

TOPAS[®] COC

High Barrier for Antiseptic Packaging



Cyclic Olefin Copolymer (COC)

A New Family of Thermoplastic Materials



- Olefinic Resin
- Amorphous, Clear and Colorless
- High Purity
- High Moisture Barrier
- Good Chemical Resistance
- Easy to Process

TOPAS® COC - Production Plant

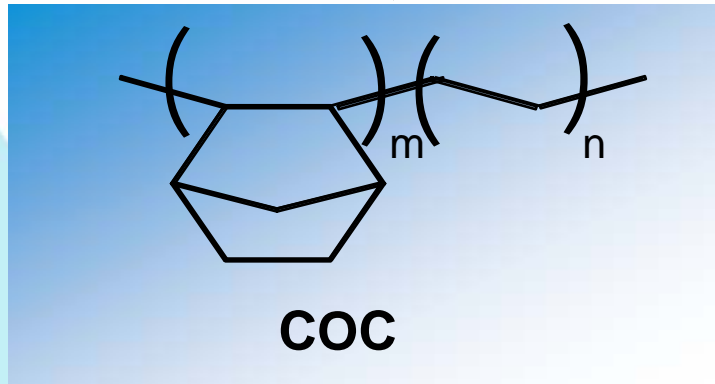
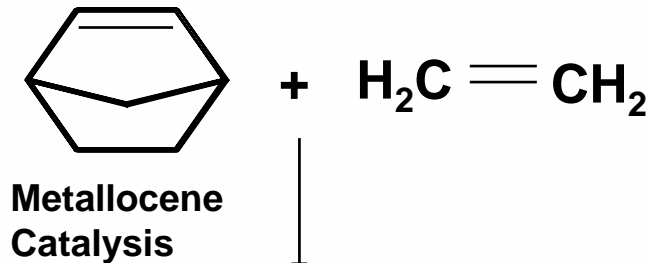
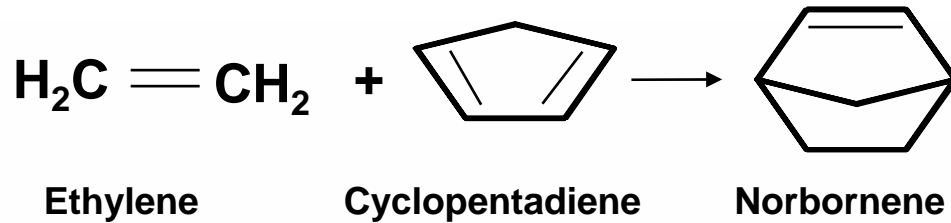


- Production plant on stream since Oct 2000
- 30 000 tons / year production capacity
- Backward integrated in Norbornene
- Largest Cyclic Olefin Copolymer (COC) plant in the world

Large scale production enables TOPAS Advanced Polymers to offer a product at competitive pricing



COC - Synthesis and Structure



- Readily available raw materials
- Highly efficient catalysis
 - Low usage
 - Catalyst removed as of process
 - High purity product
- Amorphous
- Crystal clear



COC - Basic Properties

Glass transition temperatures in [°C]

70 - 180

Modulus of elasticity in [N/mm²]

2600 - 3200

Tensile strength in [N/mm²]

66

Density in [g/cm³]

1.02

Water uptake in [%]

< 0.01

Water permeability in [g × mm/m² × day]

0.02 - 0.04

- Glass clear, Transparent
- High UV Transmission
- Resistant to Alcohols, Acids, Bases, Polar Solvents
- High Purity, Low Extractables
- Low Water Transmission Rate (WVTR)
- Biocompatible
- Halogen-free



TOPAS® COC – Regulatory Status

- FDA Regulation 21 CFR 177.1520 (3.9)
- TOPAS® COC FDA Food Contact Notification (FCN #75) became effective August 22, 2000, covers films, sheets, and articles made therein from and molded articles for repeated use.
- TOPAS® COC FDA Food Contact Notification (FCN #405) became effective May 20, 2004, expands #75 to cover all applications, including bottles.
- FDA Drug Master File, DMF# 12132, established.
- FDA Device Master File, MAF# 1043, established.
- The monomers are listed in the EU-Directive 2002/72/EG
 - Norbornene has a SML = 0.05 mg/kg.

