

**PLACE** 2016

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# New HDPE Resins May Offer Film Improvements

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# Agenda

## New HDPE Resins May Offer Film Improvements

- Traditional Cereal, Cookie, & Cracker Packaging Market
- Potential New Markets
- Experimental
  - Resins
  - Films
- Results
  - Effects of Nucleation
  - Effects of LLDPE
  - Down-gauging
- Conclusions

# Traditional Cereal, Cookie, & Cracker Packaging Market

- The shelf life for cereal, cookies, and crackers typically depends on the Water Vapor Transmission Rate (WVTR) of the package
  - Lower WVTR indicates better barrier
  - Typically use HDPE to provide WVTR performance
- Development of PE nucleation led to further barrier improvement in some HDPE by modifying crystal orientation
- Package also requires adequate Machine Direction (MD) Tear to limit bag from ripping during initial opening
- Modulus, tensile, and optics may have importance depending on the end-use application

# Traditional Cereal, Cookie, & Cracker Packaging Market

- Advances in HDPE resin design and nucleation led to significant improvements in WVTR
- Changes in barrier led to film package reformulation

Product	2012		2015	
	Gauge	WVTR	Gauge	WVTR
Cereal # 1	0.064 (2.50)	2.17 (0.14)	0.053 (2.10)	1.55 (0.10)
Cake Mix # 1	0.052 (2.05)	5.07 (0.33)	0.042 (1.65)	3.97 (0.26)
Crackers # 1	0.052 (2.05)	2.80 (0.18)	0.046 (1.80)	1.91 (0.12)

**Property improvements led to gauge reduction and improved barrier performance for various packages**

Gauge shown in mm (mil).

WVTR is Water Vapor Transmission Rate for overall structure and shown in grams per square meter per day (grams per 100 square inches per day).

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# Potential New Markets



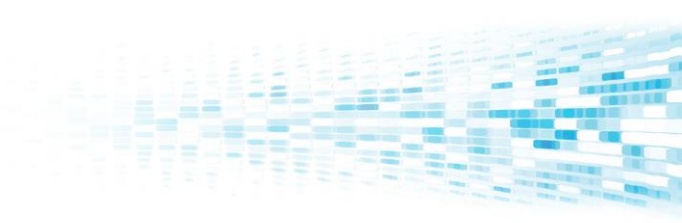
- Improvements in HDPE resins may allow new or modified packaging markets to emerge

## Examples

- Improved barrier may displace over-engineered WVTR packages
  - Metalized film replacement for pouches, snack food packaging
- Films with increased toughness while providing some level of WVTR performance
- See-through packaging
  - Laminating films with lower haze than incumbent structures

