Dow Elastomers

Advances in Midsole Technology

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Agenda

• Introduction/Abstract
• Evolution of Athletic Shoes
• Market Overview
• Performance Drivers
• Olefin Block Copolymer (OBC) Technology
• OBC Performance vs. Other Materials in Midsoles
• Conclusion
Evolution of Athletic Shoes

1960  New Balance “Trackster” first mass produced running shoe with ripple tread; also first available in multiple widths

1967  *Distance Running* publishes first shoe review

1971  Nike co-founder Bill Bowerman experiments with replacing spikes with a PU outsole made in his wife’s waffle iron

1977  Brooks *Vantage*, first EVA midsole with “varus wedge” to help pronation, start of emphasis on cushioning and motion control

1979  First Nike Air released using air bladder for cushioning
Evolution of Athletic Shoes

1982  New Balance 990 released, breaking the $100/pair barrier, using PU foam midsole

1989  Reebok “Pump,” customizable fit

2005  Vibram “Five Fingers” ushers in “minimalist” trend

2009  Hoka One One, maximum cushioning shoe

2013  Adidas BOOST, E-TPU solution with better cushioning in minimum package space
# Key Market Trends: Purchase Influencers

<table>
<thead>
<tr>
<th>Influencers</th>
<th>Extremely Important</th>
<th>Somewhat Important</th>
<th>Neutral</th>
<th>Somewhat Unimportant</th>
<th>Not at all Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Quality</td>
<td>70%</td>
<td>22%</td>
<td>6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value for the Price</td>
<td>58%</td>
<td>31%</td>
<td>9%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Past Experience with the Brand</td>
<td>48%</td>
<td>35%</td>
<td>13%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Style/Fashion/Fit</td>
<td>47%</td>
<td>32%</td>
<td>14%</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Innovation/Technology</td>
<td>34%</td>
<td>33%</td>
<td>22%</td>
<td>6% 5%</td>
<td></td>
</tr>
<tr>
<td>Low Price</td>
<td>34%</td>
<td>31%</td>
<td>22%</td>
<td>8% 5%</td>
<td></td>
</tr>
<tr>
<td>Brand Name</td>
<td>29%</td>
<td>32%</td>
<td>23%</td>
<td>8% 8%</td>
<td></td>
</tr>
<tr>
<td>Environmental Initiatives</td>
<td>23%</td>
<td>24%</td>
<td>26%</td>
<td>12% 15%</td>
<td></td>
</tr>
<tr>
<td>Athlete/Celebrity Sponsorship</td>
<td>16%</td>
<td>13%</td>
<td>15%</td>
<td>12% 43%</td>
<td></td>
</tr>
</tbody>
</table>

- **Product Quality, Value for the Price** consistently top influencers
- **“Low Price”** drops for third year in a row to 6th
- **“Innovation/Technology”** surpassed “Low Price” for first time

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Key Market Trends: Running Shoes\(^{(1)}\)

- Consumer buying decision increasingly driven by foam performance
- Stability & Motion Control lose share of mind of the Consumer
- Brand Owner placing greater emphasis on foam performance in response to consumer interest

\(^{(1)}\)Source: Leisure Trends Group webinar, November 2013, “Running Specialty Retail Sales and Trends in 2013”
Consumer Needs

Foam Performance

Performance = Energy Management

• Increased Rebound:
  Energy returned during “push-off”

• Light Weight / Softness:
  More comfortable experience

• Reduced Dynamic Compression Set:
  Foam retains performance over time

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### Material Descriptions

#### Ethylene Vinyl Acetate (EVA)
- Conventional 18% VA
- High VA EVA - 40% VA

#### Block Copolymers

<table>
<thead>
<tr>
<th>Block Copolymers</th>
<th>Hard Segment</th>
<th>Soft Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-TPU (Bead Foam)</td>
<td>Aliphatic Isocyanate + Short Chain Diols</td>
<td>Isocyanate + Long Chain (Ester, Ether &amp; PC) Diols</td>
</tr>
<tr>
<td>SEBS</td>
<td>Styrene</td>
<td>Ethylene Butene</td>
</tr>
<tr>
<td>OBC</td>
<td>High Density Ethylene</td>
<td>Ethylene Octene</td>
</tr>
</tbody>
</table>

**HARD SEGMENT**

**SOFT SEGMENT**
Random vs. Block Copolymer Structures

**Random Copolymers**

- Adding more comonomer lowers the polymer’s crystallinity / density while increasing the flexibility.
- However, the melting and crystallization temperatures and heat resistance also drop as density decreases.

