

# ***Heat Seal Characteristics of Cyclic Olefin Copolymer / Polyethylene Blends***

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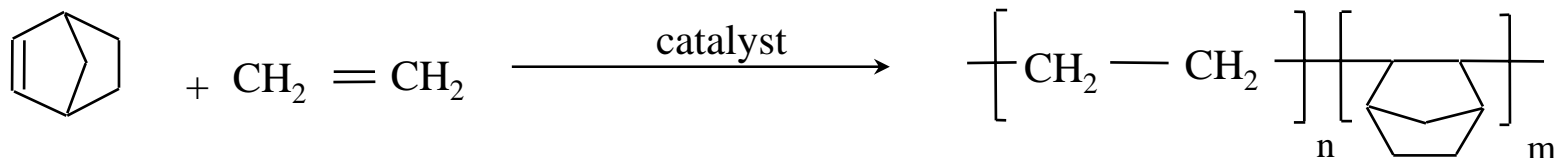
# Topas<sup>®</sup> COC Manufacturing Plant



- Oberhausen, Germany
- Start-up October 2000
- COC Capacity: 66 MM lbs.
- Backward integrated in Norbornene
- Cost efficient continuous process using metallocene technology

**Largest COC and Norbornene Plant in the World**

# What is COC?



## ■ Feedstocks

- ◆ Norbornene
- ◆ Ethylene

## ■ Catalyst : Metallocenes

- ◆ High activity, low residues
- ◆ Narrow MW distribution
- ◆ Microstructure control

**COC properties can be tailored by adjusting the Norbornene content**

## Abstract

- *Cyclic Olefin Copolymers (COC) use is growing in flexible packaging films*
- *Attributes include easy processing, stiffness, heat resistance, moisture barrier and clarity*
- *Can be used to modify the heat sealing characteristics of polyethylenes:*
  - *improvements in seal strength*
  - *improvement of hot-tack strength*
  - *high temperature seal through capability with high Tg grades.*

## Experimental

- Materials:

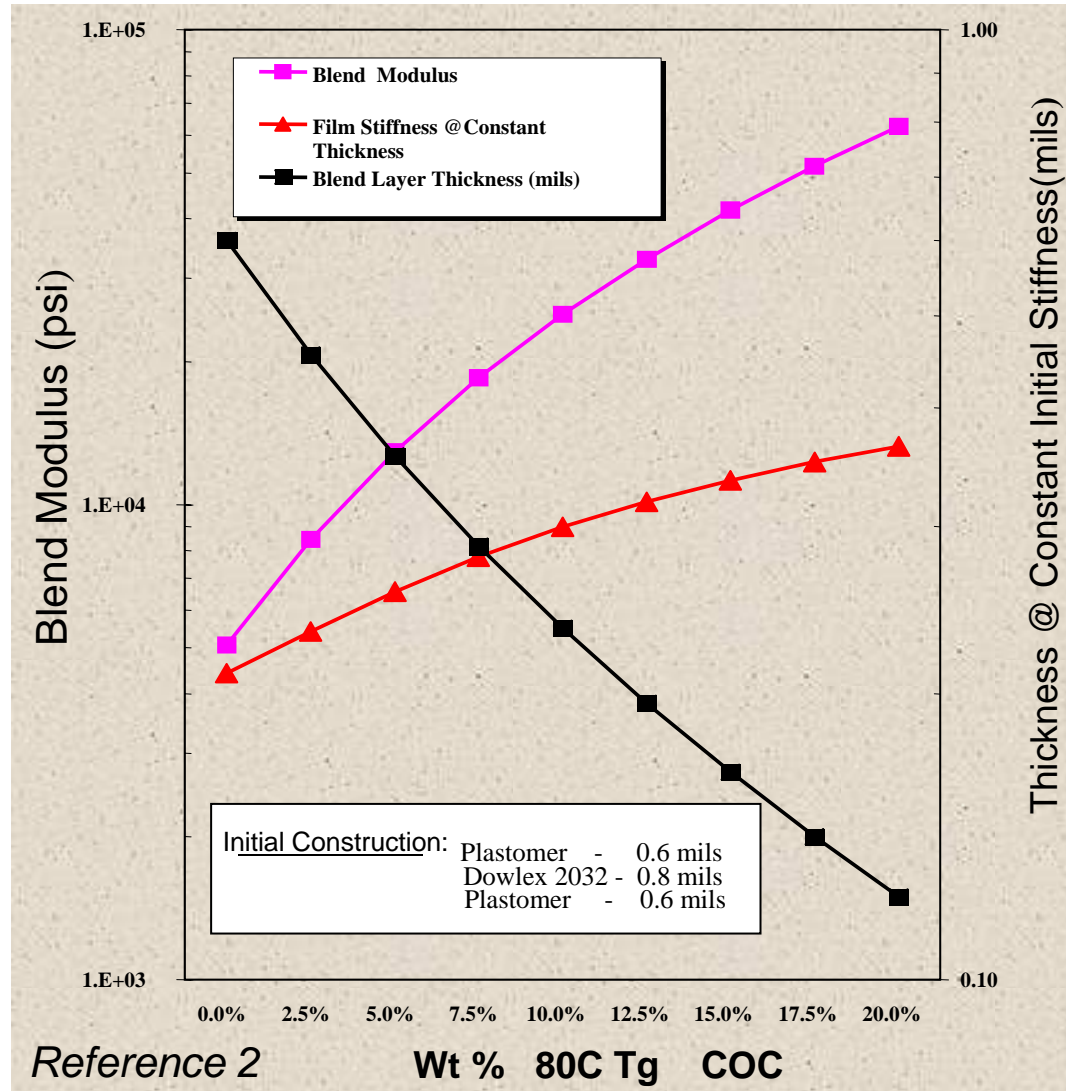
	<u>MI</u>	<u>Density</u>	<u>T<sub>g</sub></u> °C
– Dow 2045 LLDPE	4	0.920	-127
– Equistar NA 952 LDPE	2	0.918	-127
– Equistar NA 204 LDPE	3	0.931	-127
– Borealis 7230 LDPE	4.5	0.923	-127
– Exxon Mobil 3125 Plastomer	1.2	0.91	-121
– Dow 1140 Plastomer	1.2	0.902	-121
– Ticona 8007 COC	1.8	1.02	80 (low)
– Ticona 5013 COC	< 1.0	1.02	136 (high)
- Extrusion:
  - 25 mm Killion (DS), DSB I barrier type screw, 30: 1 L/D, Maddock Mixing head
    - T range: 160 - 260°C, Cast rolls: 35°C, film: 51 microns