**Further structure improvements may lead to longer shelf life, lower costs, and/or inter-material substitution**

# Experimental – Resins

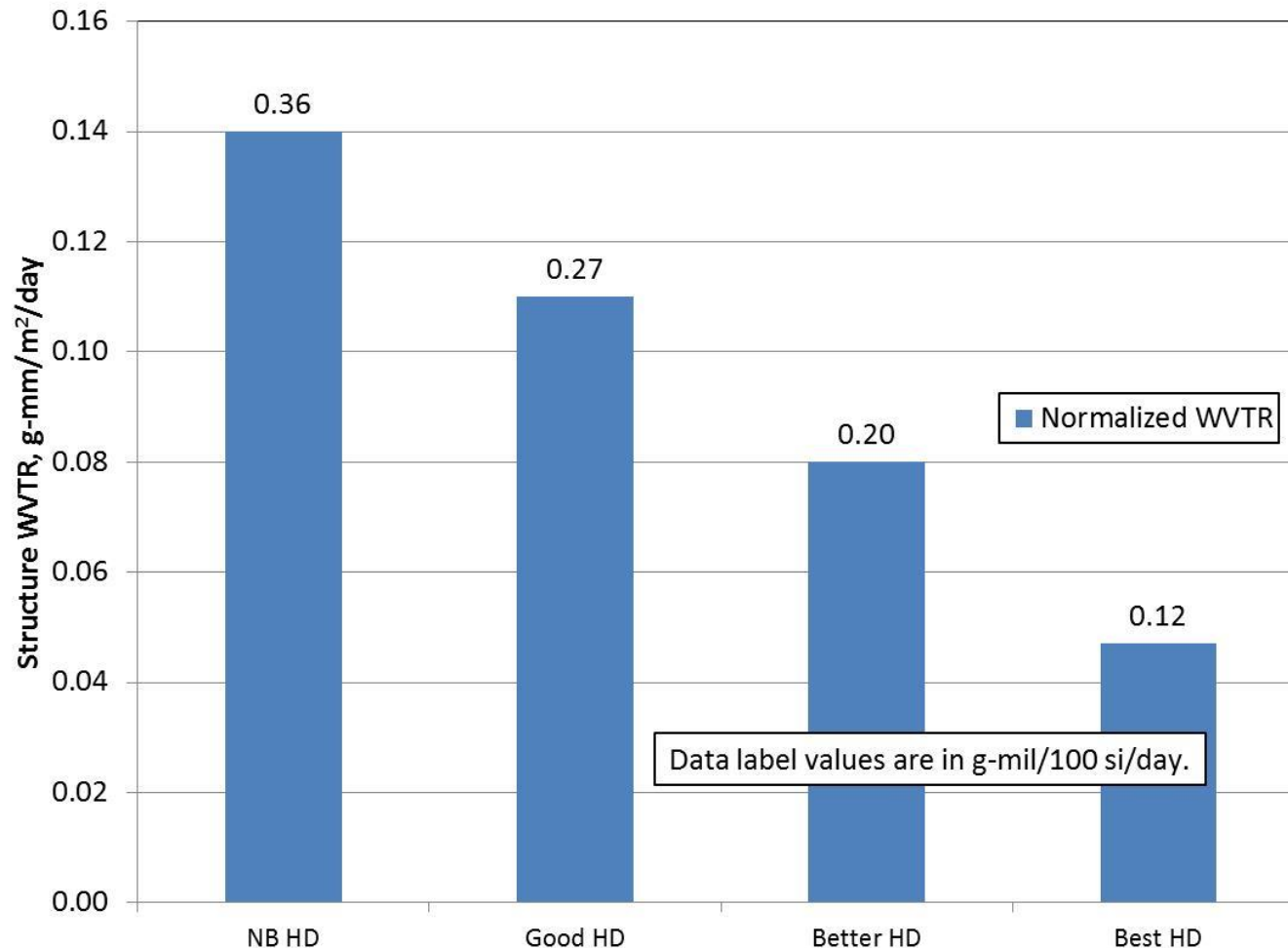


Product	Designation	Resin Type	Melt Index	Density
L5485	NB HD	Non-Barrier HDPE	0.85	0.954
M6020	Good HD	Good Barrier HDPE	2.0	0.960
Nuc. M6020	Better HD	Better Barrier HDPE	2.0	0.960
M6020SB	Best HD	Best Barrier HDPE	2.0	0.960
GA501020	C4 LL	Butene LLDPE	1.0	0.918
GS906061	SC6 LL	Super-Hexene LLDPE	0.6	0.916
NA960000	Sealant	LDPE	1.0	0.920

- Better HD and Best HD are both nucleated

Melt Index shown in grams per 10 minutes.  
Density shown in grams per cubic centimeter.

# Experimental – Resins



**Best HD has enhanced nucleation to give significant improvement in WVTR performance**

WVTR measured on 0.032 mm (1.25 mil) monolayer films and normalized.

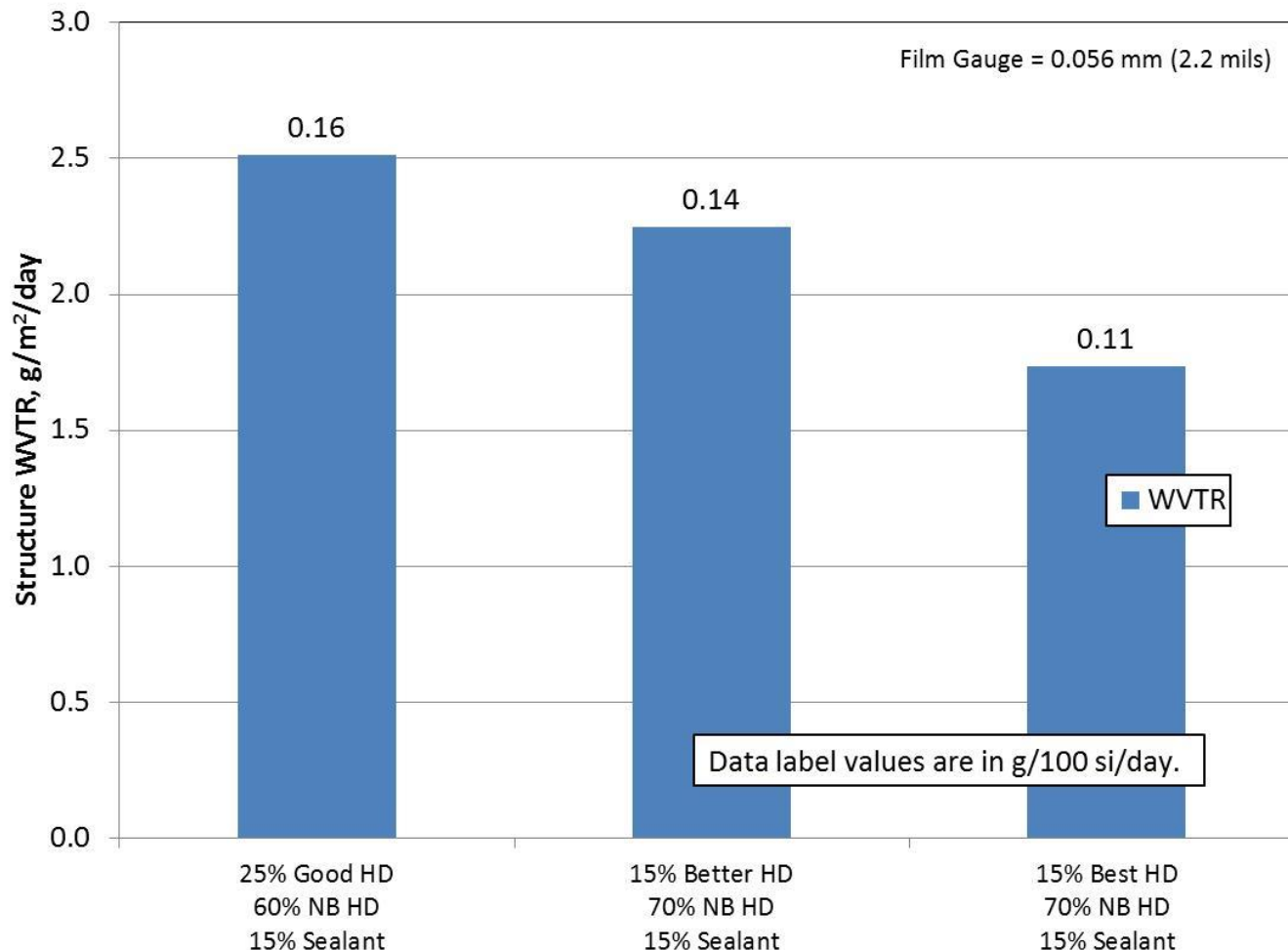
# Experimental – Films

- Produced 3-layer co-ex films
- Layer distributions as indicated
  - All films contained 15% skin layer of Sealant
- Film Gauge = 0.046, 0.056 mm (1.8, 2.2 mil) as indicated
- Die Gap = 1.27 mm (50 mil)
- Die Size = 152.4 mm (6 inch)
- Blow-up Ratio = 2.5:1
- Production Rate = 68 kg/hr (150 lb/hr)

**Project Goal: Identify changes to blown film formulations to modify critical properties to provide value throughout supply chain**