**TOPAS® COC meets all major regulatory requirements
for food contact and medical use**



COC - Enhancement in Value

Customized Performance

- Barrier
 - WVTR – extended shelf life
 - Special barrier (e.g. acetic acid, alcohol, aroma barrier, Iodine, moderate gas-barrier)
- Mechanical Properties
 - Added stiffness – down-gauging
 - Improved thermoforming
 - Higher temperature resistance
 - Controlled tear
 - Better puncture resistance
- Seal Properties
 - Low T_g COC can improve seal strength and hot tack



Typical Film Structures (mono/coex)

COC Discrete Layer - Films

- COC monolayer-film PVDC, laminated with PP, PVC, PAN (Barex[®]), PCTFE, PE/EVOH for blister packaging

- COC multilayer-film
 - co-extrusion PP / COC / PP blister packaging
COC / PE-LLD / COC sleeves, twist wrap
 - extrusion coating cardboard / (LDPE) / COC / LDPE

- adhesion in co-extrusion
 - directly to PE-HD, PE-LLD, Plastomer, EVA, (PE-LD)
 - tie-layer needed for PP, PET, PA, EVOH, HDPE, (PE-LD)
=> individual cases to be checked



Typical Film Structures (blends)

COC / Polyethylene Blend - Films

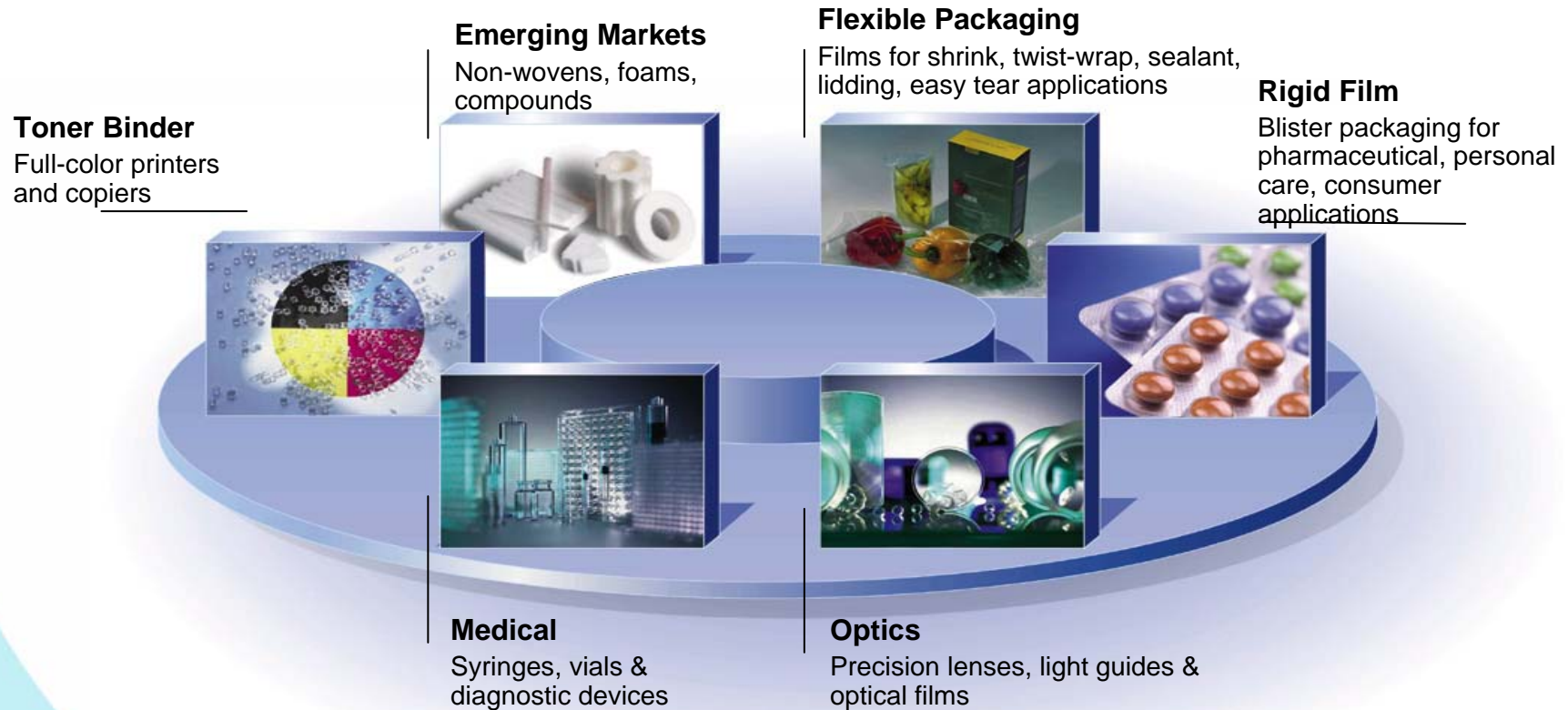
- PE-LD, PE-LLD, Plastomer, EVA
 - Semi-compatible blends
 - Increasing compatibility
HDPE - LDPE - LLDPE - Plastomer

