Enhancing Film Performance via Resin and Structure Selection

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SPI Future of Film and Bag Conference
Orlando, FL
May 17, 2011

Enhancing Film Performance via Resin and Structure Selection

- Using material selection and film structure design, film manufacturers can optimize film performance and cost

- In this presentation, four film structures will be introduced:
  - High visual impact collation shrink films
  - Moisture barrier films for dry foods packaging
  - Stretch hooder films for product unitization
  - Typical oxygen barrier structures

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High Visual Impact Collation Shrink Films

Collation Shrink Market

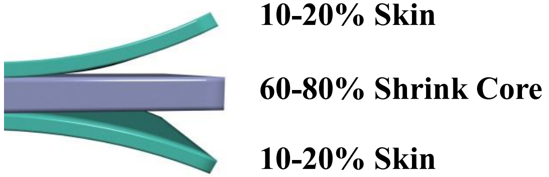
- Low Visual Impact Films
  - Break-bulk product distribution, club store bulk packaging, etc.
  - No significant optical property requirements
  - Usually not printed
  - Mostly monolayer films

- High Visual Impact Films
  - Bottled water/beverages, bundled consumer products, etc.
  - Significant optical property (haze, gloss) requirements
  - Often heavily printed
  - High growth due to increased popularity of bottled water, replacement of other packaging materials, product bundling
  - Monolayer and three-layer films

High Visual Impact Collation Shrink Market

- Film Structures
  - Monolayer Structure
    - LDPE rich shrink engine
    - HDPE or LLDPE added for modulus or toughness
  - Three-Layer Structures (10-20% skin layer thickness)
    - Skins: LLDPE / LDPE blend for clarity, gloss and toughness
    - Core: LDPE rich shrink engine with HDPE or LLDPE added for modulus or toughness

Typical Three-Layer Structure



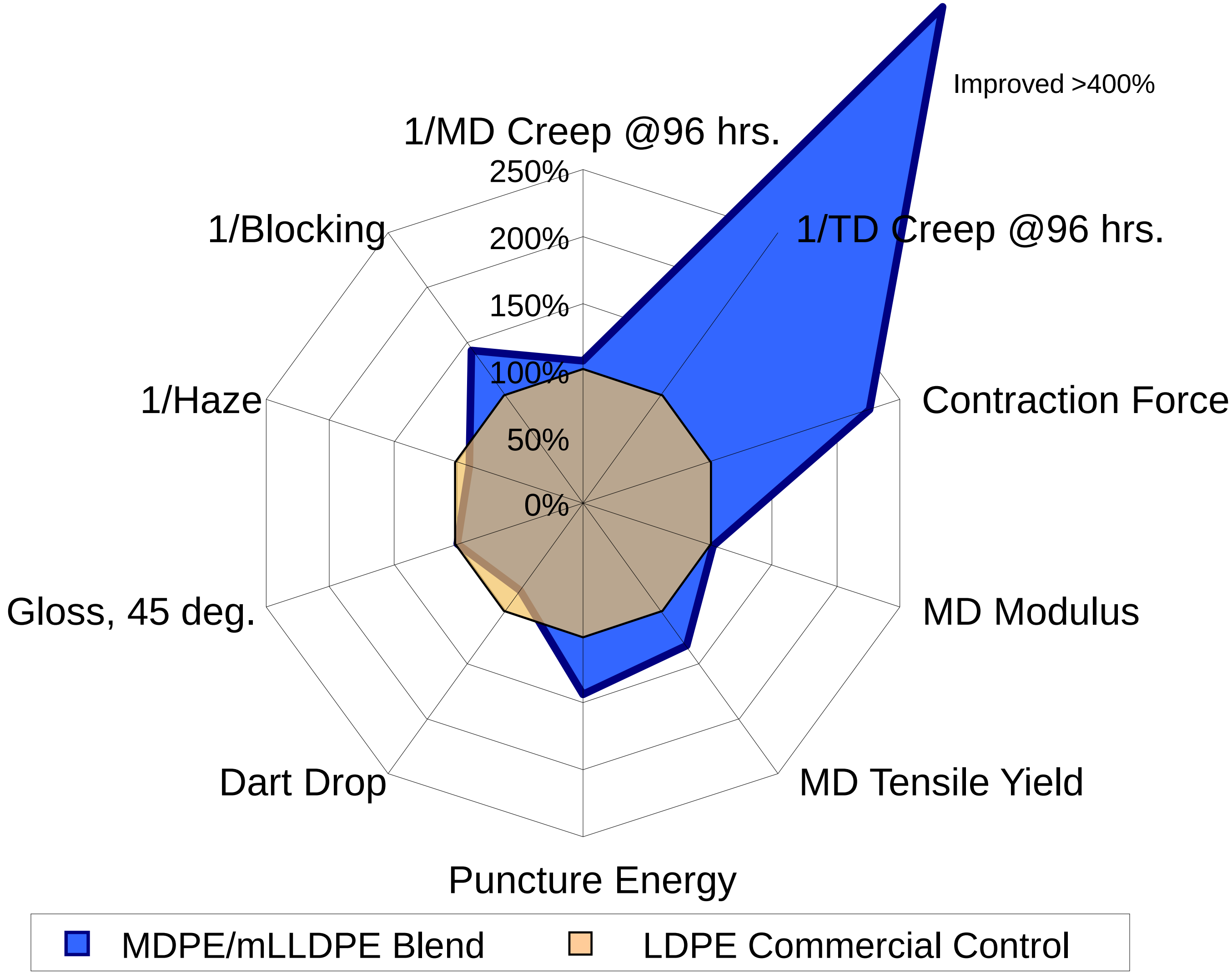
- Market Drivers and Needs
  - Downgauging to improve cost and environmental footprint
  - Eliminate trays – again for cost and sustainability
  - Enhanced visual appearance – point of sale
    - Excellent transparency for reverse printing
  - Increased package robustness – tight package

