Addressing Global Waterproofing with a Unique Polymer Portfolio

Stefan Ultsch, Mercedes Alonso – Dow Europe GmbH
Lamy Chopin, Damien Polansky – The Dow Chemical Company

• Waterproofing Markets and Applications
• Technical Trends and Requirements
• The Dow Polymer Portfolio in Waterproofing
• A Toolbox for Tailored Waterproofing Solutions
European polymer usage in Waterproofing Membranes

Source: AMI 2007

<table>
<thead>
<tr>
<th>Share [%]</th>
<th>Volume [kt/a]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC 16</td>
<td>120</td>
</tr>
<tr>
<td>EPDM 3</td>
<td>25</td>
</tr>
<tr>
<td>PE 48</td>
<td>360</td>
</tr>
<tr>
<td>PP 33</td>
<td>250</td>
</tr>
<tr>
<td>Other</td>
<td>84</td>
</tr>
<tr>
<td>Flat roof 17%</td>
<td>635</td>
</tr>
<tr>
<td>Walls 6%</td>
<td></td>
</tr>
<tr>
<td>Pitched roof 8%</td>
<td></td>
</tr>
<tr>
<td>Landfill/Tunnel 11%</td>
<td></td>
</tr>
<tr>
<td>Chemical containment 2%</td>
<td></td>
</tr>
<tr>
<td>Waste water 3%</td>
<td></td>
</tr>
<tr>
<td>Clean water 13%</td>
<td></td>
</tr>
<tr>
<td>Building substructures 24%</td>
<td></td>
</tr>
</tbody>
</table>

777-02601-1010
Selected Single-Ply Roofing Markets by Polymers in 2008

**North America**
310MM m²/a
5% growth/a

**Western Europe**
320MM m²/a
2.5% growth/a

**China**
180MM m²/a
19.5% growth/a

Source = Dow internal

Source = SPRI

Source = Dow internal

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What's Next?

Consolidated Growth Rates for North America, Western Europe and China

Introduction | Growth | Maturity | Decline

Total market growth: 7%

- PVC: 27%
- TPO: 12%
- SBS MBR: 6%
- aPP MBR: -1%
- EPDM: -2.4%
Roofing

Unballasted

Ballasted

Green roof
Geomembranes, Water Management, Tunnel Liners
Modern Architecture
Waterproofing in Civil Engineering

- Liquid roofing
- Insulation bonding
- Acrylics adhered roof
- Bitumen bonding
- PUR adhered refurbishment
- Expansion joints
- Façade sealants
- Wet room sealants
- Subsoil waterproofing
- Pitched roof
Trends in Waterproofing

Reduction of Total System Cost

Design
- Simple systems from one supplier
- Enhanced functionality

Manufacturing
- Direct extrusion
- Fast changeover
- High production rates
- Low scrap-rates

Installation
- Fast, simple and reliable
- Fast welding any climate
- Self-adhesion
- Smart fasteners...

Service-Life
- Longevity,
- Low maintenance,
- Ease of repair
- Environment friendly

Ease of removal, ease of refurbishment, recyclability, ecology
Requirements of Waterproofing Membranes

- Flexibility
- Easy and reliable welding
- Cold temperature resistance
- Cold contraction
- Heat resistance
- Puncture resistance
- Chemical resistance
- Weathering
- UV-resistance
- Fire resistance
- Root resistance
- Energy efficiency
- Drinking water approvals
- ...

= most critical
## Dow Polymers in Building and Construction Membranes

### Dow Polymers in Building and Construction Membranes

<table>
<thead>
<tr>
<th>Roofing</th>
<th>Geomembranes</th>
<th>Tapes</th>
<th>Others</th>
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</thead>
<tbody>
<tr>
<td>Single-ply low slope</td>
<td>Pitched roof vapor barriers</td>
<td>Reservoir liners</td>
<td>Wet room Façade</td>
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<tr>
<td></td>
<td></td>
<td>Landfill</td>
<td>Expansion joints</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perimeter liners</td>
<td>Tank and Pool liners</td>
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<tr>
<td></td>
<td></td>
<td>Tunnel liners</td>
<td>Bitumen modification</td>
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<tr>
<td></td>
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<td></td>
<td>Banners Tarpaulins</td>
</tr>
<tr>
<td>INSPIRE* PP</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>ELITE* EPE</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>DOWLEX* LLDPE</td>
<td>●</td>
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</tr>
<tr>
<td>LDPE</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>ENGAGE* POE</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>NORDEL* EPDM</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>VERSIFY* PBE</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>TYRIN* CPE</td>
<td>●</td>
<td>●</td>
<td></td>
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• Polymerization of a high-molecular C3/C2–copolymer
• Based on INSITE™ catalyst technology

• No reactor blend, no reactor cascades, no vis-break process
• Tailored, tight tolerance molecular structure
• No oligomers, no low-molecular fraction

• Excellent and lasting heat welding
• Excellent filler uptake and general properties

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Formulation Toolbox: Various Concepts

- TPO Systems
- New Elastomer Systems
- Adherable Systems
- Highly flame retardant Systems
- Halogenated, plasticizer free Systems

European Standards
North American Standards
Asian Requirements
Designing the Formulation Toolbox

**Engage™ POE**
**Nordel™ EPDM**
**Infuse™ OBC**
**Attane™ ULDPE**

- Flexibility...
- Cold temperature impact

**Versify™ PBE**

- Welding...

**Tyrin™ CPE**

- Chemical resistance...

**Elite™ EPE**
**Dowlex™ LLDPE**
**LDPE**

- Physical strength...
- Heat resistance...
- Compatibilization

**Inspire™ PP**

**Amplify™ PE-graft**

- Flame retardancy...

Others, fillers....

