Polypropylene Based Olefin Block Copolymer for Clear Cold Tough Applications

Jihean Lee, Colin Li Pi Shan, Ray Laakso, Lisa Madenjian, Eddy Garcia-Meitin, Michael White
The Dow Chemical Company, Freeport, TX

**Elastomers, Electrical, and Telecommunication*

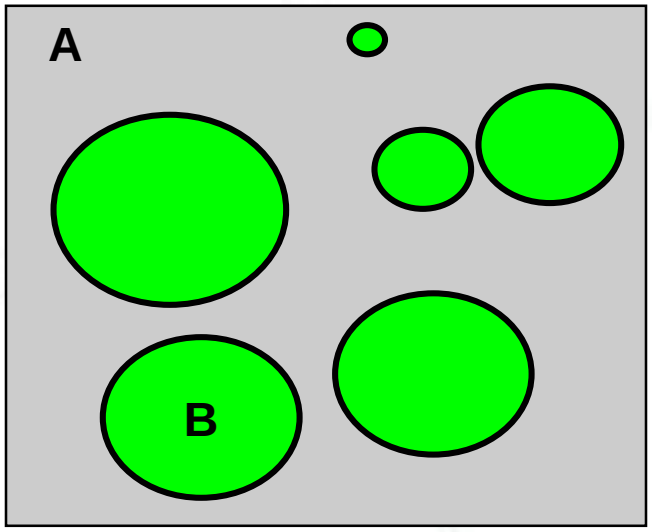
Objective

To connect and balance the properties of polyethylene and polypropylene to develop a new solutions that has clarity, toughness, and flow

Polypropylene for clear tough applications

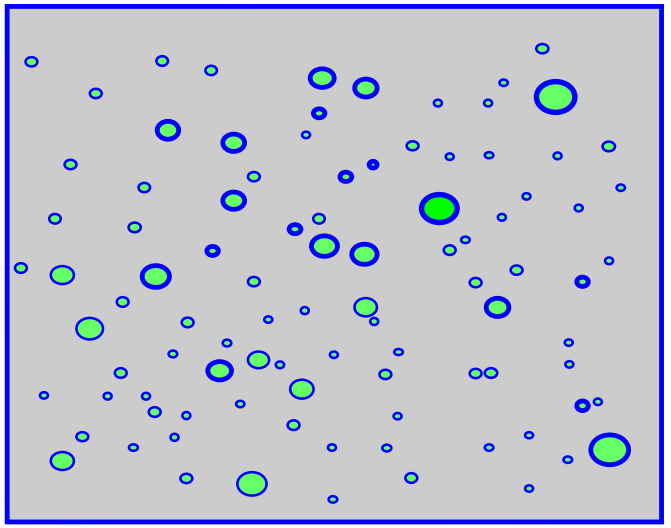
Polypropylene random copolymers	• Clarified grades available • Limited cold temperature impact resistance
Impact-modified polypropylene copolymer	• Can have good impact performance down to -40 °F • Opaque
Clear Impact-modified polypropylene	• Achieved via choice of impact modifier • Controlled elastomer domain size • Clear blends with low temperature impact possible – several options from Dow

Impact Modification: Morphology Illustration



Poor dispersion of Modifier B in Matrix A

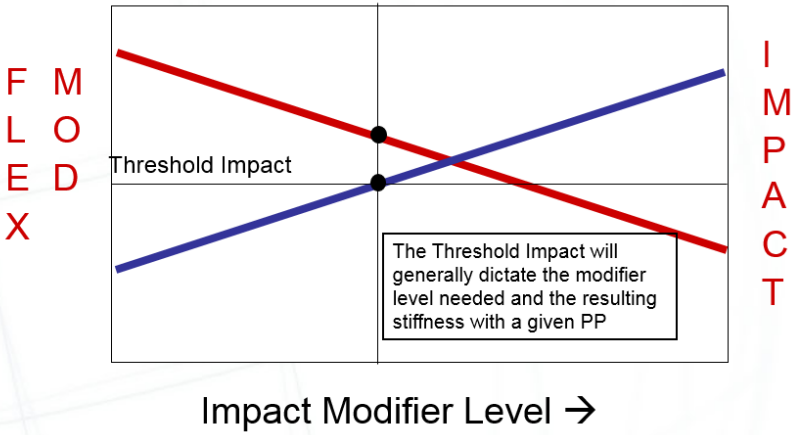
Morphology of Blend

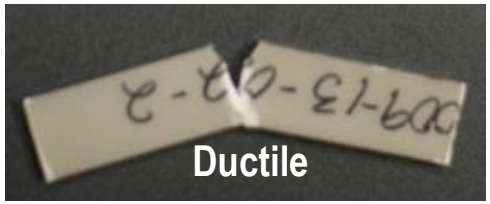


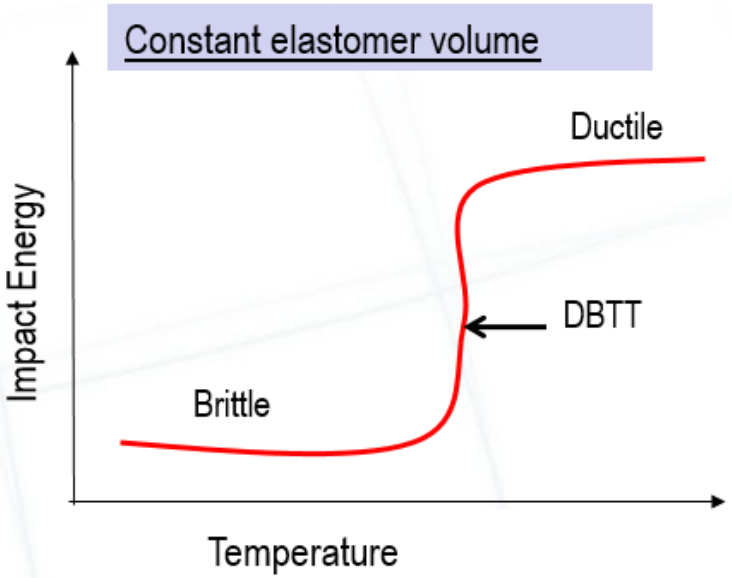
Improved dispersion of Modifier B

- **Balanced rubber phase dispersion is critical for impact strength**
- **The proper selection of modifier type, mixing conditions, loading level, etc., all play a critical role in developing the proper morphology for the desired part performance**

