

Advances in Polyethylene Yarn Technology

Updated Criteria for Turf Fibers

Martin Schlegel



Requirements

1. Durability
2. Softness
3. Processibility
4. Temperature resistance



Three important Parameters of Yarn *"The three P's"*

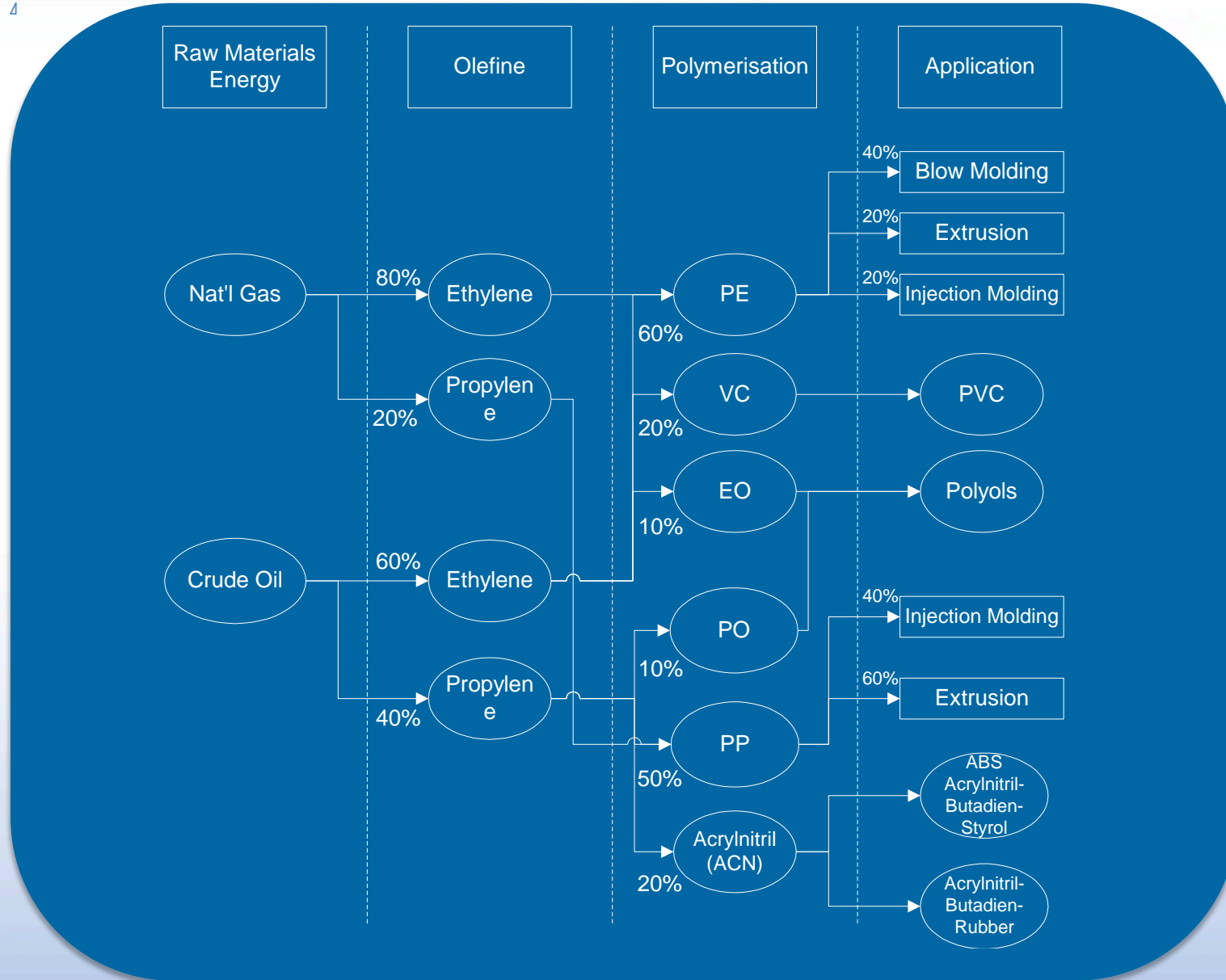
1. Polymer – Chemical Building Blocks
2. Process – Yarn Extrusion and Treatment
3. Pattern – Geometry of Yarn