Monolayer or Three-layer?

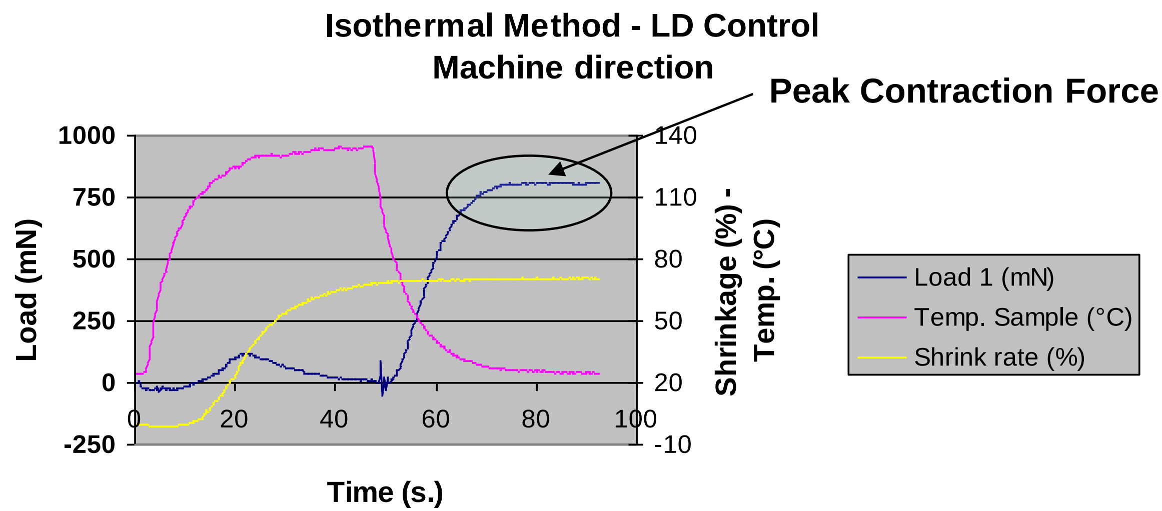
- Advantages of monolayer
  - Lower capital cost outlay/depreciation cost
  - Reduced operating complexity

