

Imagine working with a company that has no boundaries on exploring solutions.



Mayzo Makes It Possible

**Major Markets &  
Applications for  
Beta Nucleated  
Polypropylene**

# Outline

1. Attributes of beta crystallinity and differences from alpha crystallinity
2. Major Markets
  - I. Geogrids
  - II. Packaging:
    - a) welding & heat sealing
    - b) Thermoforming
  - III. Pressure Pipe
  - IV. Oriented film
  - V. Impact Improvement
3. Mayzo's Strengths & New Technology

## Differences Between Alpha and Beta Crystal Phases in PP

### Alpha Phase

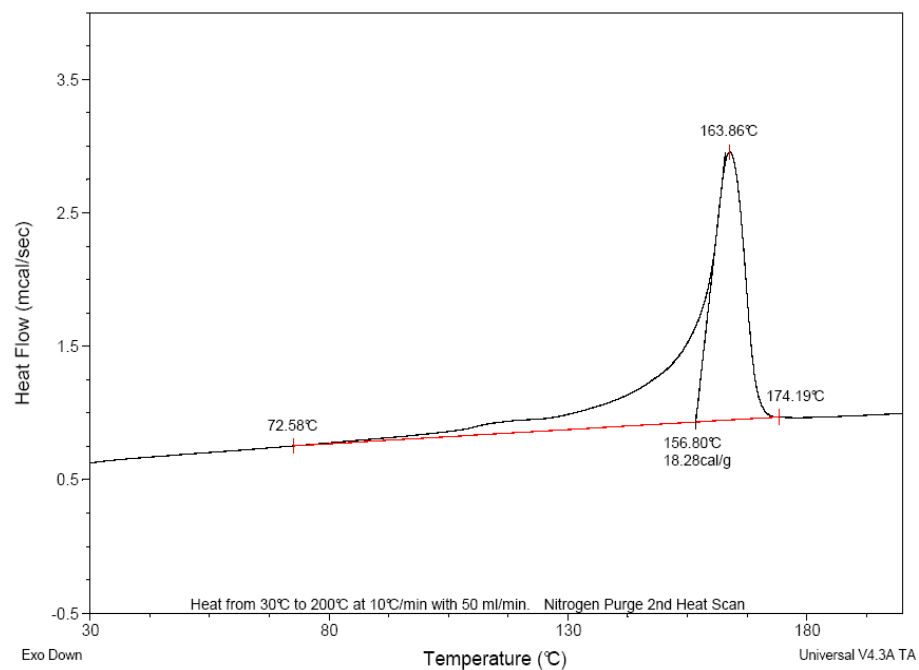
- Melts at ~ 164 °C
- Most common phase
- Many nucleants known:  
Some nucleants are also clarifiers
- Alpha nucleants increase modulus and reduce cycle time

### Beta Phase

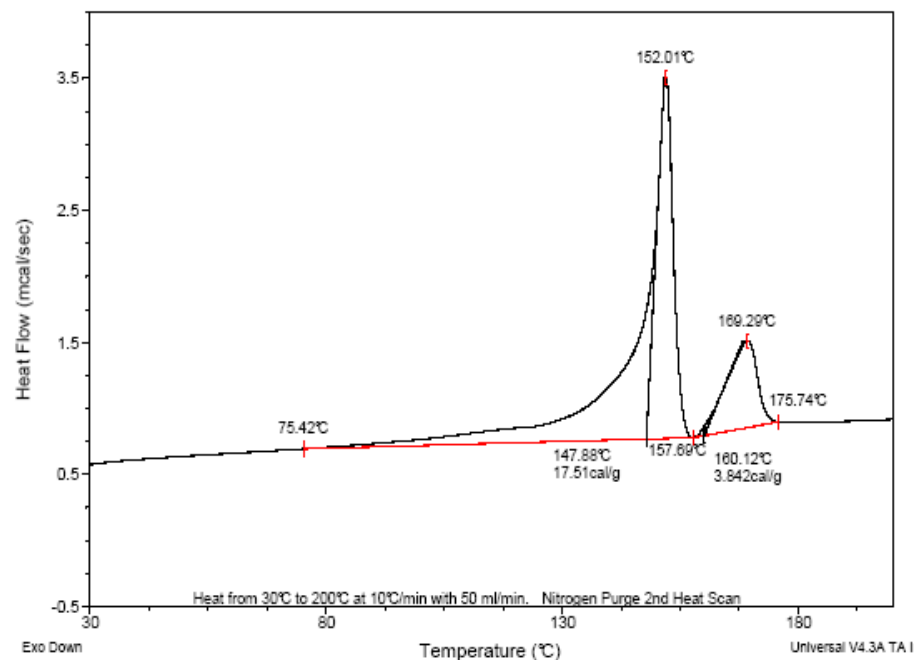
- Melts at ~ 150 °C
- More ductile: Increases impact strength and break elongation with small losses in tensile strength and flexural modulus
- Very few beta nucleants are known
- Generally cannot be produced in alpha nucleated PP