Chemical Building Blocks

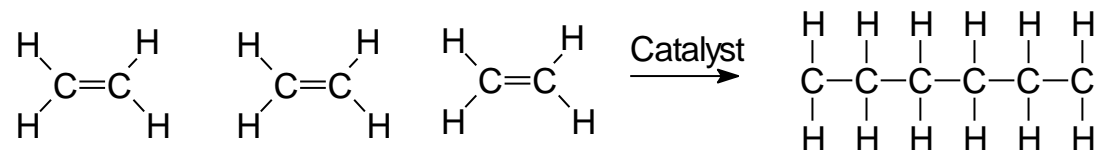


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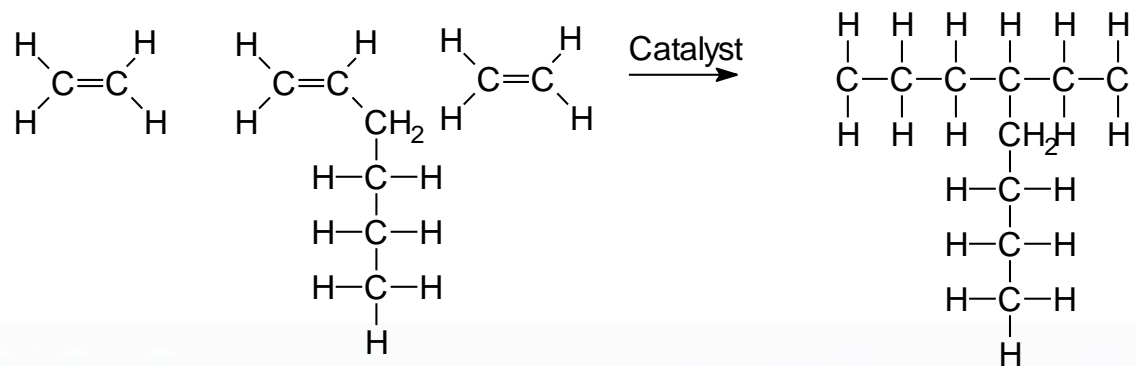


Formation of Ethylene Homopolymer: High-density Polyethylene (HDPE)