## Experimental (cont.)

- Testing Equipment:

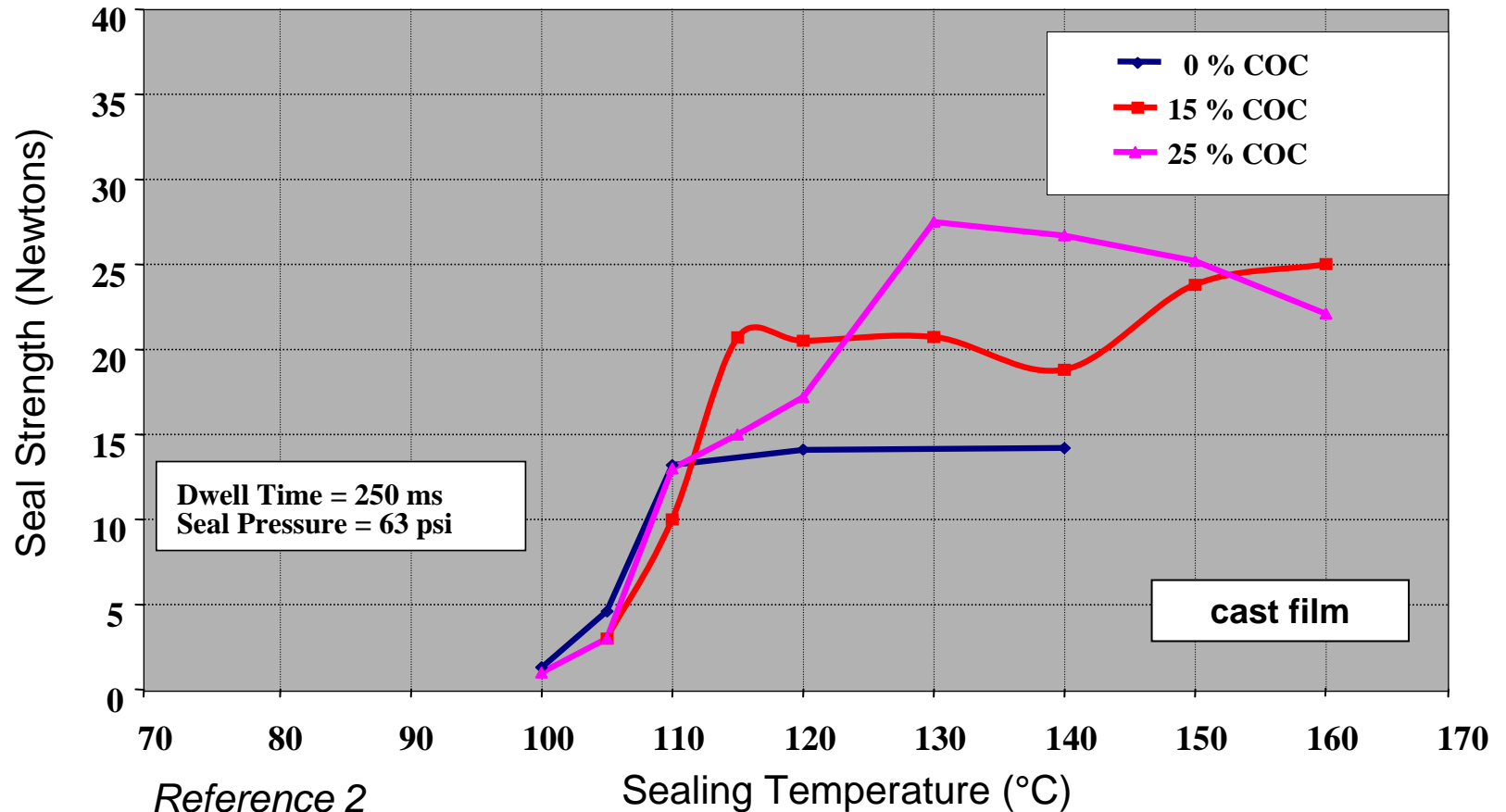
- Tensiles MTS 8016 Tensile testing machine,, 23°C, 50% r.h. (ASTM D 882)
- Microscopy Optical (phase contrast)
- DMA TA Instruments Dynamic Mechanical Analyzer (DMA), model 2980, tension mode on MD film, 3°C/min. temperature sweeps, at 10HZ
- Heat Seal Davinor Inc., J&B Hot Tack Tester
  - Seal Strength Test - Seal Pressure = 0.3034 N/mm (44psi), Seal Time = 1 sec., Cool Time = 30 sec., Peel speed = 200 mm/sec, sample size = 25.4 mm (1 inch ) wide.
  - Hot-Tack Test - Seal Pressure = 0.3034 N/mm (44psi), Seal Time = 1 sec., Cool Time = 0.1 sec., Peel speed = 200 mm/sec, sample size = 25.4 mm (1 inch ) wide.
  - Seal Initiation Temperature - defined as seal temperature where a 8.8 Newton seal strength is achieved.