# DSC Melting Curves for Alpha and Beta PP

## Alpha PP

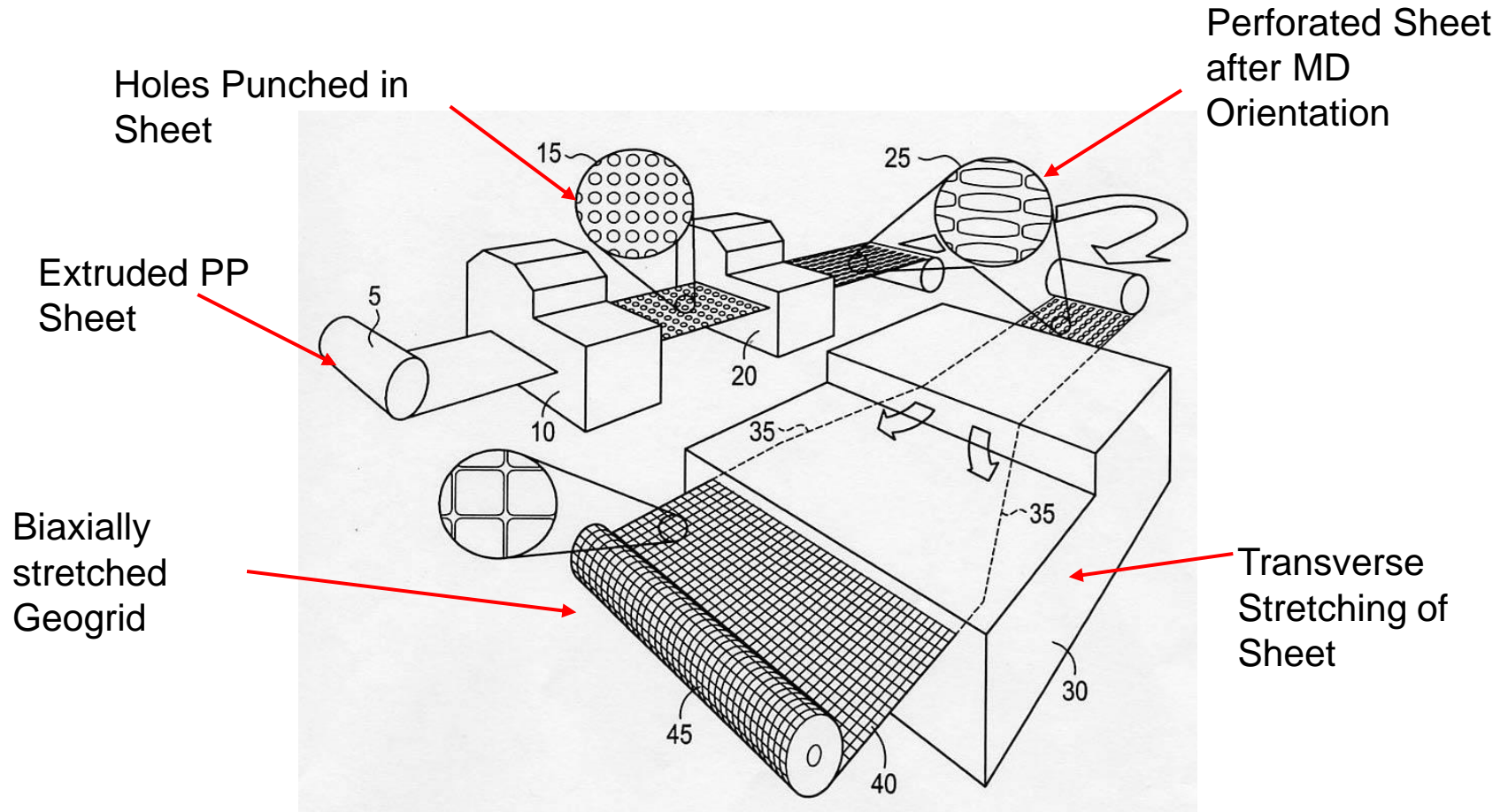


## Beta PP



# Geogrids

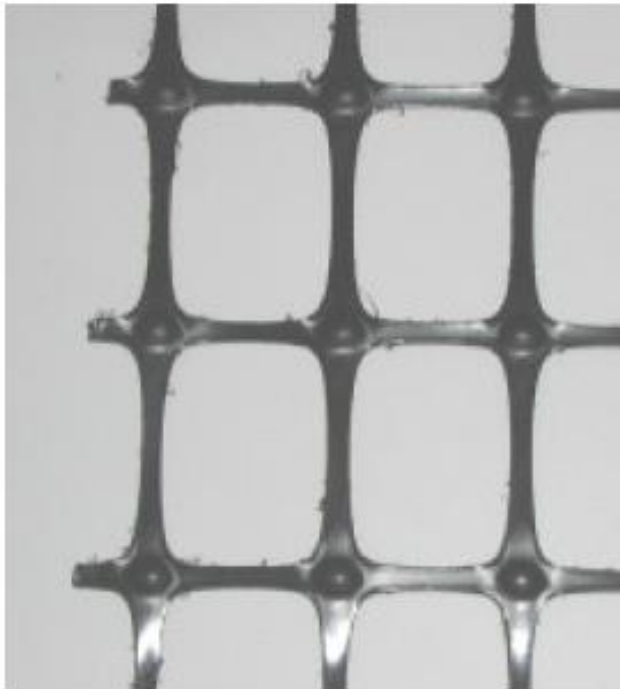
# Geogrid Production Process





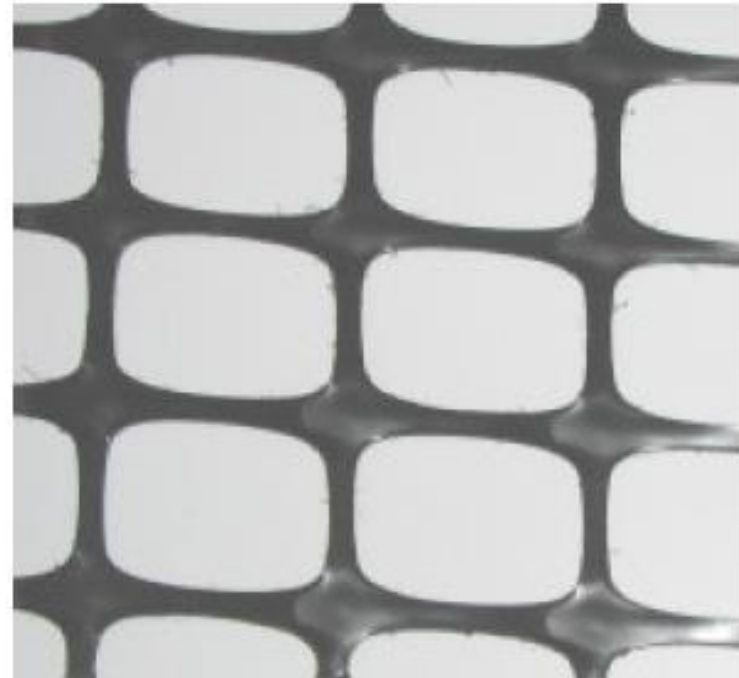
# Geogrid Made With and Without The Beta Nucleation

