ExxonMobil

Section 1 Products | Section 2 Extrusion & Conversion | Section 3 Value added solutions | Section 4 Customer engagement | Section 5 Practical training

**Module 2.9a** **Blow Molding Polyolefins**

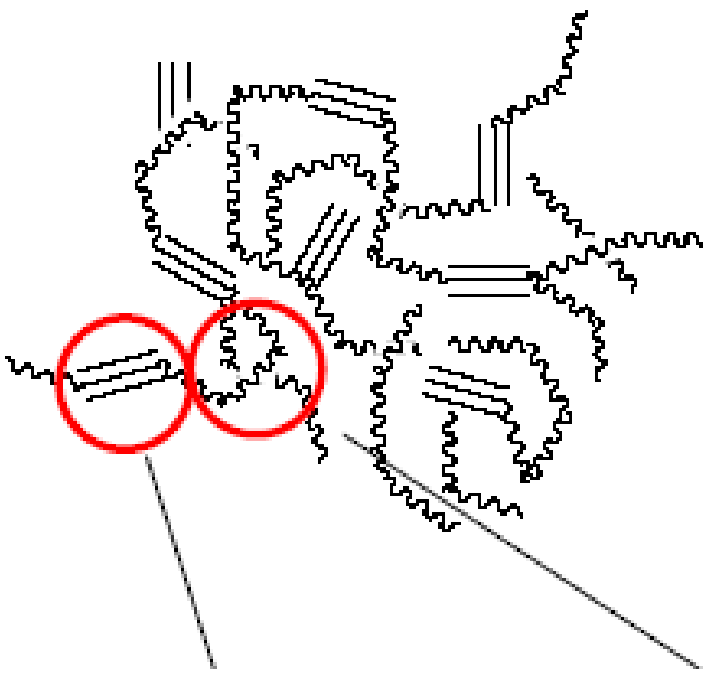
Revision 0 May 2017

Version: Americas

Energy lives here™

# PO Technology
## Branded Distributor Academy

# What is Vistamaxx™ Performance Polymers




- Vistamaxx™ performance polymers are olefinic specialty elastomers produced by using ExxonMobil Chemical's Metallocene technology
- They are unique semi-crystalline copolymers of propylene and ethylene (6-16wt%)
- Reduced crystallinity is obtained through introduction of amorphous regions into the polypropylene sequences via ethylene
- Vistamaxx polymers elastic properties are the consequence of a predominantly amorphous ethylene-propylene (EP) matrix laced with a network of fine, well-dispersed isotactic polypropylene (PP) crystallites

# What can Vistamaxx™ Polymers do for You

Key Benefits

- Improved Environmental Stress Cracking Resistance
  - Vistamaxx™ polymers embeds itself at the interface between the crystalline and amorphous regions decreasing stress cracking propagation
- Enhanced impact properties, soft touch, grip and squeezability
  - Decreases the overall modulus and crystallinity of the blend
- Increased filler dispersion and loading
  - Filler loading can increase stiffness / top load balance
  - Vistamaxx polymer blends with PP and PE