Effect of Elastomer Level and Temperature







DBTT = ductile-brittle transition temperature

- Effect of elastomer level and temperature is not linear
- Percolation type phenomenon, similar to effect of conductive carbon black level on conductivity

Materials and Properties

	MFR (230°C) or MI (190°C) (g/10 min)	Density (g/cm^3)	Description
Clarity RCP	40	0.902	Random copolymer, PP (clarified)
Clarity ICP	30	0.900	PP Impact copolymer (clarified)
INTUNE™ 10510 OBC	90	0.890	Olefin Block Copolymer, propylene-based
INFUSE™ 9817 OBC	15	0.890	Olefin Block Copolymer, ethylene-based
POE 1	30	0.902	Random copolymer, ethylene-octene
POE 2	5	0.870	Random copolymer, ethylene-octene
PBE	25	0.868	Random copolymer, propylene-ethylene

Study of Various Modifiers for Clear, Tough PP Applications

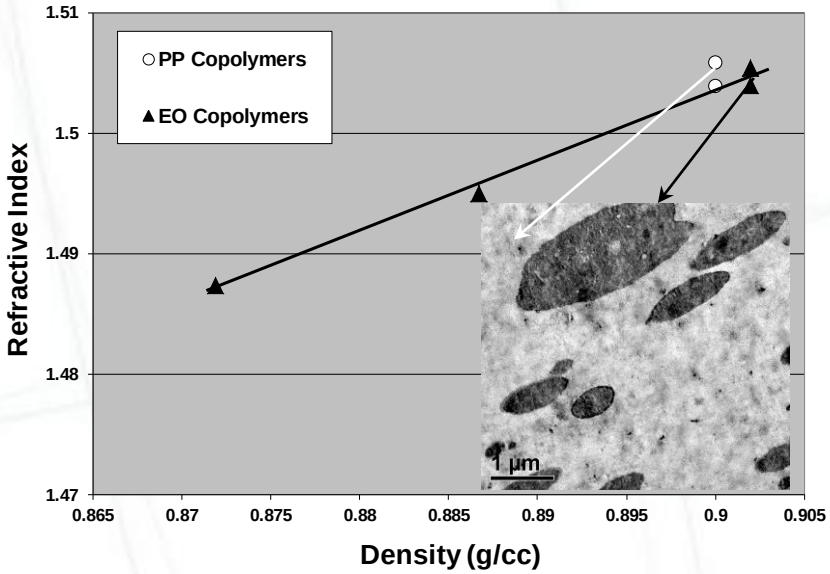
- Benchmark:
  - Clarity ICP
  - Clarity RCP with 20 wt% elastomer loadings
    - ***Note: Elastomer loading varies with application, for example:***
      - ***~20 wt% loading is typical for freezer-grade applications***
      - ***~10 wt% loading is typical for refrigerator-grade applications***
      - ***~3-10 wt% loading is typical for room-temperature applications***
- Tests:
  - TEM
  - Clarity pictures
  - Charpy Impact
  - Izod Impact
  - Tensile

Compatibilization Approach for Improved Clarity and Impact Resistance in PP

Traditional Approach

Refractive index matching of elastomer with PP

Disadvantage:
Limited to 0.90 g/cc plastomer with poor impact properties

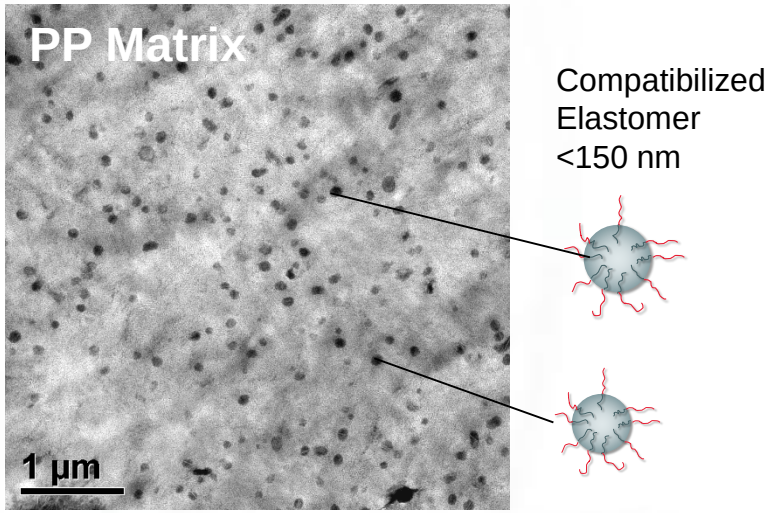


Compatibilization Approach

INTUNE
OLEFIN BLOCK COPOLYMERS

Particle sizing via compatibilization of non-refractive index matched elastomer with PP

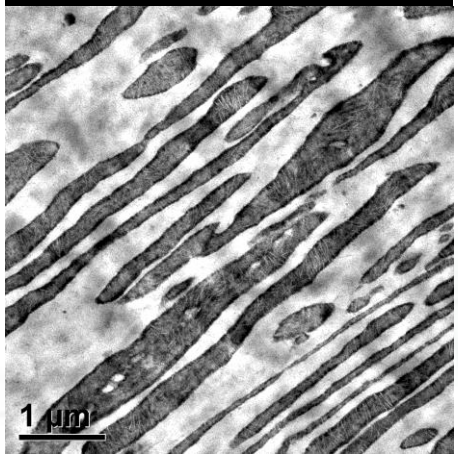
Advantage:
Expanded use of 0.85-0.87 g/cc elastomers with low Tg and excellent impact properties