- Depending on...
 - crystalline (density, refractive index)
 - side chains, viscosity

- Typical blend mixes
 - 5 - 30% PE in COC
 - 5 - 30% COC in PE



COC – Market Segments



COC can substitute traditional products in different growth markets

COC - Chemical Resistance

pH < 7 (acidic / aqueous)

hydrochloric acid 36 %
sulfuric acid 40 %
nitric acid 65 %
acetic acid > 94 %



pH = 7 (neutral / aqueous)

Water
Aqueous solution
of soap
saline solution



pH > 7 (basic / aqueous)

sodium hydroxide 50 %
ammonia (aq. Sol.) 35 %



Polar organic solvents

ethanol, methanol,
butanol, isopropanol,
(short chain alcohols)
Acetone, butanone
(short chain ketones)



Aromatic solvents

Benzaldehyde
Toluene
Benzene
Chlorinated Solvents



Non-polar organic solvents




Pentane, hexane,
heptane etc. (alkanes)
Gasoline (petrol ether)
Norbornene



Other

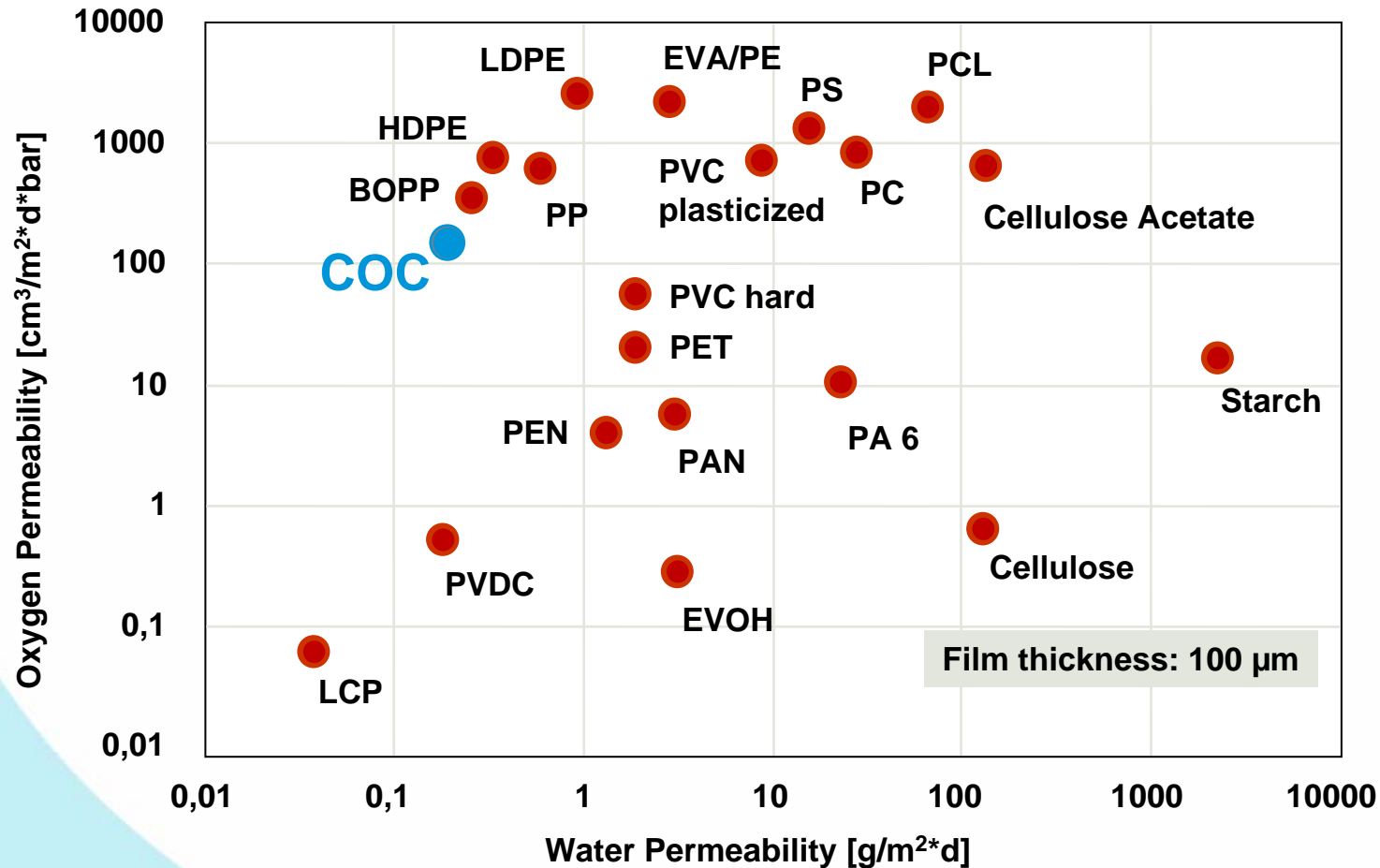
Oleic Acid



-  resistant, increase of weight < 3% or loss of weight < 0,5%, elongation at break not substantially altered
-  limited resistance, increase of weight 3-8% or loss of weight 0,5-5%, elongation at break reduced by < 50%
-  not resistant, increase of weight > 8% or loss of weight > 5%, elongation at break reduced by > 50%

