Waterproofing Membranes
Matching Trends, Needs and Standards with Excellent Economics

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• Markets, Applications, Trends and Standards
• Polymers and Formulations for Waterproofing
• Manufacturing of Flexible Membranes
• Property Profiles of Next Generation Waterproofing Membranes
• Cost Modeling and Value Chain Analysis
European Polymer Usage in B+C-Membranes

- Dow Polyolefins are commercial in each of these waterproofing applications.
Europe

- PVC: 16%
- PVC Specials: 1%
- oxid. Bitumen: 5%
- aPP Bitumen: 27%
- EPDM: 4%
- TPO: 4%
- ECB: 1%
- PIB, CPE...: 1%

412 mio m²

North America

- EPDM: 27%
- TPO: 33%
- PVC: 12%
- sbs Bitumen: 14%
- aPP Bitumen: 27%
- oxid. Bitumen: 5%
- PIB, CPE...: 1%
- ECB: 1%

288 mio m²

Source = AMI 2009

Source = SPRI 2009
**European Roofing and its 2008 to 2012 Growth Perspective**

- **TPO and EPDM** - olefin based systems - represent the largest growth segments

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**Total Market growth**
- **2004 to ‘08:** 7.4 %
- **2008 to ‘12:** 4.4 %

**Source:** AMI 2009
Key Driver: Minimizing Total System Cost

Design
- Simple systems
- Cost optimized

Manufacturing
- Economy of scales
- Economic process
- Low scrap

Installation
- Fast
- Simple
- Reliable

Service-Life
- Longevity
- Low maintenance
- Economics

Ease of removal, ease of refurbishment, recyclability, ecology

Energy saving…
Dow Elastomers

Norms and Standards

NAA  ASTM D 6878-03  TPO Waterproofing  
ASTM D 4637-04 EPDM Sheet used in Single-Ply Roof Membrane...

Europe  EN 13707  Reinforced Bitumen Sheets for Roof Waterproofing (09/2006)  
EN 13956  Plastic and Rubber Sheets for Roof Waterproofing (04/2007)...

<table>
<thead>
<tr>
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<th>EN 13501-5</th>
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ENV 1187 System Tests: t1, t2, t3, t4

Re-design of Formulations and Constructions

Asia  Norming committees on TPO, leveraging from EN and ASTM

- Market trends and new norms often require re-design of formulations and membranes
Requirements on Waterproofing Membranes

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

● = most critical
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Development Concepts

- Highly flame retardant Systems
- Tailored Solutions for Waterproofing and Membrane Applications
- Specialty Elastomer Systems

- European Standards
- North American Standards
- Asian Requirements

• Market and customer driven development
Formulation Toolbox

**Tailored Blends for Waterproofing and Membrane Applications**

- **Commercially proven formulations for a broad range of waterproofing applications**

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Manufacturing of Flexible Membranes

- Direct extrusion: compounding and shaping in one step
- Internal mixers, calendaring
- Single-screw extrusion, often from pre-compound
- Blown film extrusion
- Lamination processes
- Crosslinking...
- Coatings...

Polymer Selection

- Pellets or bales
- Melting properties, process temperature
- Viscosity – output and shaping
- Filler uptake and dispersion
- Melt strength
- Melt stickiness
- Melt strength, crystallization
- Welding, adhesion, fabric coating
- Crosslink process, polymer response
- Surface energy

- Let us assist in adapting DOW polymers to your process
Dow Elastomers

Direct Extrusion of highly filled Compounds

Diagram: courtesy of Krauss Maffei Berstorff, Hanover Germany

DOW Elastomers for TPO:

- High throughput rates
- Excellent filler up-take and dispersion
- Energy efficient: low torque and die pressure
- Mass temperature < 200 ºC, usage of ATH flame retardant
DOW Elastomers

Viscosity Matching with DOW Elastomers

• DOW TPO formulations can be formulated to match viscosity- and process-needs
• DOW assists in fast development of targeted formulations
No simple test procedure specified for membranes

- **DOW**: Torsion modulus with reference to ASTM, EN
- Flexibility and temperature resistance
- Rating of reinforced and unreinforced membranes

**Typical parameters**
- Samples: s x 10 x 35 mm
- Heat rate: 2 °C/min
- Oscillating frequency: 10 rad/sec

- Response: Torque
DOW polymers offer tailored flexibility in combination with excellent heat resistance.