Possible challenges

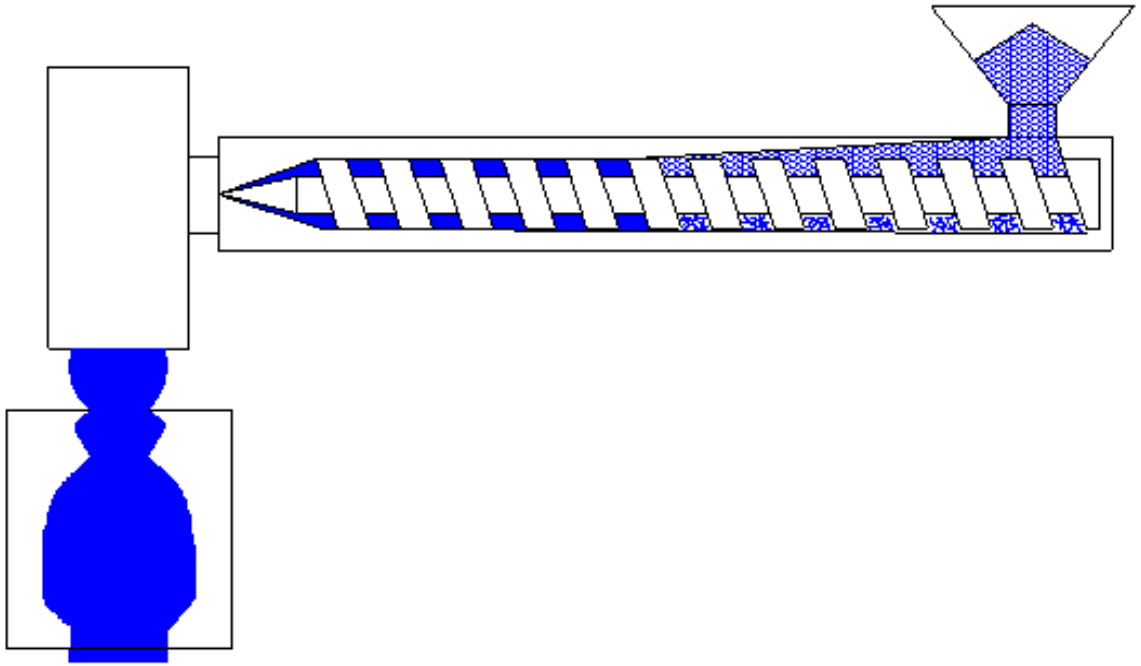
- Stiffness (top load, modulus) tradeoff
- Processing changes: tooling, coefficient of friction, deflashing, lower shrink, cuffing, melt strength differences

ExxonMobil

# Blow Molding Basics

# Definition

- A process by which a molten tube of thermoplastic is captured inside a mold cavity, injected with pressurized air, and forced outwards to take the shape of the cavity
- Tube is commonly referred to as a parison

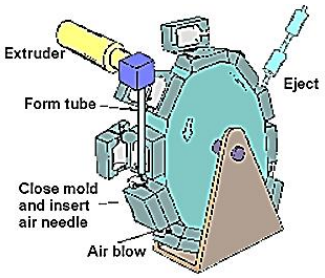


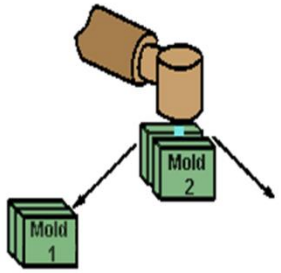
# Key Processing Parameters & Definitions

- Temperatures: Changes the viscosity (flow) of the material
- Extruder Speed: Determines the speed that the parison is made
- Blow Time: Cooling rates in the mold
- Blow Pressure: Helps to pick up surface detail in the mold
- Parison Drop Time: How long the parison hangs and stretches before the mold closes
- Parison Programming: To control bottle wall thickness distribution
- Flash: Important for strong weld lines, bottle integrity, part handling, and cooling

# Two Common types of Extrusion Blow Molding

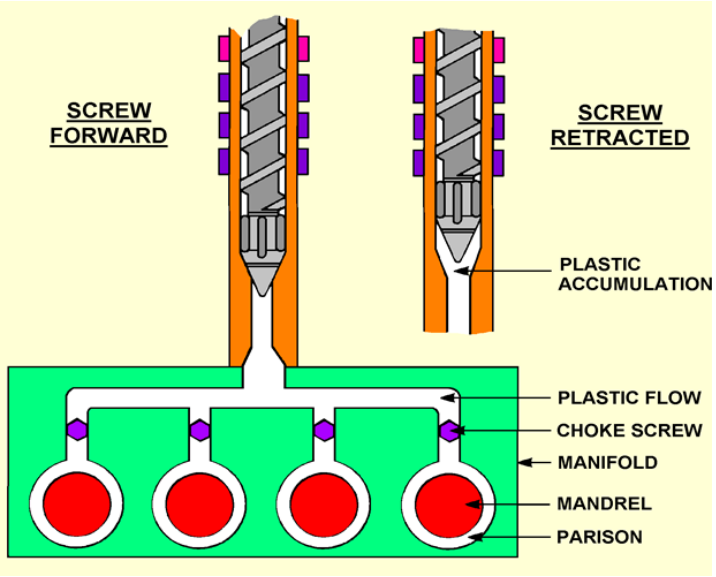
- Continuous parison delivery
  - Low to moderate shear rates
  - Example downstream parison capture can use vertical rotary wheels or shuttle blow molding designs




