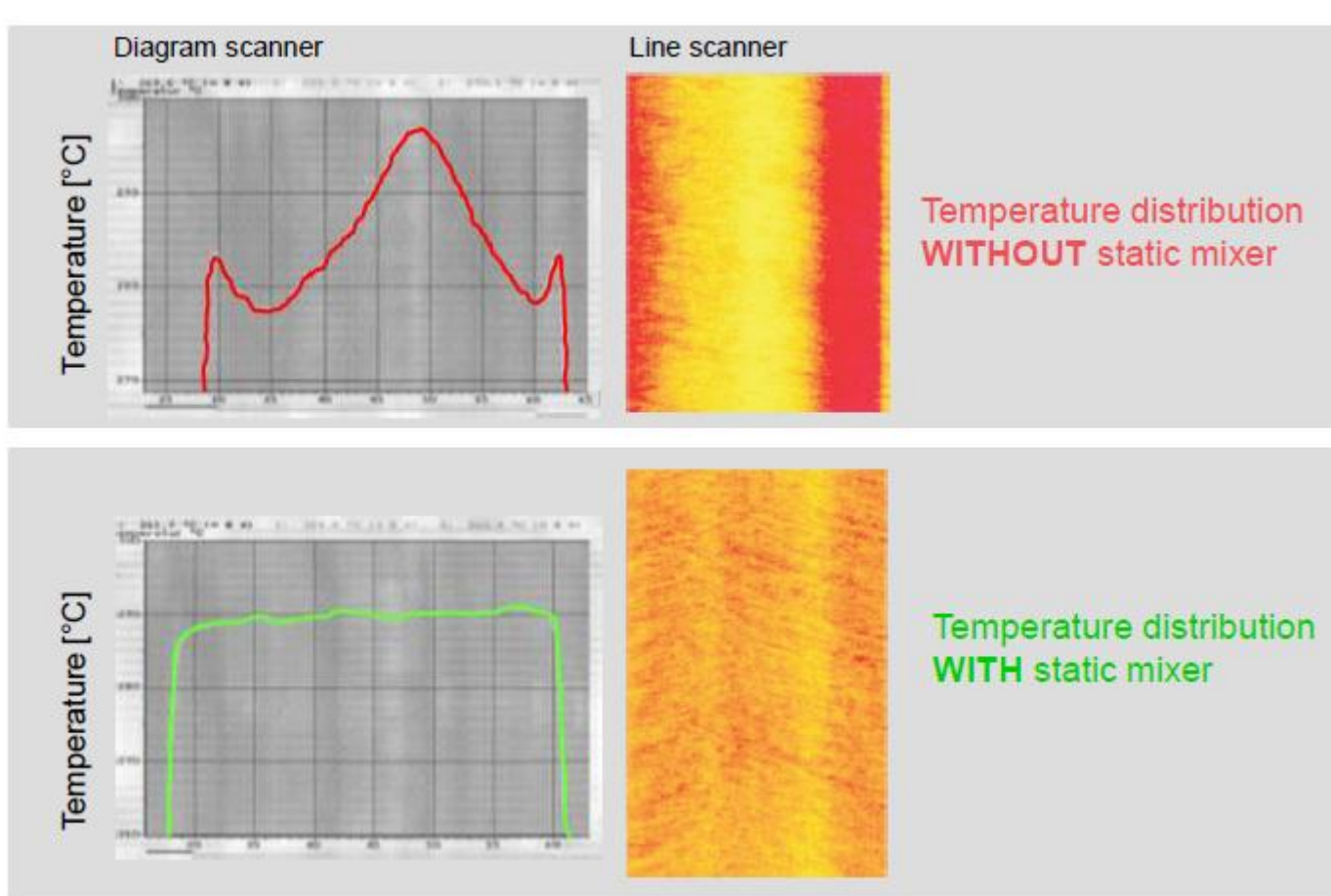
- Equal velocity
- Equal temperature
- Narrow residence time distribution
- Excellent melt homogeneity