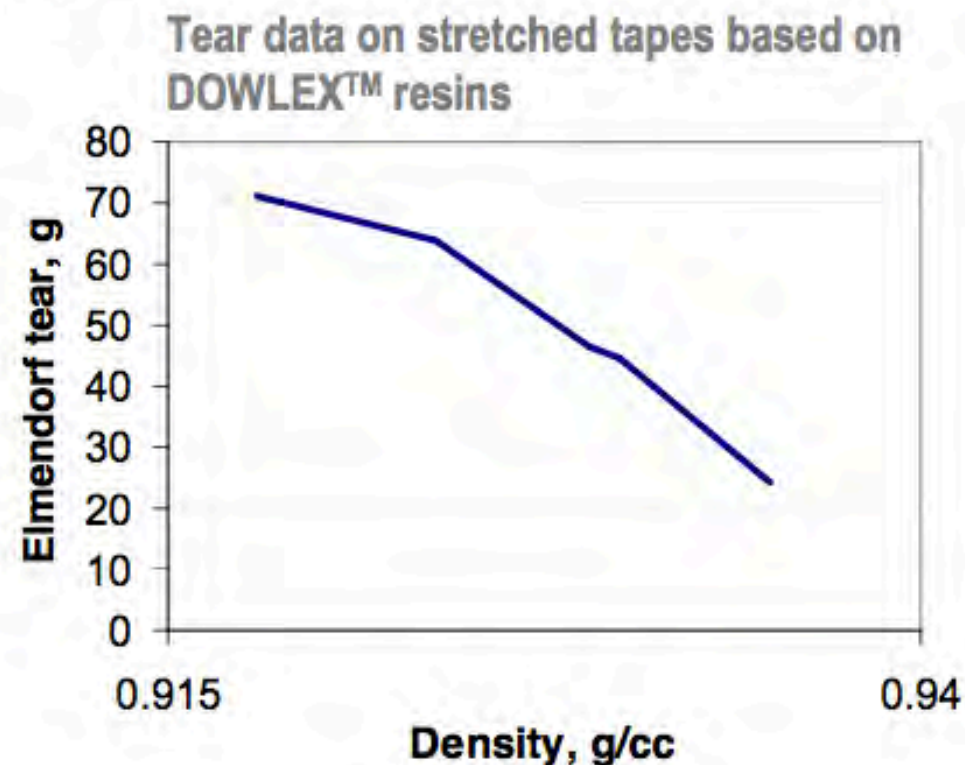
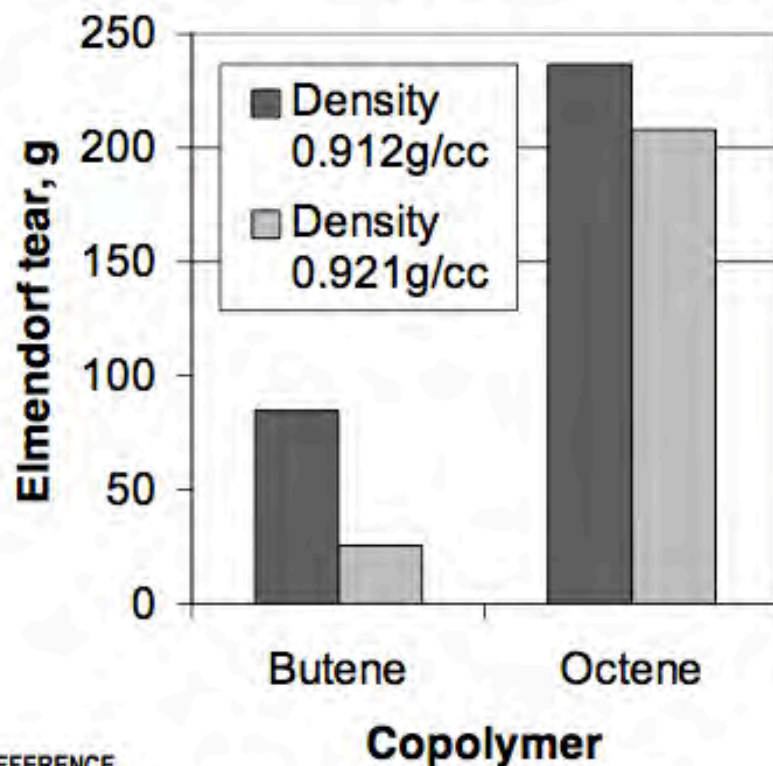
Formation of Ethylene Copolymer: Linear low-density Polyethylene (LLDPE)





What Improves Tear Resistance?

Tie-chain concentration and crystal connectivity as function of density and comonomer improve material toughness



REFERENCE

Kale, LT, et al., "Structure-Property Relationships of Ethylene/1-Octene and Ethylene/1-Butene Copolymers made Using INSITE™ Technology", SPE ANTEC, 1996

Copolymer choice is critical to final tear resistance.

®Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

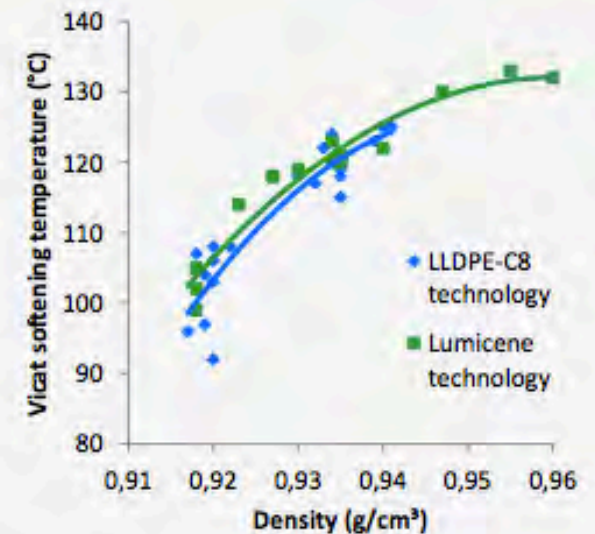
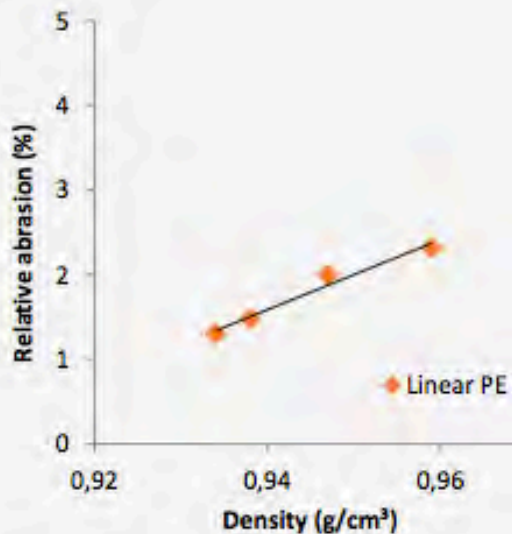
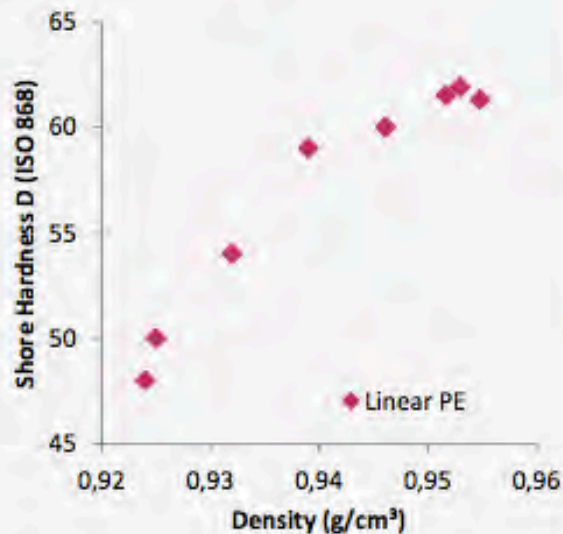
INTRODUCING *lumicene*® M1835 FOR HIGH QUALITY GRASS YARN

ADVANTAGES LOWER DENSITY

- Softness
- Abrasion Resistance
- Better Elastic Recovery
- Increased Yarn Toughness
- Lumicene Technology Safeguards Temperature Resistance

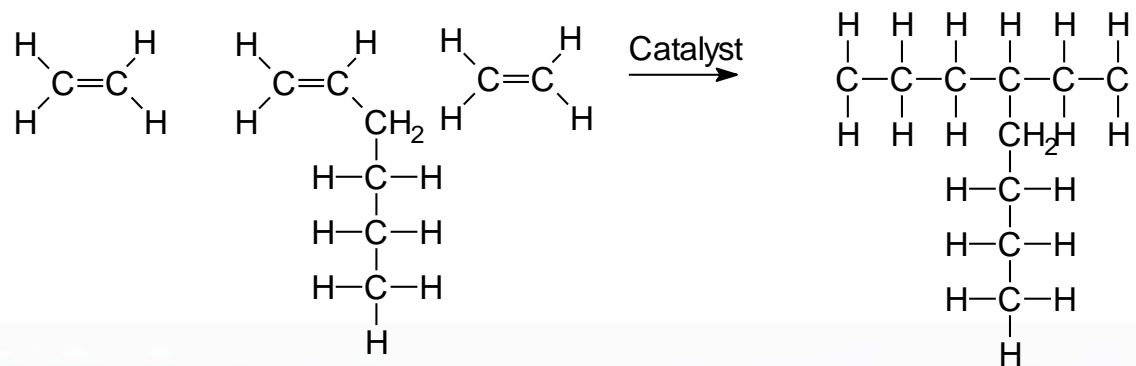


M1835 (d 0.918; MI2 3.5)





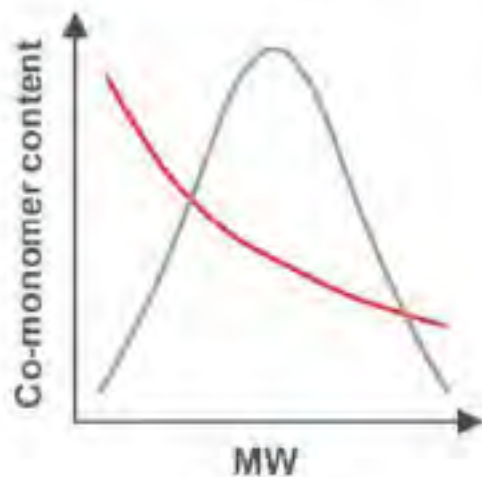
Formation of Ethylene Copolymer: Linear low-density Polyethylene (LLDPE)