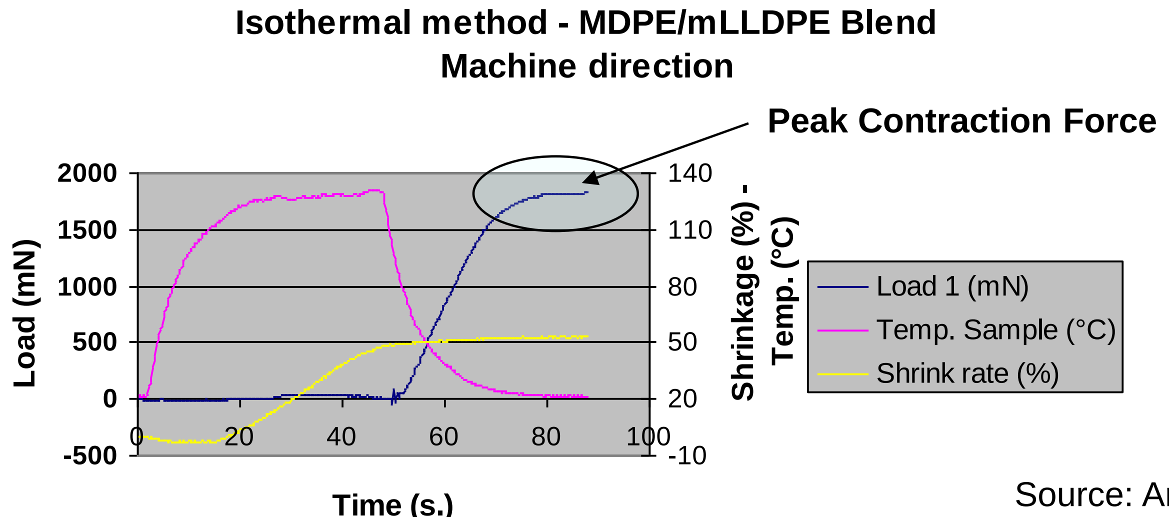
- Advantages of three-layer
  - More flexibility in resin selection
    - single resin or blend does not have to provide all of the film features
    - especially important when balancing optical and physical properties

Formulated Monolayer Shrink Film Study: Optimum Critical Property Retention



Isothermal Shrink and Contraction Forces





Source: Artec Testnology

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Moisture Barrier Films Used in Dry Foods Packaging

MMW HDPE Barrier Market Overview

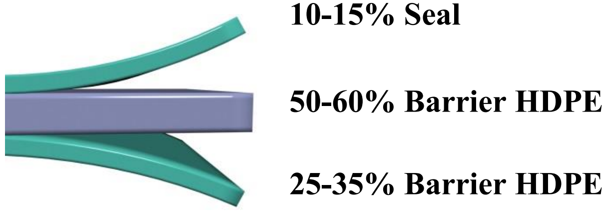
- HDPE based barrier films are typically used by consumer goods producers for cookie, cracker, cereal and dry powder packaging
- Moisture barrier and sometimes oxygen (aroma and flavor) barrier properties in these applications are critical for food shelf life and maintaining freshness
- Product packaging requirements include moisture and oxygen barrier, low taste and odor, stiffness, tear strength and puncture

Customer Dry Foods Packaging Market

- Film Structures
  - Three-layer blown film structures are most common
  - If oxygen barrier is required, five- and some seven- and nine-layer structures are utilized

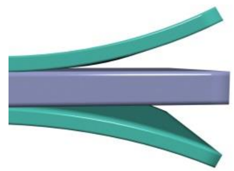
- Market Drivers and Needs
  - Downgauging for lower cost and film sustainability
    - Must meet minimum barrier and toughness requirements
  - Foil replacement – again for cost and film sustainability
  - Toughness improvement for existing high-demand applications
    - Such as food products with sharp edges

Typical 3-Layer Structure



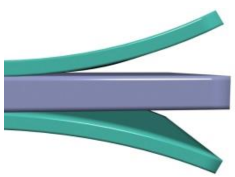
Dry Foods Packaging
Film Structure Examples

Control Structure



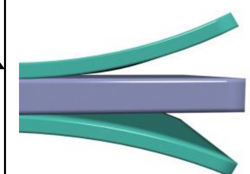
15% Seal
50% Std. Barrier HDPE
35% Std. Barrier HDPE

