(valor™

Barrier Resins for PET Bottle Applications

The Valspar Corporation
ValOR™ is the registered trademark for Valspar's proprietary barrier resin, a polymer blend providing superior gas barrier performance and compatibility with PET. ValOR exhibits improved processability compared to other barriers, while offering substantial improvements in delamination resistance and gas barrier performance. Three grades of ValOR are available and have been developed to meet the specific needs of PET bottles in all food and beverage applications, bottle designs, storage conditions, and for use in multilayer or monolayer structures. In addition, Valspar can further modify existing grades to develop customized versions for your specific product and process needs, optimizing performance and efficiency.

ValOR offers a complete range of properties ideal for meeting the most stringent gas barrier demands in PET packaging, including:

- Gas barrier protection tailored to all food and beverage applications
- Moisture-activated oxygen scavengers
- Flavor and aroma barrier protection
- Improved performance over EVOH under high humidity conditions
- Improved Processability
- High tensile strength and modulus for optimal integrity
- Custom-tailored formulation capabilities
Characteristics

Gas Permeability Resistance and Oxygen Scavenging

ValOR resins show superior gas barrier properties compared to nylon barriers. Carbonation loss limits the shelf lives of carbonated beverages, while oxygen ingress causes stored food products and alcoholic beverages to degrade and lose flavor. The use of ValOR gas barriers ensures your packaging effectively retains carbonation and controls the oxygen level over maximum shelf times.

Delamination Resistance

Bottles made with ValOR barrier resins blend extremely well in the PET multilayer injection molding process and exhibit superior delamination resistance in all stages of bottle manufacturing, distribution, and end use areas. While some other barriers delaminate when dropped from 3’ or less, ValOR has shown up to 6’ of delamination resistance in Bruceton Staircase testing. Using ValOR barriers will ensure your bottles will look good under adverse handling conditions and will allow you to maximize your bottle design capabilities. ValOR gives you the ability to differentiate your products from the competition.

Clarity

PET bottles containing ValOR resins have displayed superior clarity. Because no bottle-making process or formulation is identical, Valspar’s formulation team will tailor the standard ValOR grades to achieve optimal clarity and compatibility with your specific bottle structures and manufacturing processes.
**Moisture Activated Scavenger**

The oxygen scavenger in ValOR resins is moisture activated, meaning the oxygen scavenger does not activate until the bottle is filled. Scavengers that are not moisture activated can lose up to 40% of the effective preform or prefill shelf life. ValOR resins give you more flexibility to schedule filling or delivery and eliminate the need to use excess resin to ensure the required scavenging performance with extended prefill storage times.

**Processability with PET**

ValOR can be easily used in PET injection molding because it has a wide range of processing temperatures. ValOR was formulated using proprietary technology to provide improved run stability, maximizing your run-time productivity.

**Chemical Compatibility**

ValOR is compatible with any food, beverage or chemical that is compatible with PET. For additional details regarding compatibility with specific chemicals, please contact your Valspar representative.

**Custom-Tailored Formulations**

Three standard grades of ValOR resins were formulated to meet the gas barrier, delamination, and clarity demands for storage of foods and beverages in PET containers. However, these grades can be adjusted as needed to meet your specific process demands. With ValOR, you can leverage Valspar’s unsurpassed customer dedication and resin manufacturing expertise to add value to your products.

**Temperature and humidity resistance**

ValOR offers superior performance over a wide range of temperature and humidity.
ValOR ActivBloc100 offers total barrier performance in multilayer structures, combining a high performance carbonation barrier with an industry-leading oxygen scavenger. It is designed primarily for beer, carbonated juice and flavored alcoholic beverage packaging, and can be used in any PET multilayer bottle application requiring high carbonation retention and low oxygen content. Its proprietary formulation yields superior processing characteristics in multilayer PET bottles, and is ideal for use as the middle layer in hot- or cold-filled applications. ValOR ActivBloc100 delivers the longest possible storage time under normal or adverse storage temperature and humidity conditions. Having industry-leading oxygen permeability resistance and oxygen scavenging capacity, ValOR ActivBloc100 has maintained oxygen levels below 0.8 ppm after 8 months of storage. ValOR ActivBloc100 also offers outstanding delamination resistance making it the best product available for use in filling tunnel-pasteurized beverages.

Oxygen Concentration vs. Shelf Time of ValOR™ Multilayer Bottle and PET Monolayer Bottle
*ValOR* Activ100 utilizes a heavy-duty, moisture-activated oxygen scavenger designed for use in monolayer or multilayer bottles that require maximum oxygen scavenging performance, aroma barrier and flavor preservation. Its superior scavenging performance and delamination resistance makes it the best product available for use in juice, beer, tea, and condiment containers. Formulated for optimal processing in monolayer applications, *ValOR Activ100* provides superior bottle design flexibility while ensuring long run stability. *ValOR Activ100* also prevents browning, loss of ascorbic acid, and oxygen ingress, and ensures proper taste and color retention. For all PET bottles requiring the minimum possible oxygen level, *ValOR Activ100* is proven to offer the next level of barrier performance. *ValOR Activ100* is FDA approved for direct food contact.