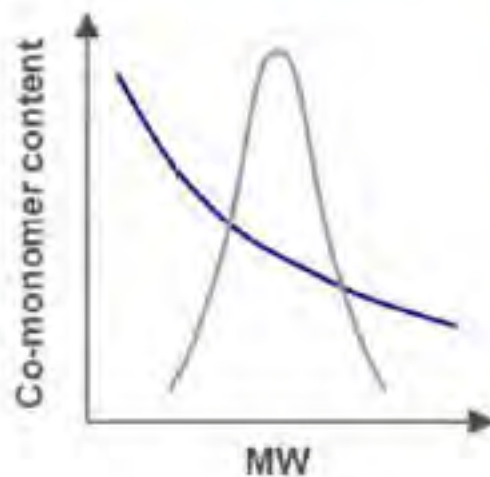


Polyethylene Catalysis

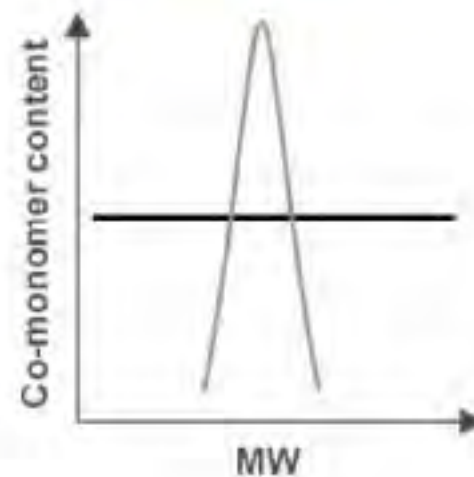
Multiple site
Cr catalyst



Multiple site
ZN catalyst

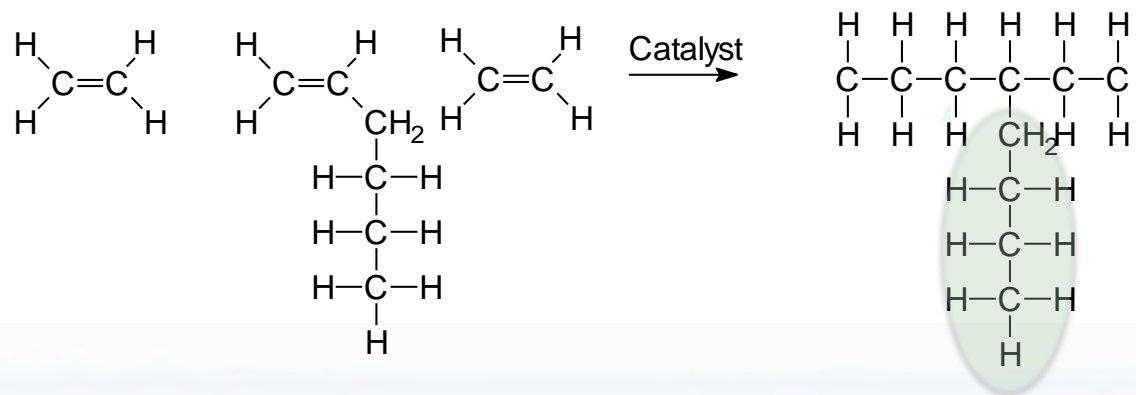


Single site
Metallocene





Formation of Ethylene Copolymer: Linear low-density Polyethylene (LLDPE)