Non-nucleated



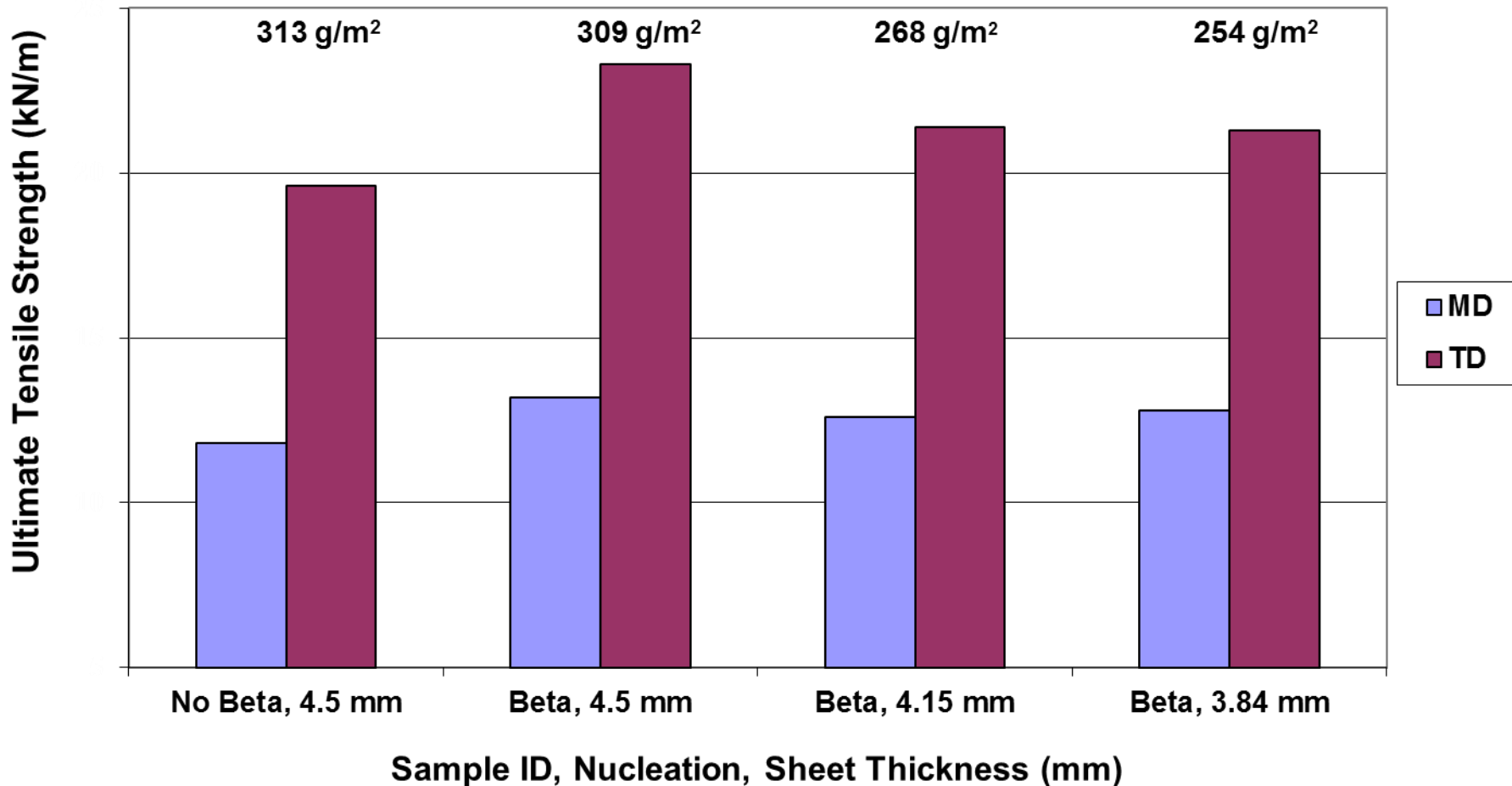
Node thickness of 3.4 mm

Beta Nucleated



Node thickness of 2.3 mm

## Ultimate Tensile Strength of PP Geogrids With and Without Beta Nucleation





## **Advantages of Beta Nucleation in the Production of Geogrids**

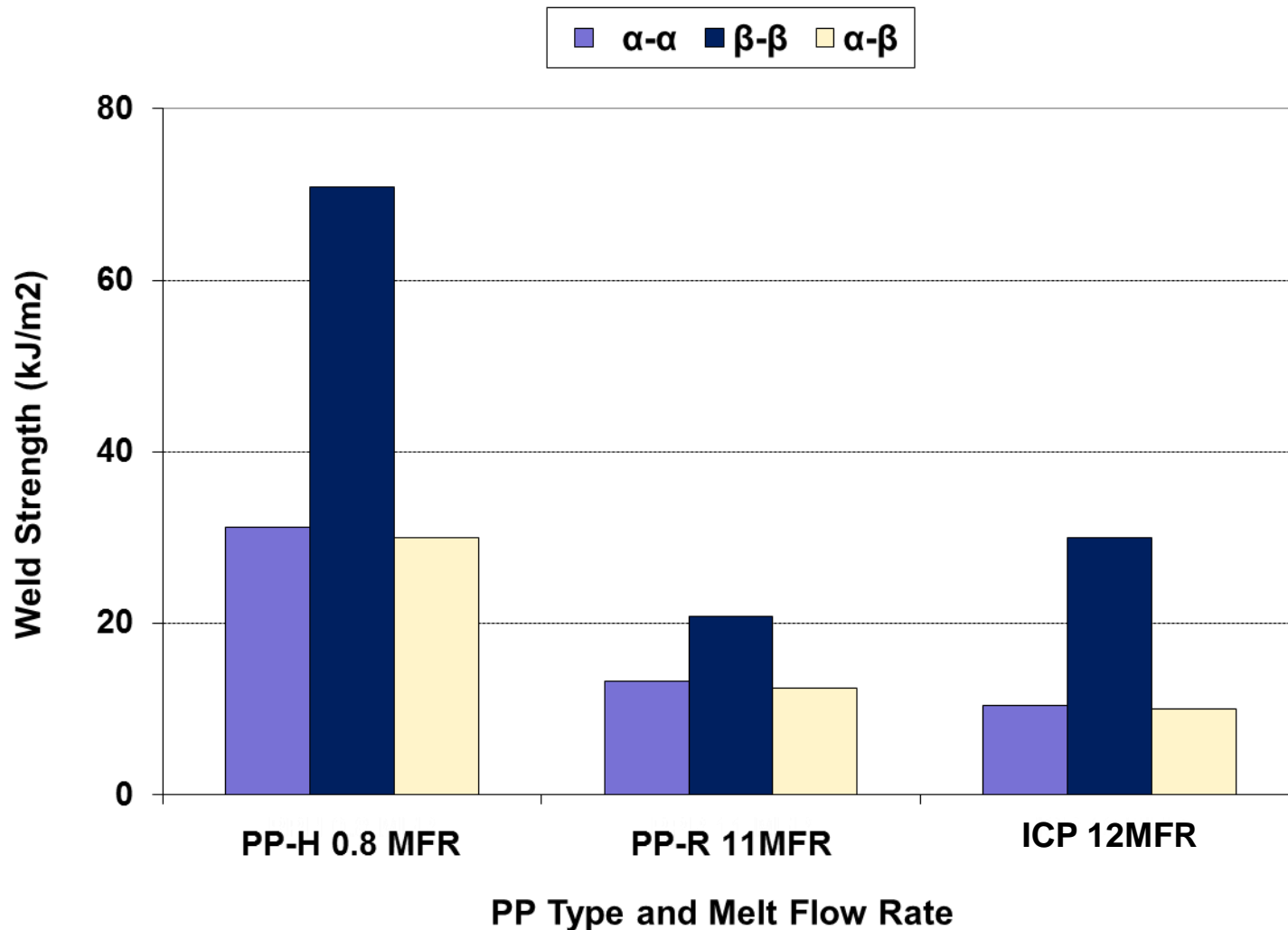
- Higher tensile strength allowing for up to 20% down-weighting
  - less material, lower costs
- Can be run at higher production speeds
  - Increased throughput and productivity

# Packaging

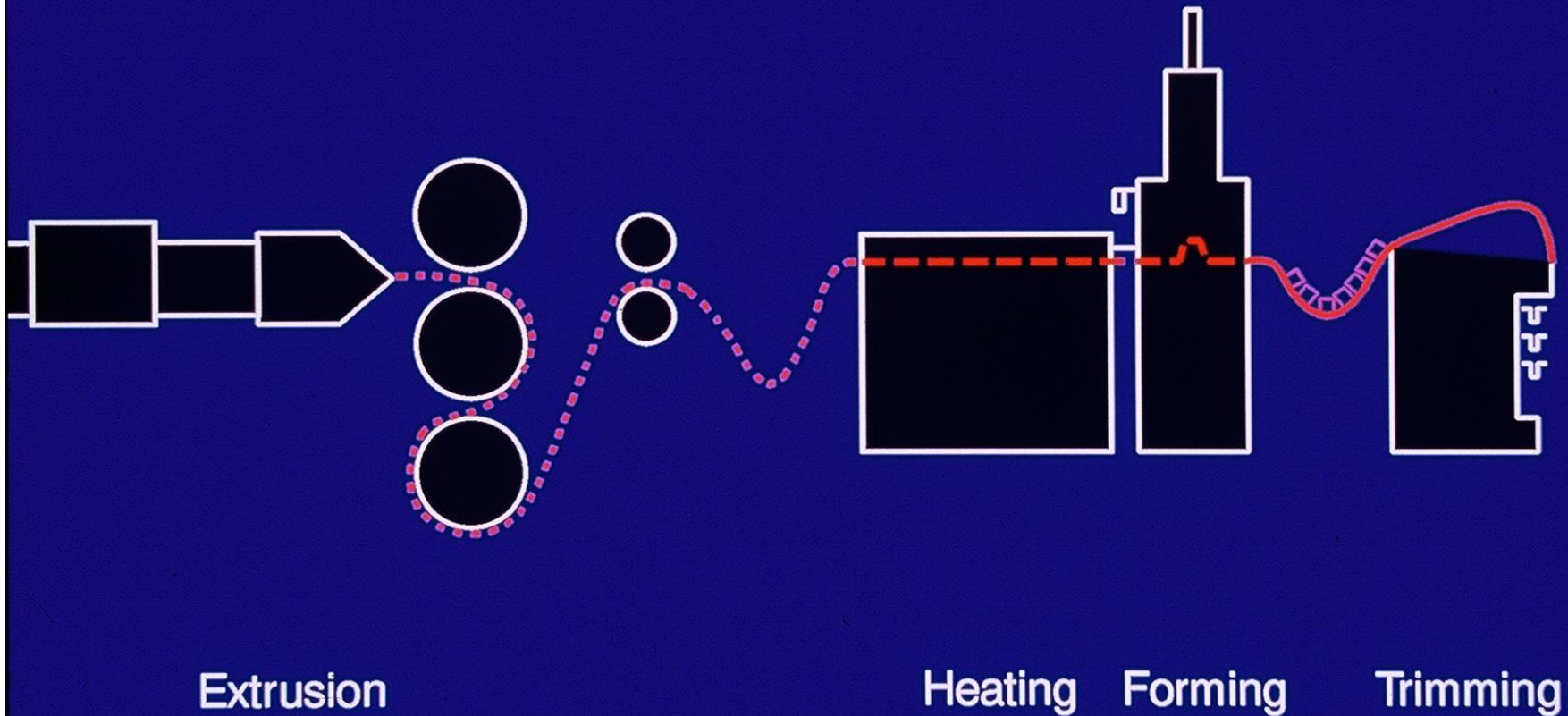
## **Welding & Heat Sealing**

- Good weld and heat sealing are important aspects for many packaging segments such as food and personal care
  - increases throughput and productivity
  - reduces product reject rates
  - provides broader package design capability
- Beta nucleation leads to much higher weld strengths in polypropylene