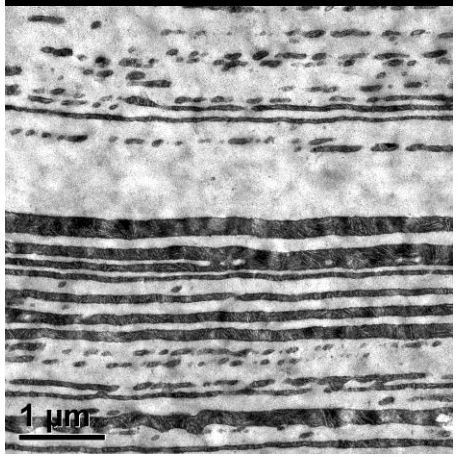
Impact Efficiency-- It's all about Dispersion

Transmission Electron Microscopy (TEM) – Dow Chemical – E. Garcia-Meitin

Clarity ICP



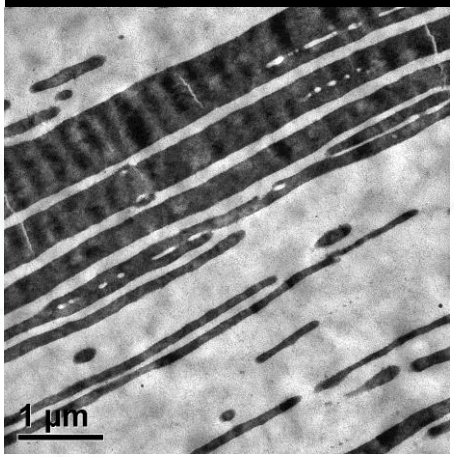
20% INFUSE™ 9817



The TEM micrographs show the dispersion of the elastomers vs. the ICP

INTUNE™ 10510 is unique – observe the breakdown of the elastomer domains

POE 2



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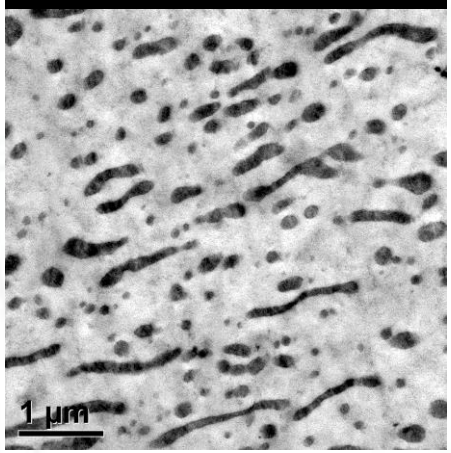
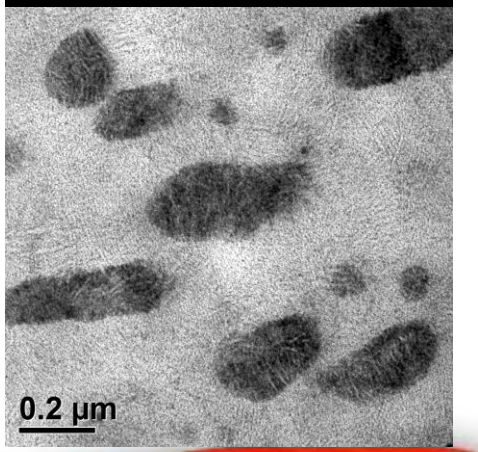
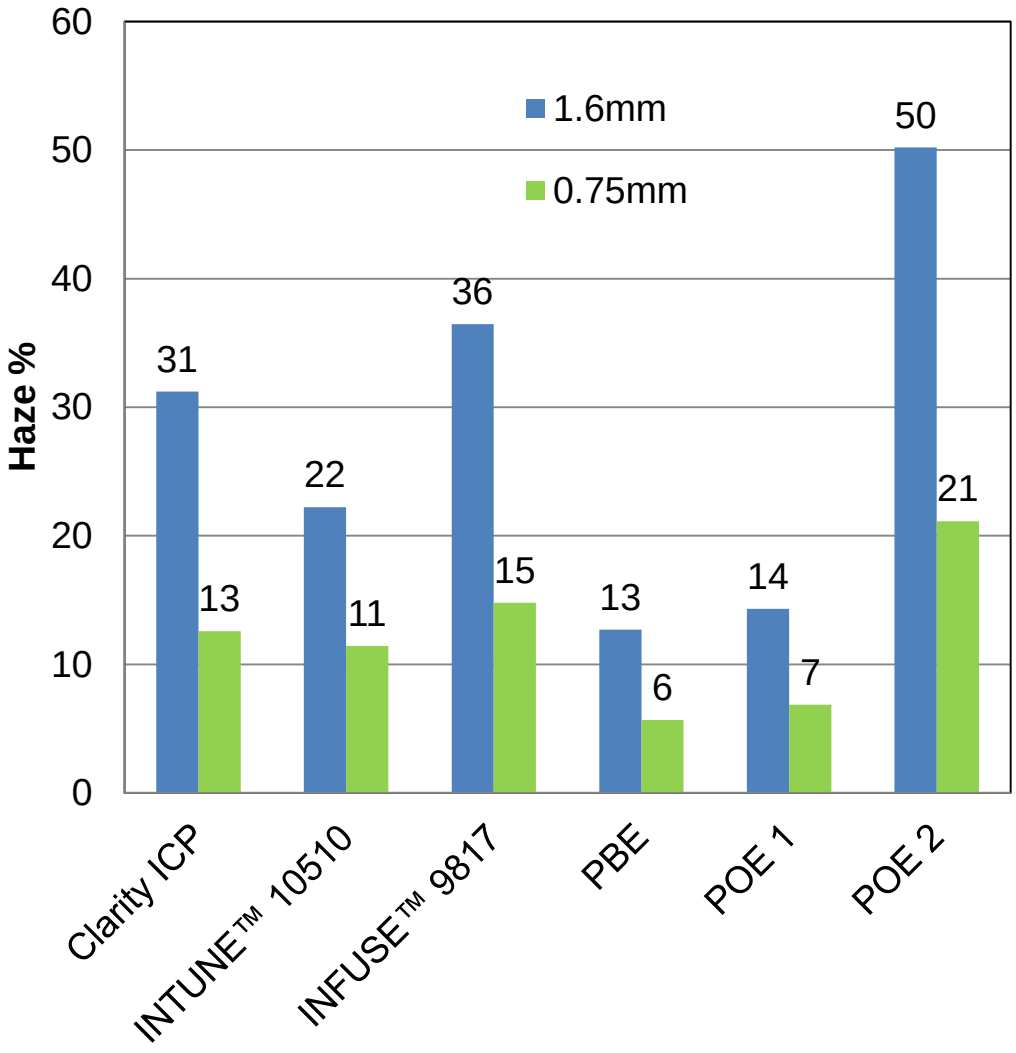