# COC allows downgauging of films



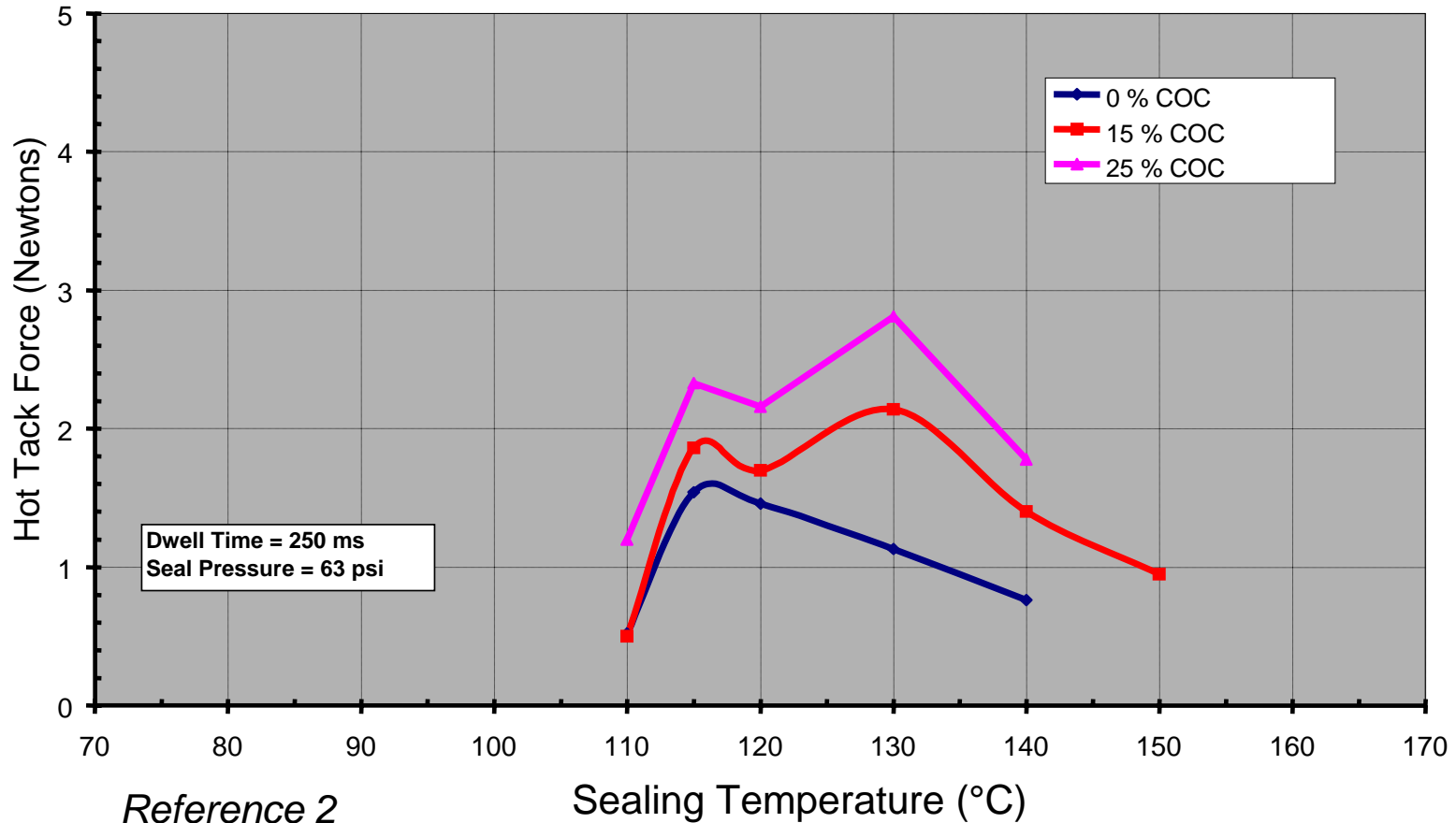
**COC blends offer potential cost savings**