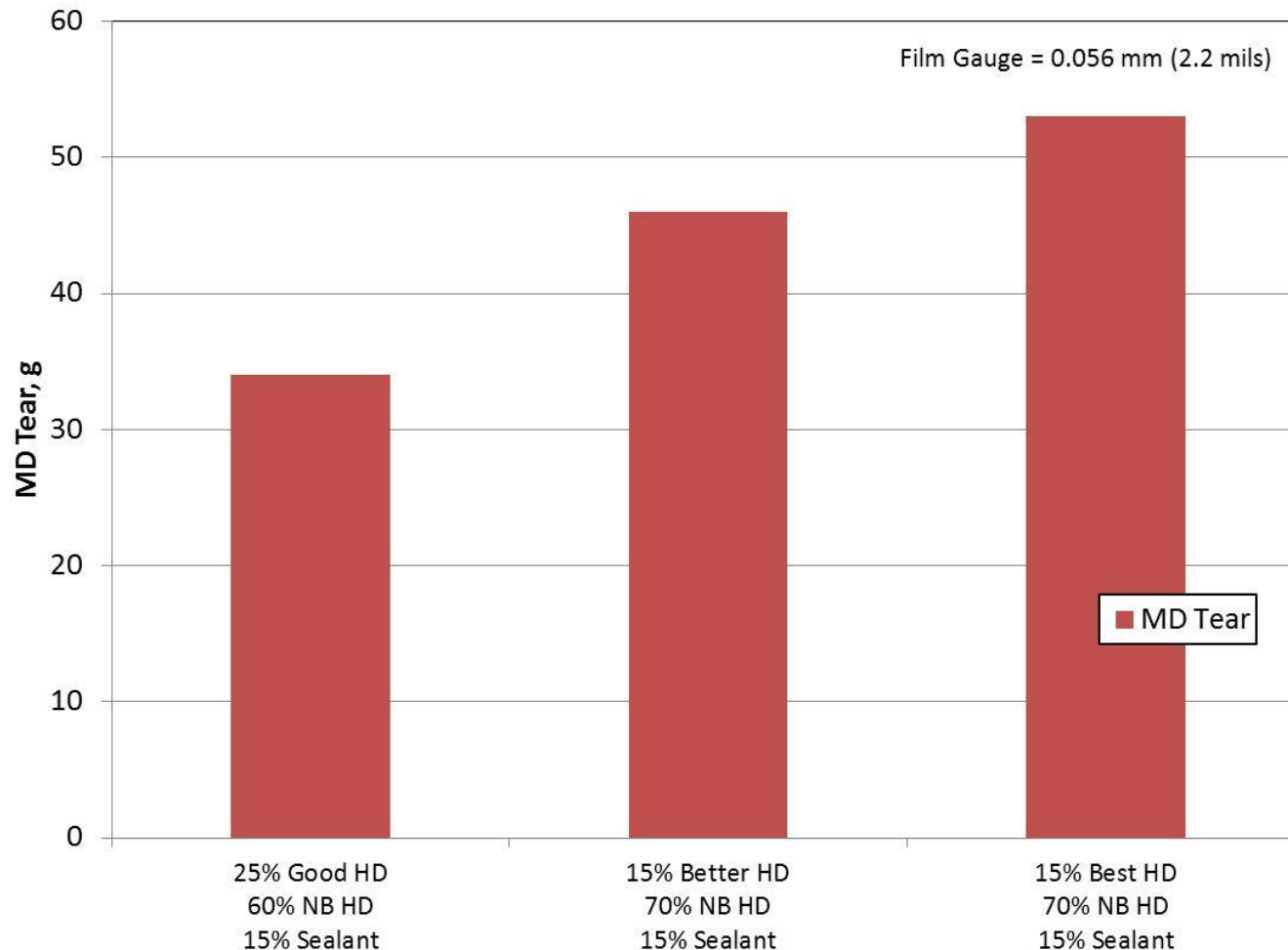


# Effects of Nucleation on WVTR



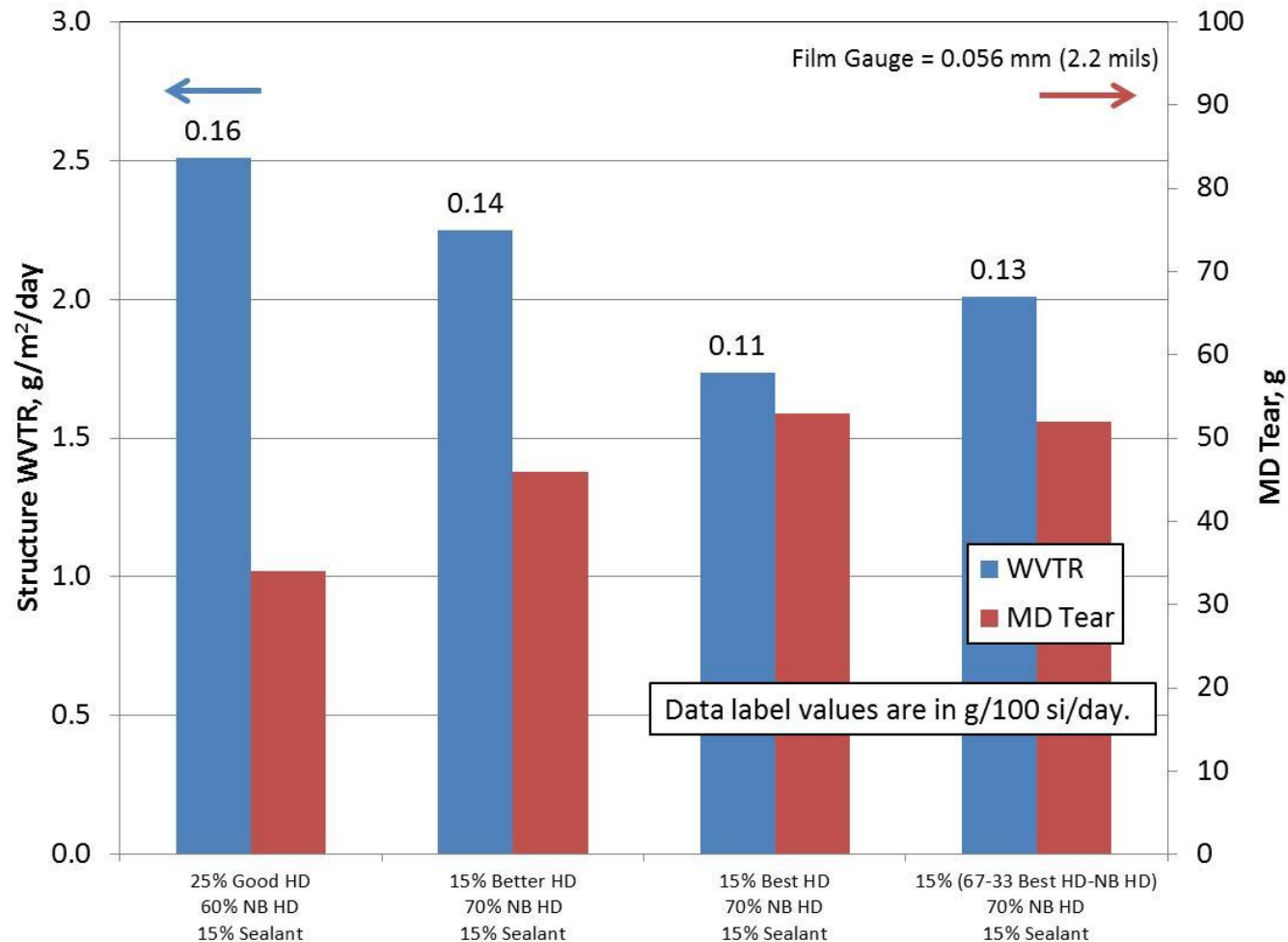
**Despite less barrier resin, nucleated films have improved WVTR. Enhanced nucleation of Best HD resin shows significant improvement in overall structure barrier.**

