Solutions for Protective Packaging: *Enhanced* Expanded PolyEthylene (EPE) Foams

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SPE International Polyolefins Conference
February 24-27, 2019

Outline

- NA Polyolefin (PO) Foam Market & Applications
- Polyolefin Resins
- Foam Formation and Processing
- Resin Properties
- Foam Sheet Properties
- Summary

PO Foam Applications

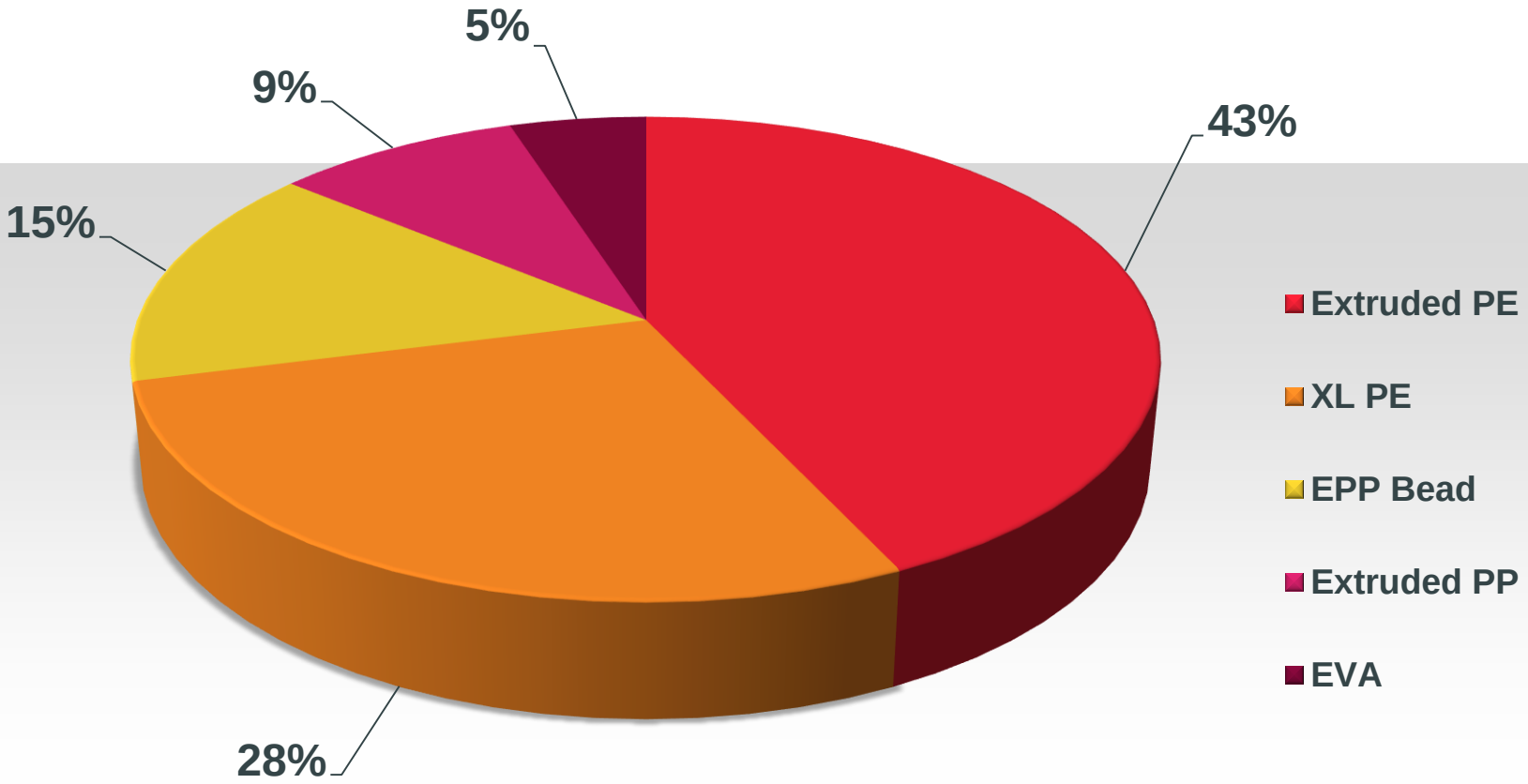
PROTECTIVE PACKAGING

INSULATION

SPORTS & LEISURE

AUTOMOTIVE

NA PO Foam *Materials*



NA PO Foam Materials 2018

Source: ADI Chemical Market Resources (www.adi-cmr.com), 2019

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PO Foam Materials

- **LDPE**
  - Highest volume PO used
  - High melt strength for processing
  - Able to achieve low density foams
- **LLDPE**
  - Often blended with LDPE to improve physical properties
- **HDPE**
  - Used when higher stiffness foam is required
  - Primarily used for high density foams
- **PP**
  - Used when higher stiffness foam is required
  - Used when higher heat resistance foam is required
- **EVA / Polyolefin elastomers (POE)**
  - Used when a softer or more flexible foam is required