# Improved Ultimate Seal Strength with 80°C T<sub>g</sub> COC blended with LLDPE



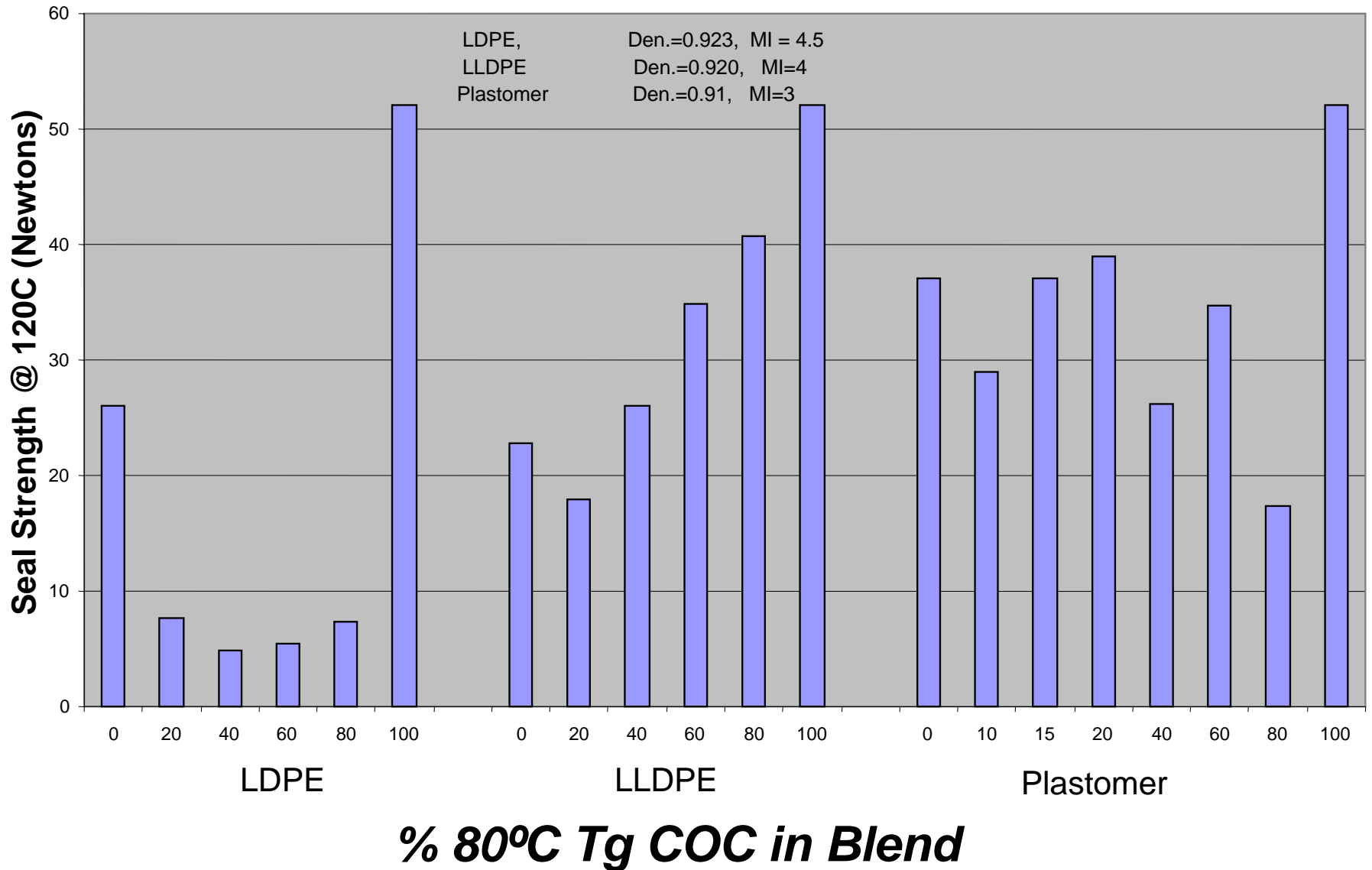
**COC blends produce a wider sealing window**

