Investigation of Post-Consumer Regrind Content in Polyethylene and Polypropylene for Consumer Packaging Applications

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Why Recycle?

- Growing environmental concerns surrounding plastics
- Ocean life is starting to become affected
  - For example, South Pacific Garbage patch
- Prevent build up of plastic waste in landfills
  - Landfills becoming completely full in the next several years

Why the Plastic Industry uses Plastic Regrind!

- Resin prices are variable
- Excess material and rejected parts can be reclaimed to control cost
- Using post-consumer regrind will reduce demand on natural resources and optimize the material usage
- Items of concern to industry:
  - Amount of plastic regrind that can be used in a part with virgin material with loss of performance
  - How regrind was originally processed
  - Regrind granule size
  - Any potential contamination

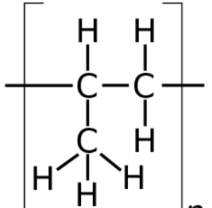
Project Goals

- Purpose of this project
  - To determine the differences between virgin resins and resins that contains post-consumer recycled content (PCR)
  - Injection molding samples
  - Characterizing sample properties
    - *Mechanical properties*
    - Thermal properties
    - Rheological properties
- Identify a potential plastic with significant PCR content that can replace a conventional virgin plastic in consumer packaging

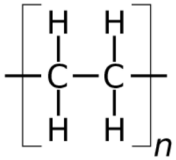
Plastic Resin Materials:

- Control Resins
  - Ineos H05A-00 Polypropylene Homopolymer
  - Marlex 9012 High - Density Polyethylene

Polypropylene



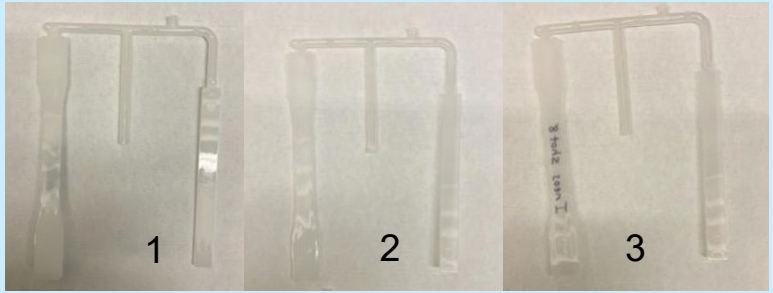
Polyethylene



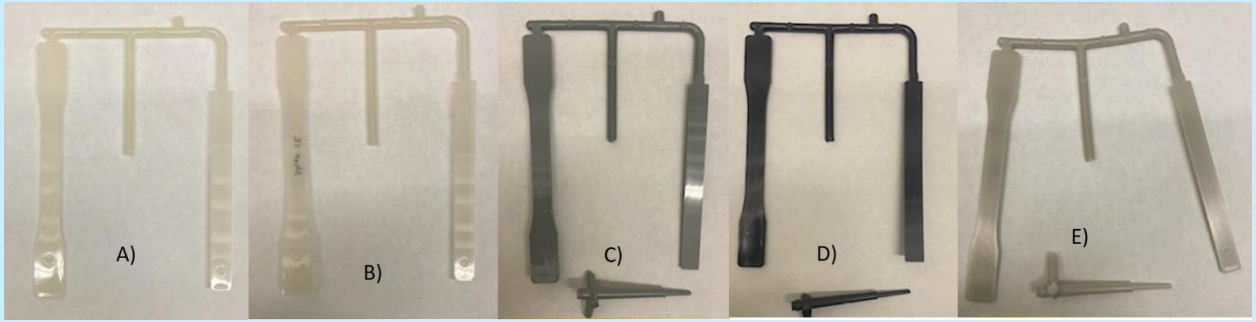
- Experimental Resins
  - Plastic Bank SDS clear Polypropylene (Social Plastic)
  - KWR621 Post Consumer Recycled FDA Polypropylene Resin
  - KW Post - Consumer Recycled Polyethylene Resins:
    - KWR 102 BM High - Density Polyethylene
    - KWR 101 150 Natural High - Density Polyethylene

Injection Molding

- Control (1-3) and experimental resins (A-E) were obtained and injection molded



1) Chevron Phillips Marlex 9012, 2)Ineos H05A-00 PP 2019, and 3)Ineos H05A-00 PP 2020.



