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

- Building substructures: 24%
- Clean water: 13%
- Waste water: 3%
- Chemical containment: 2%
- Landfill/Tunnel: 11%
- Other construction: 16%
- Flat roof: 17%
- Pitched roof: 8%
- Walls: 6%

750 kt/a

<table>
<thead>
<tr>
<th>Share [%]</th>
<th>Volume [kt/a]</th>
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</thead>
<tbody>
<tr>
<td>PVC</td>
<td>16</td>
</tr>
<tr>
<td>EPDM</td>
<td>3</td>
</tr>
<tr>
<td>PE</td>
<td>48</td>
</tr>
<tr>
<td>PP</td>
<td>33</td>
</tr>
<tr>
<td>Other</td>
<td>84</td>
</tr>
</tbody>
</table>

Source: AMI 2007
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 = SPRI

Source = Dow internal

Source = Dow internal
Consolidated Growth Rates for North America, Western Europe and China

What's Next?

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

Total market growth: 7%

Introduction Growth Maturity Decline
Geomembranes, Water Management, Tunnel Liners
Waterproofing in Civil Engineering

- Insulation bonding
- Liquid roofing
- Façade sealants
- Expansion joints
- Wet room sealants
- Pitched roof
- Acrylics adhered roof
- Bitumen bonding
- PUR adhered refurbishment
- Subsoil waterproofing
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
Polymeric Building Blocks: The Dow Polymer Portfolio

Modulus

HDPE
LLDPE
LDPE
POE

OBC
EPDM

-MAH
-EA

PBE

CPE
PVC

PP
RCP
ICP

PBE

ATH
Mg(OH)₂
CaCO₃
TiO₂
AO

EVA

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## Dow Polymers in Building and Construction Membranes

<table>
<thead>
<tr>
<th></th>
<th>Roofing</th>
<th>Geomembranes</th>
<th>Tapes</th>
<th>Others</th>
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<tbody>
<tr>
<td><strong>Roofing</strong></td>
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<tr>
<td>Single-ply low slope</td>
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<tr>
<td>Pitched roof, vapor barriers</td>
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<tr>
<td>Reservoir liners</td>
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<tr>
<td>Landfill</td>
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<tr>
<td>Perimeter liners</td>
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<tr>
<td>Tunnel liners</td>
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<tr>
<td><strong>Geomembranes</strong></td>
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<tr>
<td>Wet room, Façade</td>
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<tr>
<td>Expansion joints</td>
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<td>Tank and Pool liners</td>
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<tr>
<td>Bitumen modification</td>
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<td>Banners, Tarpaulins...</td>
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<tr>
<td><strong>Others</strong></td>
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</tbody>
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|                |         |              |       |        |
| **INSPIRE**    | PP      | ● ● ● ● ● ● ● |       |        |
| **ELITE**      | EPE     | ● ● ● ● ● ●   |       | ● ●    |
| **DOWLEX**     | LLDPE   | ● ● ● ● ● ●   | ● ●   | ● ●    |
| **LDPE**       | LDPE    | ● ● ● ● ● ●   | ● ●   | ● ●    |
| **ENGAGE**     | POE     | ● ● ● ● ● ●   | ● ●   | ● ●    |
| **NORDEL**     | EPDM    | ● ● ● ● ● ●   | ● ●   | ● ●    |
| **VERSIFY**    | PBE     | ● ● ● ● ● ●   | ● ●   | ● ●    |
| **TYRIN**      | CPE     | ● ● ● ● ● ●   | ● ●   | ● ●    |

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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

Tailored Solutions for Waterproofing and Membrane Applications

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...

**INSPIRE™ PP**
- Heat resistance...

**AMPLIFY™ PE-graft**
- Compatibilization
- 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>TPO Europe</td>
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<tr>
<td>TPO North America</td>
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<tr>
<td>Halogenated Systems</td>
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<td>New Elastomer Systems</td>
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<tr>
<td>Adhereable Systems</td>
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</table>

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

<table>
<thead>
<tr>
<th>TMA (Thermomechanical Analysis)</th>
<th>DSC Calorimetry</th>
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<tbody>
<tr>
<td>3 mm pin, 1 N load, 5 K/min</td>
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</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 [°C]</th>
<th>0.50 mm penetration temperature [°C]</th>
<th>melting range [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPO Europe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPO North America</td>
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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>50 150 50 150 100 200</td>
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</tbody>
</table>
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 (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

Flexibility

Ease of welding

Adherability

End Use

Norms define the minimum

Best balance of properties and costs

- Recyclability
- Fire resistance
- UV-resistance
- Weathering
- Heat resistance
- Cold temp. resistance
- Cold contraction

777-02601-1010
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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