# Effect of Blending 80°C Tg COC with LLDPE on Hot Tack Force

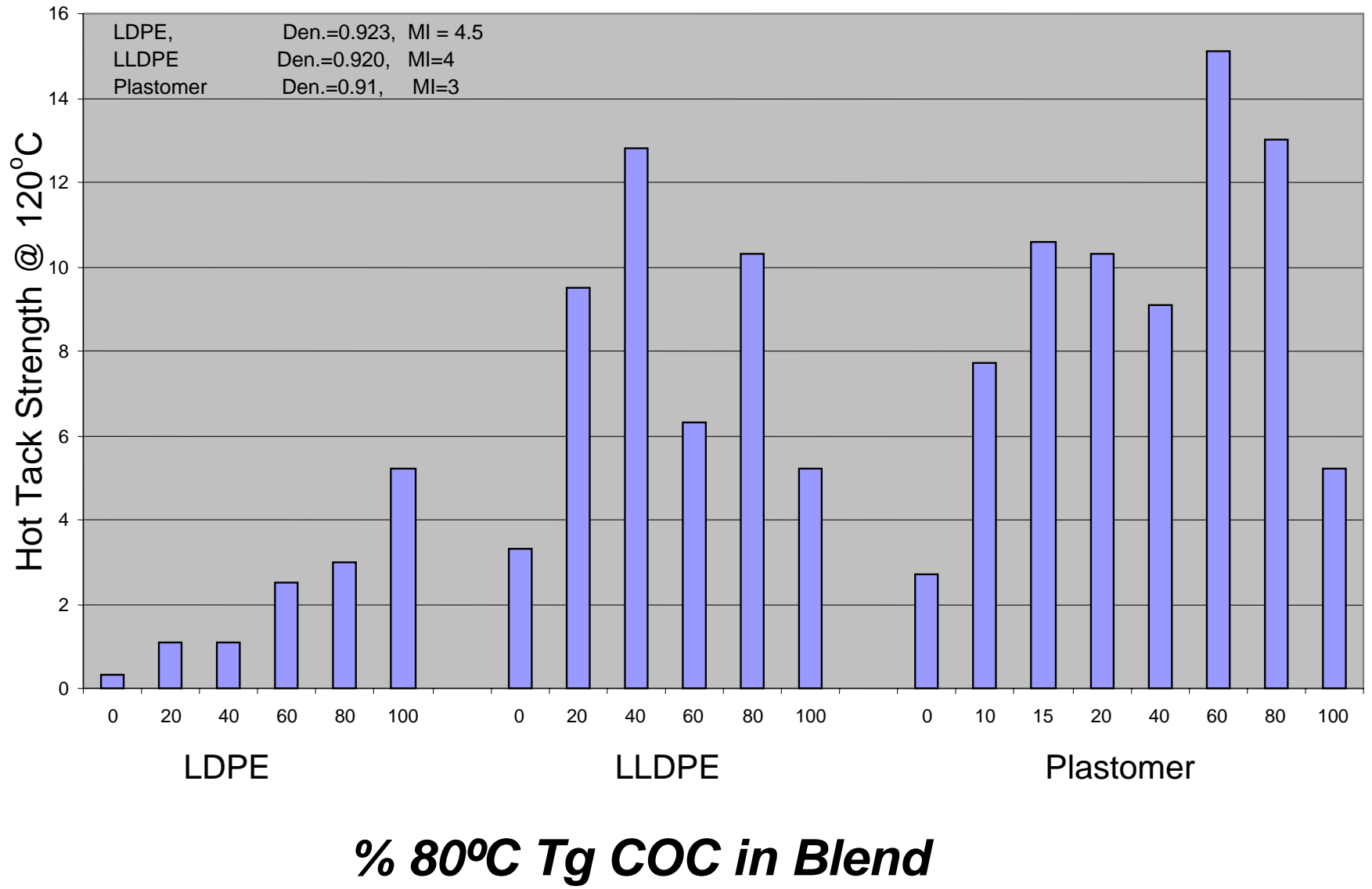


***COC blends produce a wider sealing window***

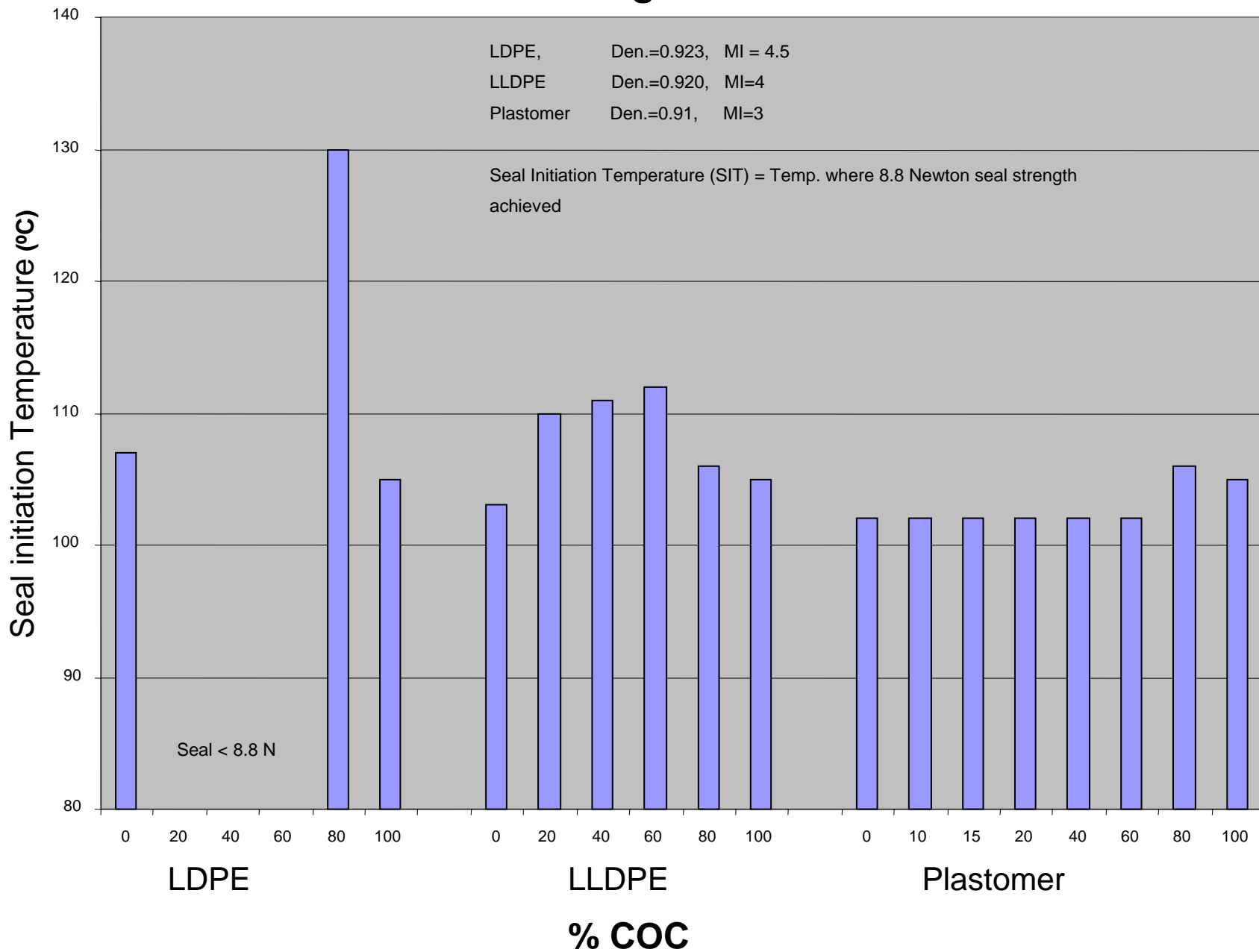
# Effect of COC Addition on Seal Strength



