



Investigation of Post-Consumer Regrind Content in ABS and Polystyrene for Consumer Packaging Applications

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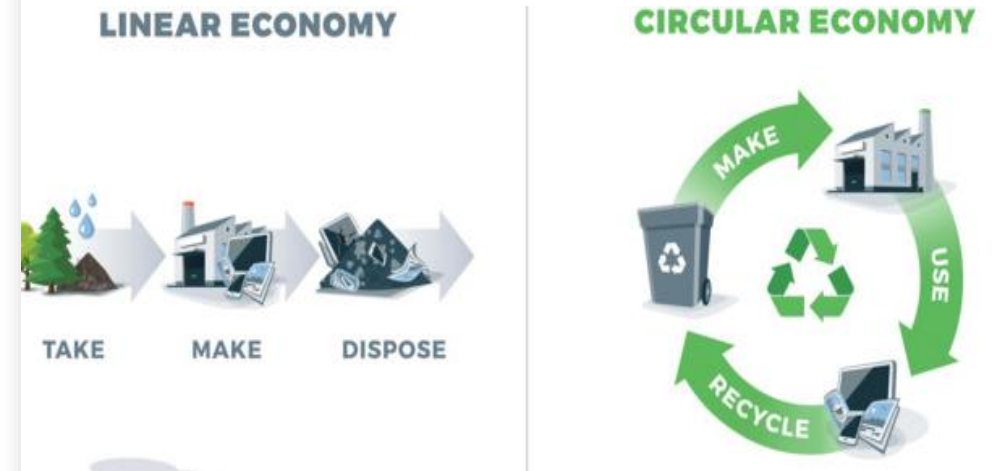


Overview

- Background
- Initial Objectives
- Materials
- Methods
- Results and Characterization
- Conclusions