- Intermittent (shot or reciprocal) parison delivery
  - Higher shear rates
  - Typically uses a reciprocating screw
  - But also accumulator head (for larger parts)

**Common PE and PP extrusion types used to process medium molecular weight (MMW) polymers targeting liquid food (LF) and household and industrial container (HIC) markets**



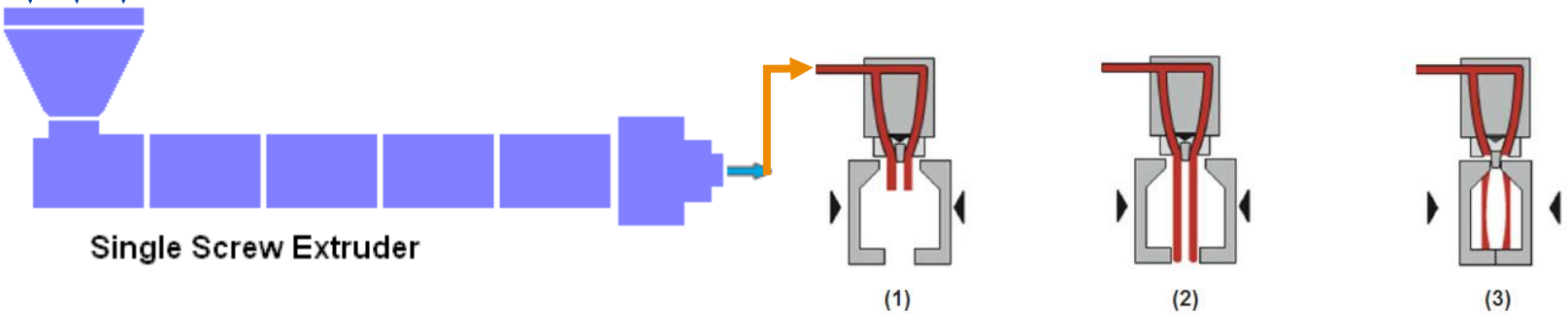

ExxonMobil

# Extrusion Blow Molding Process

**Base stock:**
hPP/ICP/RCP/HDPE
80% - 99%

**Modifier:**
Vistamaxx™ performance polymers
1% - 20%

**Additives and others:**
UV package/AO MB
Nucleating/clarifying MB
Color MB
0-5%




Typical extrusion blow molding (EBM) process

- Extrusion to form a parison
- Close mold cavity
- Inject air to blow or inflate the parison
- Maintain air pressure and cooling
- Open cavity and release molded article

ExxonMobil

# The Basics for Blow Molding Vistamaxx™ Performance Polymers

# Processing Considerations

- Processing with Vistamaxx™ polymers does not typically require significant changes from those used for neat polypropylene (PP) or polyethylene (PE), but can vary depending on
  - The percentage of Vistamaxx polymer used
  - Extruder configuration and type of blow molding process used
- The basic design principles used when designing molds for producing standard PP/PE parts applies to Vistamaxx polymer blends
- Vistamaxx polymer can be blow molded as a blend partner with PP or PE at percentages ranging from 1% to 20%
- For blow molding, VM3020FL and VM6102 should be considered since they have the lowest MFR and help maintain melt strength
- For flow modification, a low viscosity Vistamaxx ™, like VM8880 may be considered

The appropriate grade and percentage of Vistamaxx performance polymer needed will depend on the desired property balance required