Improved Barrier Structure



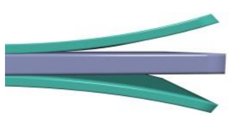
15% Seal
50% High Barrier HDPE
35% High Barrier HDPE

Maximize Toughness



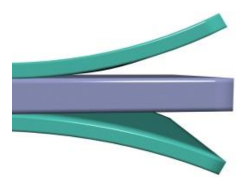
15% Seal
50% High Barrier HDPE
35% mLLDPE

Film Gauge Reduction



15% Seal
50% High Barrier HDPE
35% High Barrier HDPE

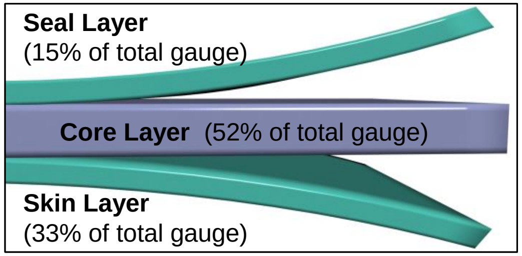
Barrier, Toughness & Stiffness

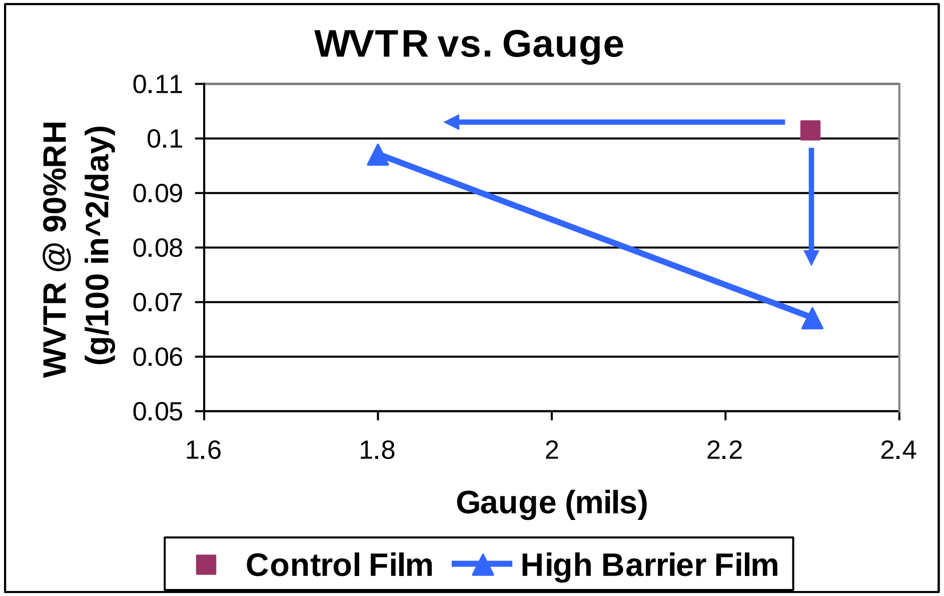


15% Seal
50% High Barrier HDPE
35% High Toughness HDPE

Multilayer Structure Optimization*

- Maximize Barrier
- Gauge Reduction



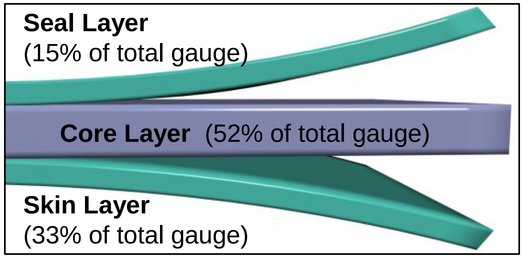


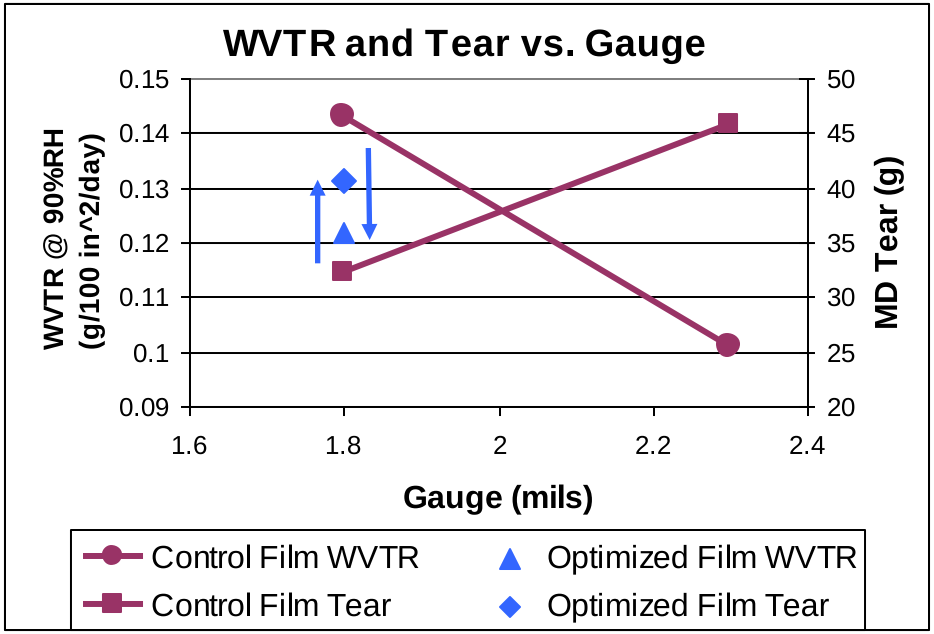
	Units	Control Film	High Barrier Film	Gauge Reduction + High Barrier
Seal Layer - 15% of gauge		Sealant	Sealant	Sealant
Core Layer - 52% of gauge		Std. HDPE	High Barrier HDPE	High Barrier HDPE
Skin Layer - 33% of gauge		Std. HDPE	High Barrier HDPE	High Barrier HDPE
Film gauge	mils	**2.3**	**2.3**	**1.8**
WVTR @ 90% RH	g/100 in^2/day	**0.101**	**0.067**	**0.097**