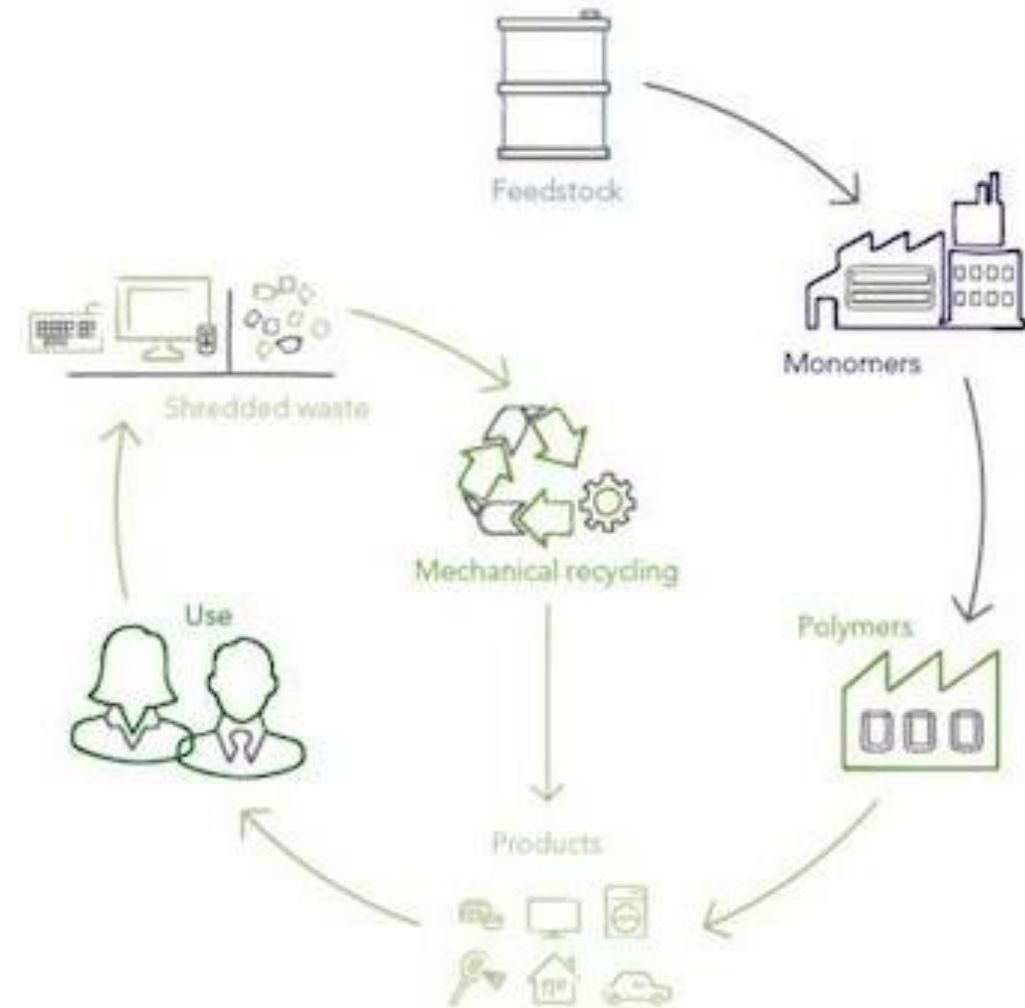
Background

- Today's major issues in the plastics industry:
 - Waste management
 - Circular economy
- What is post-consumer regrind (PCR)?
 - Definition: Recycled post consumer plastics that have been collected, cleaned, and reprocessed into new products.
 - Utilization is ideal for a circular economy.
- Applications for PCR:
 - Various plastics packaging.



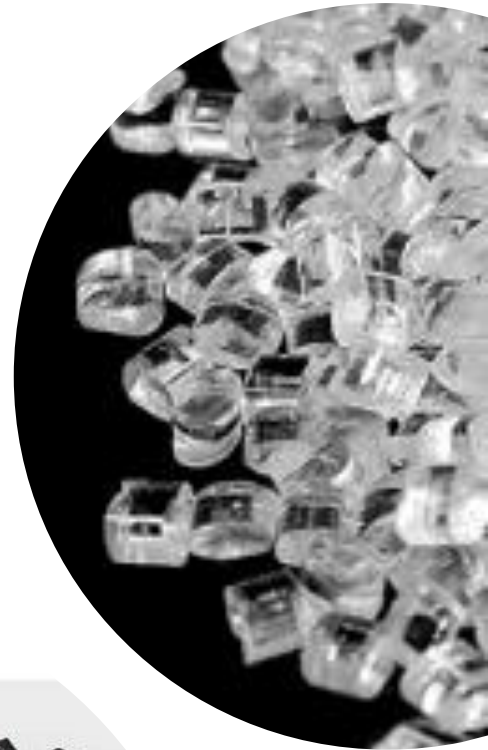
Initial Objectives

- Study how post-consumer regrind (PCR) of various styrene materials perform in comparison to their virgin counterparts.
 - Acrylonitrile Butadiene Styrene (ABS)
 - General Purpose Polystyrene (GPPS)
- Testing Outline:
 - Mechanical
 - *Tensile*
 - *Impact*
 - Thermal
 - *Thermogravimetric Analysis (TGA)*



Materials

- ABS Virgin + PCR
 - Supplier: Industrial partner
 - One generation was processed.
- GPPS Virgin + PCR Imitation
 - Supplier: PolyOne (Now Avient)
 - Three generations were processed.



Methods

- Processing:
 - Injection Molding Machine
 - Arburg All-Rounder 320S 500-150
 - ASTM Mold
 - Tensile bars and Impact Bars
- Testing Outline:
 - Mechanical
 - Tensile – Instron
 - Impact - IZOD
 - Thermal
 - Thermogravimetric Analysis (TGA)