# Effects of Nucleated Resin Content on MD Tear



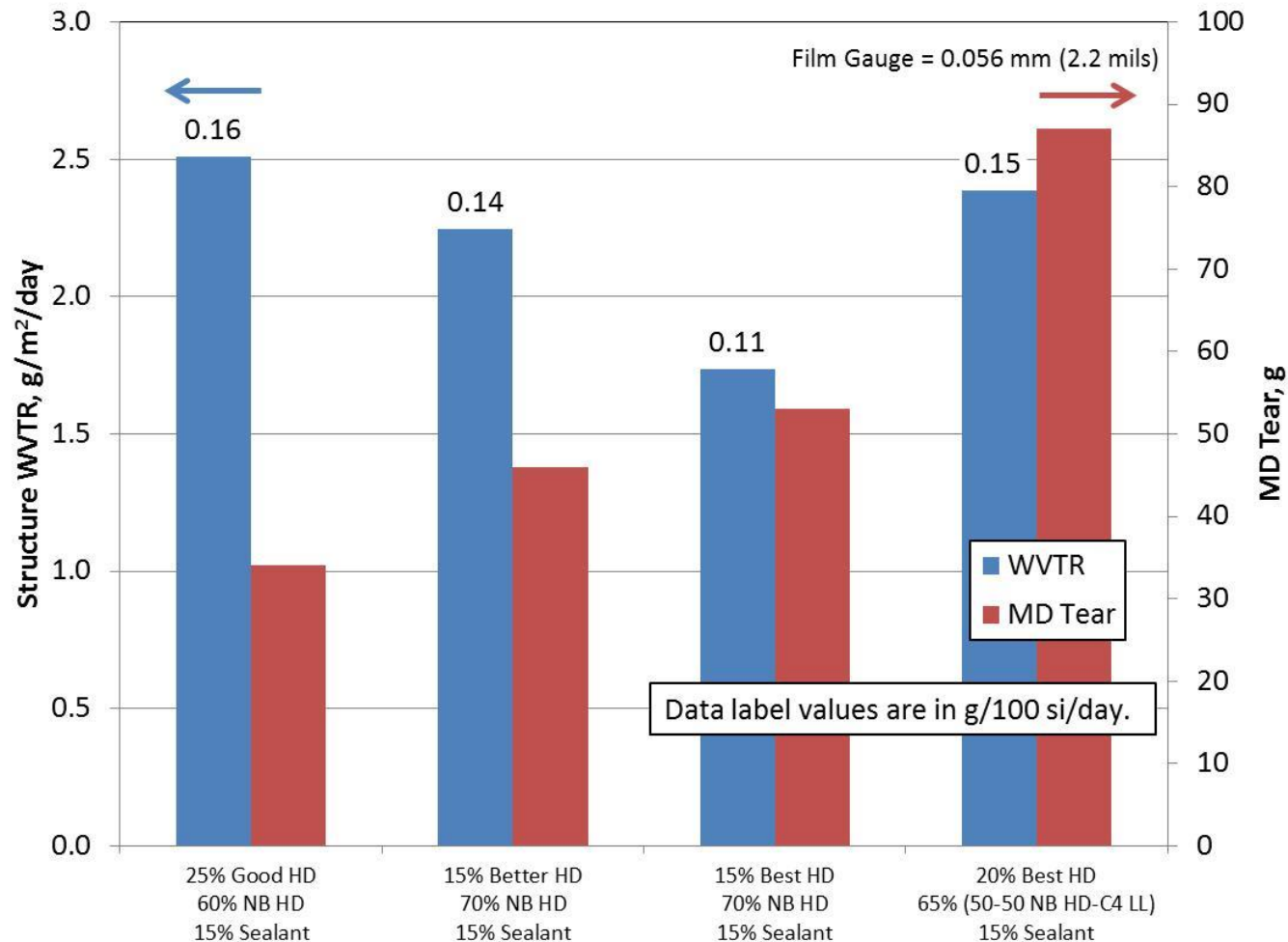
**Lower levels of nucleated barrier HDPE allow increased amounts of NB HD in formulations that likely lead to higher MD Tear**