*ValOR Activ100* can be used as a blend with PET in monolayer or multilayer applications. *ValOR Activ100* can also be used in combination with *ValOR Bloc100* to provide total barrier performance in multilayer structures. Blending *ValOR Activ100* into the sidewall and injecting *ValOR Bloc100* into the middle layer may yield additional price to performance value depending on your formulations and manufacturing processes.

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**Oxygen Concentration vs. Shelf Time of Monolayer Bottle with *ValOR* Barrier Resin**

![Graph](image.png)

*ValOR Activ100* offers superior performance vs. the leading monolayer scavenger. With *ValOR Activ100*, you can manufacture bottles with longer shelf lives or reduce costs by using less material.
Grades (cont. from pg 6)

**ValOR™ Bloc100**

*ValOR Bloc100* provides all the barrier performance needed for carbonation retention and flavor preservation. Ideal for use in carbonated soft drink and water containers, *ValOR Bloc100* provides superior carbon dioxide barrier performance, unsurpassed delamination resistance, and long-run process stability in a cost-effective solution. *ValOR Bloc100* allows you to develop new and exciting bottle designs for carbonated beverages while remaining cost-competitive, and ensures your products retain proper appearance under harsh end use conditions.

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**Carbonation retention vs. shelf time of ValOR™ multilayer bottle and PET monolayer bottle**

- **ValOR™ Bloc100**
- PET

![Graph showing carbonation retention vs. shelf time](chart.png)
Applications

*ValOR* resins meet the needs of all PET food and beverage barrier bottles, multilayer or monolayer.

## Suitable Grades for Various Applications

<table>
<thead>
<tr>
<th>Applications</th>
<th>Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bottle Construction</strong></td>
<td><strong>Required Barrier</strong></td>
</tr>
<tr>
<td>Multilayer Bottles</td>
<td>Carbonation</td>
</tr>
<tr>
<td>Monolayer Bottles</td>
<td>Oxygen Scavenging</td>
</tr>
<tr>
<td>Multilayer Bottles</td>
<td>Carbonation and Oxygen Scavenging</td>
</tr>
<tr>
<td>Multilayer Bottles</td>
<td>Carbonation and Oxygen Scavenging</td>
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<tr>
<td>Multilayer Bottles</td>
<td>Oxygen Scavenging</td>
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Physical, Thermal, Rheological Properties

<table>
<thead>
<tr>
<th>Standard Properties</th>
<th>Unit</th>
<th>Valor™ ActivBloc100</th>
<th>Valor™ Activ100</th>
<th>Valor™ Bloc100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing Temperatures</td>
<td>°C</td>
<td>270-290</td>
<td>270-290</td>
<td>270-290</td>
</tr>
<tr>
<td>Heat Deflection Temperature</td>
<td>°C</td>
<td>67.8</td>
<td>69.0</td>
<td>69.0</td>
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<tr>
<td>Thermal Expansion</td>
<td>°/°C</td>
<td>61 x 10^{-6}</td>
<td>72 x 10^{-6}</td>
<td>66 x 10^{-6}</td>
</tr>
<tr>
<td>Melt Density</td>
<td>kg/m³</td>
<td>1143</td>
<td>1122</td>
<td>1171</td>
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<tr>
<td>Melt Flow Rate @ 260°C</td>
<td>g/10 min</td>
<td>25.3</td>
<td>39.5</td>
<td>4.9</td>
</tr>
<tr>
<td>Melt Flow Rate @ 280°C</td>
<td>g/10 min</td>
<td>67.5</td>
<td>59.9</td>
<td>9.9</td>
</tr>
<tr>
<td>Tm</td>
<td>°C</td>
<td>239</td>
<td>238</td>
<td>240</td>
</tr>
<tr>
<td>Tg</td>
<td>°C</td>
<td>72</td>
<td>72</td>
<td>75</td>
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</table>
### Physical Properties of Injection Molded ValOR