**COC is resistant to acids, alcohols,
bases and polar solvents**

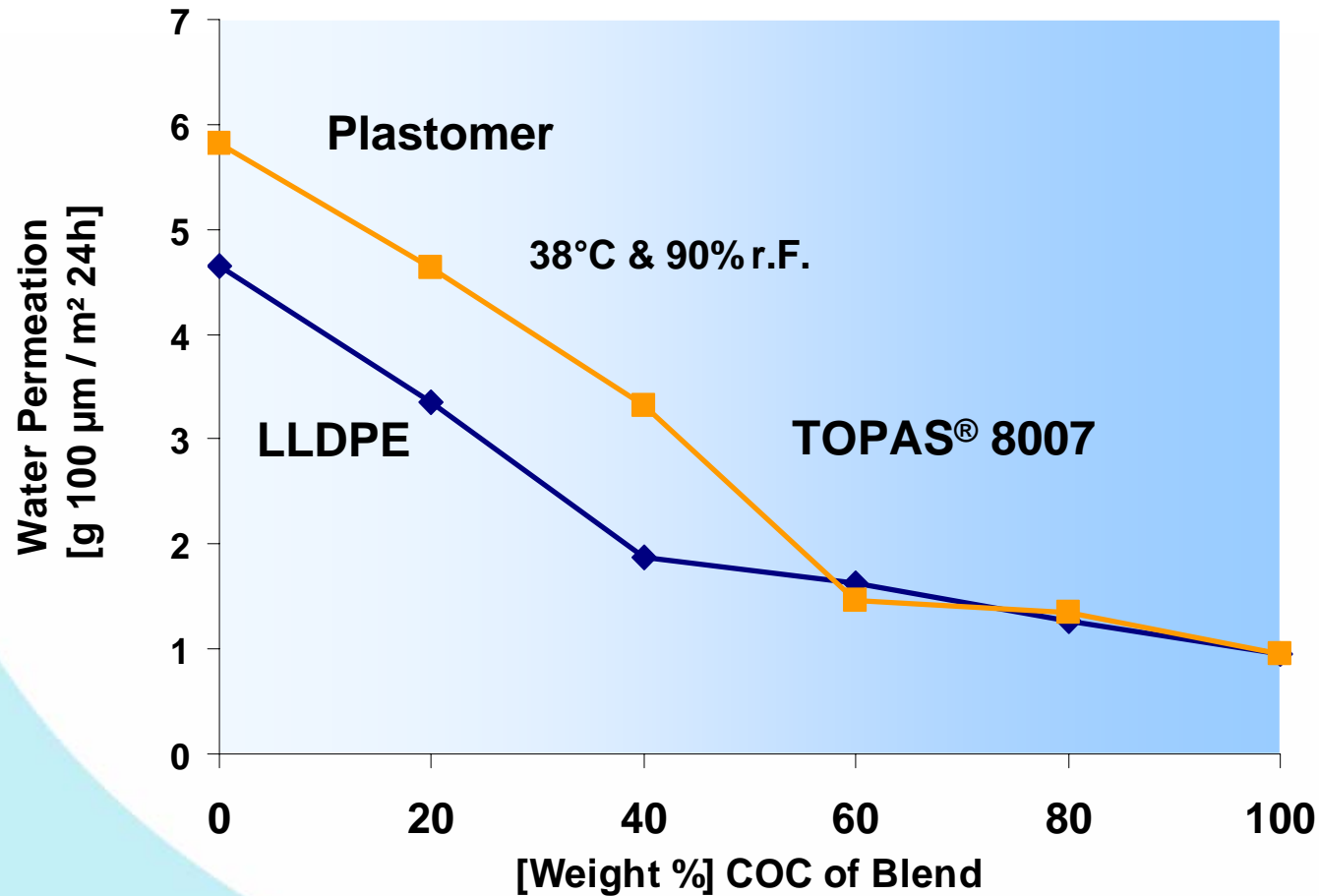
COC - Barrier Properties