# Effects of Nucleated Resin Content on WVTR/MD Tear



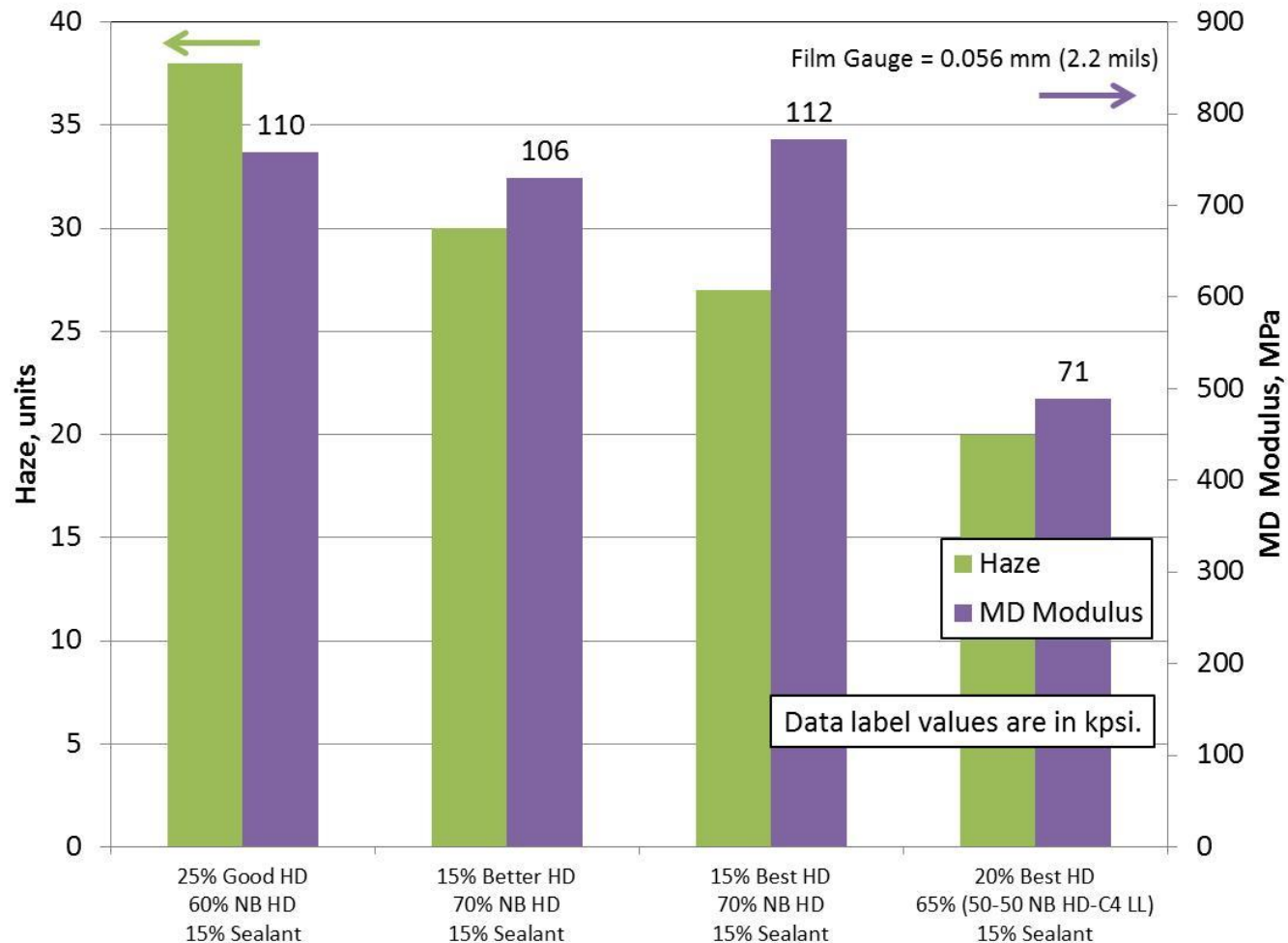
**Addition of NB HD to Best HD in skin layer provides improved structure WVTR to other barrier HD skins while retaining MD Tear**

# Effects of LLDPE on WVTR and MD Tear



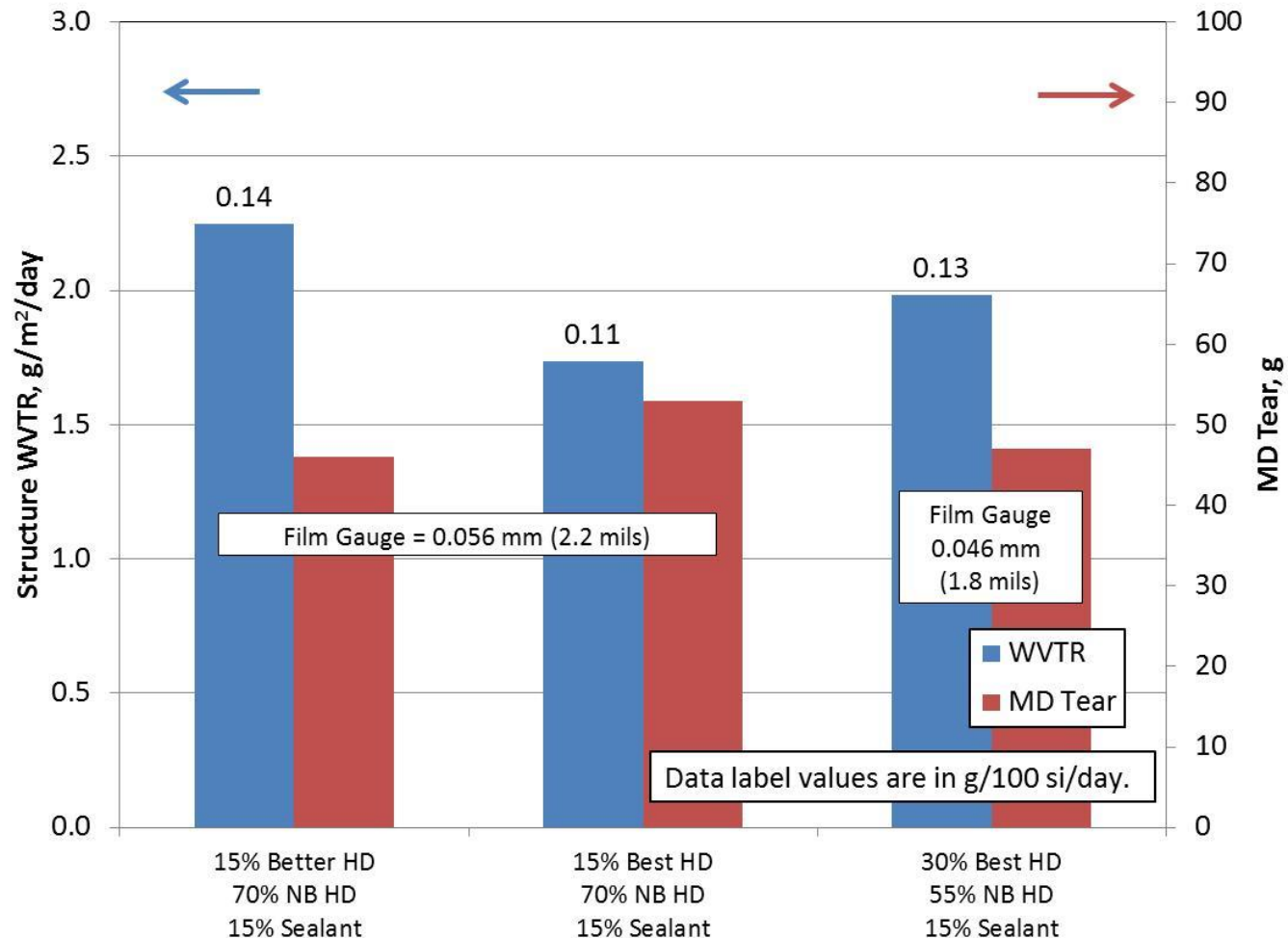
**Addition of C4 LL to core layer provides barrier comparable to films with other barrier skins, but with significantly improved MD Tear**