Tailored Blends for Waterproofing and Membrane Applications

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Processing: Direct Extrusion of FR Compounds

Diagram courtesy of BERSTORFF, Hanover Germany
Lab-scale Direct Extrusion Line

Photo courtesy of BERSTORFF, Hanover Germany
VERSIFY™ Processing on Direct Extrusion Lines

Formulations based on VERSIFY™ Plastomers and Elastomers provide:

- Low extrusion temperatures
- High outputs and low torque
- Low die pressure

- Excellent dispersion of fillers and flame retardants

  ➔ Excellent blend homogeneity

  ➔ Excellent overall properties

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TPO Direct Extrusion Study, 35% MgOH₂

Incumbent

70% VERSIFY™ 2300
30% icPP

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Adjustable Properties: Flexibility and Mechanical Strength

<table>
<thead>
<tr>
<th></th>
<th>Flexibility, E-Modulus [MPa]</th>
<th>Tensile Strength [MPa]</th>
<th>Break Elongation [%]</th>
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<tbody>
<tr>
<td><strong>TPO Europe</strong></td>
<td><img src="image1" alt="Value" /></td>
<td><img src="image2" alt="Value" /></td>
<td><img src="image3" alt="Value" /></td>
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<tr>
<td><strong>TPO North America</strong></td>
<td><img src="image4" alt="Value" /></td>
<td><img src="image5" alt="Value" /></td>
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<tr>
<td><strong>Halogenated Systems</strong></td>
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<td><img src="image8" alt="Value" /></td>
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<td><strong>New Elastomer Systems</strong></td>
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<td><img src="image11" alt="Value" /></td>
<td><img src="image12" alt="Value" /></td>
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<tr>
<td><strong>Adhereable Systems</strong></td>
<td><img src="image13" alt="Value" /></td>
<td><img src="image14" alt="Value" /></td>
<td><img src="image15" alt="Value" /></td>
</tr>
</tbody>
</table>

Requirement / State of the Art
### Adjustable Properties: Temperature Resistance

<table>
<thead>
<tr>
<th>TMA (Thermomechanical Analysis)</th>
<th>DSC</th>
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</thead>
<tbody>
<tr>
<td>3 mm pin, 1 N load, 5 K/min</td>
<td>Calorimetry</td>
</tr>
<tr>
<td>1.5 mm membrane thickness</td>
<td>10 K/min, second run</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>0.25 mm penetration temperature [ºC]</th>
<th>0.50 mm penetration temperature [ºC]</th>
<th>melting range [ºC]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPO Europe</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>TPO North America</td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>Halogenated Systems</td>
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<tr>
<td>Adhereable Systems</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

**Requirement / State of the Art**
VERSIFY™ Plastomers and Elastomers provide:
• Excellent and consistent welding due to low oligomer level

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Flame Retardancy

• **Halogen-free flame retardants** are in main use today
  
  - Aluminum trihydrate \( \text{Al(OH)}_3 \) **decomposition at 200 °C**
  - Magnesium hydroxide \( \text{Mg(OH)}_2 \) **decomposition at 300 °C**

• **Addition level** depends on norm and system requirements:
  
  - 30 wt% in North America
  - 40 to 50 wt% in Europe

• **Purity, particle size distribution, surface coating** affect membrane manufacturing, end properties and may be decisive for long-term/weathering performance

VERSIFY™ based formulations and flame retardants:

• Low melt temperature processing allows high production rates with \( \text{Al(OH)}_3 \)
• Very high filler loads without loss of mechanical properties
• Can match with most stringent requirements
Weathering and UV-Resistance

- Processing and longterm stabilizer packages are key for longevity and are added in amounts of 0.05 to 1.5 wt%, often via master batches

- Titanium dioxide ($\text{TiO}_2$) 2 to 5 wt% are added as colorant and UV-stabilizer

- Carbon black 0.01 to 0.05 wt% for greyish membranes improves UV-stability

VERSIFY™ based formulations and stabilizers:
- High stabilizer levels possible without negative effects on welding
- VERSIFY™ formulations can be tailored to any state of the art longevity level
- VERSIFY™ based formulations have a proven track record

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The Formulation Toolbox

Manufacturing

Installation

After Use

Extrusion

Recyclability

Flexibility

Ease of welding

Adherability

UV-resistance

Fire resistance

Norms define the minimum

End Use

Best balance of properties and costs

Weathering

Heat resistance

Cold temp. resistance

Cold contraction
Installation of a TPO Membrane on Dow Premises
Summary

Markets
• Global waterproofing applications require different solutions
• TPO roofing is growing substantially

Dow offers
• A unique portfolio of proven polymers for tailored solutions
• Excellent technical expertise and global presence

Dow polymers
• NORDEL™ EPDM is #1 in EPDM waterproofing
• DOWLEX™ PE, AFFINITY™ POP, ENGAGE™ POE: #1 in geomembranes and tunnel liners
• VERSIFY™ PBE is key in commercially proven, high-performance membranes
• Other Dow Elastomers enable specific functionality and tailored solutions

Let us be the partner in developing your Waterproofing System

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Appendix Dow Tradename Products

- AFFINITY™ Polyolefin Plastomers
- AMPLIFY™ Functional Polymers
- ATTANE™ Ultra Low Density Polyethylene Resins
- DOWLEX™ Linear Low Density Polyethylene Resins
- ELITE™ Enhanced Polyethylene Resins
- ENGAGE™ Polyolefin Elastomers
- INFUSE™ Olefin Block Copolymers
- INSPIRE™ Performance Polymers
- NORDEL™ IP & MG Hydrocarbon Rubber
- TYRIN™ Chlorinated Polyethylene
- VERSIFY™ Plastomers and Elastomers

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