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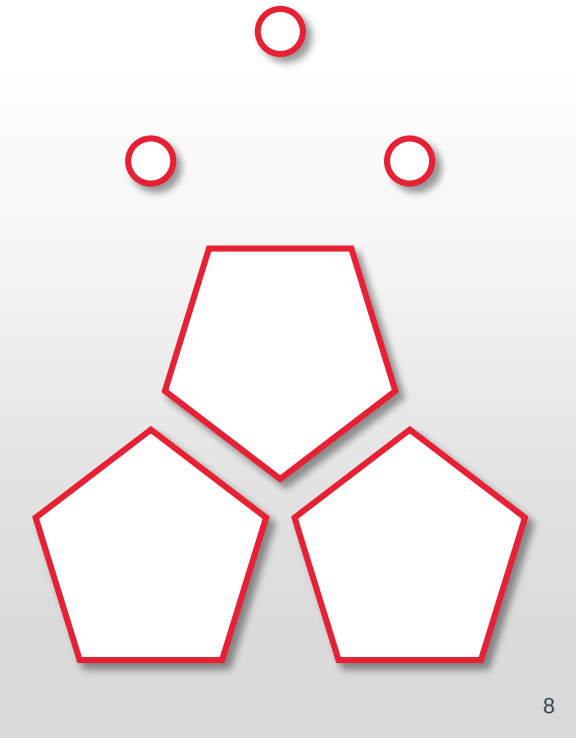
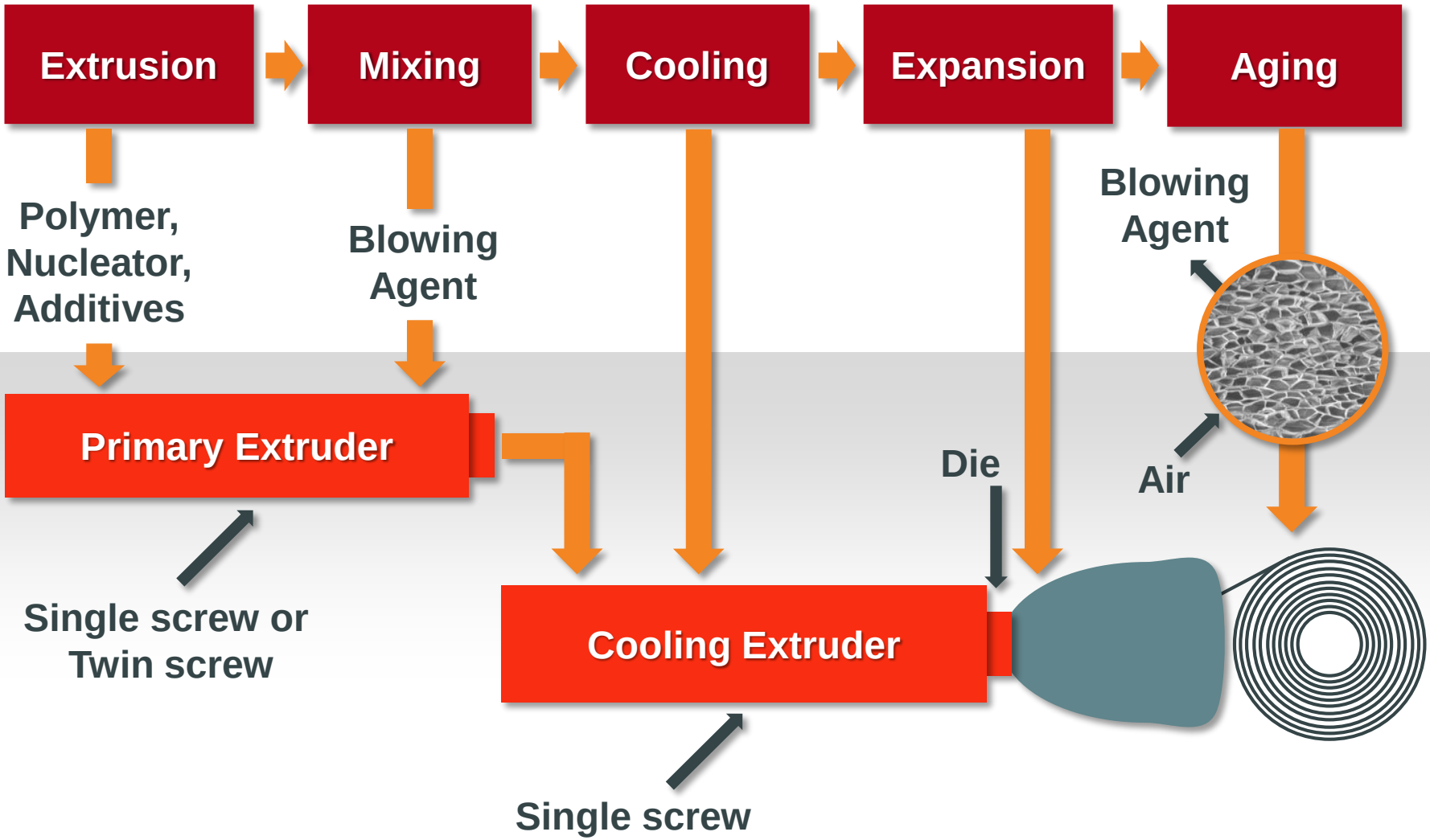
Thermoplastic Foaming

Continuous Extrusion Process – Key Operations

- Feed, melt and mix the base resins and additives to produce a homogeneous melt
- Uniformly **mix** the foaming agent into molten polymer
- Uniformly **cool** the polymer-foaming agent mixture (gel)
- Maintain **die pressure** to prevent pre-foaming
- **Nucleate** cells
- **Stabilize** the bubbles during the expansion step
- Stabilize the cells during **aging**
  - blowing agent out, air in



Continuous Extrusion Process



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Key Polyolefin Resin Properties