# Material Handling

- Ease of use
  - Free flowing pellets are easy to incorporate
- Material handling before molding
  - Generally pre-drying is not needed
  - Use of a weigh scale blender is suggested
  - Vistamaxx™ clumps can be broken up by tumbling or use of a screened shaker if needed
- Use of regrind
  - Regrind can be used as you would in your normal process
  - Keep regrind ratio consistent for a more stable process
- Coloring
  - PP/PE based color concentrate can be used
  - Use similar flow rate color concentrate to disperse with the base polymer
  - Vistamaxx™ polymer grades can be mixed at the hopper feeder just as you would with master batch but is more consistent blend when added upstream in volumetric blenders

# Overcoming Part Issues Molding Vistamaxx™ Performance Polymers

# Questions to Ask

- Machine Considerations:
  - What kind of screw do you have? Conventional, Mixing, Barrier
- Mold Considerations:
  - Was the mold made for PP or PE (or other)
- Material Considerations:
  - What is the melt flow
  - What is the flex modulus
- Part Considerations:
  - Make sure you have a current production part to compare with
  - What is top load and drop test of the incumbent part
  - What is the specification needed for the part
  - What kind of optical properties are desired in the final part

# Things to Think About

- Understand what problems might be occurring when molding the current part
- Prepare for part weight changes when adding Vistamaxx polymers due to the density difference
- Consider the time between production and part testing, especially with slow crystallizing grades (like polypropylene)

# A Starting Point for Problem Solving

Processing changes are likely not required to transition to a Vistamaxx™ modified formulation. However…

- Optimized formulations will vary
  - The same Vistamaxx™ polymer grade will mold differently in different PO grades due to melt flow rate, shear viscosity, and molecular distribution
  - As the amount of Vistamaxx polymer increases the way it blow molds may change
- Vistamaxx polymers crystalizes slower than the base materials so it may need more time to cool at higher loading percentages
  - If the bottles are sticking on downstream equipment, try increasing the blow time – pressing the material against the mold wall longer will assist in cooling
  - Decreasing temperatures will also help since less heat will need to be removed

# Summary of Vistamaxx Polymers in Blow Molding

# Blow Molding Grade Slate Overview

| Vistamaxx™ performance polymer grade | MFR[1] (2.16kg/230°C) | Melt Index[1] (2.16kg/190°C) | Weight % C2[2] | Flexural modulus[3] Mpa |
|---|---|---|---|---|
| 3000 | 8 | 3.6 | 11 | 59.3 |
| 3020FL | 3 | 1.1 | 11 | 59.7 |
| 3588FL | 8 | / | 4 | 393 |
| 3980FL | 8 | 3.7 | 9 | 110 |
| 6102 | 3 | 1.4 | 16 | 12.3 |
| 8880 | / | / | 6 | / |

[1] g/10 min, ASTM D1238
[2] ExxonMobil Method
[3] 1% secant, based on ASTM D790

Vistamaxx performance polymer grades offer
different ethylene concentrations and flow characteristics

# Improved ESCR and Impact Resistance in HDPE Blow Molding

**•High ESCR performance**

- Improves ESCR of standard HDPE resin
- Equals or outperforms ESCR of high performance Unimodal HDPE resin
- Substitution of high ESCR Unimodal HDPE at lower cost