Processing: light weight extrusion - Promix



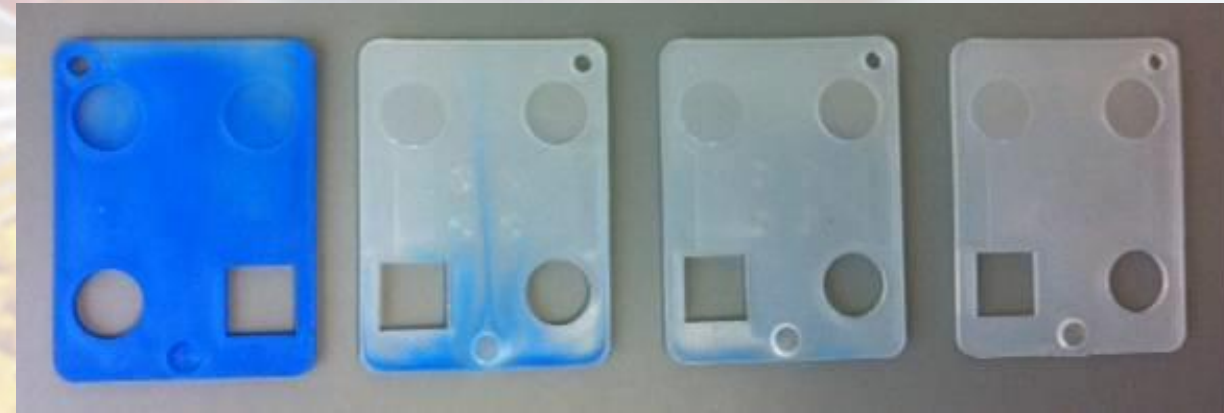
Processing: light weight extrusion - Promix



Effective temperature homogenization

Benefits of Promix Mixing Nozzles

- Effective avoidance of color streaks
- Equalized color depth / better color appearance
- Saving of 20 – 30% master batch (= 1'000 to >10'000 Euro savings / year)
- No brilliant spots due to homogenization of temperature profile
- Reduced cycle time due to optimized processing parameters
- Better tolerances
- Improved processing of recyclates (usability of more recyclate or better product quality)
- Improved balancing of hot runner systems



shot 1

shot 2

shot 3

shot 4

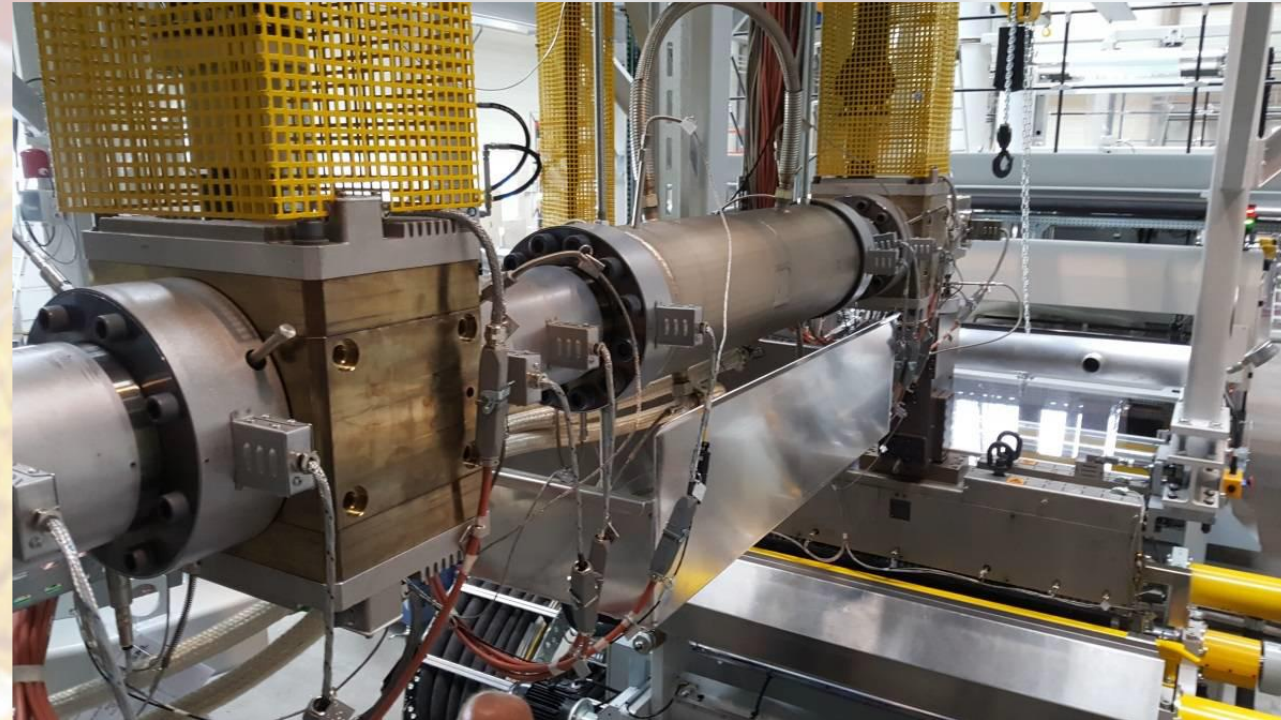
*3-4 shots of non colored PP
can purge out the blue masterbatch*

Processing: light weight extrusion - Promix

Promix foaming system is a patented process for the production of extruded microcellular foams.