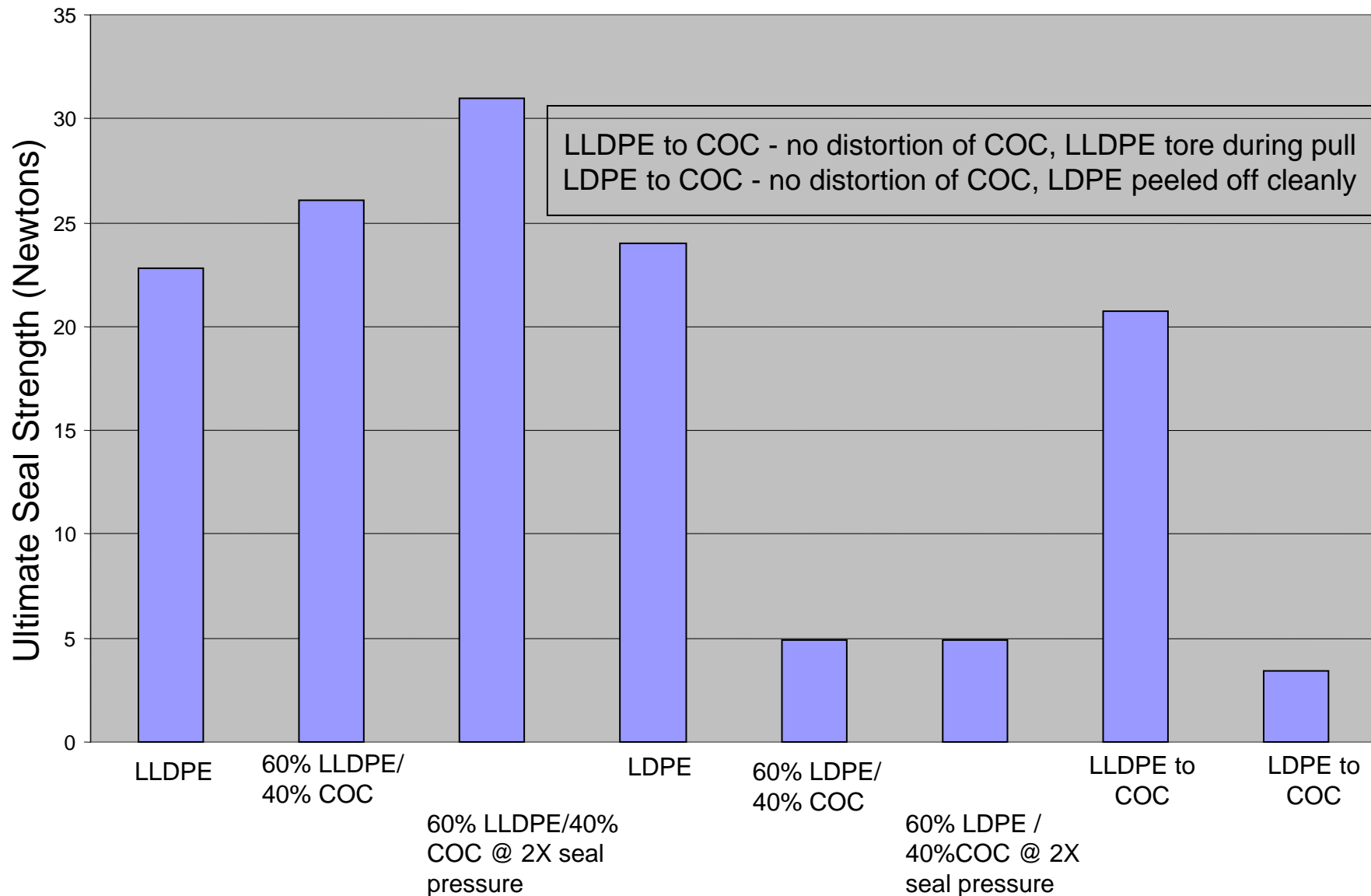
# Effect of COC Addition on Hot-Tack



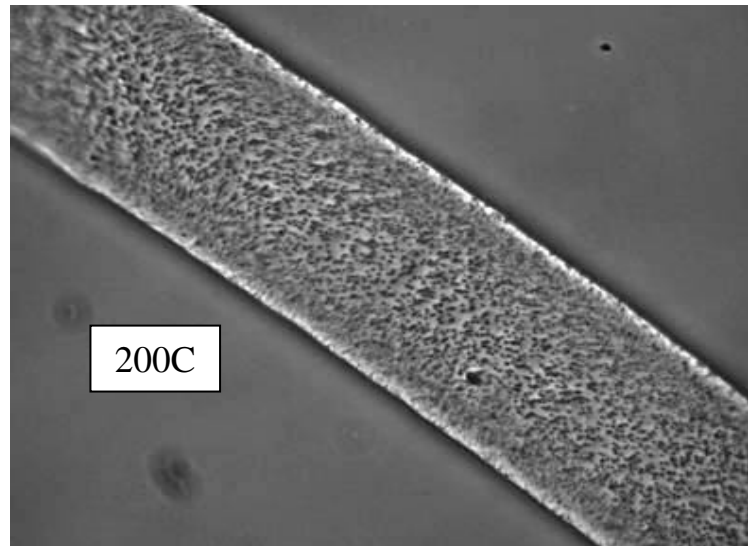