COC can extend the shelf life of products due to its very high moisture barrier

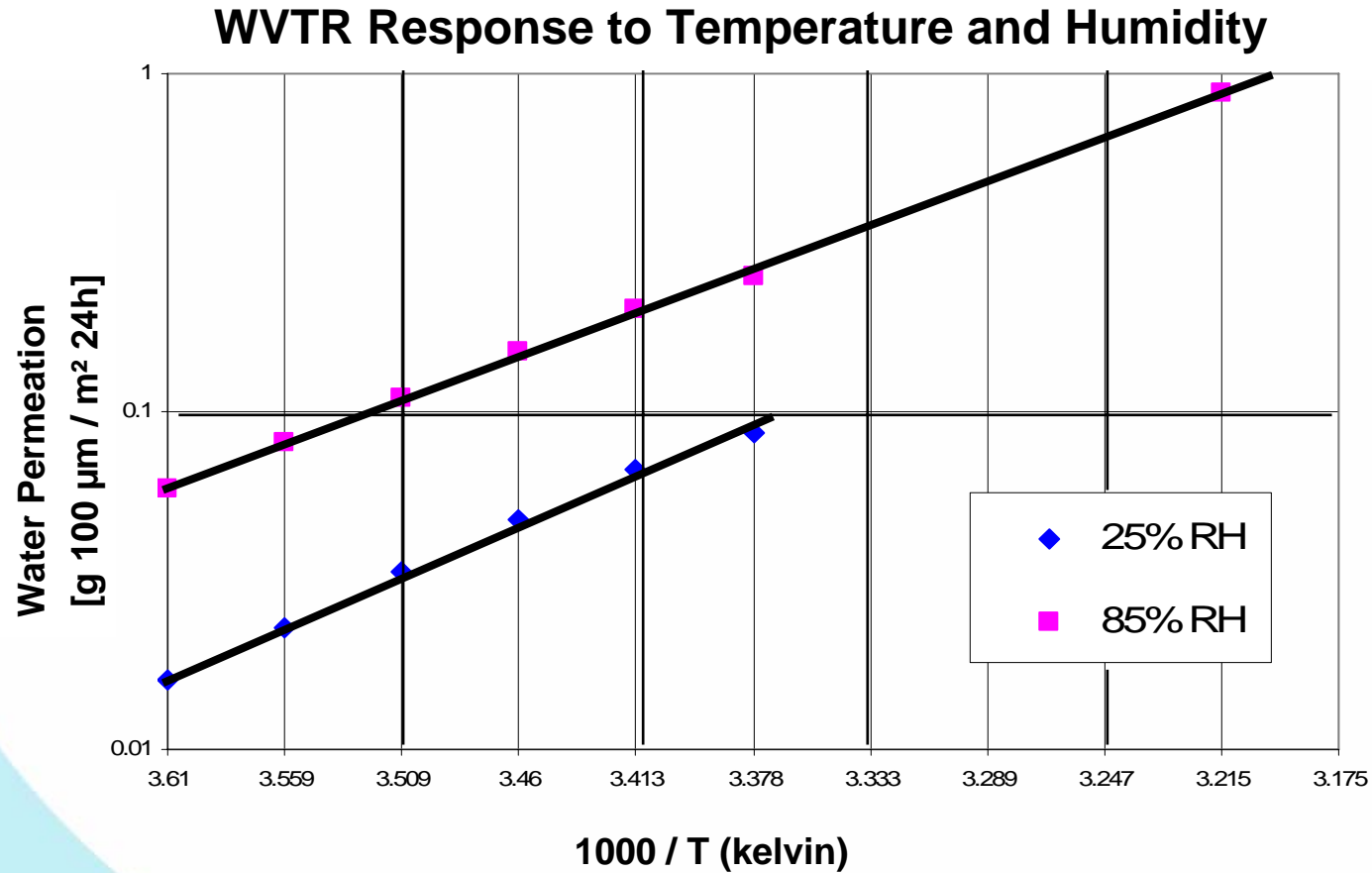