## Vibration Weld Strength of Beta vs Alpha Crystalline Polypropylene



# Schematic of In-Line Thermoforming

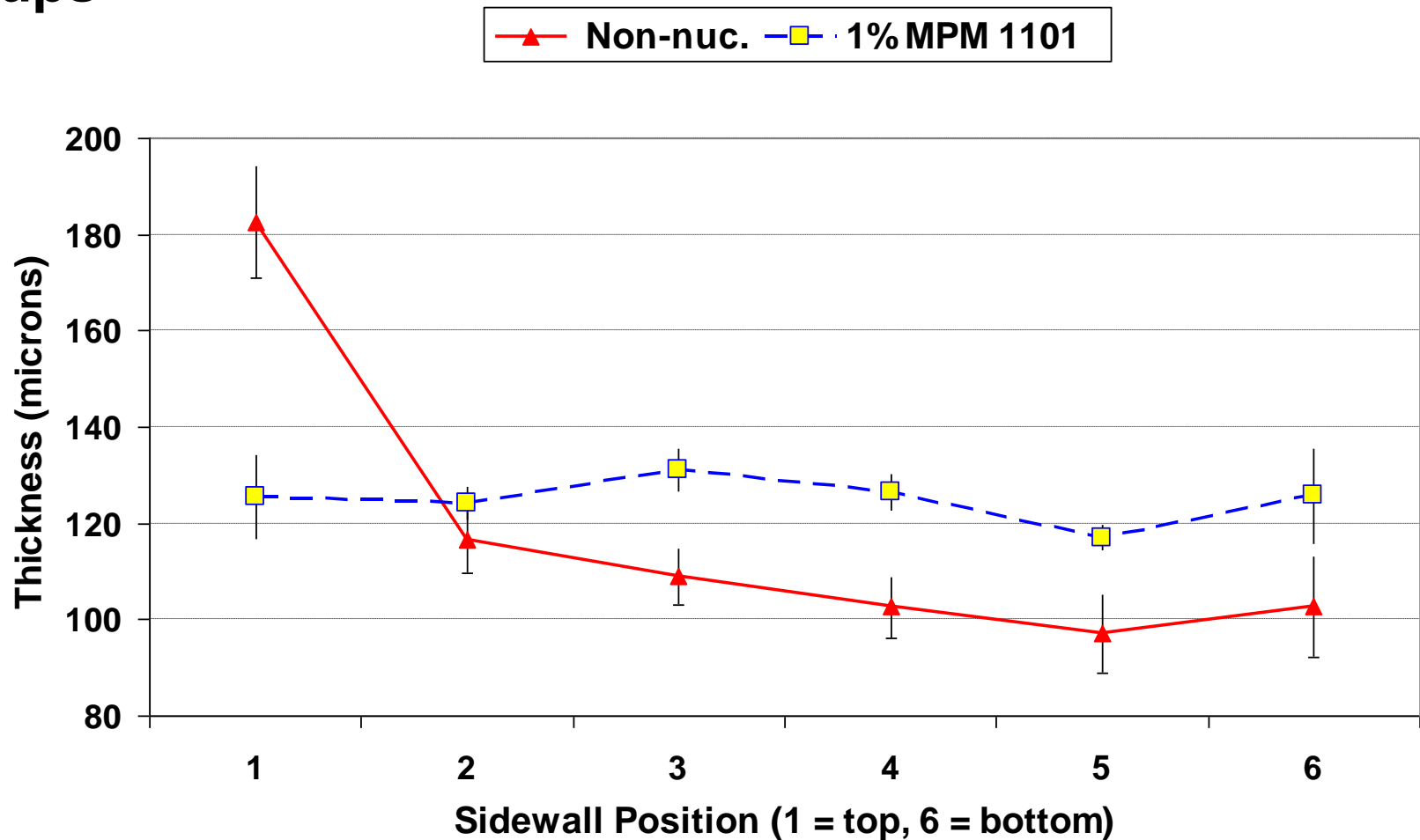


# Thermoformed 16 oz Cups Made with Non-nucleated and $\beta$ -Nucleated PP

Note: No TiO<sub>2</sub> used in Beta nucleated HPP

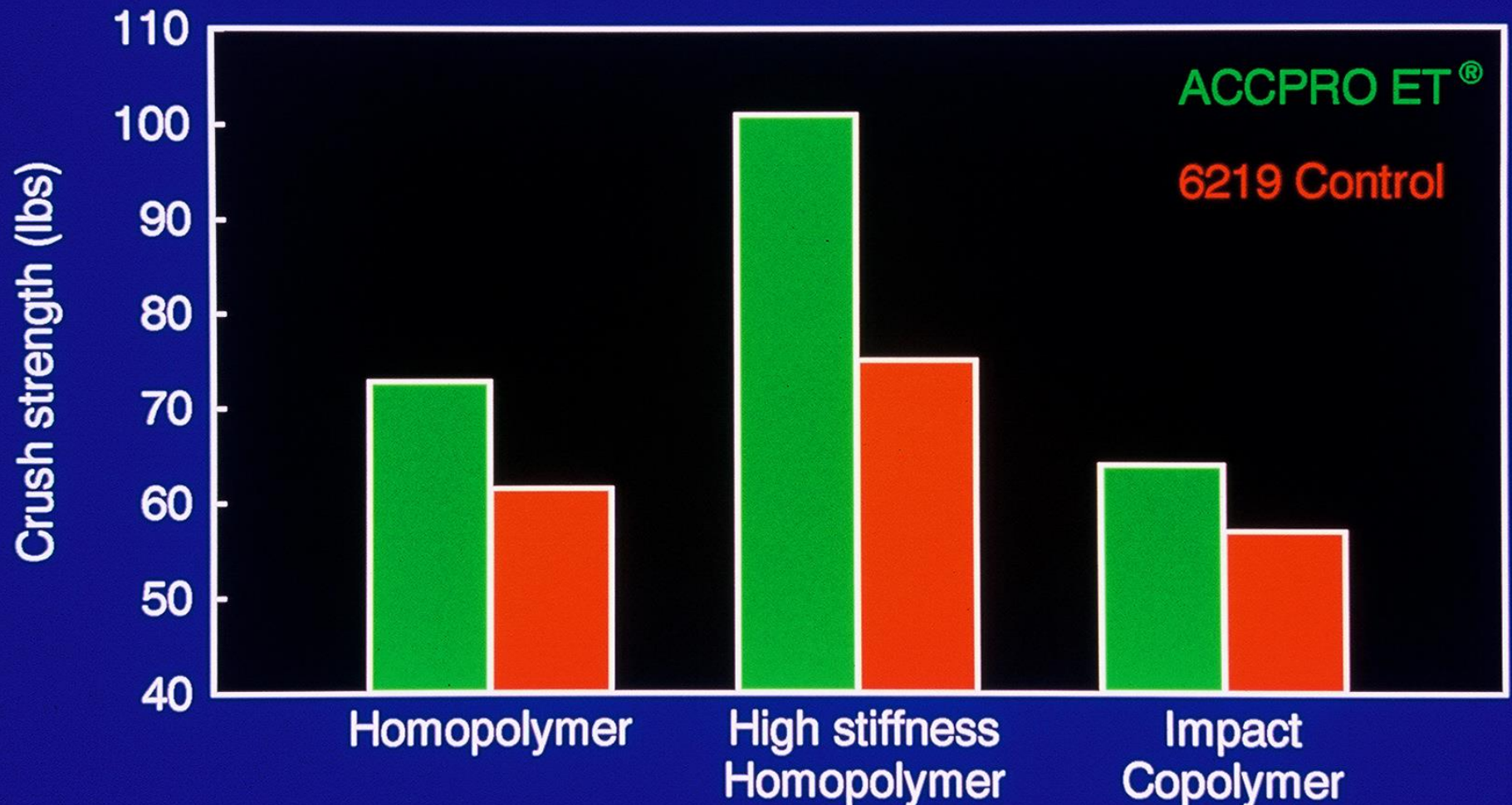


# Sidewall Thickness Distribution in Melt-Phase Formed Cups

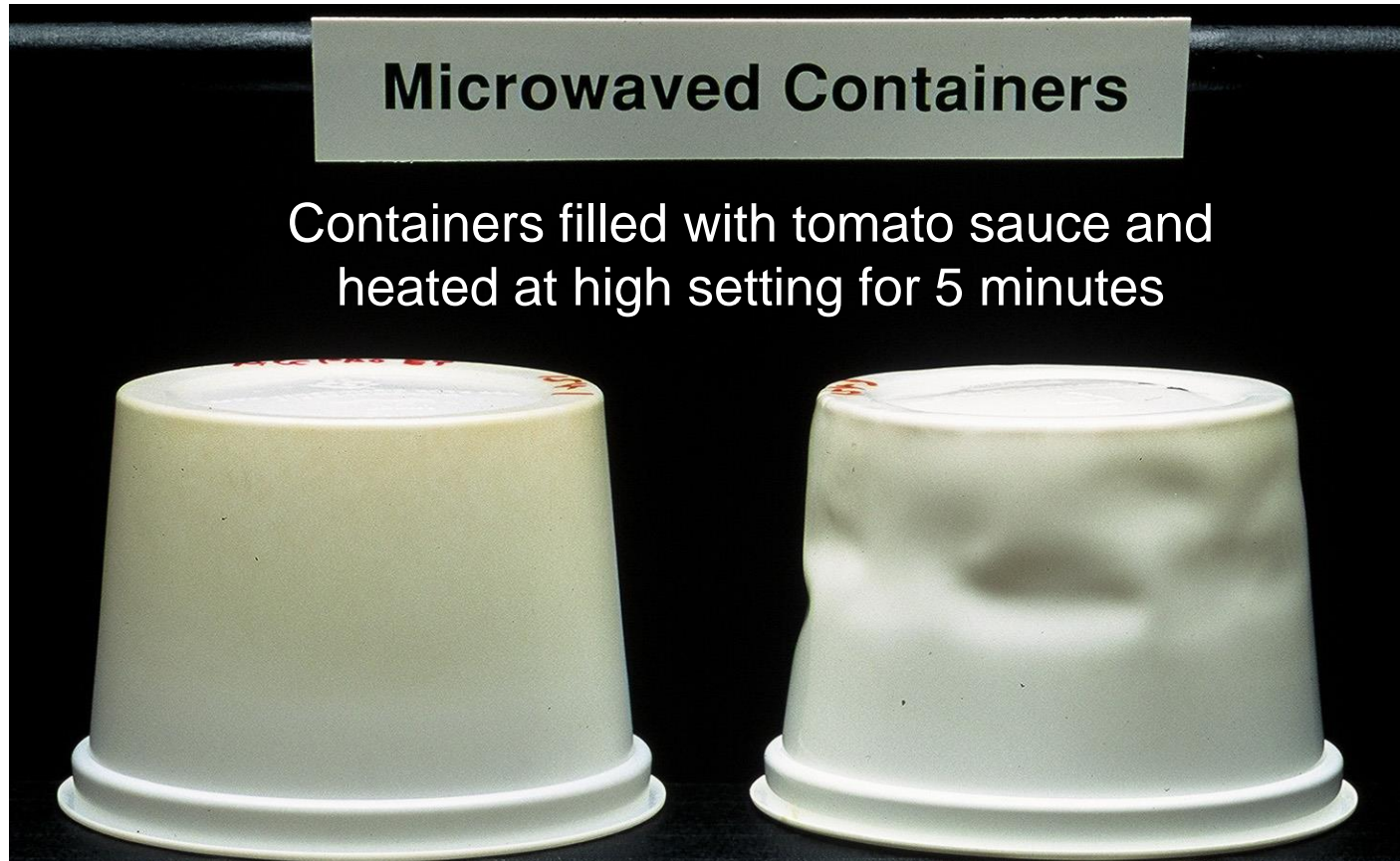




# Optimum Crush Strength of ACCPRO ET<sup>®</sup> vs Control Resins with the 6219 Package



# High Temperature Dimensional Stability of Beta vs Alpha Nucleated PP



Beta Nucleated

Alpha Nucleated

## **Advantages of Mayzo Beta Nucleation Technology in the Thermoforming of PP**

- Broader processing window
- Less sag with no change in melt rheology
- Lower sidewall density (lighter weight)
- White appearance without pigments
- Better material distribution and better crush strength
- Potential to down-weight up to 20%, equals cost savings
- Faster cycle times (up to 25% higher productivity)
- Improved High Temperature Dimensional Stability