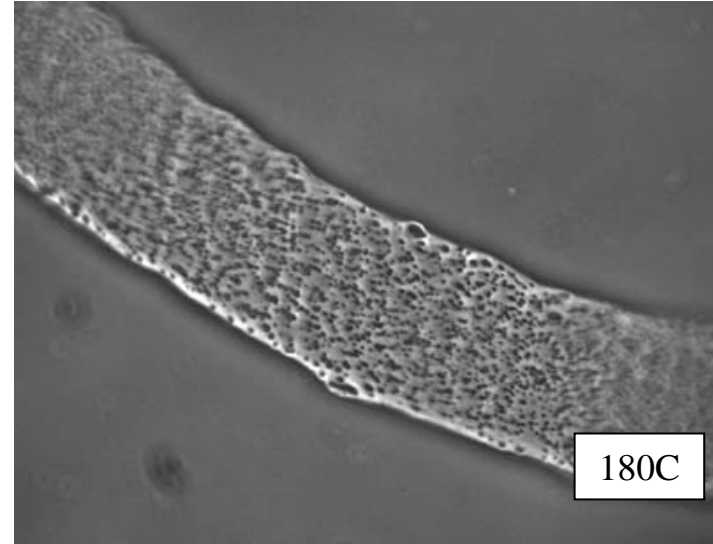
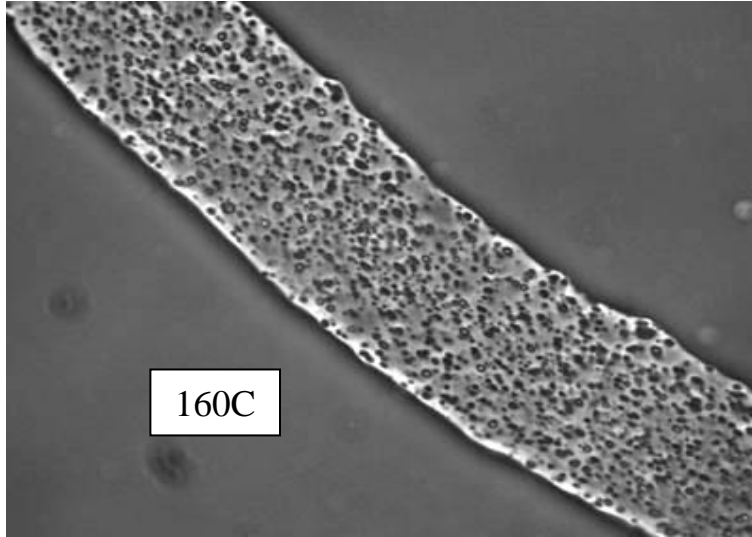
# Effect of 80° C Tg COC Addition on SIT