20% INTUNE™10510

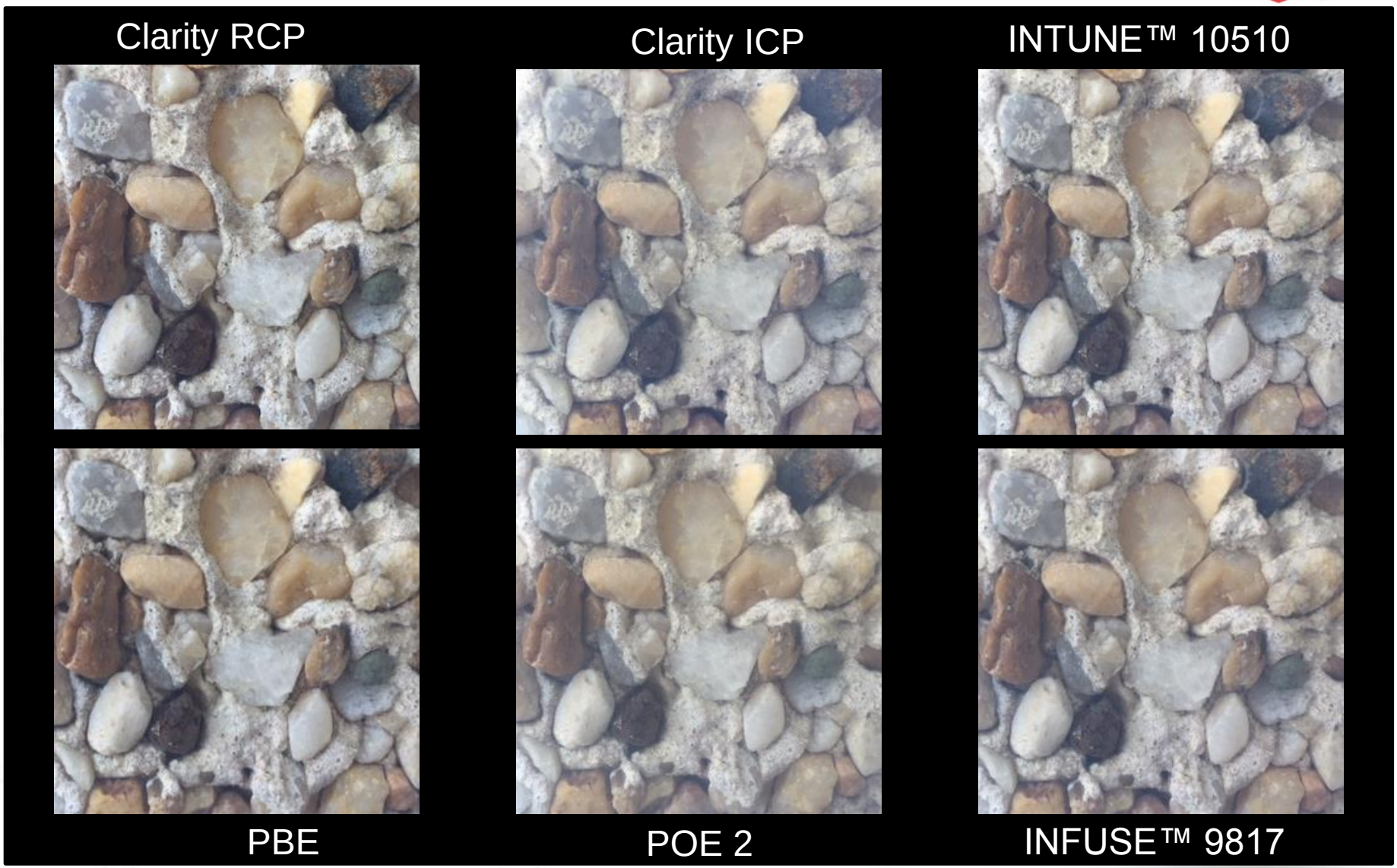


How Clear is Clear? Optics-Haze %



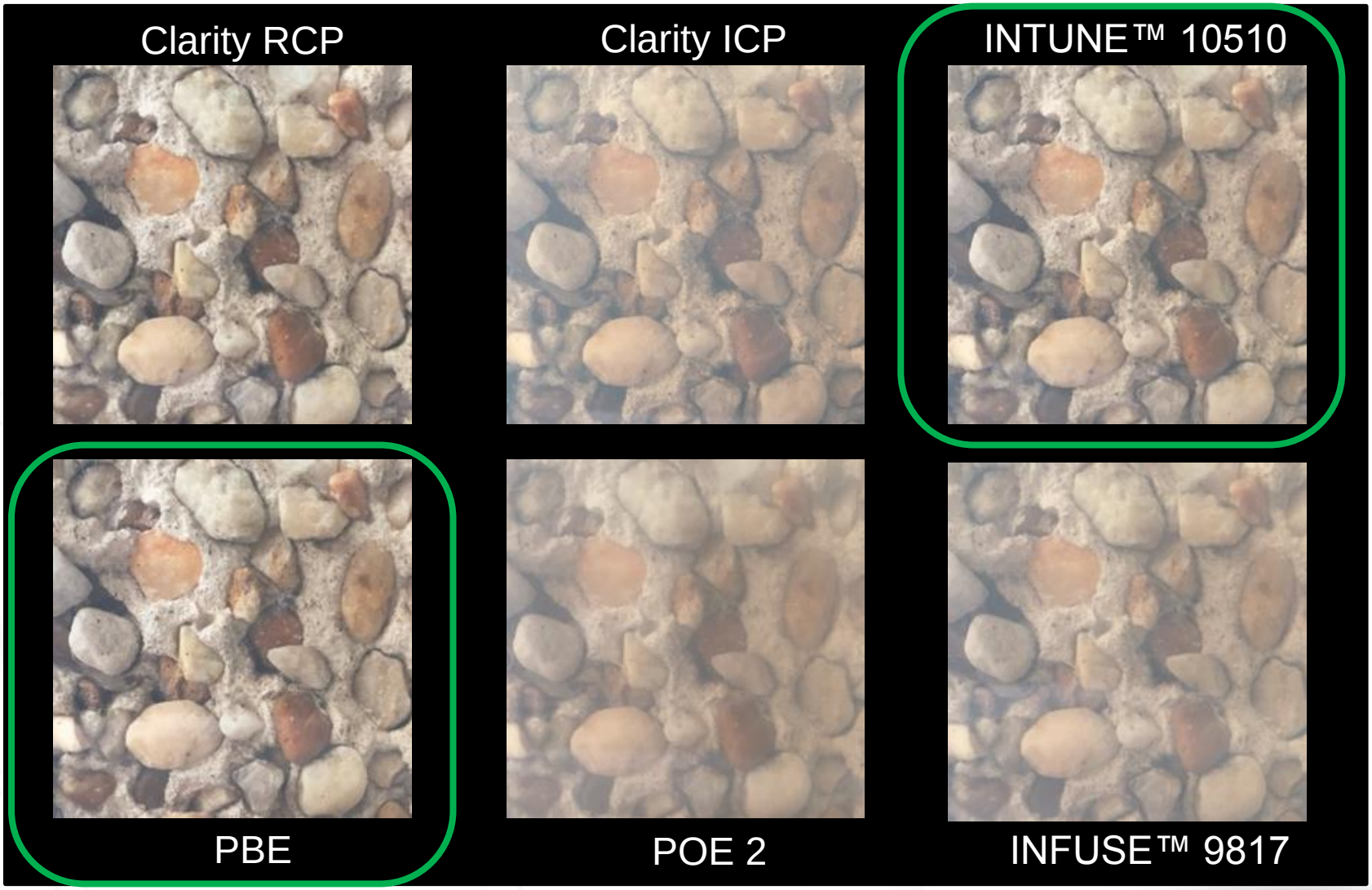
How does this correlate to what you see?