A) Social Plastic PP 2019, B) Social Plastic PP 2020,
C) KW-621 PCR FDA PP, D) KWR 102 BM PE, and E) KWR 101 150 Nat PE

Tensile Testing

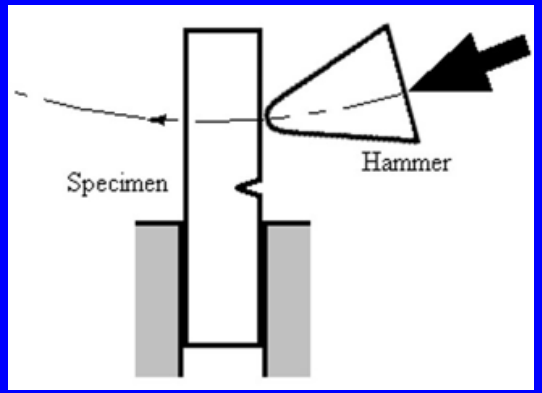
- Tensile testing determines multiple parameters related to material strength and flexibility
  - Modulus
  - Break Stress
  - Break Elongation

Tensile Testing Results

Material	**Modulus (MPa)**	**Break Stress (MPa)**	**Break Elongation (%)**
Ineos H05A-PP Homopolymer (2019)	362.69 (±7.18)	15.68 (±1.90)	122.91 (±31.05)
Ineos H05A-PP Homopolymer (2020)	341.99 (±4.15)	14.27 (±4.81)	216.45 (±79.29)
KWR 621 PCR FDA Grade PP	76.85 (±1.76)	10.63 (±1.94)	85.34 (±10.32)
Social Plastic PP (2019)	351.57 (±7.91)	23.76 (±5.27)	70.22 (±18.93)
Social Plastic PP (2020)	322.70 (±11.30)	16.26 (±2.31)	377.40 (±155.64)
Chevron 9012 HDPE (Marlex)	133.13 (±6.58)	11.13 (±1.20)	1480.93 (±407.81)
KWR-101-150 NAT	220.87 (±5.78)	12.01 (±2.21)	426.48 (±58.53)
KWR 102 BM	152.56 (±4.50)	10.48 (±1.01)	852.40 (±335.70)

Izod Impact Testing

- Impact testing is a measure of material toughness
- Izod testing uses the apparatus shown here



Izod Impact Results

Material	Notched Resistance (Ft-Lb)	Average Breaks	Un-Notched Resistance (Ft-Lb)	Average Breaks
Ineos H05A-PP Homopolymer (2019)	1.17 (±0.26)	Break	26.99 (±2.01)	Partial
Ineos H05A-PP Homopolymer (2020)	0.75 (±0.07)	Break	29.26 (±3.73)	Partial
KWR 621 PCR FDA Grade PP	1.05 (±0.07)	Break	17.91 (±3.83)	Break
Social Plastic PP (2019)	0.60 (±0.08)	Break	22.10 (±3.10)	Break
Social Plastic PP (2020)	0.56 (±0.08)	Break	20.71 (±2.95)	Break
Chevron 9012 HDPE (Marlex)	1.30 (±0.11)	Break	17.39 (±1.69)	Non-Break
KWR 101-150 NAT	4.41 (±0.48)	Break	21.19 (±2.62)	Non-Break
KWR 102 BM	1.78 (±0.08)	Break	18.99 (±1.59)	Non-Break

Summary and Next Steps

- All experimental and control resins were successfully injection molded
- Tensile Results
  - KWR 621 PCR FDA Grade PP was weaker and less flexible than the controls
  - Social plastic PP (2019 and 2020) had similar strength to the controls but flexibility varied year to year
  - KWR 102 BM was similar to the control in terms of strength and flexibility
  - KWR-101-150 NAT is stronger than the control, but is also more brittle
- Izod Impact Results
  - Social plastic had lower impact than the controls
  - KWR 621 PCR FDA Grade PP and KWR 102 BM were simliar to the controls
  - KWR-101-150 NAT had greater impact strength than the controls

Next Steps:

- Compare thermal properties of experimental resins with control resins
  - Thermogravimetric analysis
  - Differential scanning calorimetry
- Compare melt rheology of experimental resins with control resins
  - Melt flow analysis

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