# Effects of LLDPE on Haze and MD Modulus



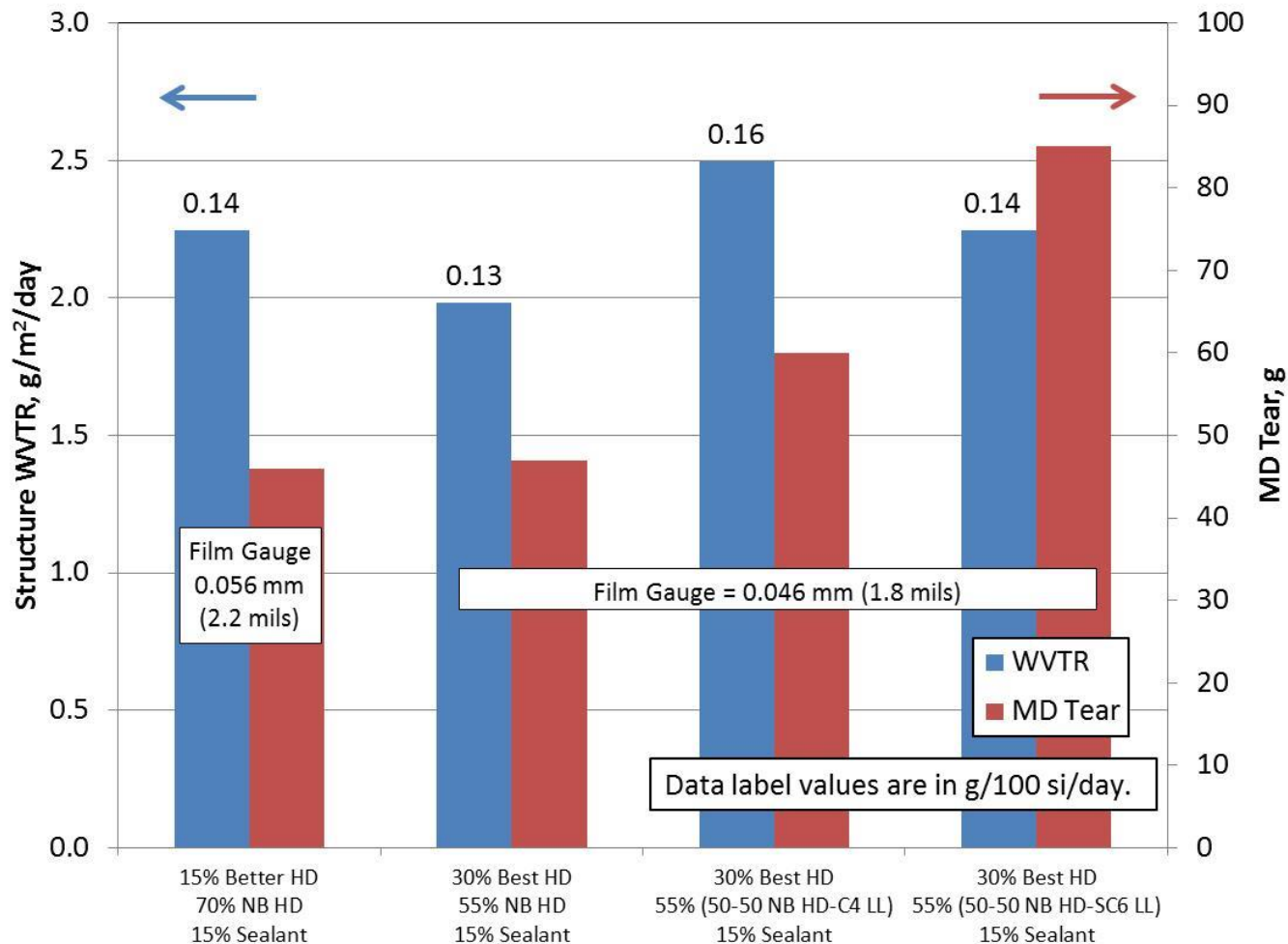
**Addition of C4 LL to core layer lowers haze of structure while MD Modulus decreases**