Options for Clarity in Thinwall Parts (0.75 mm)



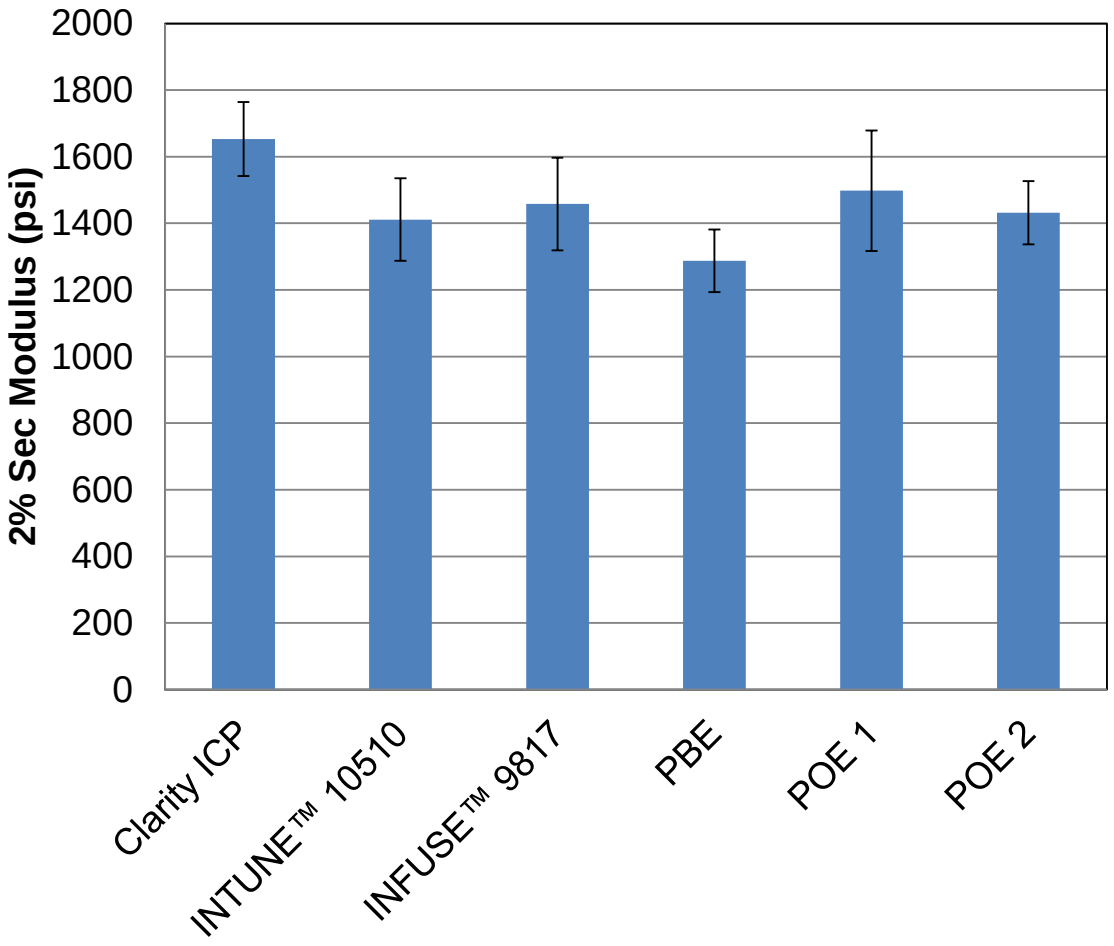
Injection Molded Plaques

Options for Clear Storage Containers (1.6 mm)