- Fire resistant roofing membranes
- Commercial TPO’s
- DOW TPO start formulations
- Other commercial roofing solutions
- DOW Specialty Elastomers

• DOW polymers offer tailored flexibility in combination with excellent heat resistance
Trials at LEISTER Process Technologies

- VARIMAT V2 welding system
  Latest generation automatic welder
- Speed nozzle
- 40 mm seam width...

according to industrial practice
• Outstanding and reliable welding Performance of DOW Elastomers due to narrow and tailored molecular Structure, resulting in minimal to no migration of Oligomers
Excellent Welding by Molecular Structure

- **INSITE™-catalyst technology, one reactor**
- **No reactor-cascades, no vis-break**
- **Tight tolerance molecular structure**

- **Excellent and lasting heat welding**
- **Excellent filler uptake and general properties**

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Longevity is mainly a function of stabilizers and additives

- Ongoing studies in-house, with customers and development partners
- TPO formulations including colorants and flame retardant
- Example: 15000 h weatherometer testing (ASTM G26 A)

Today Polyolefins can be stabilized to very high longevity levels
DOW has formulation and testing expertise

Diagrams = Courtesy of CIBA (part of BASF), Basel, Switzerland
Tests under most severe conditions at certified test institutes

ENV 1187 t1 (Germany, Eastern Europe...)  ENV 1187 t3 (France)
ENV 1187 tests: passed with various membrane designs

- Membrane designs that clearly pass most stringent and future standards
- Very flexible membranes with excellent overall properties at high flame retardant loadings
Manufacturing Cost Estimates: Two Scenarios

Process characteristics: Western Europe, one-step direct extrusion, line speed ...

66% Capacity Usage

100% Capacity Usage

Questions:
- How are process economics affected by the polymer?
- Less energy consumption at higher line speed?
- Reduced scrap rate and start-up time?
- Increase usage with more applications and DOW polymer component strategy?
• Material costs are moving targets
• Many formulation- and design-options for optimized economics
• The polymer is the most important piece of the puzzle
• Cheap components must not stand for the most economic solution
Factors affecting Production Costs

Average Cost Split of the Design Studies

<table>
<thead>
<tr>
<th>Costs/m²</th>
<th>Aspects</th>
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<tbody>
<tr>
<td>Flame retardant 32%</td>
<td>Reduced Thickness</td>
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<tr>
<td>Colorant 4%</td>
<td>Tight tolerances</td>
</tr>
<tr>
<td>Stabilizer 2%</td>
<td>Component Strategy</td>
</tr>
<tr>
<td>Scrim 16%</td>
<td>High Performance</td>
</tr>
<tr>
<td>Scrap rate 5%</td>
<td>Performance Balance</td>
</tr>
<tr>
<td>Manufacturing 8%</td>
<td>Design for less</td>
</tr>
</tbody>
</table>

Material Usage
- Reduced Thickness
- Tight tolerances

Polymer
- Component Strategy
- High Performance

Flame retardant
- Performance Balance
- Design for less

Colorant
- Synergisms
- Thin Layers and Coatings

Stabilizer
- Goal: ?-years longevity

Scrim
- Scrim versus fabric
- Tailored mesh width

Manufacturing
- Scrap rate
- Capacity usage

and many more...

• There is not just one solution
Where are win-win scenarios over the life of the membrane?

- Membrane producer – reduced design and production costs?
- Contractor – ease of installation, less accessories?
- Houseowner – maintenance and longevity?

What else?
Summary

Markets
• Global waterproofing applications require different solutions
• Olefinic-based roofing is growing substantially

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

Dow polymers
• NORDEL™ Hydrocarbon Rubbers are leading products in EPDM waterproofing
• DOWLEX™ LLDPE, AFFINITY™ POP, ENGAGE™ POE: #1 in geomembranes and tunnel liners
• VERSIFY™ PBE is key in commercially proven, high-performance membranes

• DOW Elastomers are the platform for today’s and future waterproofing membrane systems
• Let us be the partner in developing your Waterproofing System

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• 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 Hydrocarbon Rubber
• TYRIN™ Chlorinated Polyethylene
• VERSIFY™ Plastomers and Elastomers