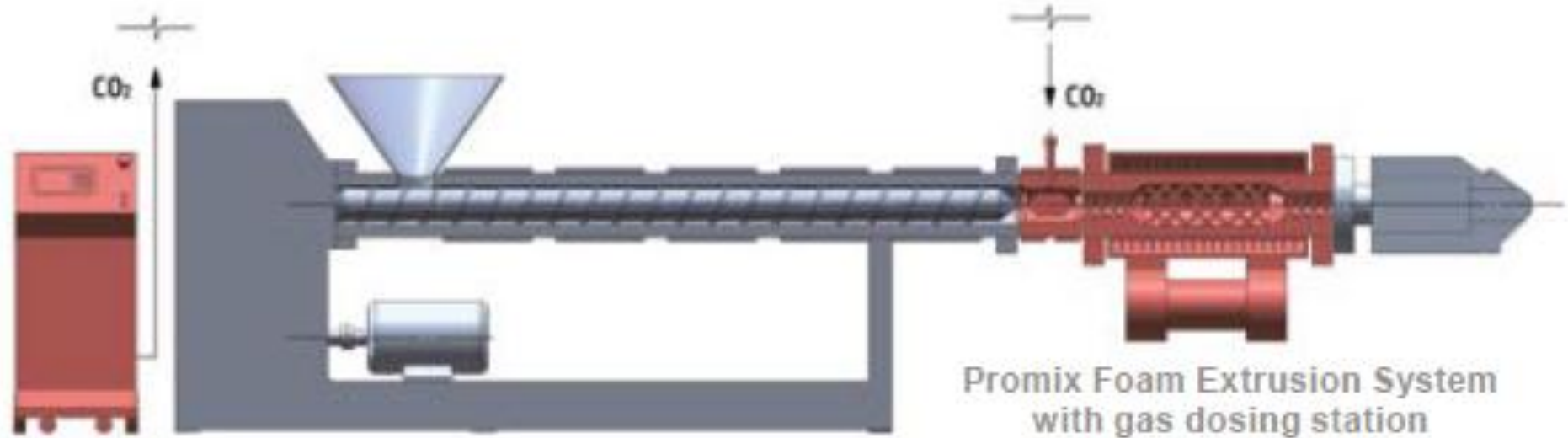
Main features:

- Significant weight and cost reductions
- High quality microcellular foams
- Density reductions of 10 to >70%
- Use of the environmental friendly blowing fluids CO₂ und N₂
- No licenses