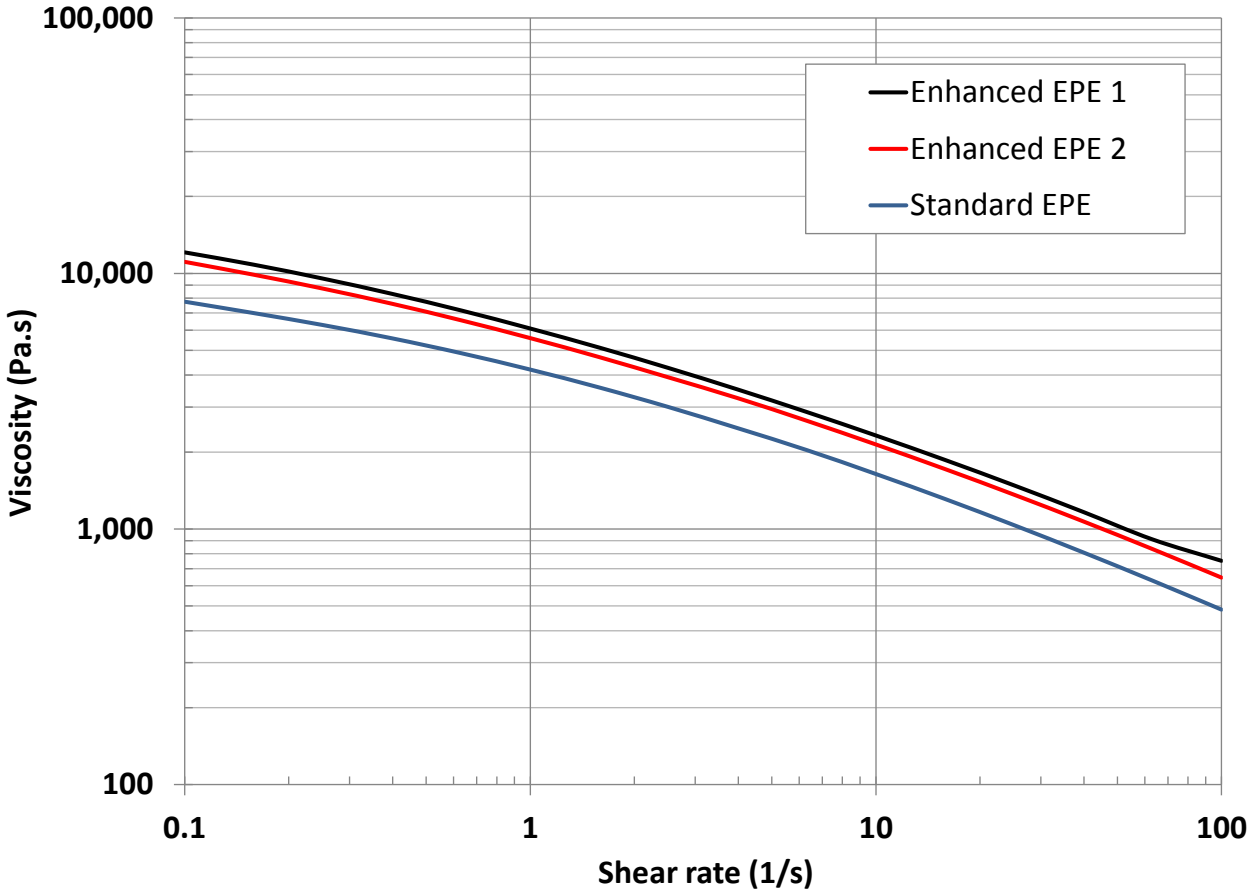
- **Rheological – determine processing performance**
  - Shear viscosity
  - Melt strength
  - Elongational viscosity
- **Mechanical – determine end use foam performance**
  - Tear resistance
  - Stiffness
  - Toughness
  - Static/Dynamic Compression

PE Resins

- DOW™ LDPE 450E Commonly used for foam sheet applications
- ELITE™ 5400G is an enhanced LLDPE used in films to provide high impact resistance and tear properties.
- ELITE™ 5100G is an enhanced LLDPE used in films to provide excellent impact strength, good tensile and puncture.