# Oriented Microporous Film

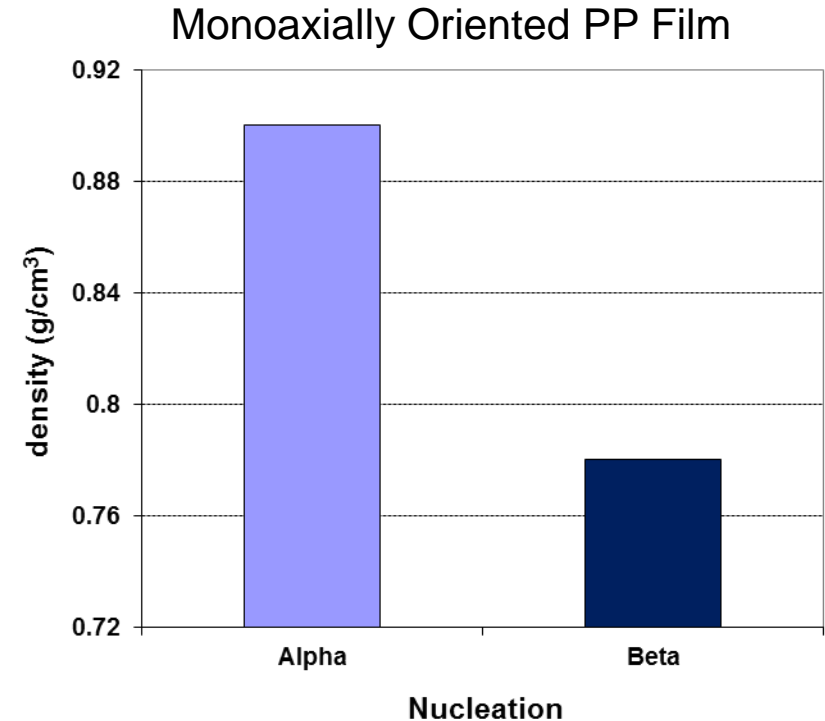


# Beta Nucleation in Oriented PP Film



$\alpha$

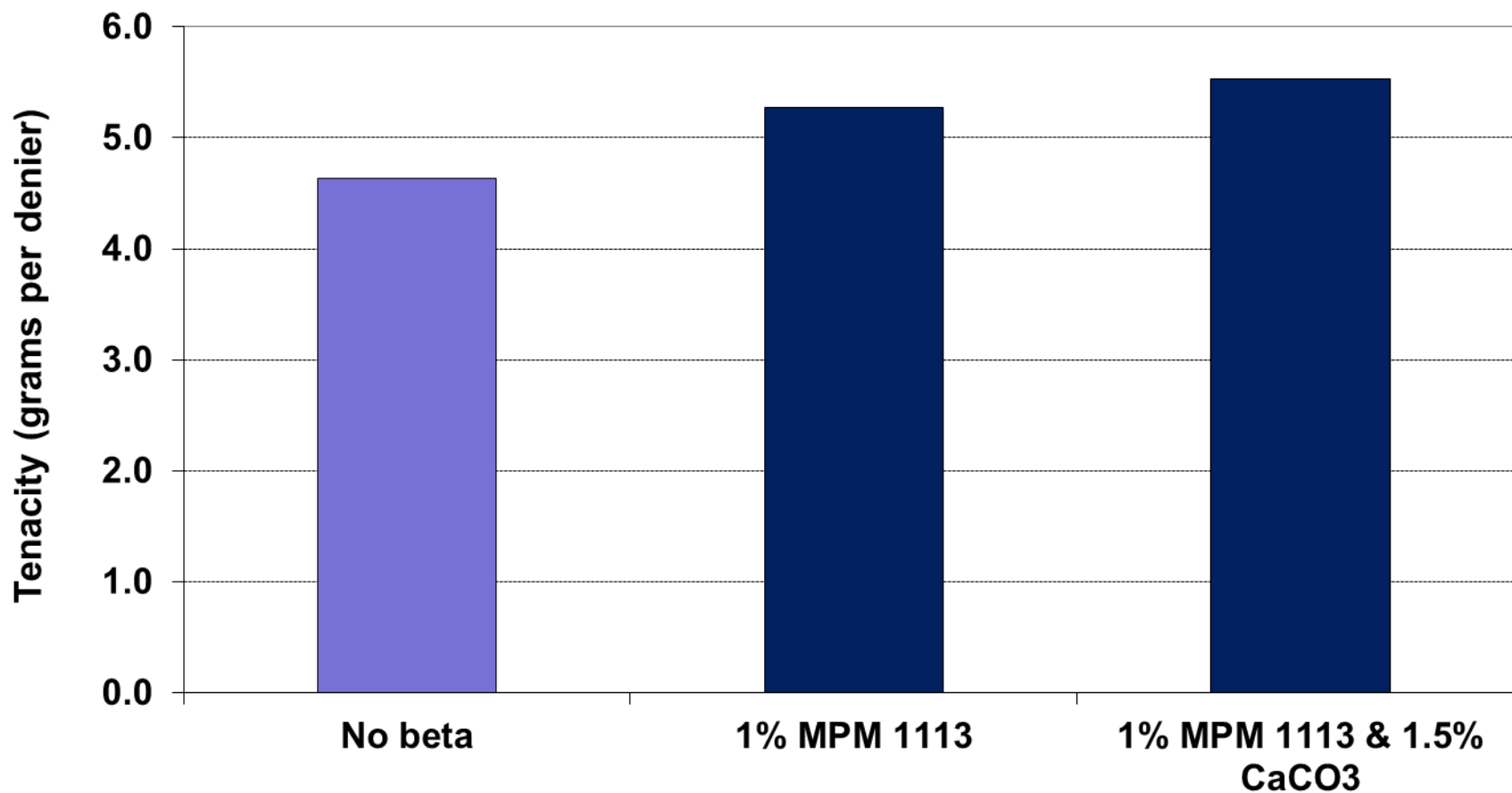
$\beta$



← Carpet Backing Tapes

- Higher Tenacity
- Higher yield (more m<sup>2</sup> per kg)
- De-lustered without fillers