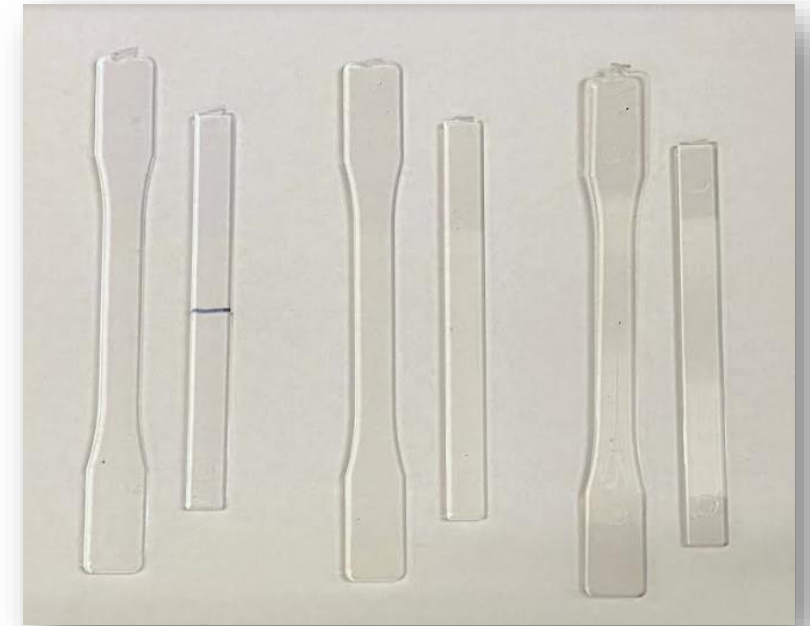
Post-Processing Observations



ABS VIRGIN Test Bars



ABS PCR Test Bars



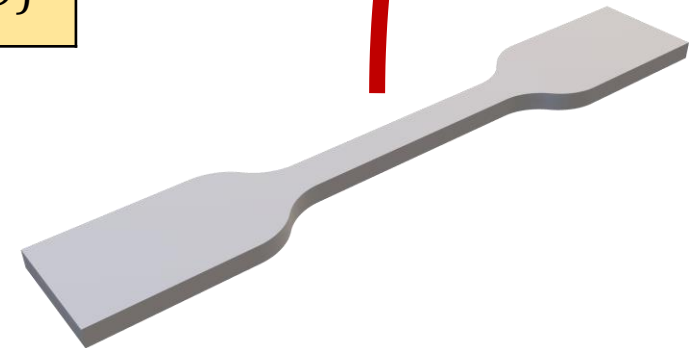
GPPS Test Bars:
1st Gen 2nd Gen 3rd Gen

***Dog bones were used for tensile testing and straight bars
were used for Izod impact testing.***

Mechanical Testing: Tensile

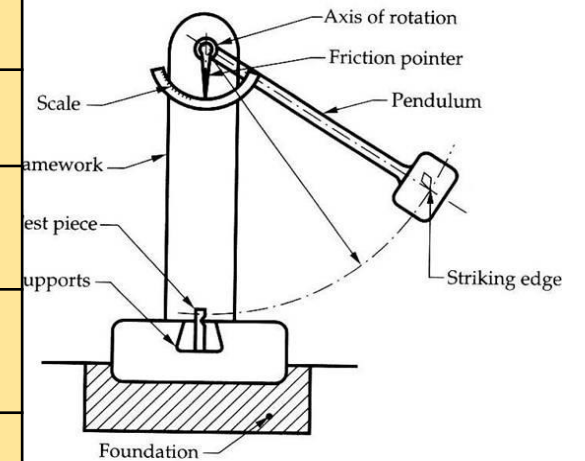
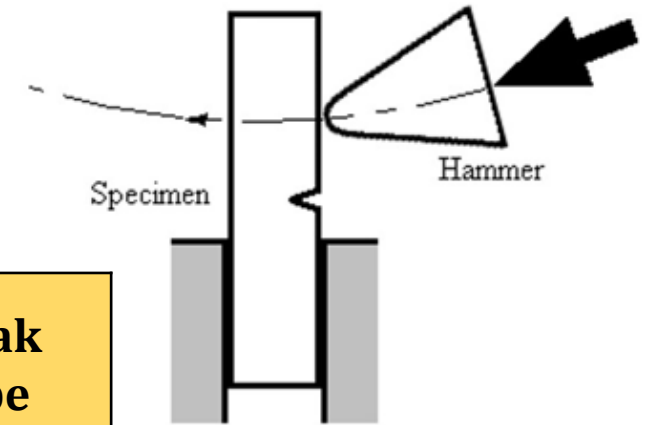
| Sample | Modulus (MPa) | Break Stress (MPa) | Break Elongation (%) |
|------------------------------------|------------------------|----------------------|----------------------|
| Virgin ABS | 482.58 (± 19.75) | 34.83 (± 0.64) | 12.05 (± 0.25) |
| PCR ABS | 521.99 (± 12.07) | 38.51 (± 0.77) | 12.38 (± 2.61) |
| GPPS 1 st Generation | 659.20 (± 24.32) | 50.41 (± 0.59) | 11.33 (± 0.53) |
| GPPS 2 nd Generation | 670.82 (± 25.76) | 51.23 (± 0.73) | 11.49 (± 0.60) |
| GPPS 3 rd Generation | 676.64 (± 33.05) | 49.98 (± 1.88) | 10.67 (± 0.19) |