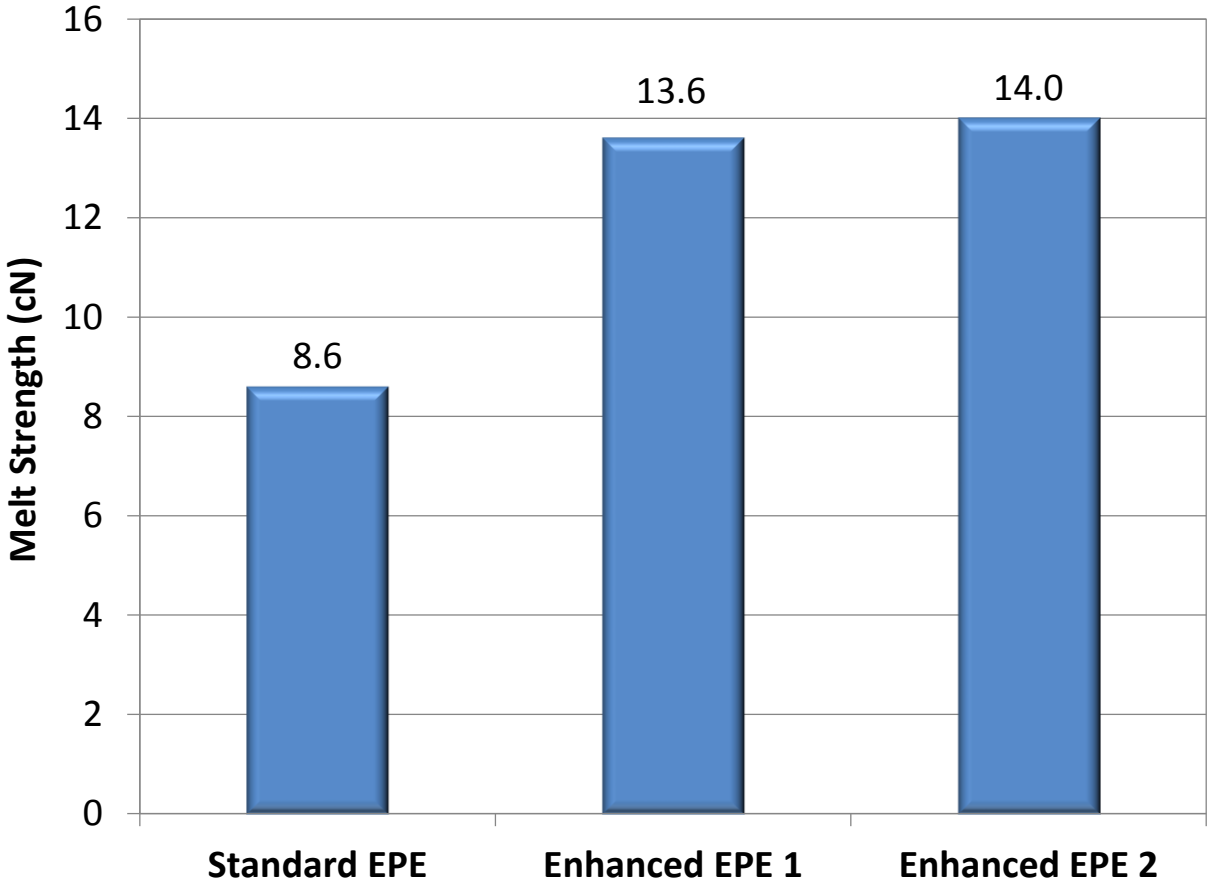
Resin	DOW™ LDPE 450E	ELITE™ 5400G	ELITE™ 5100G
Density (g/cm^3)	0.923	0.916	0.920
Melt Index 2.16 kg, 190ºC (g/10 min)	2.0	1.0	0.85
Resin Type	LDPE	LLDPE	LLDPE

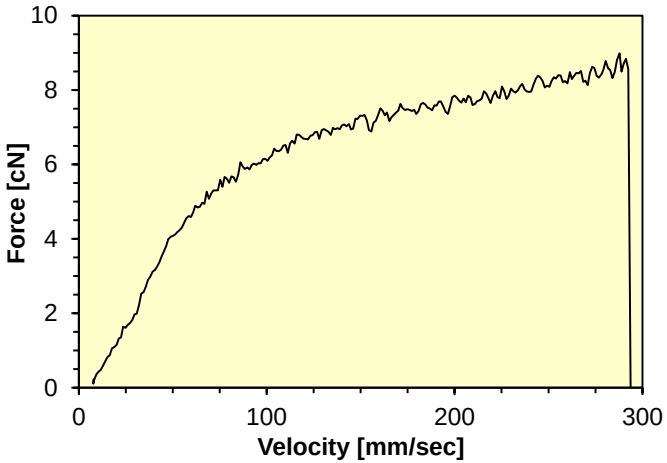
Melt Viscosity (190ºC)

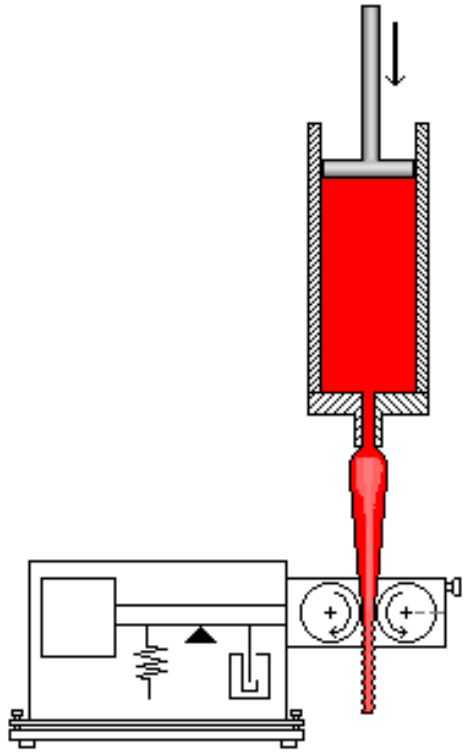


Grade	DOW™ LDPE 450E	ELITE™ 5400G	ELITE™ 5100G
Standard EPE	100%	0	0
Enhanced EPE 1	80%	20%	0
Enhanced EPE 2	85%	0	15%

Melt Strength (190ºC)