## Seal Strength at 120°C of LDPE vs. LLDPE

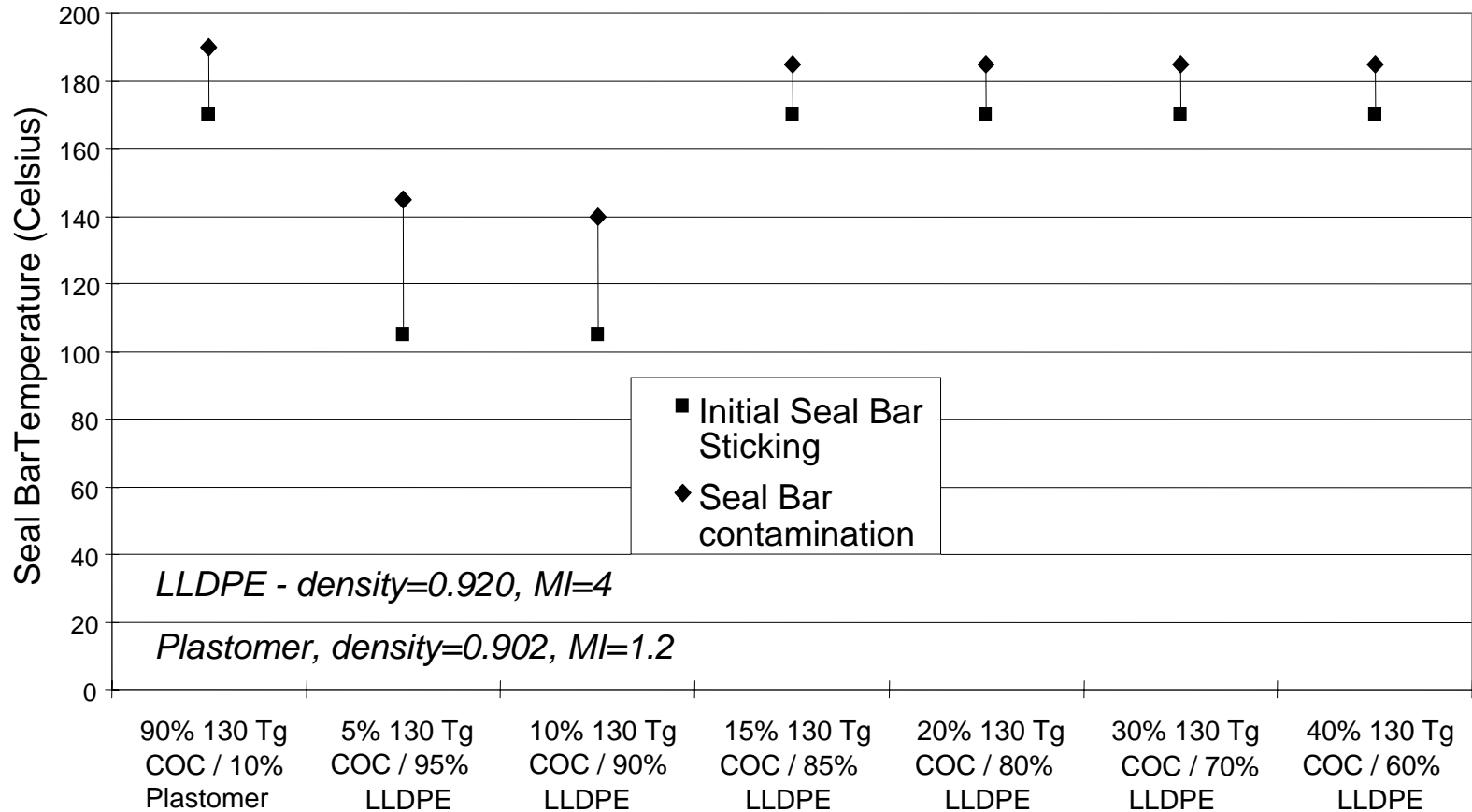


*Phase Contrast Optical Microscopy:  
80% 12 MI LDPE + 20% 80°C T<sub>g</sub> COC,  
51 μm cross section, 625X*



*Reference 3*

# Seal Through Test Results



**High Tg COC as an outer layer blend component can provide seal through capability**

## Conclusions

- ***COC/polyethylene blends can exhibit both improved modulus and heat seal performance***
- ***COC is more compatible with LLDPE and Plastomers than LDPE***
- ***COC level and matrix polymer affect heat seal performance***
  - ***80° Tg COC generally improves hot tack strength at all blend levels for the polyethylene systems studied.***
  - ***80° Tg COC reduced the seal strength of LDPE at concentrations of 20% and up while maintaining or improving the seal strength of LLDPE and Plastomer***
- ***130° Tg COC blended at levels above 20% can provide “seal through” capability to polyethylenes***

## Acknowledgements

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- *Robert Roschen*
- *Rick Vliet*
- *Betsy Kelly*
- *Kathy Fitzgibbon*
- *Betty Fernekess*

# References

1. ASTM, *Designation: F 1921-98, Standard Test Methods for Hot Seal Strength (Hot Tack) of Thermoplastic Polymers and Blends Comprising the Sealing Surfaces of Flexible Webs*, ASTM Standards 1999
2. R.R. Lamonte, "Stiffer, Thinner, Packaging Films with Improved Sealing Using Cyclic Olefin Copolymers", *Flexpac Conference, Amsterdam, Holland, November 2000*
3. D.R. Constant, "Cyclic-Olefinic Copolymers as Non-Migrating Polymeric Slip Additives in LDPE Cast Films", *ANTEC 2002 Conference, San Francisco, CA*

# **Backup Slides**

## **Regulatory Status**

- ◆ **FDA Food Contact Notification (FCN No. 75) became effective August 22, 2000**
- ◆ **Norbornene is listed by the EU as an approved monomer for use in polymers in contact with food.**
- ◆ **USP Class VI**
- ◆ **FDA Drug Master File, DMF# 12132 and Device Master File, MAF # 1043 established**

**COC meets all major regulatory requirements**