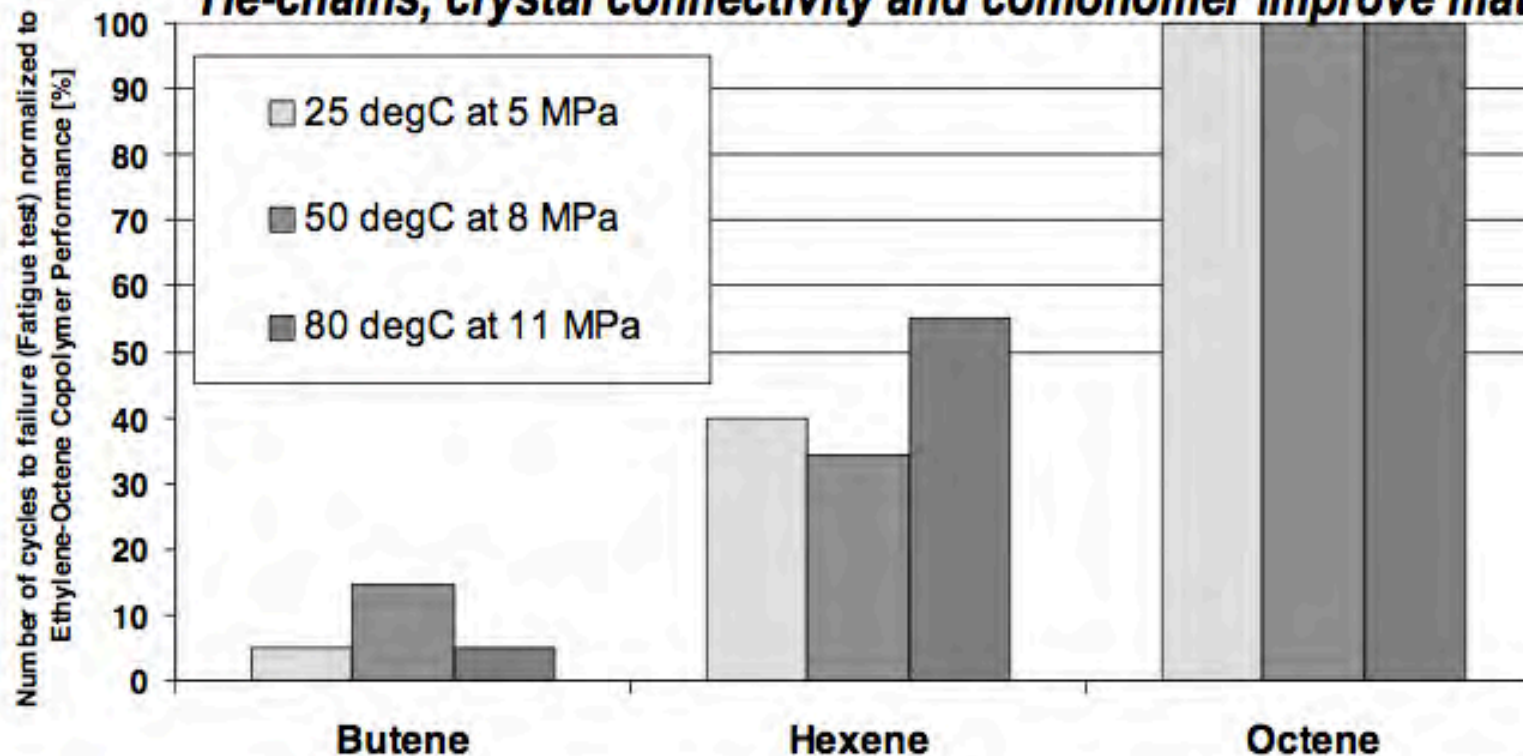
Short chain branching
(co-monomer)



Durability – Material Fatigue Resistance

Resistance to stress cycles tested till material failure.