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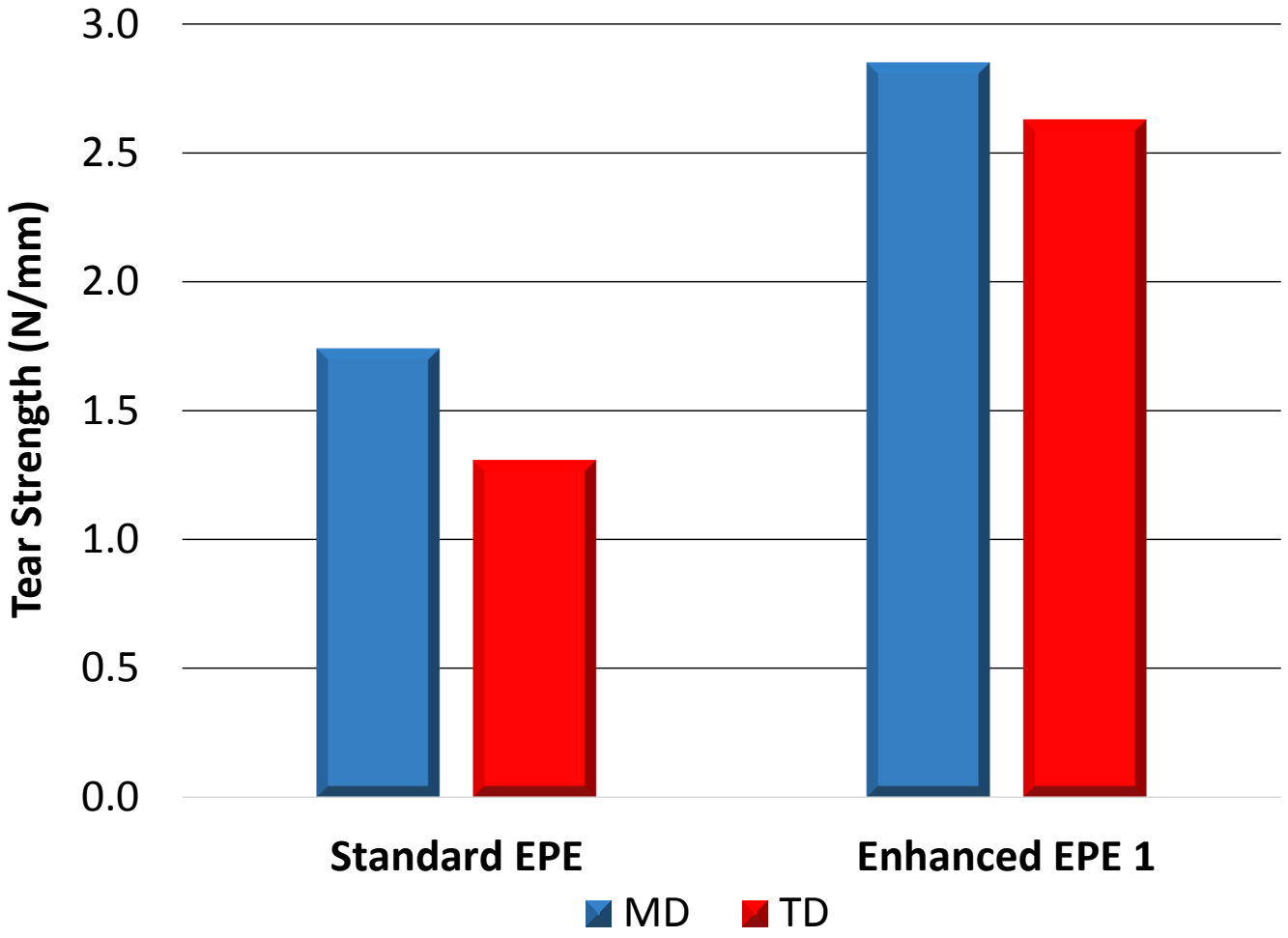
Enhanced EPE 1