Injection Molded Plaques

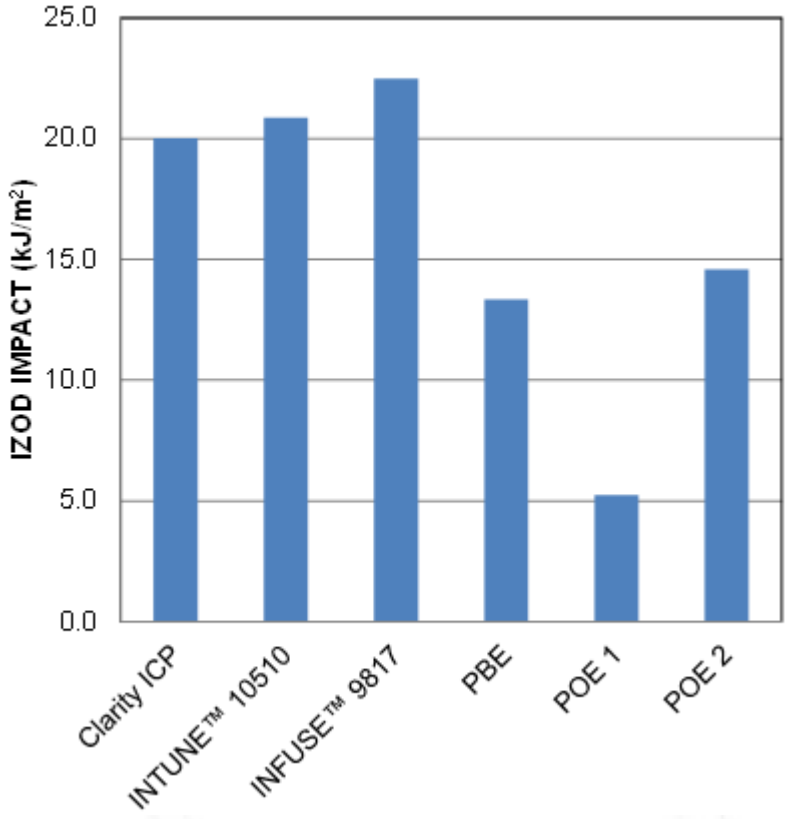
Tensile Modulus at RT



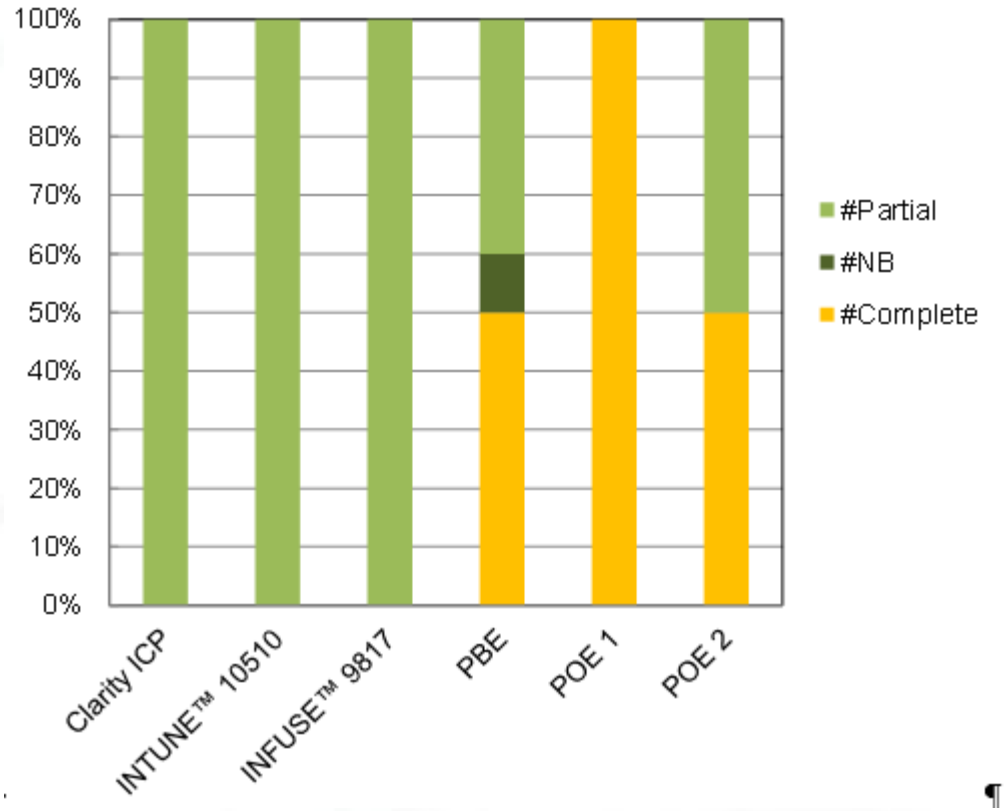
The modulus is lower than clarity ICP, but at low temperatures modulus increases