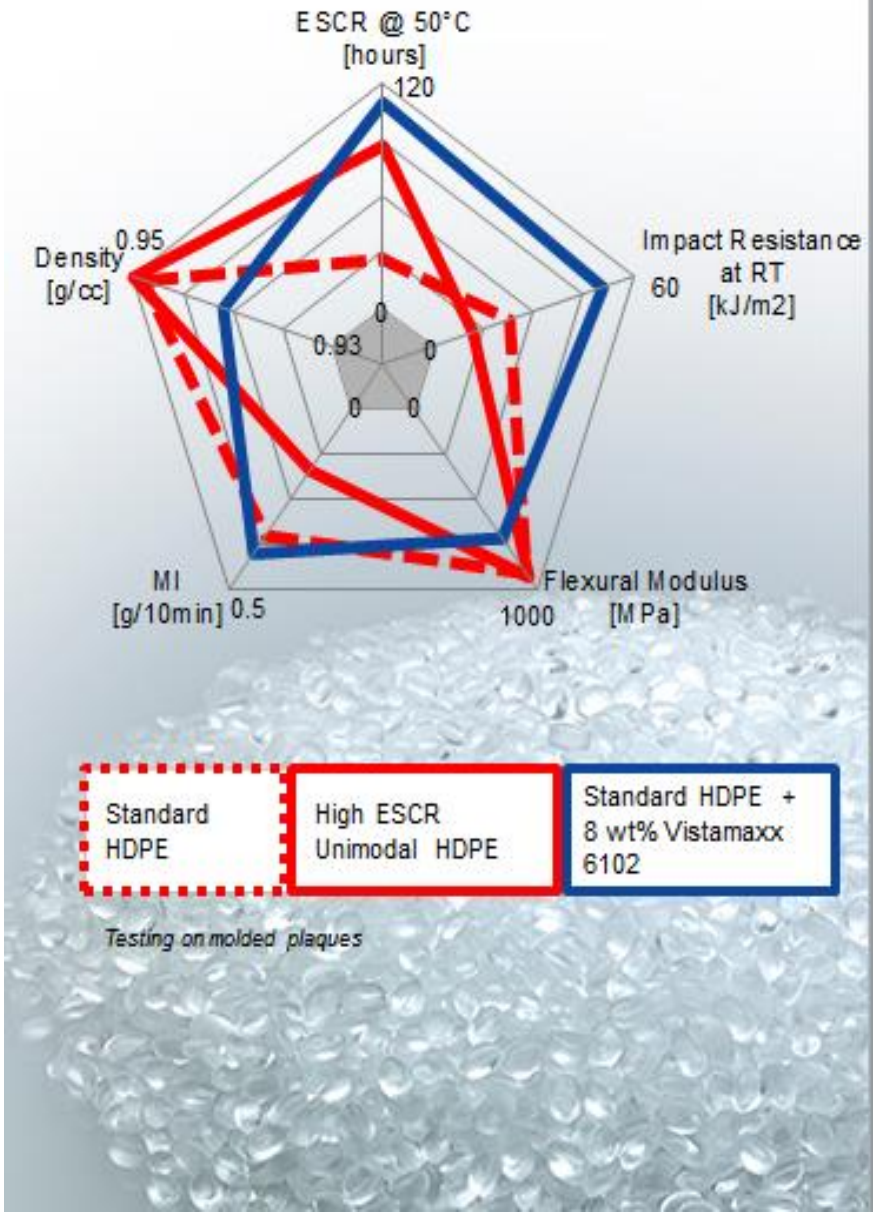
- **Outstanding impact resistance**
- Improves impact resistance of standard HDPE resin and outperforms high ESCR Unimodal HDPE resin
- Durability and less breakage of blow molded part

**Excellent processability**

- Little influence on MI of standard HDPE resin
- Reliable blow molding operation

**Soft / squeezable bottle**

- Reduction in density and flexural modulus makes it a softer part compared to standard HDPE resin
- Drawback is loss in stiffness, resulting in loss in top load of the final blow molded part