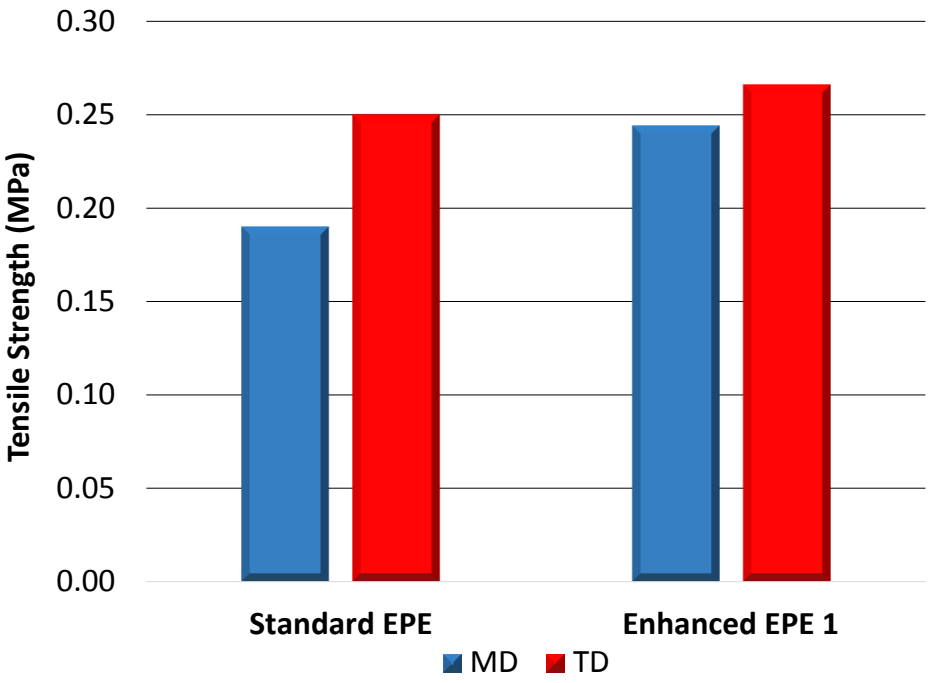
Tear Properties

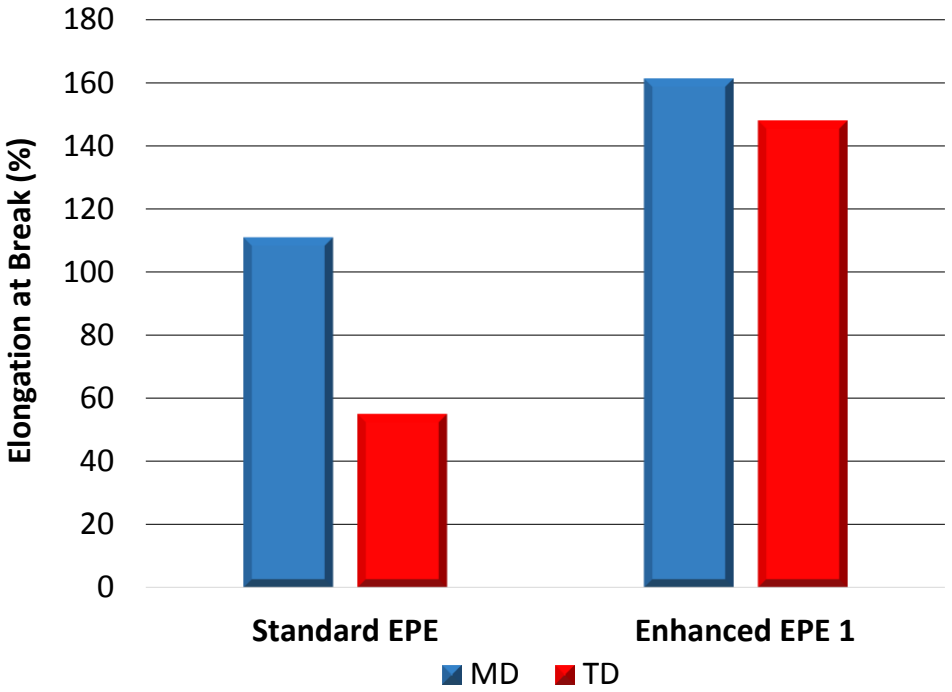


Notes: *24 Kg/m^3, 10mm thickness, 500mm/min test speed.*

Enhanced EPE 1

Tensile Properties

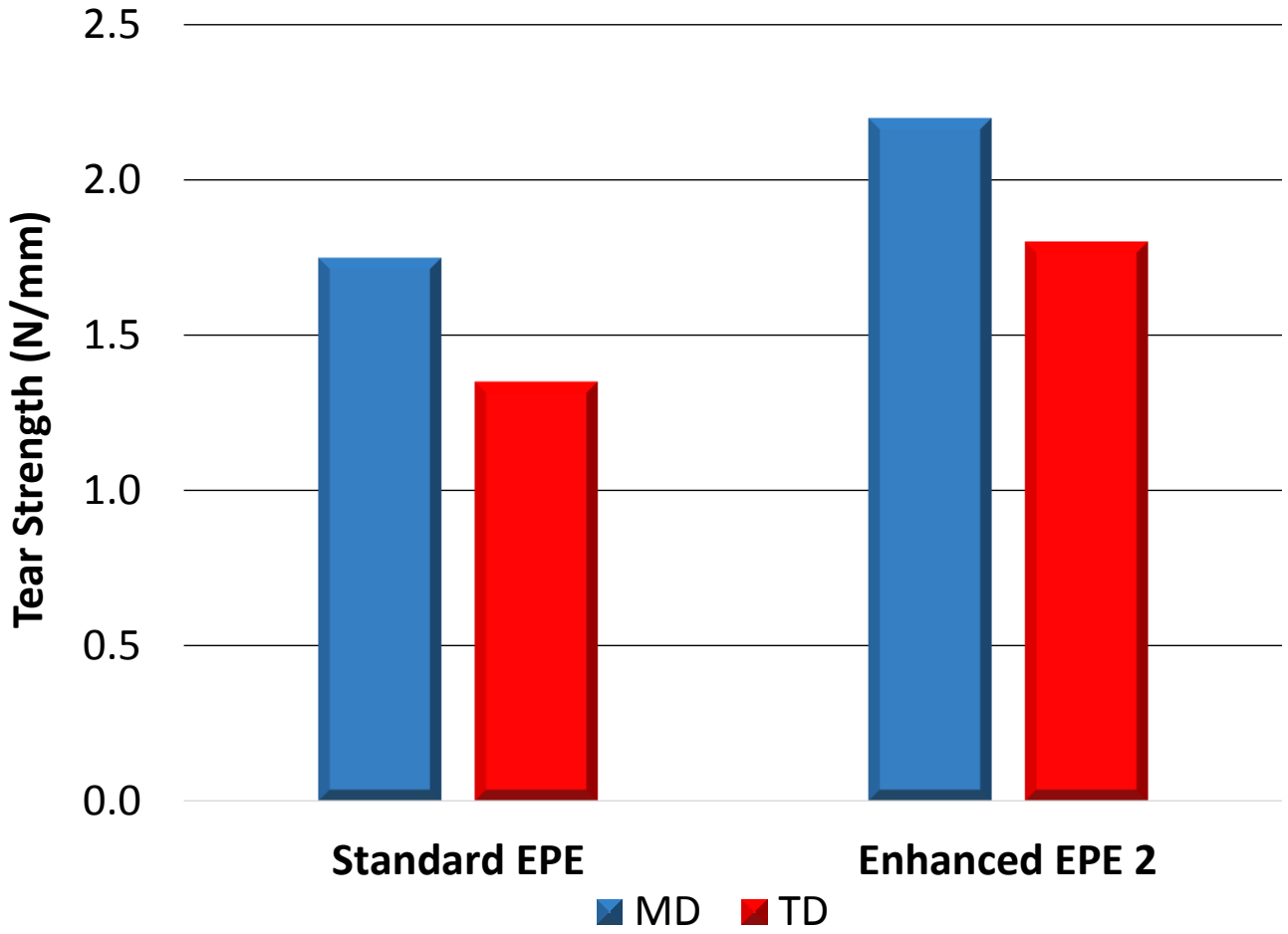




Notes: *24 Kg/m^3, 10mm thickness, 150mm/min test speed.*

Enhanced EPE 2

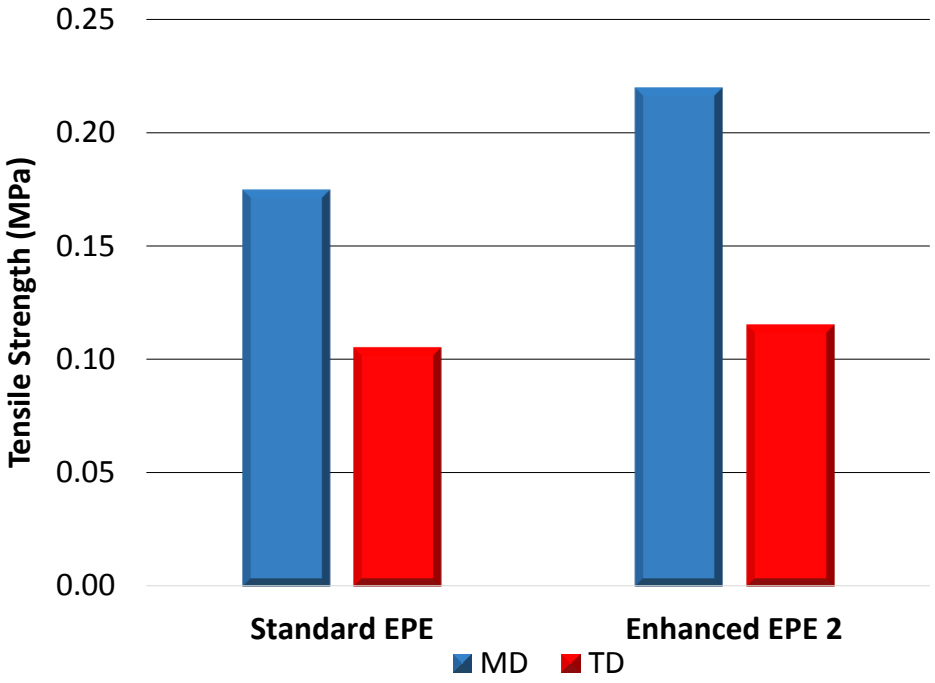
Tear Properties

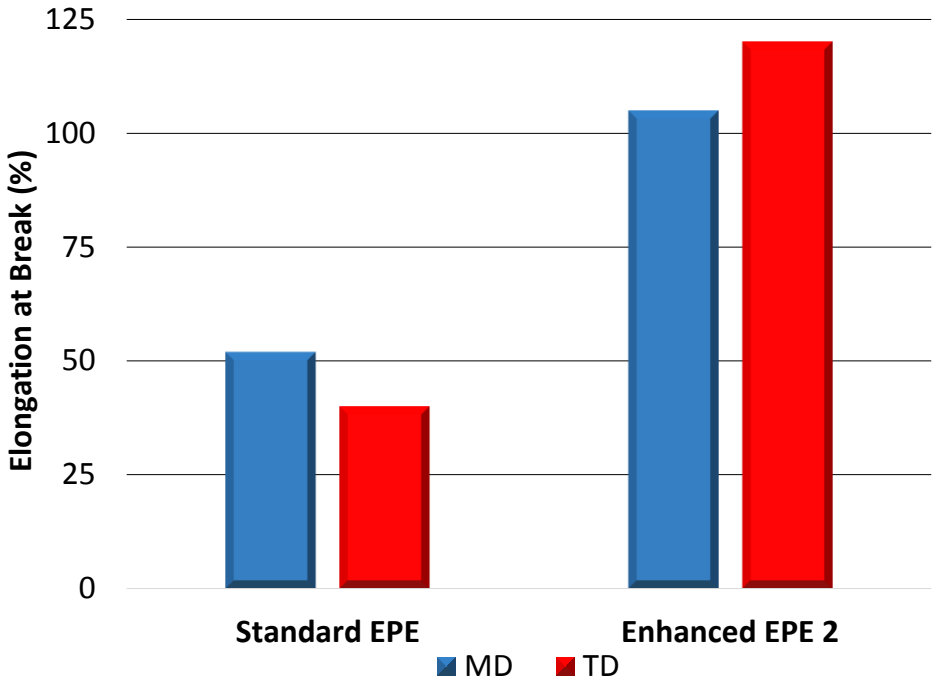


Notes: *18 Kg/m^3, 10mm thickness, 500mm/min test speed.*

Enhanced EPE 2

Tensile Properties

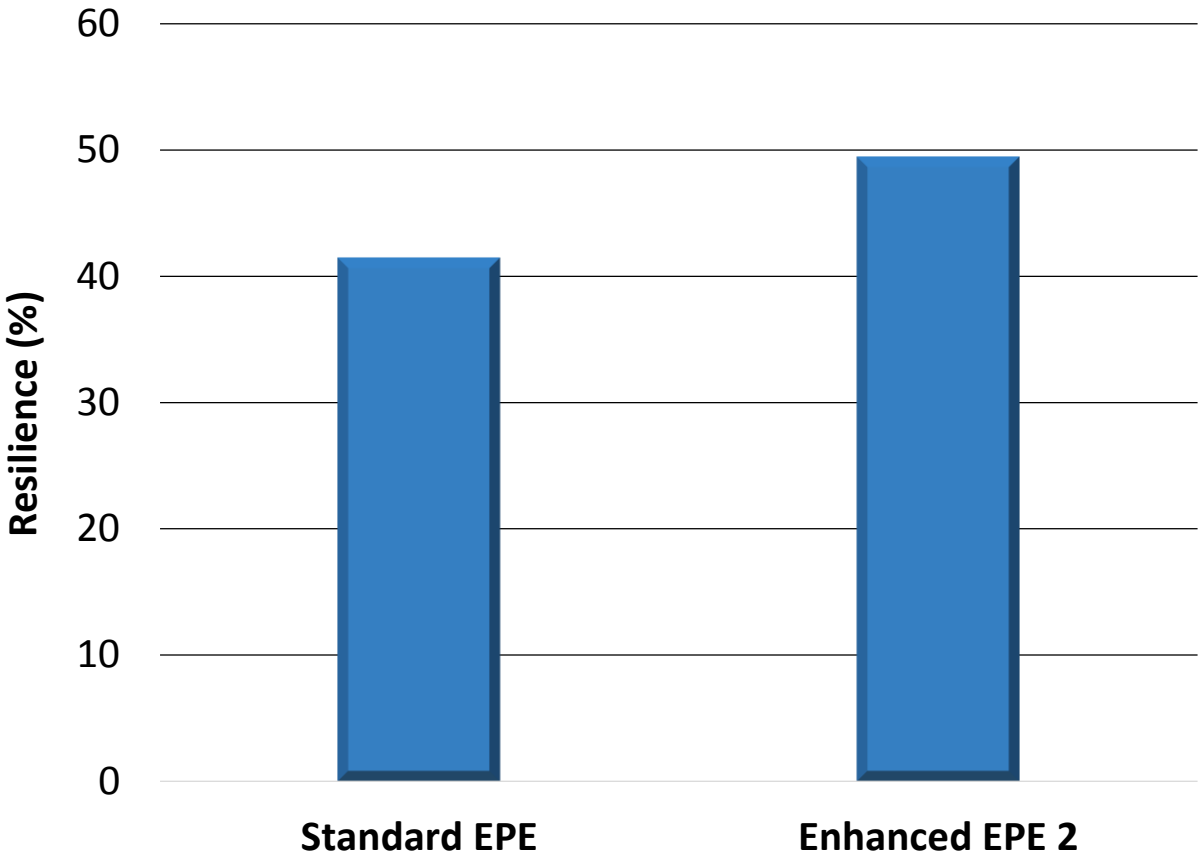


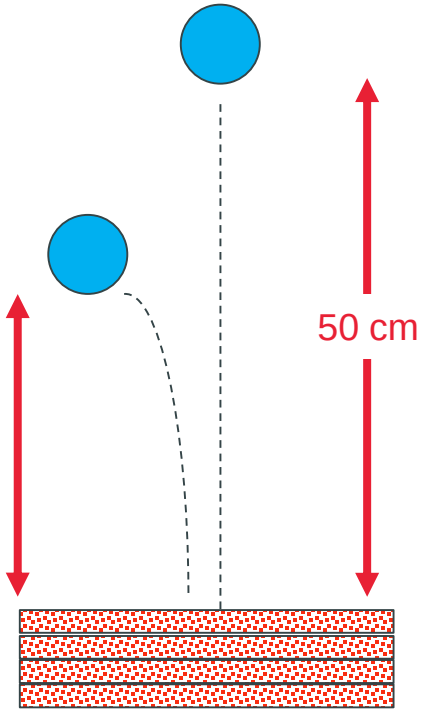


Notes: *24 Kg/m^3, 10mm thickness, 150mm/min test speed.*

Enhanced EPE 2

Resilience





Notes: *25 kg/m³, 4 layers of 10 mm laminated sheets; 50 cm drop height*