<table>
<thead>
<tr>
<th>Less comonomer and higher density</th>
</tr>
</thead>
<tbody>
<tr>
<td>More comonomer and lower density</td>
</tr>
</tbody>
</table>

**Olefin Block Copolymers**

- OBCs use same raw materials arranged into alternating “soft” and “hard” blocks.
- The soft blocks deliver flexibility and the hard blocks deliver heat resistance.

The block structure provides improved heat resistance, elastic recovery, compression set, and cycle times.
Higher Heat Resistance\(^{(1)}\)

**DSC Melting Curves (10°C/min)**

- **OBC (1MI, 0.877 g/cc)**
- **OBC (5MI, 0.865 g/cc)**
- **Random (3MI, 0.875 g/cc)**
- **Random (0.5MI, 0.863 g/cc)**

**Melting Temperature versus Density**

- **OBCs**
- **Random Ethylene Copolymers**

OBCs exhibit 50-60°C higher melt temperature versus random ethylene copolymers of similar density

\(^{(1)}\) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

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Higher Crystallization Temperature(1)

OBCs exhibit 50-60°C higher crystallization temperature versus random ethylene copolymers of similar density

(1) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.
Dynamic Mechanical Analysis – Pure Material(1)

OBCs and E-TPU show much lower modulus over a broad temperature range versus conventional EVA foam

(1) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.
OBCs and H-EVA can be used to reduce the modulus of conventional EVA foam

(1) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.
Recovery after Dynamic Fatigue

OBCs and E-TPU show significant recovery after dynamic fatigue testing

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Hardness Comparison: EVA, SEBS/Oil, and OBC\(^{(1)}\)

Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

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Compression Set: EVA, SEBS/Oil, and OBC\(^{(1)}\)

<table>
<thead>
<tr>
<th>Sample</th>
<th>CSET 25%, 23C/22h 30 min</th>
<th>CSET 25%, 50C/6h 30 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% EVA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40% SEBS/Oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40% H-EVA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40% OBC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100% OBC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{(1)}\) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.
Shrinkage: EVA, SEBS/Oil, and OBC\(^{(1)}\)

\[\text{Shrink (SA, \%), 70C/24h c} \]
\[\text{Shrink (SA, \%), 100C/24h c} \]

\[\text{Sample} \]

- 100\% EVA
- 40\% SEBS/Oil
- 40\% H-EVA
- 40\% OBC
- 100\% OBC

\(^{(1)}\) Data per tests conducted by Dow. Test protocols and additional information available upon request. Properties shown are typical, not to be construed as specifications. Users should confirm results by their own tests.

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% Rebound: EVA, SEBS/Oil, OBC,\(^{(1)}\) and E-TPU\(^{(2)}\)

![Graph showing the % Rebound of different materials](image)

- 100% EVA
- 40% SEBS/Oil
- 40% H-EVA
- 40% OBC
- E-TPU
- 100% OBC

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Summary

• The Athletic Footwear industry is currently seeing a renewed interest in developing improved properties for performance midsoles.

• New technologies such as Olefin Block Copolymers are emerging to allow “minimalism” and advanced cushioning performance to merge.

• Trade-offs exist in performance that need to be minimized when choosing a modifier or replacement for EVA in midsoles.

• Olefin Block Copolymers have shown a good balance of properties over a wide temperature range with very good recovery after many thousand cyclic deformations.
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Stop by to learn how Dow technology is changing the game for performance midsoles.

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