ExxonMobil

# Advantages and Disadvantages Summary

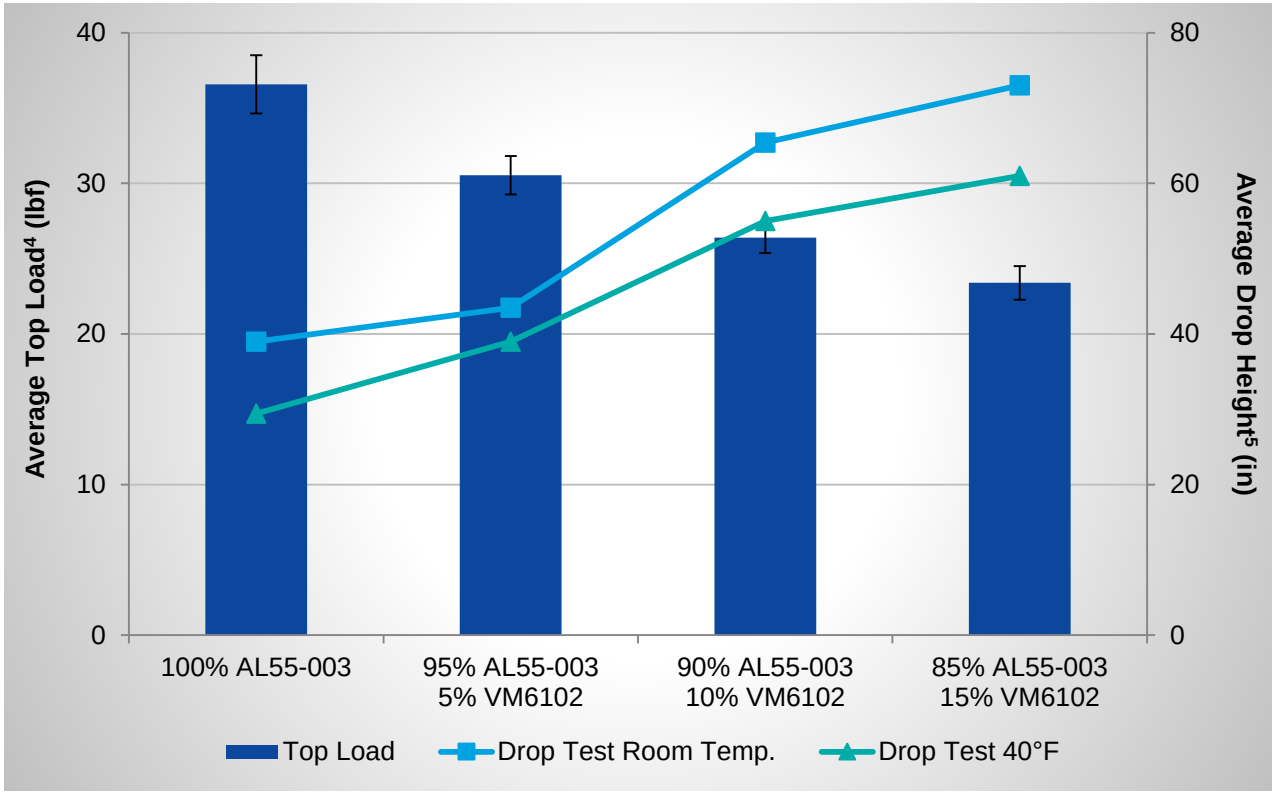
- Advantages
  - Increased ESCR value (PE only)
  - Increased impact strength (drop testing)
    - Both at room and cold (refrigerator) temperatures
  - Can maintain clarity at low percentages (RCP only)

- Disadvantages
  - Decreased top load (stiffness)
    - PE already has low stiffness, so may be hard to meet requirements
    - Since PP has high stiffness, it can lose some and still meet requirements
  - Differences in optical properties at higher percentages of Vistamaxx polymers
    - PE – starts to have a more milky color
    - RCP – loses clarity at high loading percentages
  - At higher percentages, bottles may start to stick on downstream equipment

# Dairy (1gal) Bottle Blend Study

HDPE Modified with Vistamaxx™

- Paxon™ AL55-003 (MI[1]=0.3g/10min; D[2]=0.954g/cc)
- Vistamaxx VM6102 (MI[1]=1.4g/10min; D[3]=0.862g/cc)




[1] Melt Index (190°C/2.16kg) ASTM D1238
[2] Density ASTM D4883
[3] Density ASTM D1505
[4] Bottle Top Load ExxonMobil Method
[5] Bottle Drop Test ExxonMobil Method

# Blow Molding Vistamaxx™ Applications Summary

- Favorable
  - Bottles needing better impact resistance; especially multi-layer where you can optimize stiffness-impact balance with the layer formulations
- Unfavorable
  - Large part blow molding due to melt strength
  - HDPE bottles will have limited applicability
  - Bottles going into freezer applications

# Disclaimer