Enhanced EPE 2

Compressive Strength

	Density (Kg/m^3)	Lightweight (%)	Compressive Strength	
			25%, kPa	50%,kPa
Standard EPE	26.5	0	37.6	91.0
Enhanced EPE 2	20.9	21	35.8	94.1

Notes: *4 layers of 10 mm laminated sheets*

- ***Same*** **compressive strength at 25 and 50% deflection**
- **Enhanced EPE 2 is 21% lighter (less material) than Standard EPE**

Enhanced EPE 2

Dynamic Compression – measures the ability of the foam to absorb impact (dropping a package)

	Density (Kg/m^3)	Lightweight (%)	G value Static Loading 8.16 kg/99*99 mm		G value Static Loading 5.16 kg/99*99 mm	
			1st impact	2nd - 5th average	1st impact	2nd - 5th average
Standard EPE	26.5	0	133.6	160.3	81.6	92.5
Enhanced EPE 2	20.9	21	133.7	162.4	86.4	95.3

Notes: *4 layers of 10 mm laminated sheets, 91 cm drop height*

- **Same G values at 8.16 and 5.15 kg loads**
- **Enhanced EPE 2 is 21% lighter (less material) than Standard EPE**

Summary

- **LDPE resins are the preferred materials for PO protective packaging foams and other applications**
- **Novel formulations of LDPE with enhanced LLDPE resins provide Enhanced Polyethylene (EPE) foam with superior properties over conventional LDPE.**
- **These formulations also deliver up to 20% light weighting potential . . .**

  … a more sustainable protective packaging solution

Thank you for your attention

For more information or to discuss your application, please feel free to contact us:

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