Dart Drop (F50)	grams	61	59	45
Tear (MD)	grams	46	45	30
1% Secant Modulus (MD)	psi	136,000	128,000	125,000
%Haze	%	39	28	25

* All films produced on a 6” die with 60 mil die gap at 150 lbs/hr, 2.2:1 BUR and 32” frost line

Multilayer Structure Optimization

- Toughness Retention at Reduced Gauge

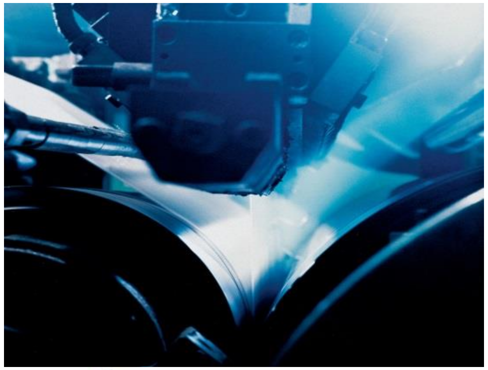




	Units	Control Film	Reduced Gauge	Optimized @ Reduced Gauge
Seal Layer - 15% of gauge		Sealant	Sealant	Sealant
Core Layer - 52% of gauge		Std. HDPE	Std. HDPE	High Barrier HDPE
Skin Layer - 33% of gauge		Std. HDPE	Std. HDPE	Tough HDPE
Film gauge	mils	**2.3**	**1.8**	**1.8**
WVTR @ 90% RH	g/100 in^2/day	**0.101**	**0.143**	**0.122**
Dart Drop (F50)	grams	61	56	54
Tear (MD)	grams	**46**	**32**	**41**
1% Secant Modulus (MD)	psi	136,000	133,000	115,000
%Haze	%	39	32	23

HDPE Barrier Films Used in Extrusion Lamination Applications

- HDPE-based barrier films can be used as a laminating film for packaging applications
  - Value-added method to meet MVTR requirements