Barrier Properties in PE/COC Blends*



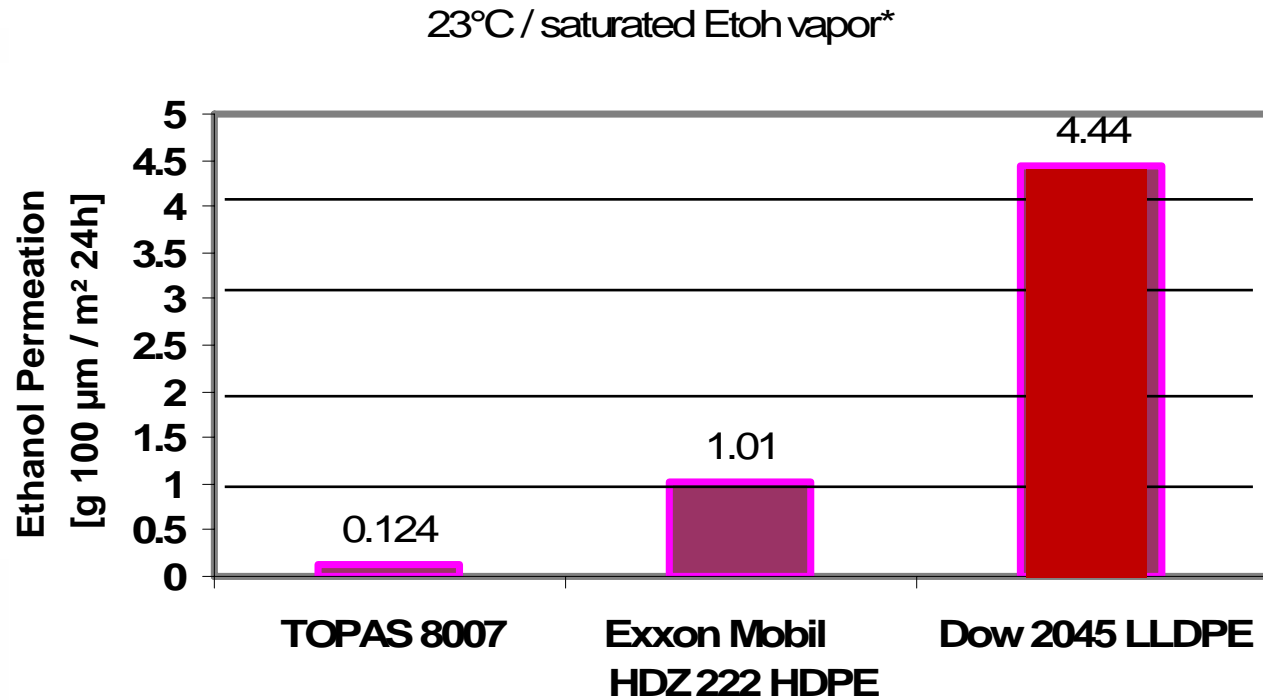
*Materials: LLDPE Dow 2035, Plastomer ExxonMobil 3125, TOPAS[®] 8007F-04