## Tenacity of Carpet Backing Tapes



## Beta Nucleated BOPP Film for Li-Ion Batteries and Supercapacitors



Film Thickness: 22 microns    Film Density: 0.28 g/cm<sup>3</sup>

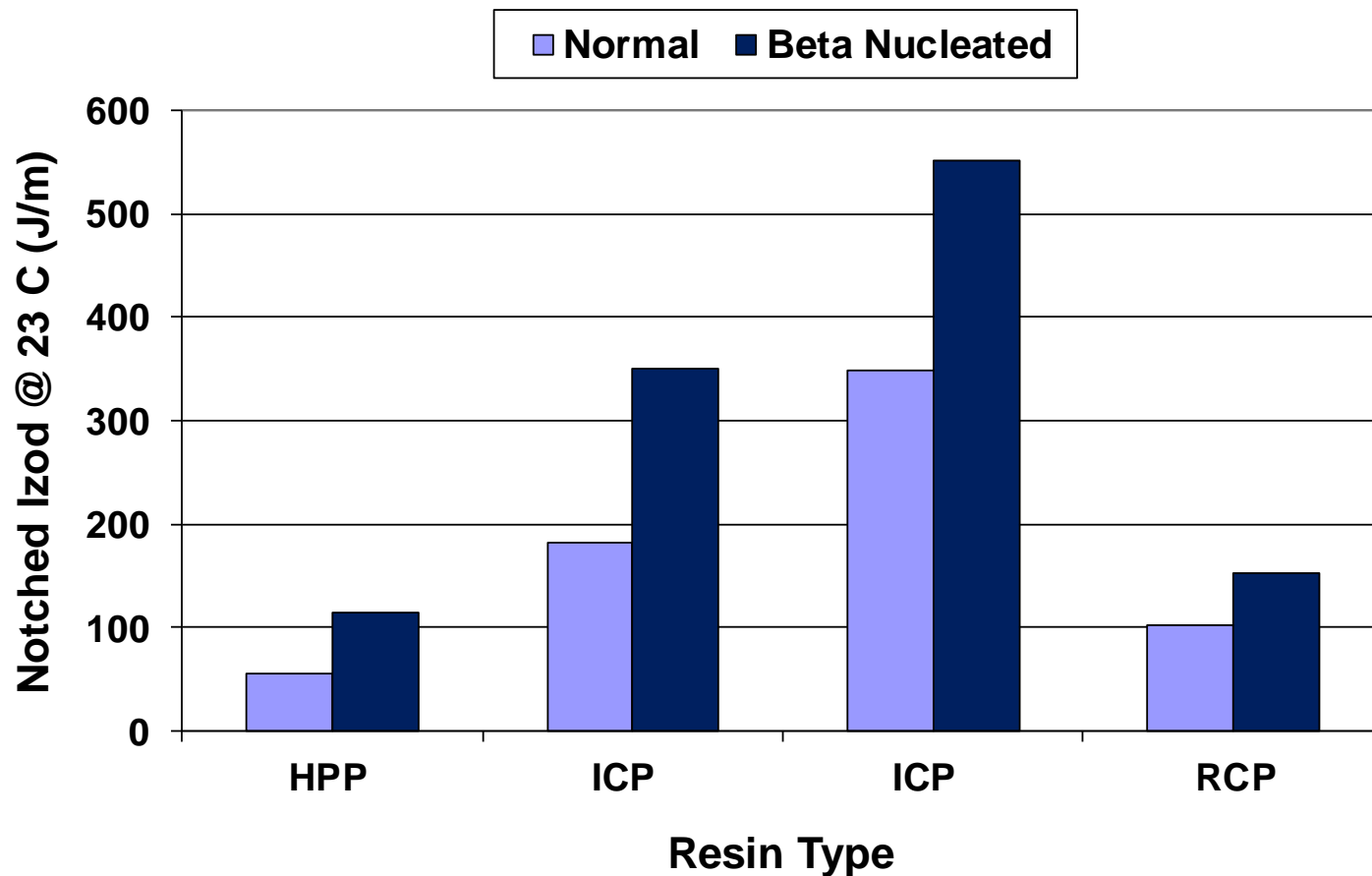


## **Advantages of Beta Nucleation in the Production of Microporous Films**

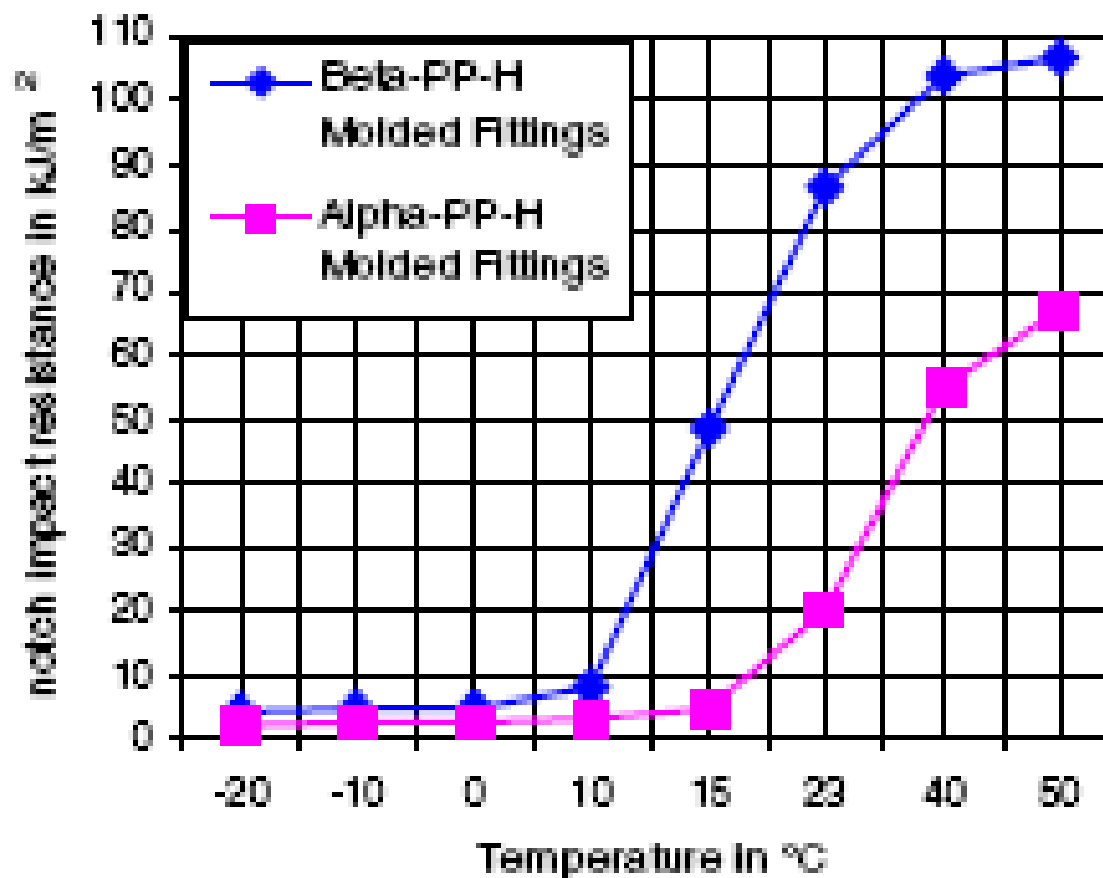
- Production of white, low density microporous films without the use of fillers or pigments
- Improved printability