- Value Proposition
  - Reduces cost by replacing foils and metalized films in over-engineered packages
  - Improves package sustainability and reduces environmental footprint
  - Provides flexibility of package design for barrier requirements

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Stretch Hooder Films Used in Product Unitization

Stretch Hood Applications

Picture: courtesy of Company Beumer

- **Petrochemical:** Low stretching ratio, but strong holding forces
- **Cement Bags:** Low stretching ratio, dust protection but robust on packaging line
- **Building materials:** Low stretching ratio, but strong puncture & tear performance
- **Beverages:** High stretching ratio + perforated hood = robust stretching + tear performance
- **Appliances:** Fast speed process + robust stretching performance @ low thickness

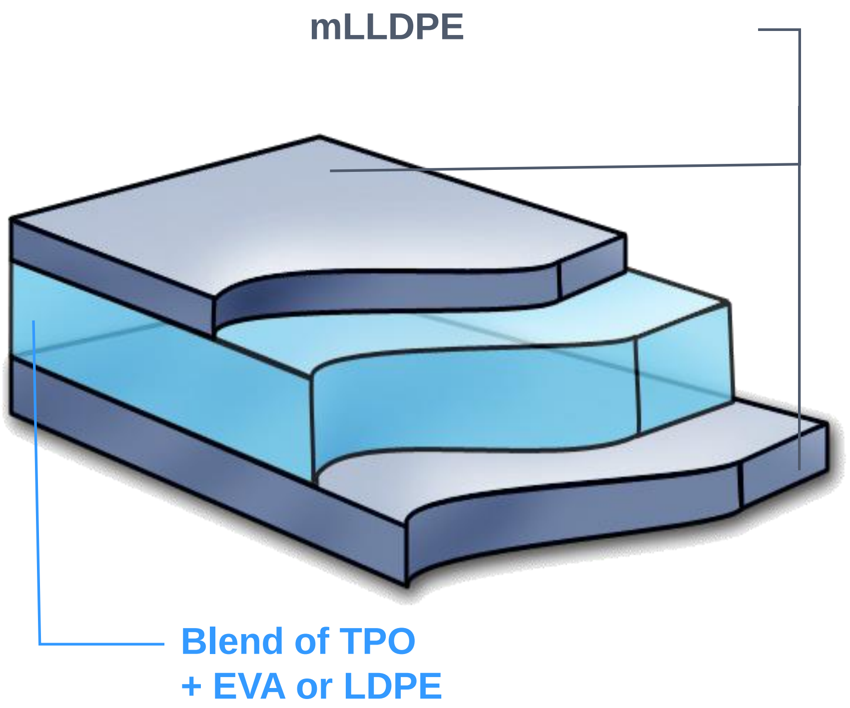
Petrochemical	Cement bags	Building materials	Beverages	Appliances