Moisture Barrier of COC



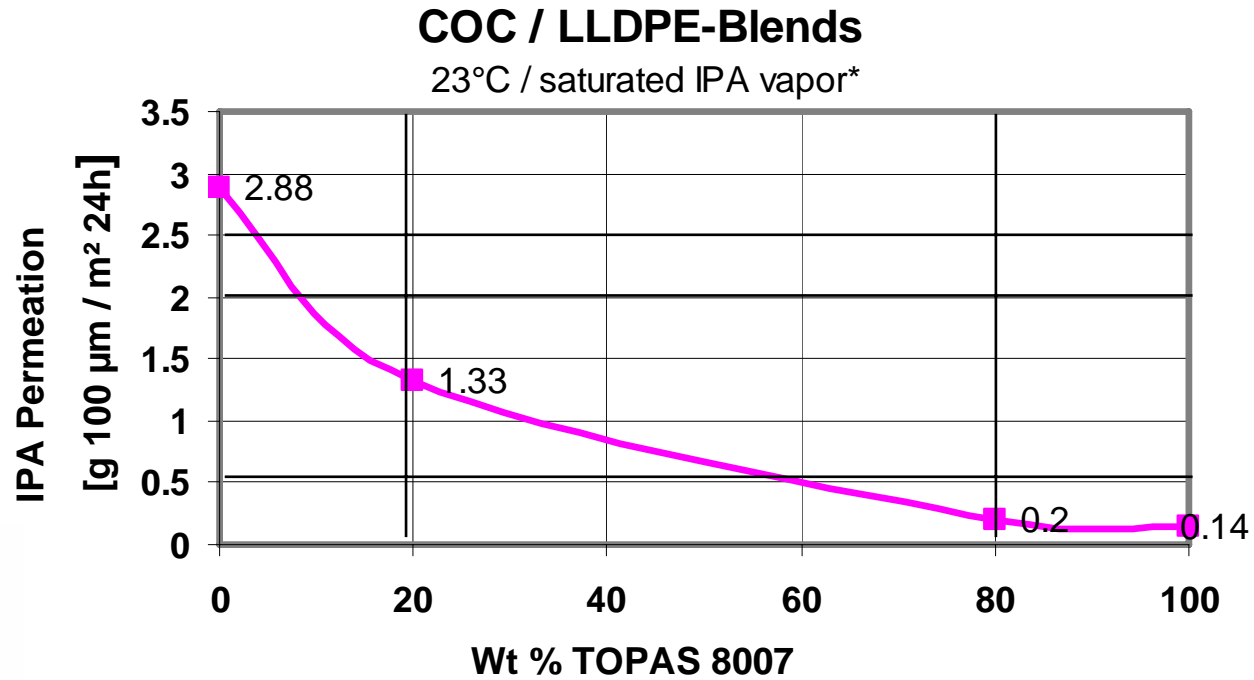
COC barrier exhibits the normal linear relationship when log transmission is plotted against the reciprocal of absolute temperature. Transmission increases linearly as humidity increases.

Ethanol Barrier



COC has significantly reduced ethanol permeability as compared to other polyolefins*.

COC/PE Blends Isopropyl Alcohol Barrier



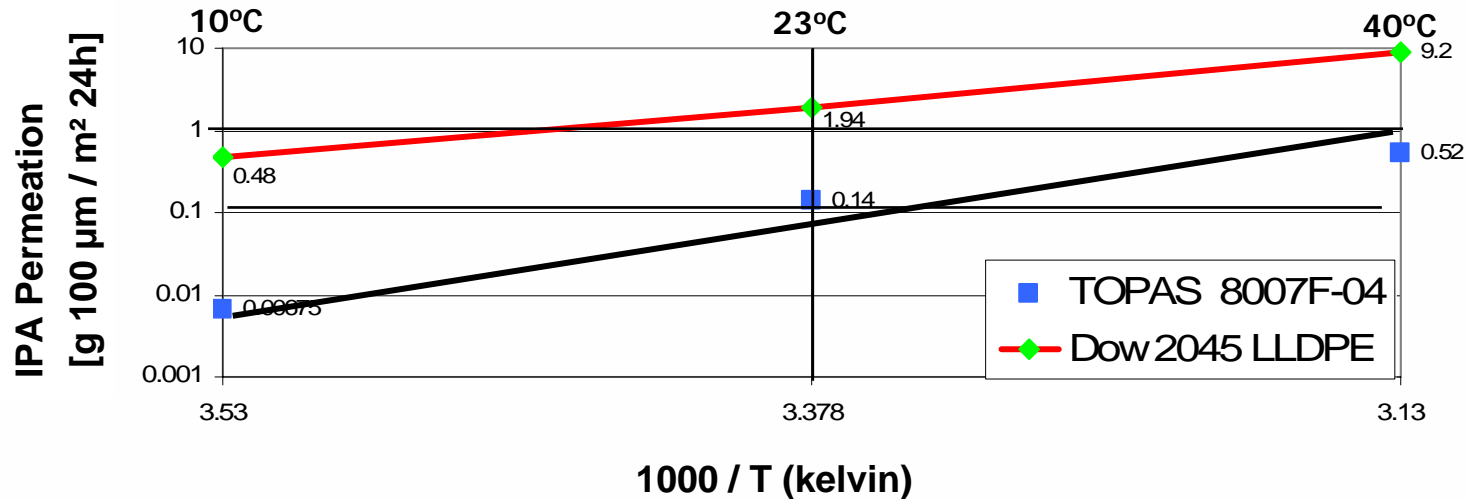
COC / LLDPE blends have significantly reduced IPA permeability as compared to pure LLDPE.**