Impact Performance at RT Conditions

Notched Izod Impact at 23°C

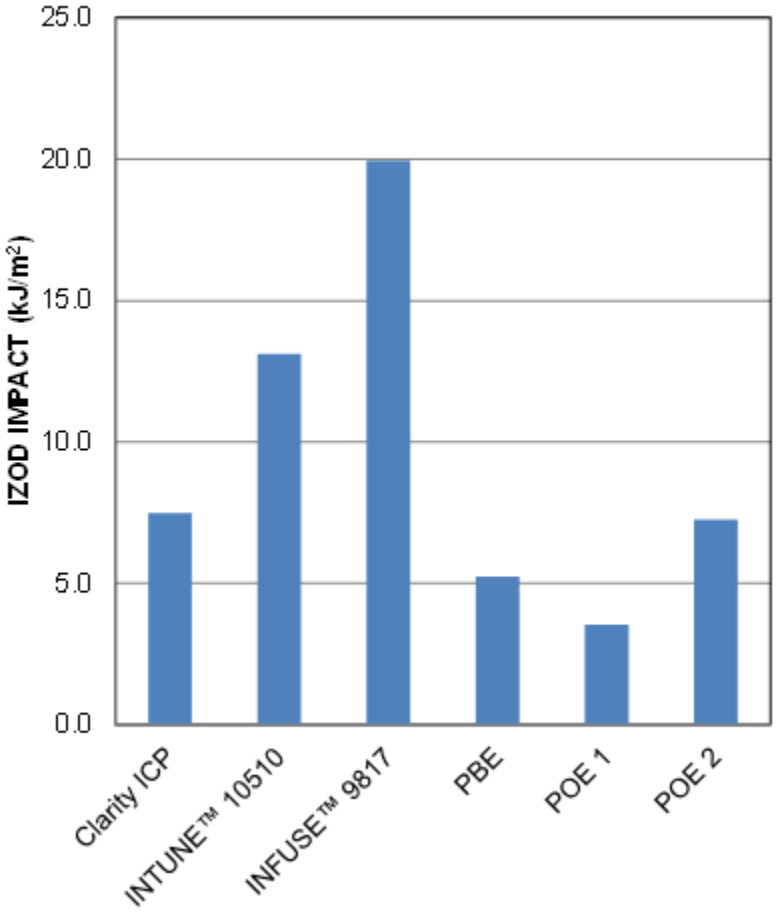


Failure Mode

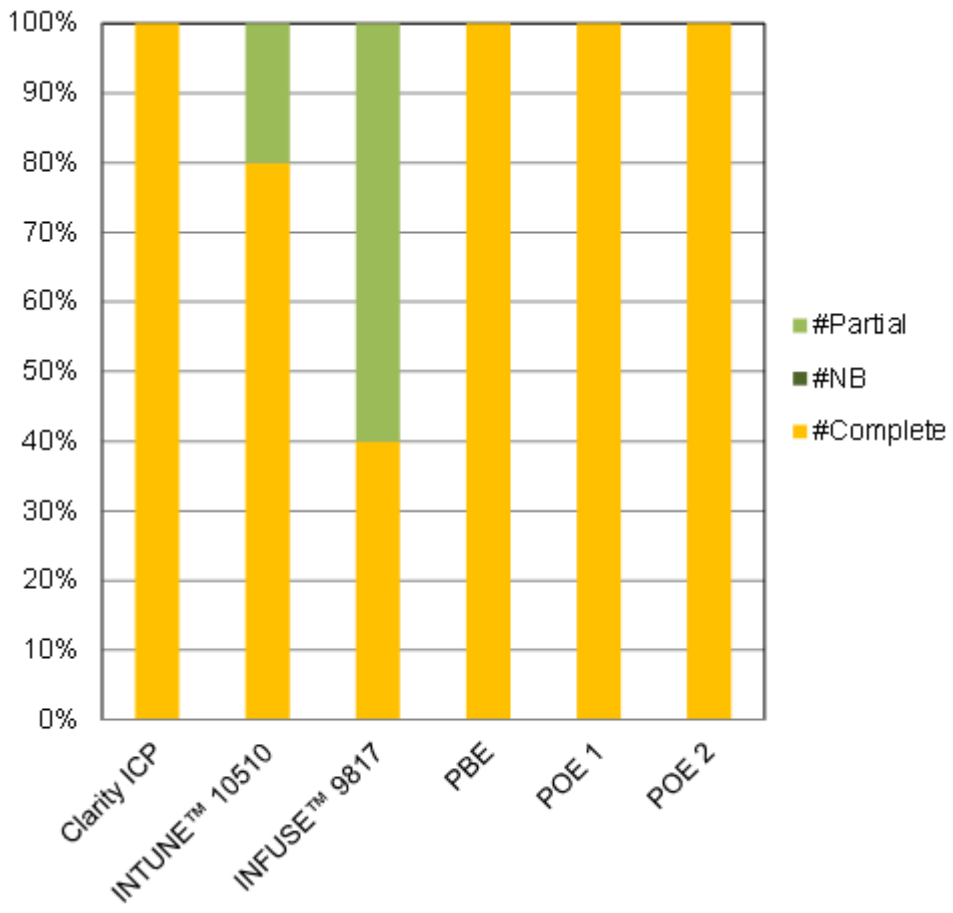


Impact Performance at Refrigerator Conditions

Notched Izod Impact at 0°C

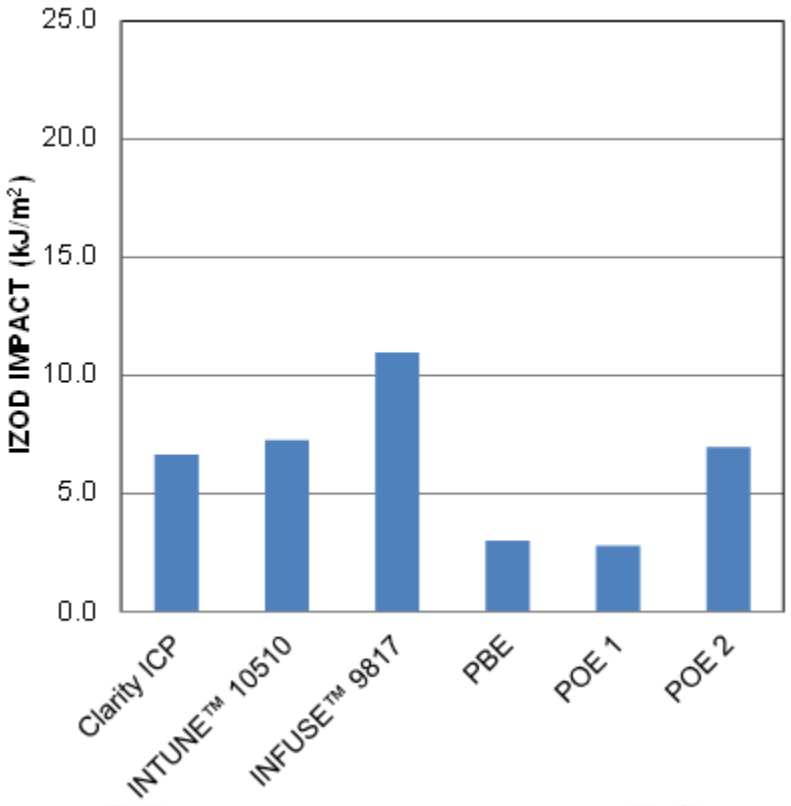


Failure Mode

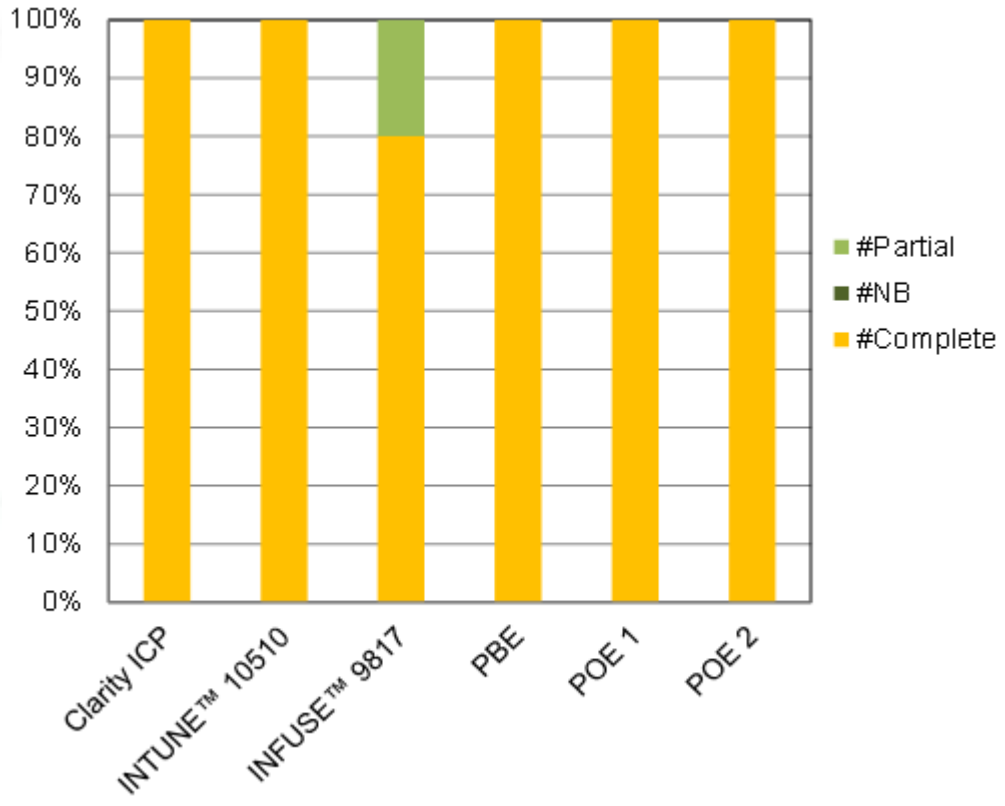


Impact Performance at Freezer Conditions