Stretch Hooder Market

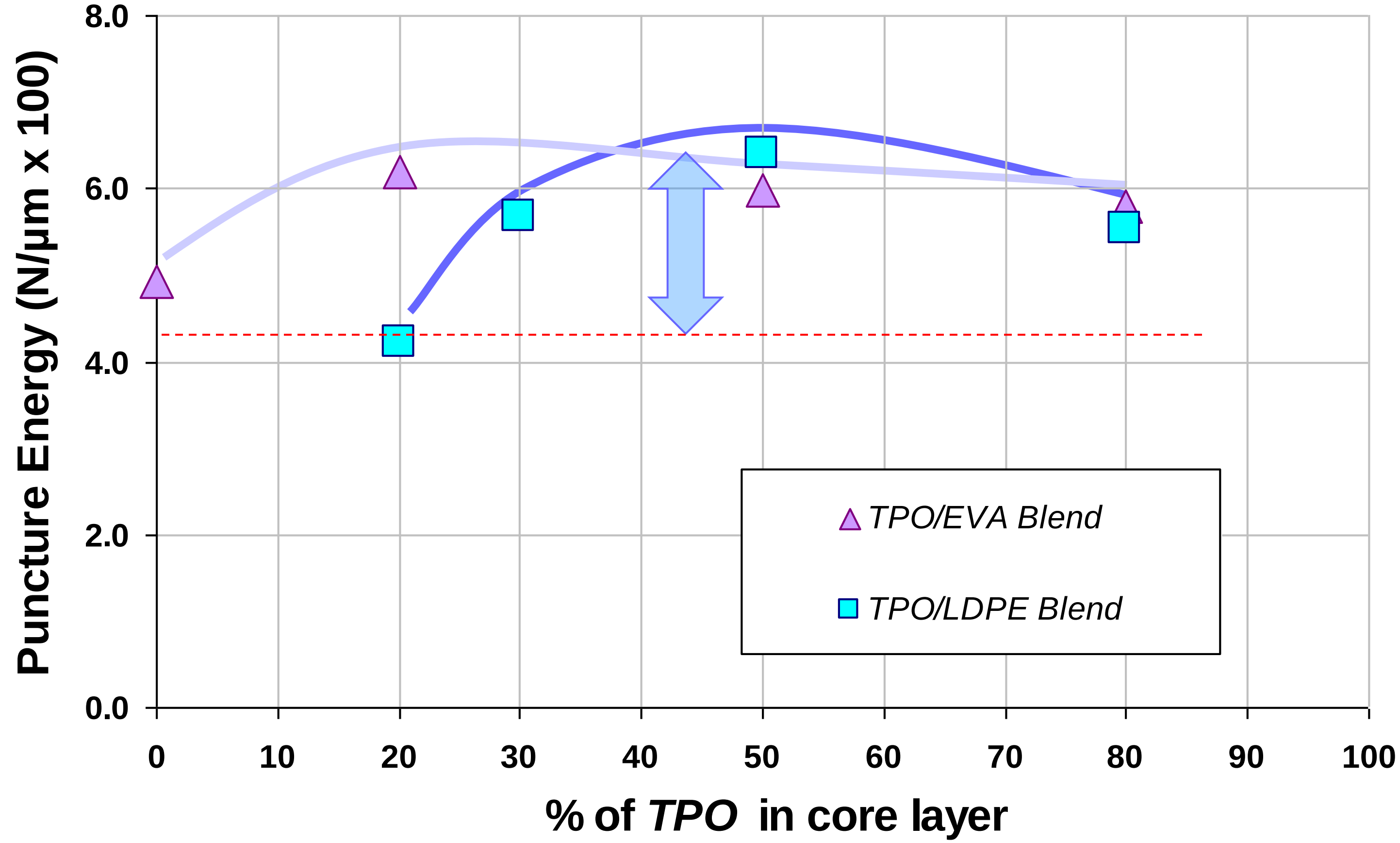
- Film Structures
  - Market has transitioned to 3-layer coex (typically 20/60/20)
  - Gauge (2 to 6 mil)
  - Core: Stretch engine/puncture

    Skins: Enhanced toughness/optics

- Market Drivers and Needs
  - Gauge reduction to improve cost
  - Enhanced stretching capability (packaging line and film) for improved cost and enhanced holding force
  - Films with improved vertical stretching-ability for better load stability