Test Method: ASTM D638



Mechanical Testing: Izod Impact

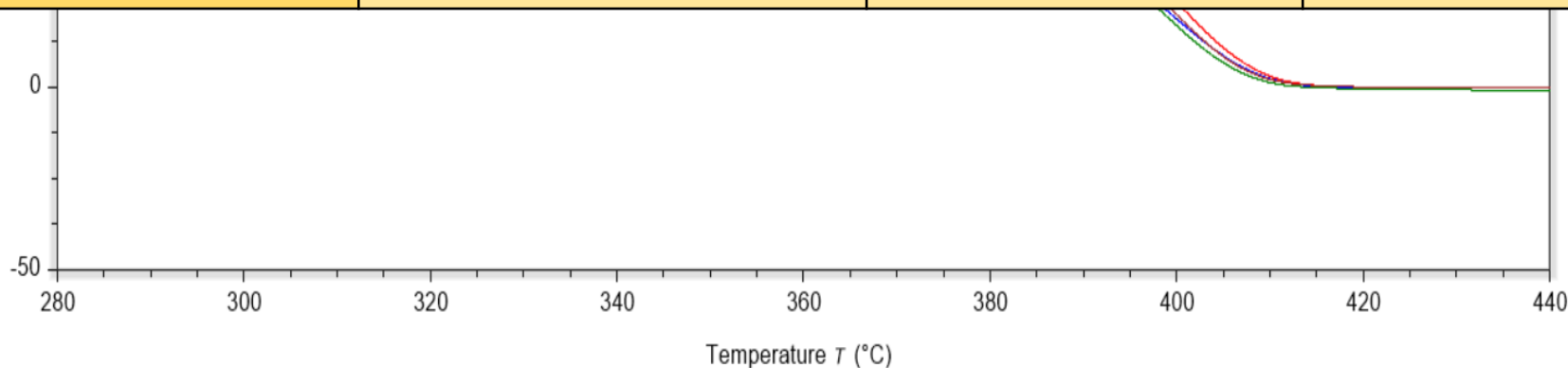
| Sample | Notched Impact (ft-lb/in) | Break Type | Un-notched Impact (ft-lb/in) | Break Type |
|------------------------------------|------------------------------|------------|---------------------------------|------------|
| Virgin ABS | 4.69 (± 0.28) | Hinge | 34.42 (± 5.45) | Partial |
| PCR ABS | 2.98 (± 0.17) | Full | 12.22 (± 2.58) | Full |
| GPPS 1 st Generation | 0.16 (± 0.03) | Full | 2.04 (± 0.39) | Full |
| GPPS 2 nd Generation | 0.18 (± 0.04) | Full | 2.99 (± 1.51) | Full |
| GPPS 3 rd Generation | 0.19 (± 0.04) | Full | 2.20 (± 0.61) | Full |



Thermal Testing: TGA



| Sample | Temperature at 10 % Degradation (Celsius) | Temperature at 50 % Degradation (Celsius) | % Residue |
|---------------------------------|---|---|-----------|
| GPPS Pellet | 340.93 | 385.26 | 18.80 |
| 1 st generation GPPS | 347.23 | 386.50 | 16.97 |
| 2 nd generation GPPS | 360.91 | 390.66 | 23.61 |
| 3 rd generation GPPS | 354.91 | 388.87 | 20.08 |



0 °C → 600 °C

Data Collected:
10% weight loss
50% weight loss
% Residue

Conclusions

- PCR ABS showed slight enhancement in modulus over virgin ABS.
- Regrind generation had little effect on tensile properties of GPPS.
- Virgin ABS material had greater impact strength than PCR ABS.
- Regrind generation had little effect on impact strength of GPPS.
- Virgin ABS materials were more thermally stable in TGA than PCR ABS materials both before and after processing of each.
- GPPS increased in thermal stability from its pellet into the 1st and 2nd PCR imitations.
 - Its 3rd generation did not follow this trend



Acknowledgements

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Thank you for your time.