Tie-chains, crystal connectivity and comonomer improve material toughness

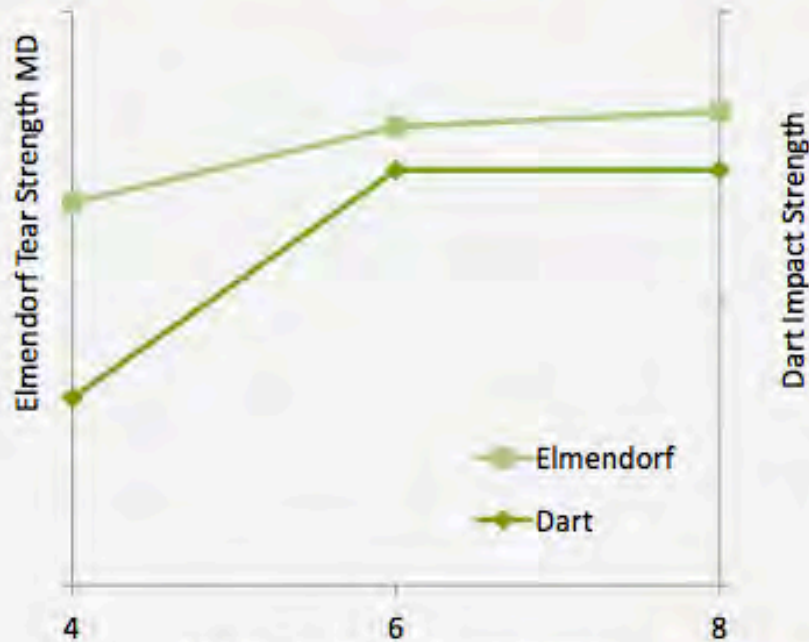


Reference:
J-t Yeh, H-s Hong;
Macromol. Chem.
Phys. 196, 705-714
(1995)

Comonomer type plays significant role for the durability of LLDPE polyethylene material exposed to stress cycles.

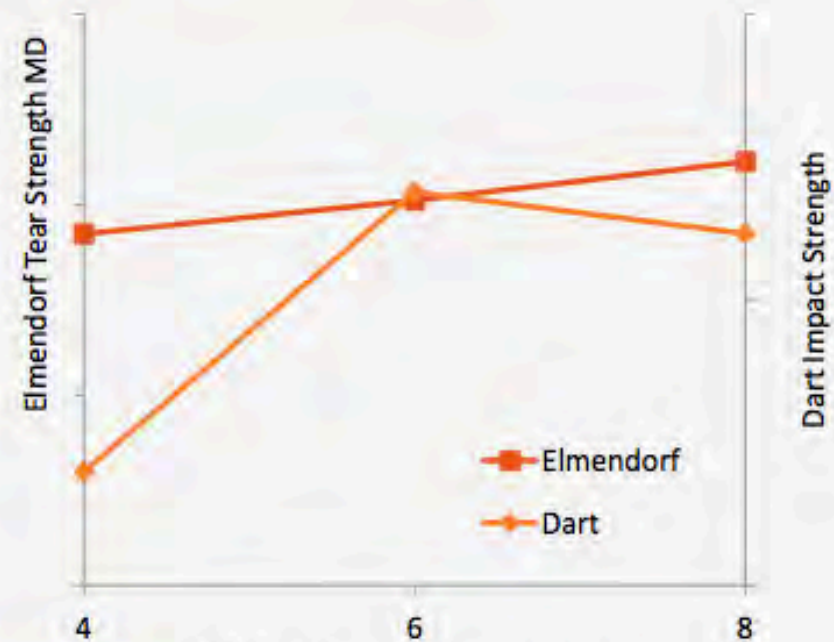
POLYETHYLENE FOR GRASS YARN
WHICH PE MAKES A GOOD YARN?

COMONOMER (C4, C6, C8) – SHORT CHAIN BRANCHING



of carbon atoms in comonomer
A.M. Sukhadia *et al.* Soc. Plast. Eng.
ANTEC, 2000 (CPChem & SABIC)

50 µm LLDPE film samples
(d 0.918 g/cm³; MI2 1.0)



of carbon atoms in comonomer
Total Internal

40 µm LLDPE film samples
(d 0.920 g/cm³; MI2 1.0)

... no significant difference
LLC6/LLC8 but much better than
LLC4



Masterbatch-Compound

Polyethylene (PE)

UV stabilizers

Pigments

Additives





Extrusion

Method of blending components

Forced under pressure through a die

Film

Tape

Monofilament





Yarn Treatment

Temperature treatment

Cutting

Stretching





Twisting

Twisting of tape into yarn

Improvement of resilience

Improvement of appearance





Three important Parameters of Yarn *"The three P's"*

1. Polymer – Chemical Building Blocks
2. Process – Yarn Extrusion and Treatment
3. Pattern – Geometry of Yarn

Optimization!



Thank you

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