Notched Izod Impact at -20°C

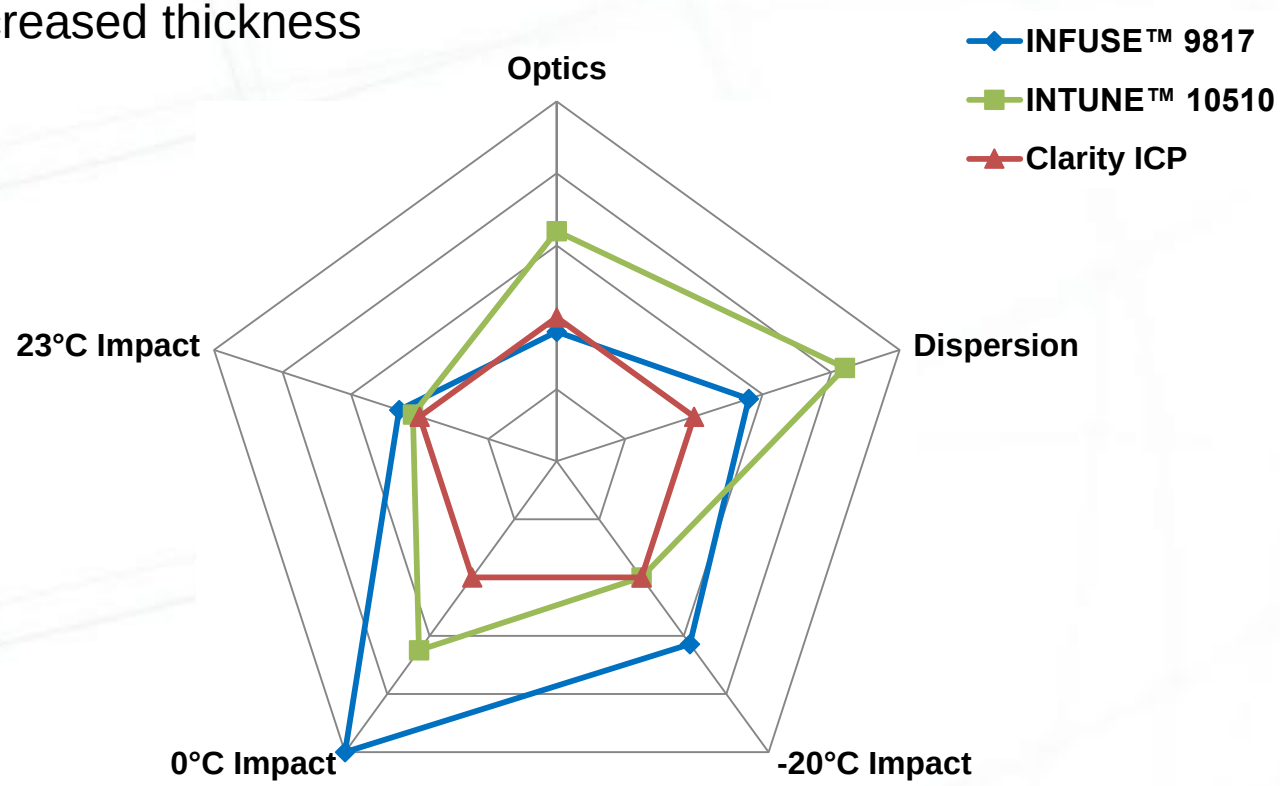


Failure Mode



Solutions for Clear, Tough Impact Modification of Random Copolymer PP

- Compared to clarity ICP, for optics and performance…
  - INTUNE™ 10510 OBC best overall balance
  - INFUSE™ 9817 OBC best impact, but poorer optics especially with increased thickness



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