# Effects of Down-gauging Using Barrier HD



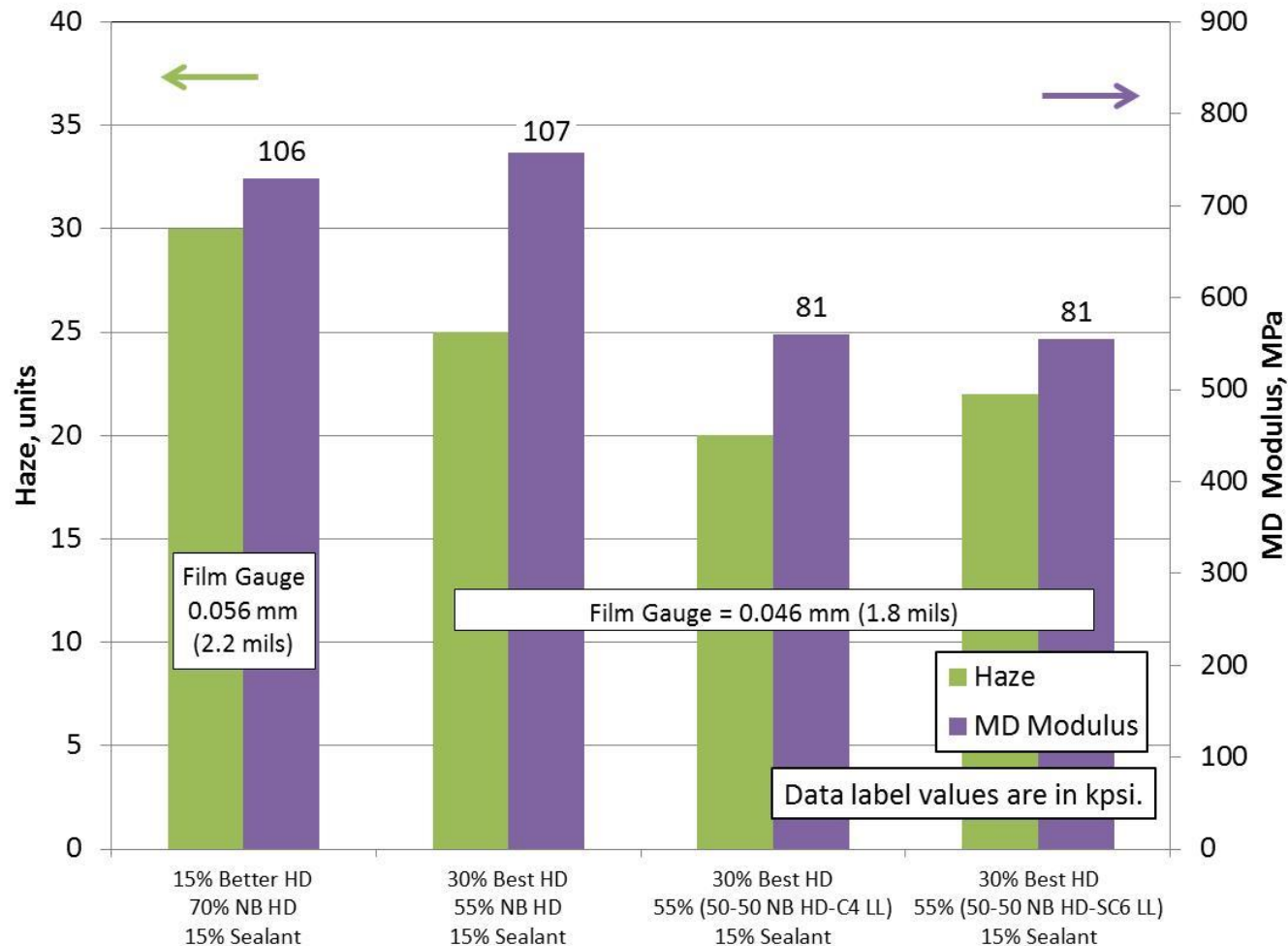
**Use of Best HD in place of Barrier HD gives improved barrier and comparable MD Tear at ~20% down-gauging**

# Down-gauging Using Barrier HD and LLDPE



**Use of SC6 LL in core layer provides down-gauged structure with similar barrier and significantly improved MD Tear as control**

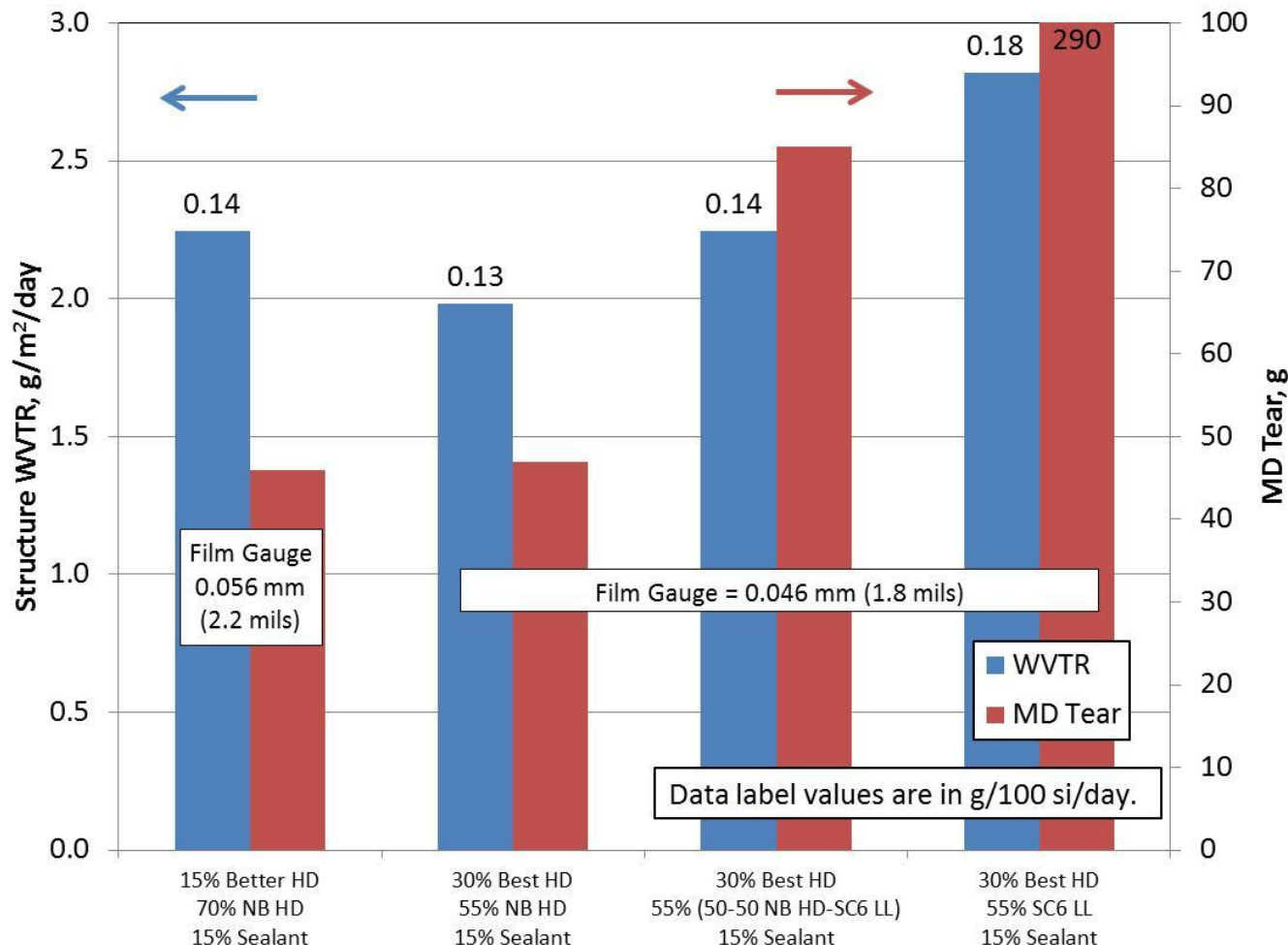
# Down-gauging Using Barrier HD and LLDPE