- Extremely low density films with high breathability can be produced in the BOPP process.
  - Used in protective clothing, construction applications, and as separator membranes in Li-ion batteries and supercapacitors
- Produces high tenacity, de-lustered carpet backing fibers (patent pending)

# Impact Improvement

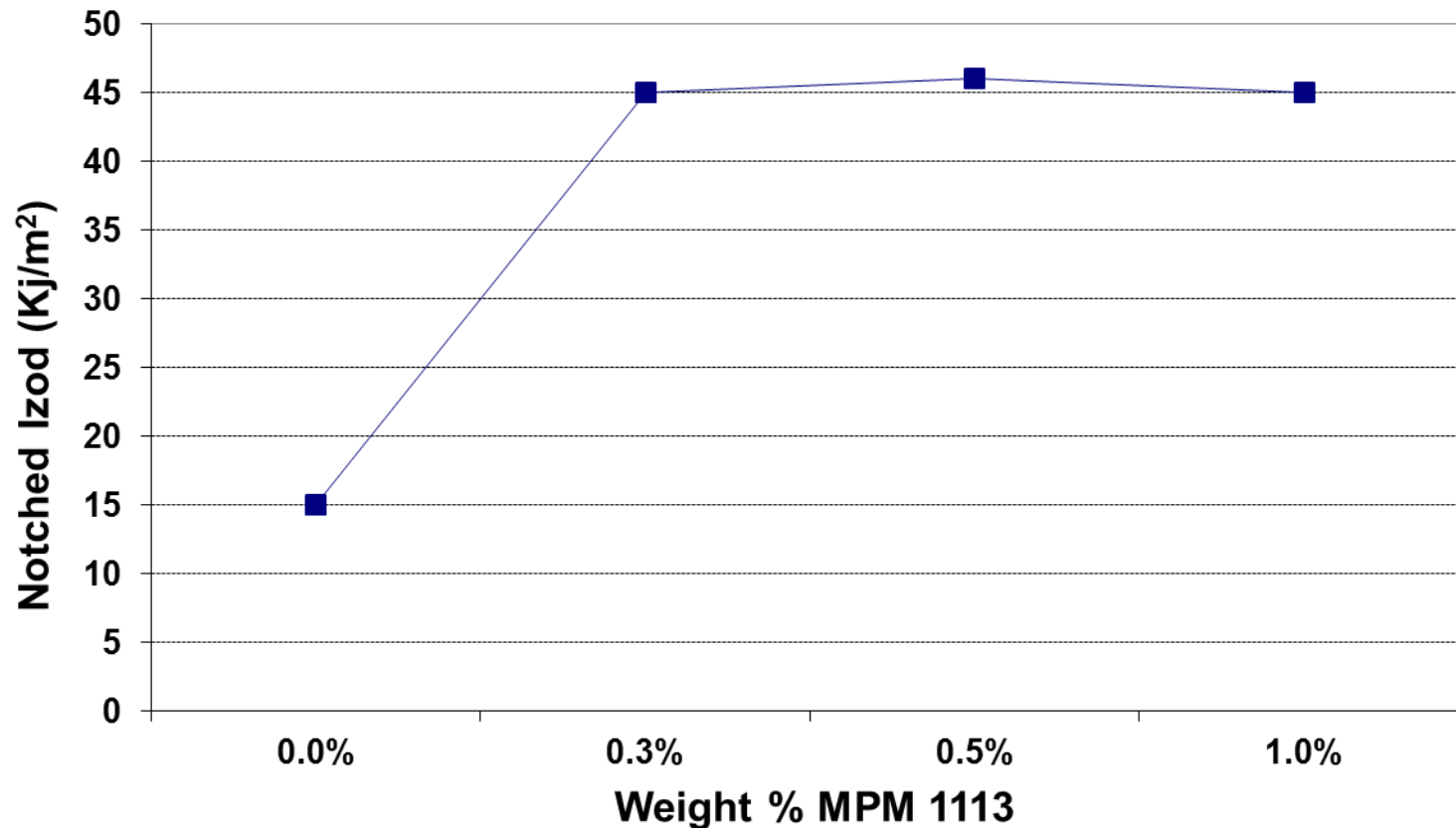
# Using Beta Nucleation to Improve the Impact Strength of PP



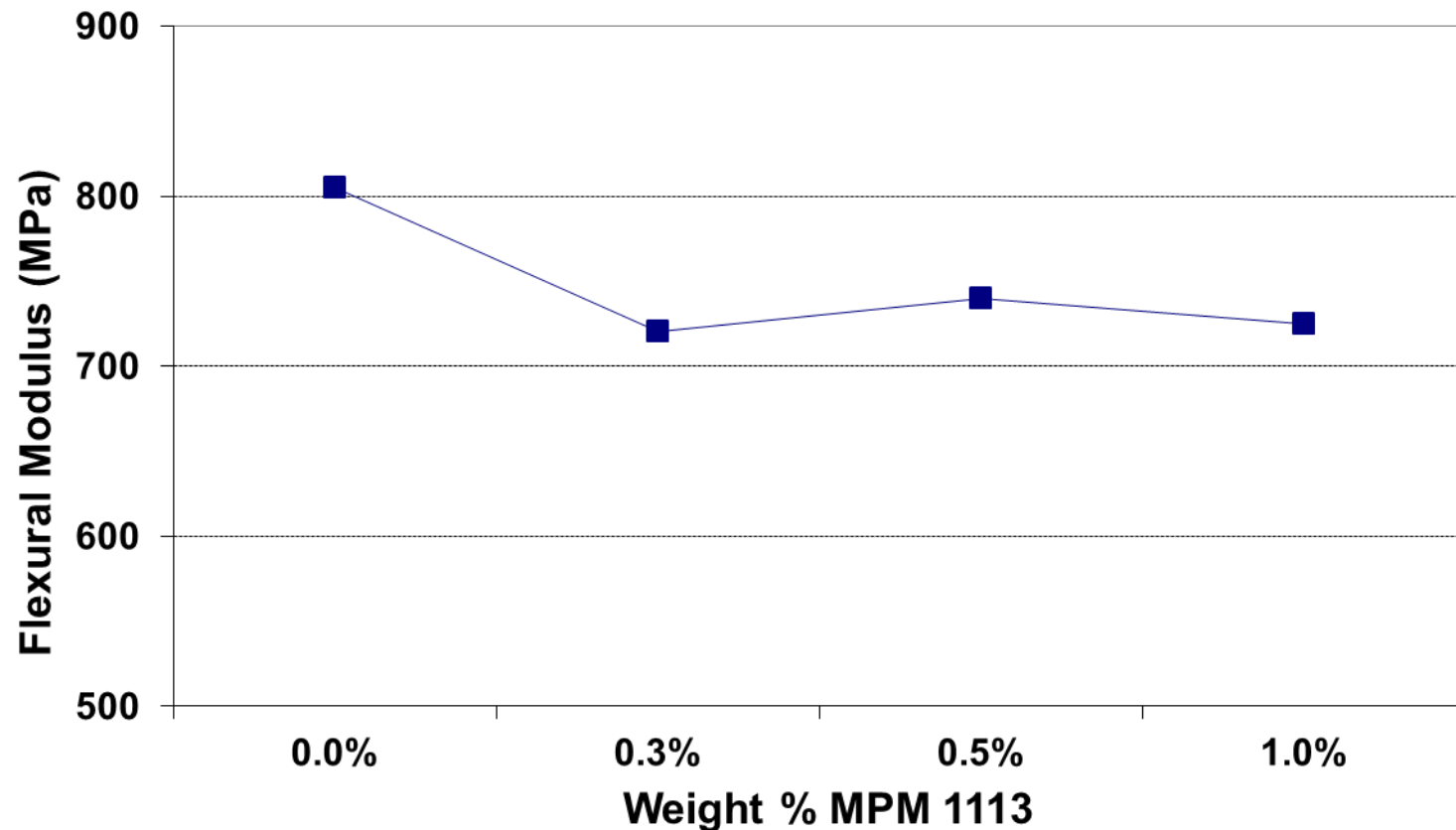
## Effect of Test Temperature on the Impact Strength of Beta Nucleated PP