<table>
<thead>
<tr>
<th>Standard Properties</th>
<th>Unit</th>
<th>ValOR™ ActivBloc100</th>
<th>ValOR™ Activ100</th>
<th>ValOR™ Bloc100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td></td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
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<tr>
<td>Tensile Strength</td>
<td>Mpa</td>
<td>68.4</td>
<td>74.3</td>
<td>81.7</td>
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<tr>
<td>Tensile Strain @ Ultimate</td>
<td>%</td>
<td>2.03</td>
<td>2.56</td>
<td>3.97</td>
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<tr>
<td>Tensile Modulus</td>
<td>Mpa</td>
<td>3650</td>
<td>3516</td>
<td>3270</td>
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<tr>
<td>Flexural Modulus</td>
<td>Mpa</td>
<td>3092</td>
<td>2978</td>
<td>3100</td>
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<tr>
<td>Flexural Strength</td>
<td>Mpa</td>
<td>127</td>
<td>118</td>
<td>120</td>
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<tr>
<td>Izod Impact</td>
<td>ft lbs/in</td>
<td>0.151</td>
<td>0.308</td>
<td>0.410</td>
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<tr>
<td>Rockwell Hardness</td>
<td>M Scale</td>
<td>102</td>
<td>100</td>
<td>101</td>
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<tr>
<td>Solid Density</td>
<td>Kg/m³</td>
<td>1284.1</td>
<td>1284.8</td>
<td>1279.9</td>
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</table>
Melt Viscosity Profiles

**ValOR™ ActivBloc 100 Melt Viscosity Profile**

![Graph showing melt viscosity profile for ValOR™ ActivBloc 100](image1)

- Viscosity (Pa-s) vs Shear Rate (s⁻¹)
- Temperatures: 260, 270, 280

**ValOR™ Bloc 100 Melt Viscosity Profile**

![Graph showing melt viscosity profile for ValOR™ Bloc 100](image2)

- Viscosity (Pa-s) vs Shear Rate (s⁻¹)
- Temperatures: 260, 270, 280

**ValOR™ Activ 100 Melt Viscosity Profile**

![Graph showing melt viscosity profile for ValOR™ Activ 100](image3)

- Viscosity (Pa-s) vs Shear Rate (s⁻¹)
- Temperatures: 260, 270, 280
Custom Formulation Adjustments and Blends

Let Valspar optimize your ValOR formulations to improve performance and efficiency, including:

♦ scavenging capacity
♦ scavenging rate
♦ processing characteristics
♦ blend colorants and additives to reduce steps in manufacturing

Recommended Injection Molding Conditions

Recommended processing temperature: 464 - 536°F.
Typical Conditions: Screw rpm 44

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>M.Pipe</th>
<th>Lead</th>
<th>D. Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw Heat 495°F</td>
<td>495°F</td>
<td>495°F</td>
<td>495°F</td>
<td>495°F</td>
<td></td>
</tr>
<tr>
<td>Head Heat 467°F</td>
<td>467°F</td>
<td>467°F</td>
<td>467°F</td>
<td>467°F</td>
<td></td>
</tr>
</tbody>
</table>

Prior to processing the material needs to be dried using a desiccant type circulating dryer, minimum air flow of 7.5 ft³/min. Temperature setting of 280°F (140°C) for a minimum of 4 hours.

Moisture level should not exceed 50 ppm of H₂O for the material.

Recommended Handling, Storage and Delivery of Preforms

Material Handling: Please refer to current Material Safety Data Sheet for proper handling.

Storage: Store in cool, dark place avoiding direct sunlight and humidity. Use open container immediately. When storing opened container apply a heat seal to tightly reseal package.

Caution: Material left exposed for an extended period of time may not be suitable for use.

Shelf life of unopened material is 4 months at 23°C.
FDA Approvals

ValOR resins may be used in PET containers to package aqueous, acidic, and low alcohol foods under temperatures to 190°F (88°C) in full compliance with the Federal Food, Drug, and Cosmetic Act and all applicable FDA Regulations. For additional details regarding the FDA status for your specific conditions of use or for compliance with EU food contact regulations, please contact your Valspar Representative.

EU Food Contact Compliance

The components of Valspar’s ValOR Barrier Resins are composed of materials listed in Synoptic Document 7, which is the list of raw materials for use in direct food contact applications. Furthermore, all film-forming materials are listed in the Plastics Directive 2002/72/EC and its subsequent amendments. The film forming components are also listed in the Council of Europe’s Resolution for Surface Coatings, AP(96)5.

Recycling

Laboratory-scale recycling studies show ValOR barrier resins to be recyclable without significant negative effects on the existing recycling stream. Please contact Valspar for additional details.
Global Leader in Packaging Coatings

- 6th Largest Paint and Coatings Company in the World
- The Industry Leader in Coatings and Polymers for the Industrial, Rigid Packaging and Architectural Markets
- Broad Technology Portfolio
- 21 Resin Plants Worldwide

Technical Core Capabilities

- Research and Polymer Design
- Polymer Optimization
- Material Science
- Customized Formulation for End Use
- Food Contact and Regulatory Affairs
- Analytical Support and Problem Resolution
- Technical Customer Service

USA

2001 Tracy Street
Pittsburgh, PA 15233

Phone: 412-766-9300
Fax: 412-766-8953

EUROPE

Deeside, UK

Phone: 011-44-1244-288901
Fax: 011-44-1244-280875

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www.valspar.com