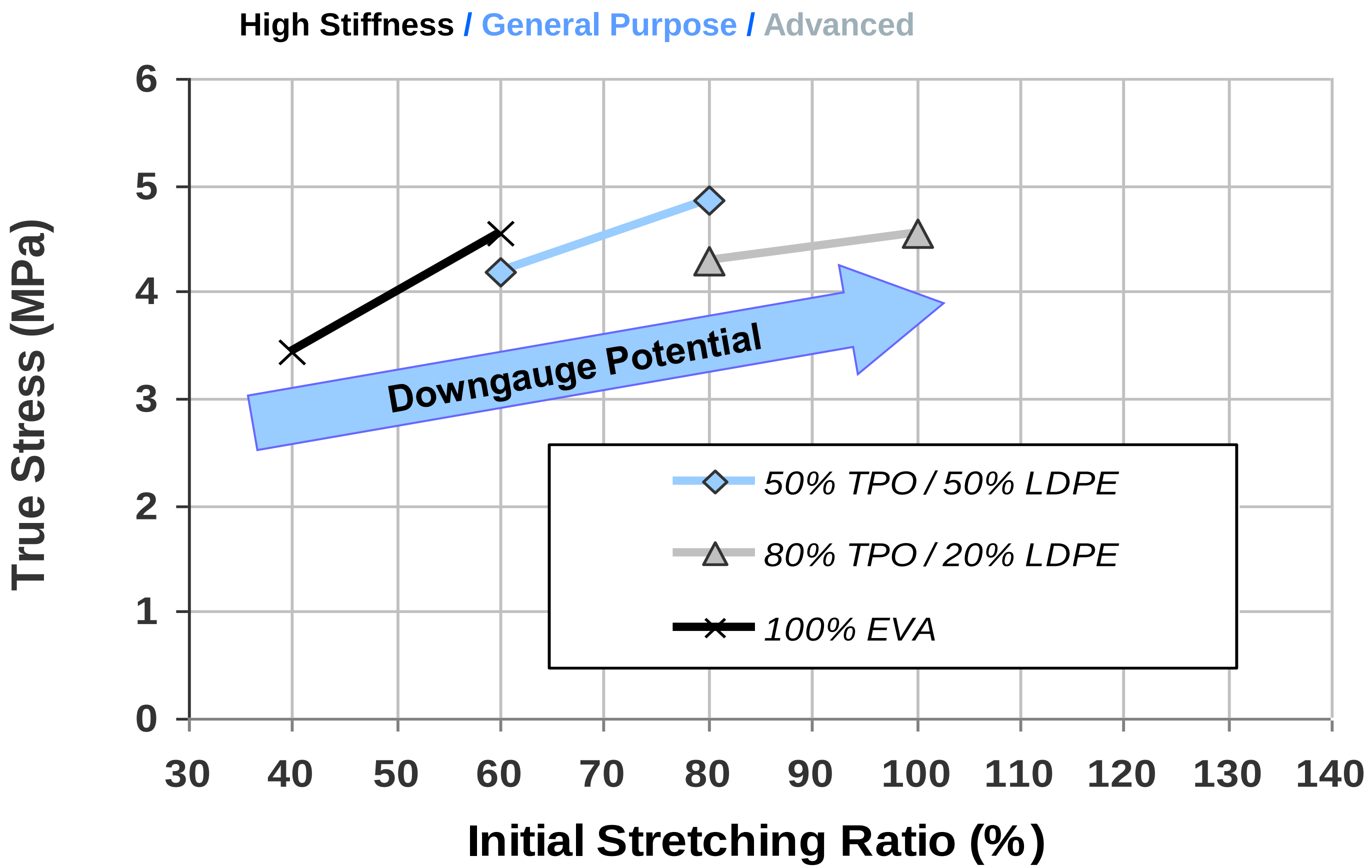


Three-layer TPO-based Structures Improved Puncture Resistance



**mLLDPE Skin* / Core Layer TPO Blend / mLLDPE Skin (Layers thickness 20:60:20)

Three-layer Structures
True Stress vs. Film Composition*



*'Residual Stress' divided by 'Film Thickness on load' times 'Initial film thickness' (80µm)

Core Layer Blend Versatility

MODERATE STRETCHING CAPABILITY

HIGH-HOLDING FORCES

LOW-BUR SENSITIVITY

HIGH-STRETCHING CAPABILITY
(both horizontal + vertical)

IMPROVED PUNCTURE RESISTANCE

IMPROVED TEAR PERFORMANCE

GAUGE REDUCTION CAPABILITY

***LDPE* rich core**

***TPO* rich core**

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Typical Oxygen Barrier Structures

Typical Five-layer Coextruded Structure

POLYETHYLENE	40-65%	
Tie Layer	5%	
Barrier layer (Polyamide, EVOH)	10%	2-5 mils
Tie Layer	5%	
POLYETHYLENE	15-40%	

Typical Seven-layer Coextruded Structure

POLYETHYLENE	35-50%
Tie Layer	5%
Polyamide	5%
EVOH	6%
Polyamide	5%
Tie Layer	5%
POLYETHYLENE	15-35%

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