## Notched Izod Impact of Random Copolymer PP With Beta Nucleation



## Flexural Modulus of Random Copolymer PP Beta Nucleation

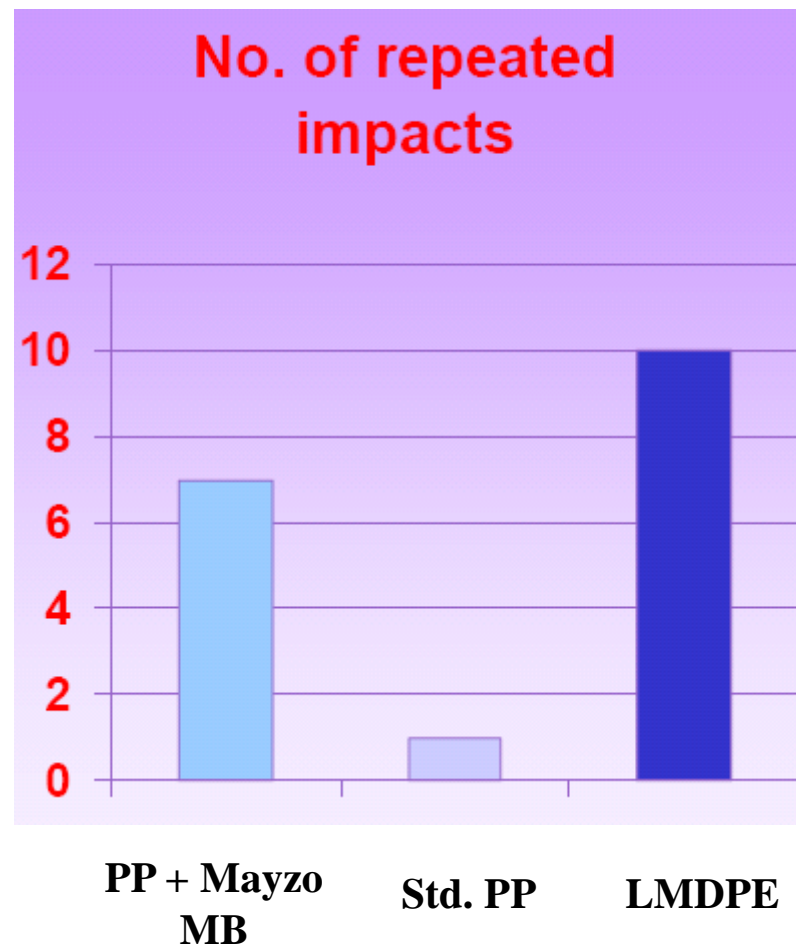
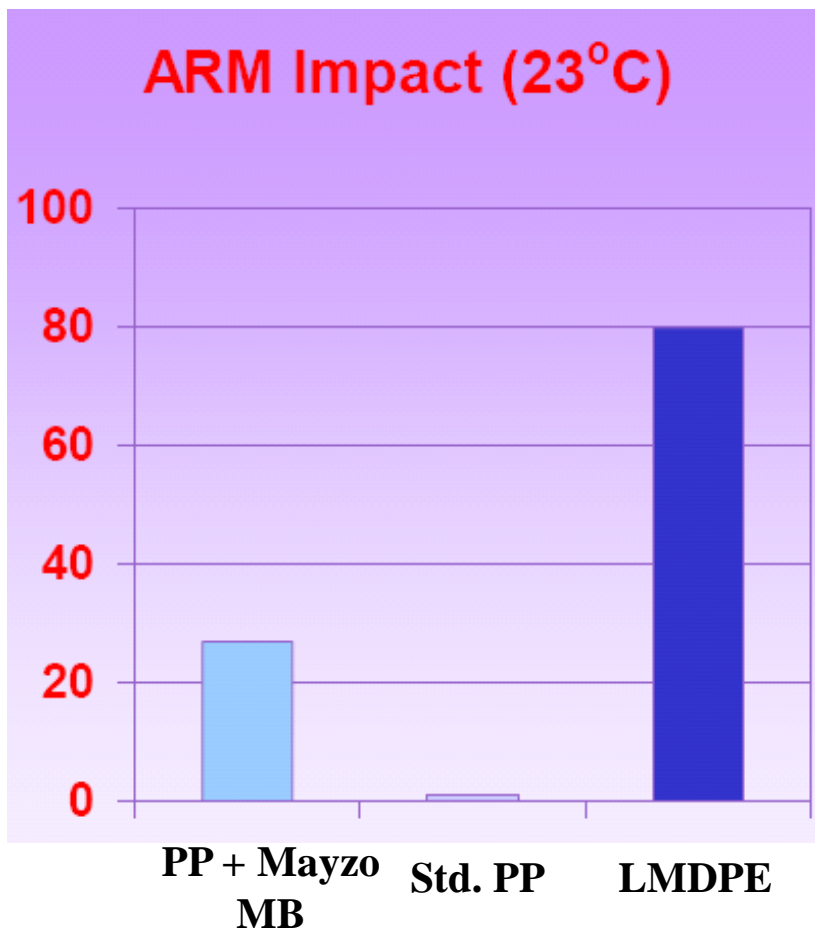


## Properties of Non-Nucleated & $\beta$ -Nucleated PP Homopolymer with 0.3% MPM 2000

Property	$\beta$ -Nucleated	Non-Nucleated
MFR (g/10 min)	3.2	3.3
Yield Strength (psi)	4350	4976
Yield Elong. (%)	11.0	8.9
Flex. Modulus (psi)	213,520	212,170
Notched Izod @23 °C (ft-lbs/in)	3.23	0.78



## Impact Enhancement in Rotomolded PP



## Impact Strength Improvements Using Beta Nucleation

- Beta nucleation leads to dramatically higher impact strength improvements with only small losses in flexural modulus
- Beta nucleation allows PP to be used in rotomolding applications without the extreme brittleness normally seen in this application
- Mayzo's latest beta masterbatch, MPM 2000, can be used at very low addition levels to achieve these benefits

## Product Offerings

- **MPM 1110:** black pellets, used for geogrids. Typically 0.75%-1% addition level.
- **MPM 1113:** brown pellets, used for thermoforming, film, injection molding, when higher loading of nucleant is needed to overcome interfering additives. Typically 0.5% - 1.5% addition level.
- **MPM 2000:** latest generation MB, white pellets. Highest beta nucleation activity and Tc value. Works in many alpha nucleated PP resins including talc reinforced PP. Typically 0.75% - 1.0% addition level