**Addition C4 LL or SC6 LL to core layer lowers haze of structure while MD Modulus decreases**

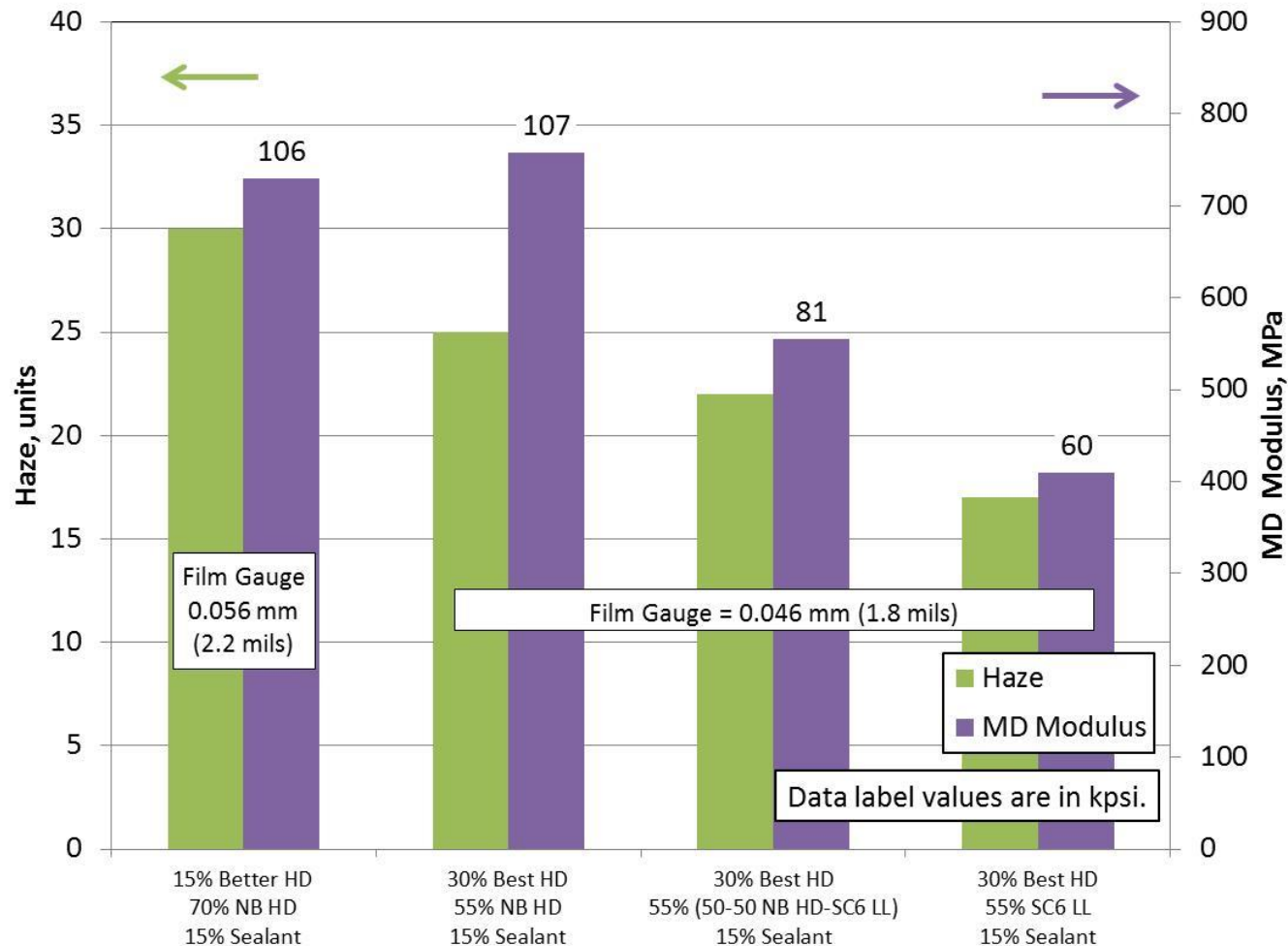


# Down-gauging Using Super C6 LLDPE Core Layer



**Use of SC6 LL in core layer gives poorer WVTR and gives significant improvement in MD Tear for down-gauged film**

# Down-gauging Using Super C6 LLDPE Core Layer



**Use of SC6 LL in core layer decreases haze and decreases MD modulus for down-gauged film**

# Conclusions



- End-use applications have varying package requirements
  - WVTR, MD Tear, Haze, Modulus, etc.
- Enhanced nucleation for Best HD may provide:
  - Improved WVTR at the same levels of Better HD
  - Use of less barrier resin to maintain WVTR performance
  - Improved optics
- As a result, use of Best HD may allow:
  - Material substitution for over-engineered barrier applications
  - Improved package toughness
  - New packaging to allow end-use product to be seen
  - Lower costs

# Conclusions

- Use of C4 LL or SC6 LL with Best HD may provide:
  - Comparable WVTR with higher MD Tear
  - Improved optics
- LLDPE with Best HD may give value via:
  - New packaging markets to provide improved barrier over current films while maintaining high MD Tear
  - New films that provide a balance of WVTR, MD Tear, and optics



# Thank you

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