Processing: light weight extrusion - Promix

Promix foam system with fluid injection and static mixing and cooling modules

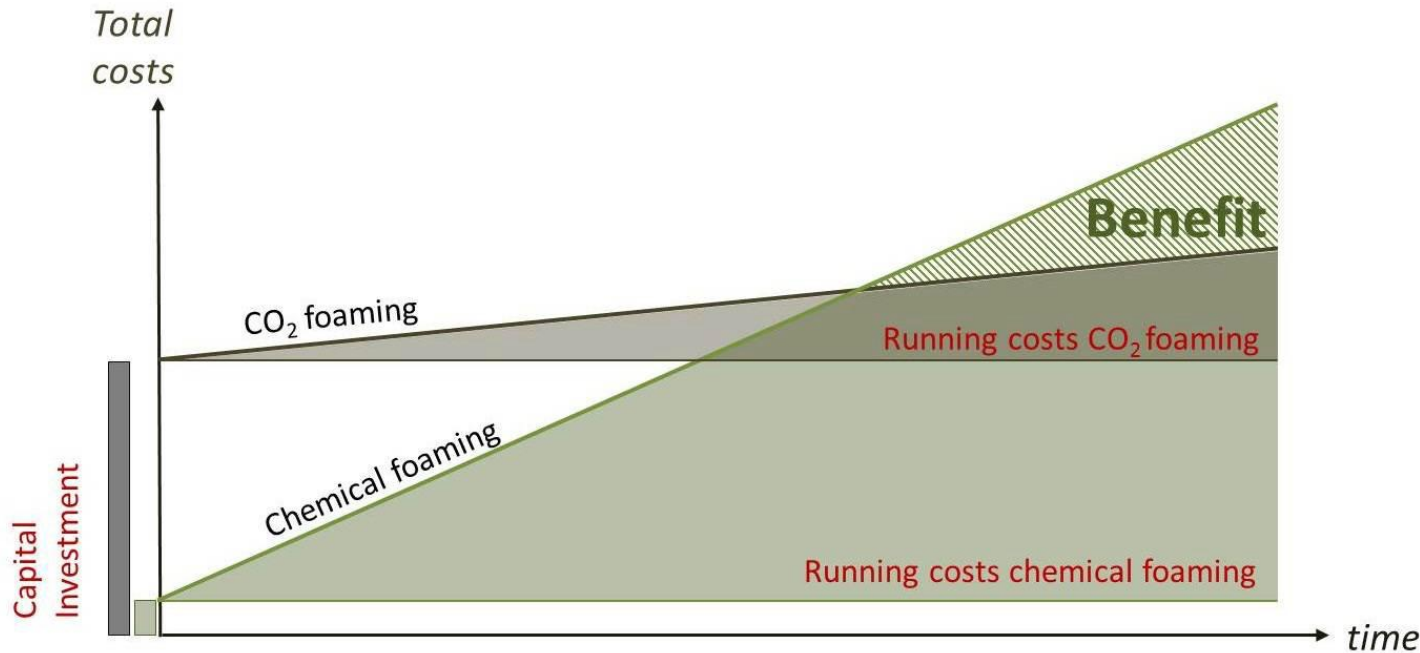


Promix foam extrusion systems are installed downstream of the existing extruder barrel and consist of components for fluid injection, homogenization and cooling.

The blowing fluid is provided by a high precision gas dosing station.

Processing: light weight extrusion - Promix

Advantages of physical vs. chemical foaming:

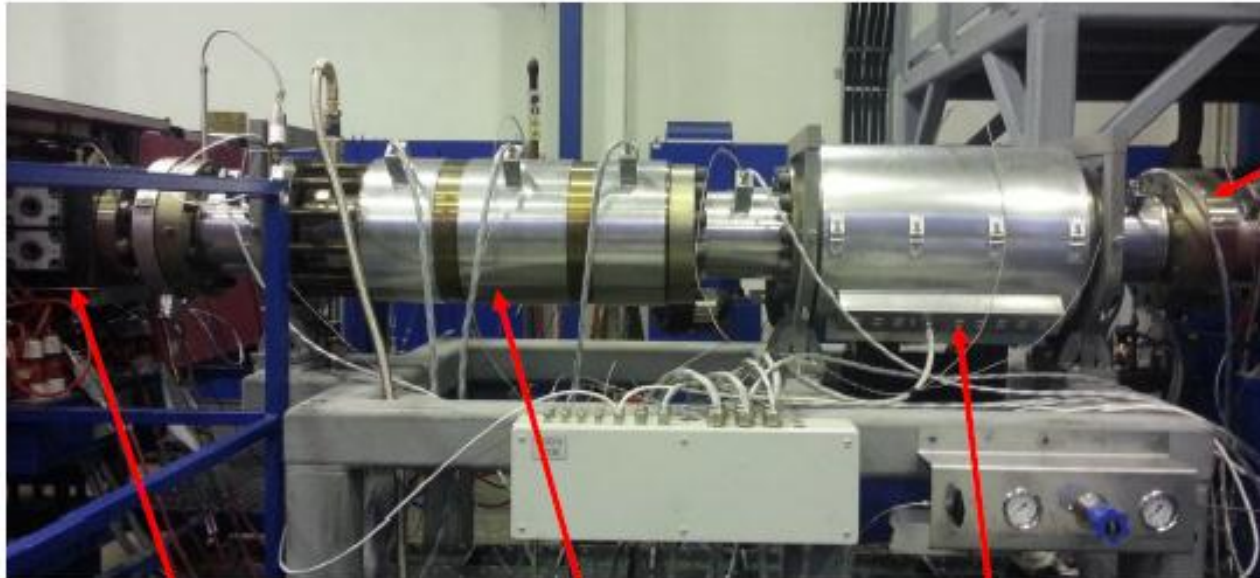


- Fast amortization of investment, usually < 1 year
- Higher process stability, better cell structure
- Lower foam densities possible
- No health risks due to chemical residues
- Production waste is 100% recyclable
- Improved cell structure and smoother surface in foam extrusion, thanks to mixers

Processing: light weight extrusion - Promix

Installation example

600 kg/h PP sandwich board line, foam density 500 kg/m³



Fluid injection module

Feed block / die

Melt cooler

Static mixing module

Case History #1 : dairy products packaging



PS foam sheet

Thermoform application for dairy products

Substitution of chemical foaming

Result:

- Reduction of foam density
- Better process stability
- Better foam structure



Processing: light weight extrusion - Promix

Case History #2 : PP foam core pipes

PP foam sheet

Automotive application

Density 210kg/m³ (13lb/ft³)

Result:

- Reduction of foam density



Thanks for your attention

Proplast - Consorzio per la promozione della cultura plastica

Strada Savonesa, 9 – 15057 Rivalta Scrivia – AL

Tel: +39 0131 1859711

proplast@proplast.it

www.proplast.it

