What drives food packaging innovation?
versalis within eni

**chemicals**
chemicals and polymers production, sales & marketing

- **5,700** employees
- **13** plants
- **335** patents
- **325** researchers
- **5.9 €/bln** turnover
- **3.8 m/ton** production to sales
- **2.0 €/bln** 2014-17 investments
**Business Overview**

**Versalis**

**Turnover:** € 5.9 bln – production: 5.8 m ton

**Production to sale:** 3.8 m ton

**Monomers and Intermediates**
- Olefins
  - Ethylene
  - Propylene
  - Butadiene
  - Raffinate 1
  - Carbon Black Feedstock
- Aromatics
  - Toluene
  - o-m-p-Xylene
  - Pseudocumene
  - DCPD
  - Benzene
- Derivatives
  - Phenol
  - Acetone
  - Alphamethylstyrene
  - Cyclohexanone/Ka-Oil
  - EB/Styrene

**Polymers**
- Polyethylene
  - LDPE
  - LLDPE
  - VLDPE
  - HDPE
  - EVA
- Styrenics
  - GPPS
  - HIPS
  - EPS
  - SAN
  - ABS
- Elastomers
  - e-SBR
  - s-SBR
  - BR
  - TPR
  - EP(D)M
  - NBR
  - Latex

**Sales**
- € 2.7 bln

**Volumes**
- 2290 k/ton
- 630 K/ton
- 1040 K/ton

**Leading player**

**Capacities and Market Position**
- **€ 1.4 bln**
  - 6th in EU
  - 3rd in EU

- **€ 0.8 bln**
  - 1060 k/ton
  - 460 K/ton

- **€ 0.7 bln**
  - 370 K/ton

**End Markets**

- Leading Player
- 6th in EU
- 3rd in EU
- 2nd in EU
the polyethylene business

**Turnover**

€ 1.4 bln

**Plants**

- Brindisi
- Ferrara
- Ragusa
- Dunkerque (F)
- Oberhausen (D)

**Applications**

- Packaging 58%
- Agriculture 11%
- Compound 7%
- Building 3%
- Tech. Goods 6%
- Other 15%

**2nd EVA producer in Europe**

versalis prides itself for a significant share within the polyethylene market

**EVA are high-value niche products**

**Brands:**

- **Greenflex®**
  - Ethylene - Vinyl Acetate copolymer (EVA)
- **Riblene®**
  - Low Density Polyethylene
- **Flexirene®**
  - Linear low density Polyethylene
- **Clearflex®**
  - Linear low density Polyethylene
- **Eraclene®**
  - High density Polyethylene

**Turnover**

€ 1,4 bln

**Plants**

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why choose a multilayer packaging film?

- Production of a film better suited to the final application
- Getting the best properties of a given polymer
- Use of each component in the best way, without compromising the main components properties (synergistic effect)

General structure of a multilayer film – courtesy of specialchem
food packaging film: european market growth

INDEXED TREND – SOME SEGMENTS : EUROPE (2007=100)

AAGR ~ 3%

source: internal marketing data
Adding value in the food supply chain through the development of partnership between the packaging industry and the packaging users seems to be the credo for the new millennium.

- m-LLDPE for flexible packaging
- Advanced polymer nano-composites
- Smart packaging for consumer goods
- Plastomers for sealant layer in flexible packaging

+ innovation + performance + added value

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food packaging film: sealant layer

Key properties
- outstanding sealability
- high mechanical properties

Clearflex® FGH B0: an advanced Z-N VLDPE made by proprietary catalyst and technology
HPT catalyst

A. Not homogeneous comonomer distribution
B. Not regular size crystals

A. Homogeneous comonomer distribution
B. Regular size crystals

Crystalline structure
Tie Chains
Clearflex FGH B0 vs std and competitor grades

### GPC Analysis

![Graph showing GPC analysis of HPT grade, Versalis Z-N grade, and Competitor Z-N grade]

<table>
<thead>
<tr>
<th></th>
<th>HPT grade</th>
<th>Versalis Z-N grade</th>
<th>Competitor Z-N grade</th>
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<tr>
<td>$\text{MFI}_{2,16kg}$</td>
<td>1,1</td>
<td>0,97</td>
<td>0,94</td>
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<tr>
<td>Density</td>
<td>0,9121</td>
<td>0,9101</td>
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<td>$\text{Mn}$</td>
<td>23500</td>
<td>24100</td>
<td>23200</td>
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<tr>
<td>$\text{Mw}$</td>
<td>111600</td>
<td>114300</td>
<td>110100</td>
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<tr>
<td>$\text{Mw}/\text{Mn}$</td>
<td>4,7</td>
<td>4,7</td>
<td>4,7</td>
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<tr>
<td>CH3/1000C</td>
<td>23,2</td>
<td>25,4</td>
<td>26,5</td>
</tr>
</tbody>
</table>
... what does it bring?

- High tie molecules content
  - Impact
  - Puncture
  - E.S.C.R.

- Lower crystals dimensions
  - Sealability
  - Optical prop.
  - Extractables

- Most regular crystals dimensions
  - Vicat
  - Stickyness

multilayer film

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Clearflex FGH B0 vs std grade

**Hot-tack test**

![Graph showing Hot-tack test results for Clearflex FGH B0 and Clearflex FGB0](image)

- **Clearflex® FGH B0**
  - MFI = 1, d = 0.912

- **Clearflex® FGB0**
  - MFI = 1, d = 0.910

**Temperature (°C)**

**Strength at break (cN)**

- 500
- 400
- 300
- 200
- 100

- 80 100 110 120 130
mechanical performances vs std grade

what a better comonomer distribution is able to give

Puncture resistance

Dart resistance

+ 45%

+ 35%
Clearflex FGH B0 vs competitor grades

Hot-tack test

- **Clearflex® FGH B0** (MFI=1, d=0.912)
- **LLDPE C8** (MFI=1, d=0.918)
- **EVA** (MFI=2, VA=4.5)

**Strength at break (cN)** vs **Temperature (°C)**

Strength at break reaches a peak at a certain temperature for each material, with Clearflex® FGH B0 and LLDPE C8 having higher values compared to EVA.
food packaging film: barrier layers

Key properties
- Oxygen and moisture barrier
- Strength

Work in progress
- Smart packaging obtained by functional additives in PE
- Nanocomposites obtained by dispersion of nanoparticles in PE
food packaging film: smart packaging

SMART PACKAGING ADDITIVES

- **Anti or counter microbial**
  - Indicators for H₂S, acetic acid
  - Aluminum silicates, ZnO, MgO, Ag, Cu

- **Oxygen removers**
  - Redox indicators
  - Fe(II) compounds

- **Humidity controllers**
  - “Sandwich” of polyacrilates salts between PE layers (KCl, NaCl)

- **Ethylene absorbers**
  - Al₂O₃, KMnO₄, zeolites, active carbon

- **CO₂**
  - Acid/base indicator

**Intelligent** | **Active**
The KEY POINT is to additivate polyethylene with nanoparticles to improve barrier properties enhancing also mechanical, optical, thermal or electrical properties.
partnership to built value along the whole supply chain
Thank You For Your Attention!

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the new face of chemicals

versalis chemistry to evolve

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