* MOCON Test Labs

** Dow 2045

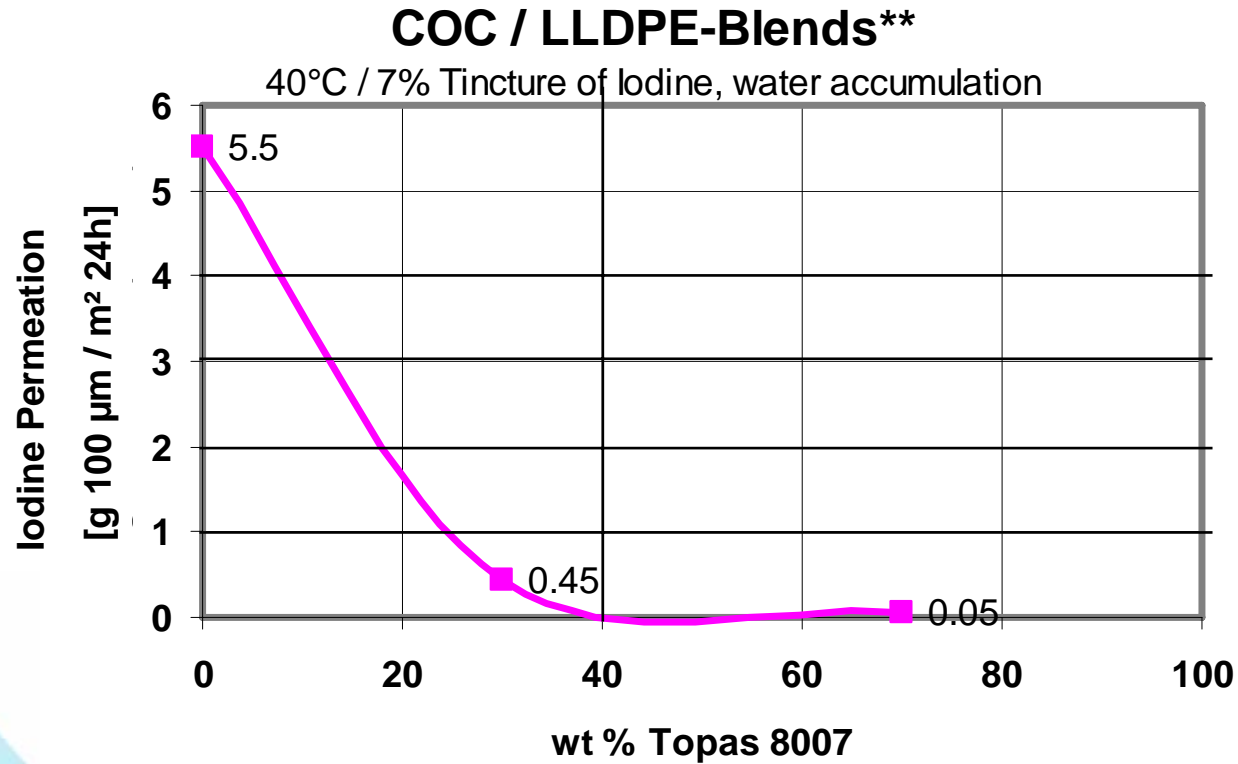
Isopropyl Alcohol Barrier

Response to Temperature



COC barrier exhibits the normal linear relationship when log transmission is plotted against the reciprocal of absolute temperature. IPA transmission at room temperature through COC is 14 times less than for LLDPE at 23°C.

COC/PE Blends Iodine Barrier



COC / LLDPE blends have significantly reduced Iodine permeability as compared to pure LLDPE*.

Conclusions

- COC functions well as a discrete layer combined with polyethylene or in blends.
- COC functions as an effective barrier for common antiseptic solutions. At room temperature:
 - COC has ~5 times the water barrier of LLDPE
 - COC has ~36 times better ethyl alcohol barrier than LLDPE
 - COC has ~21 times better isopropyl alcohol barrier than LLDPE
 - COC has ~110 times better Iodine barrier than LLDPE
- COC is in the FDA Drug master-file system

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