The above mentioned research will have a significant effect on student learning. The process and results can be duplicated with students throughout the year. The lesson will have a two-fold affect on students. While learning to use various scientific concepts to characterize polymers, students will also relate what they learn to recycling and solid waste disposal.

ISEP Interdisciplinary Science and Engineering Partnership

Buffalo State
The State University of New York

Polymer Research

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Abstract

My summer research project was on the characteristics of polymers. The objective was to identify the six kinds of recycled plastic resins by measuring their physical and chemical properties. The second objective was to learn the importance of polymer (plastic) categorization and its relationship to recycling. Plastics are made of polymers. The simplest definition of a polymer is something made of many units that are connected in repeating patterns. Polymers have been with us since the beginning of time. Polymers occur in nature and can be made to serve specific needs. Natural polymers include such things as tar and shellac, tortoise shell and horns, as well as tree saps that produce amber and latex. In addition, science students across the globe learn about another natural polymer called DNA. Upon the start of WWII, our natural sources of latex, wool, silk, and other materials were cut off, making the use of synthetics critical. Since 1988 Polymers have been classified using Resin Codes. These codes differentiate one plastic from another and assist with consistency in recycling. The following information will provide an overview of polymers and my investigation into their categorization.

Materials and Methods

As mentioned, polymers are coded into six different classes which are, Polyethylene Terephthalate (PET or PETE); High Density Polyethylene (HDPE); Vinyl (Polyvinyl Chloride or PVC); Low Density Polyethylene (LDPE); Polypropylene (PP); Polystyrene (PS). I gathered samples of each class – plastic fork (PS), coffee cup top (HDPE), water bottle (PETE), sour cream container (PP), PVC tubing, and a lab jug (LDPE). I used three methods to test the polymer properties. The methods used were density, thermal properties, and burn characteristics. Thermal testing was done with a Poly DSC machine. The machine allowed each sample to be heated to a specific temperature, which allowed me to view both the glass transition point and the melting points of the tested polymers. For the density test, I used water, alcohol, and corn oil.

Results - Density Test

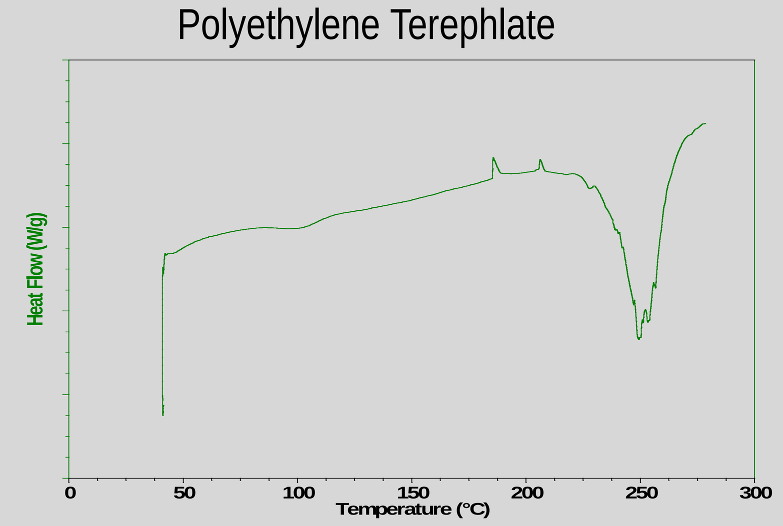
Polymer	Water (gravity = 1.00)	10% NaCl/Salt (gravity = 1.07)	46% Isopropanol (gravity = 0.940)	Vegetable Oil (gravity = 0.918)
PETE	sinks	sinks	sinks	sinks
HDPE	floats	floats	sinks	sinks
PVC	sinks	sinks	sinks	sinks
LDPE	floats	floats	floats	sinks
PP	floats	floats	floats	floats
PS	sinks	floats	sinks	sinks

Results – Burn Test

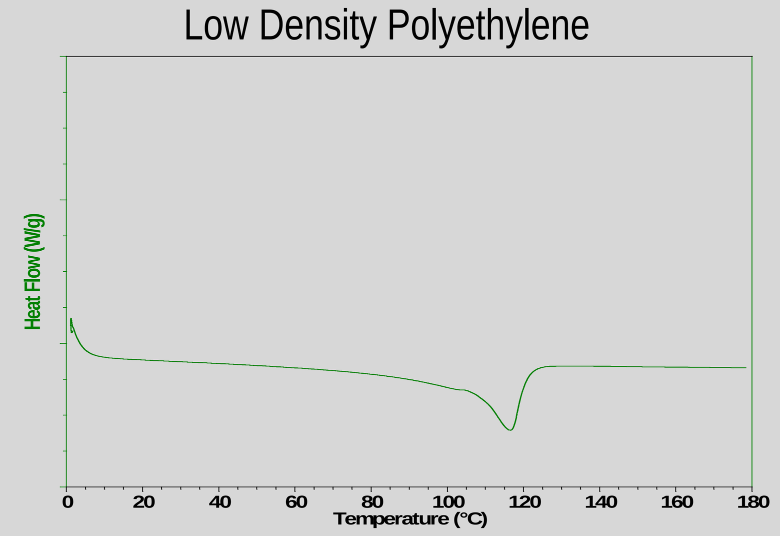
Polymer	Behavior
PETE	Melted and bubbled; burned slowly with some black ash; funny smell
HDPE	Burned fast; dripped; left white smoke when blown out.
PVC	Melted; but stopped quickly when removed from flame.
LDPE	Burned fast and dripped.
PP	Burned slower than others and dripped a little.
PS	Burned very fast with a lot black smoke and ash.

Results – Thermal Test

Polyethylene Terephlate

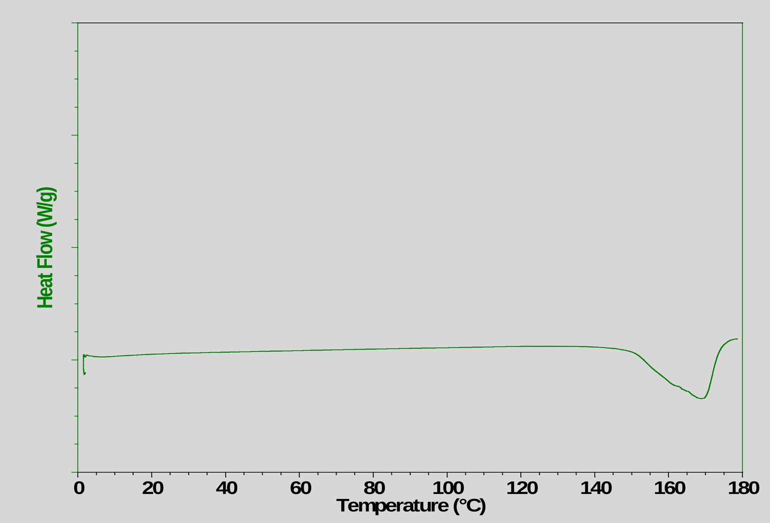


Low Density Polyethylene

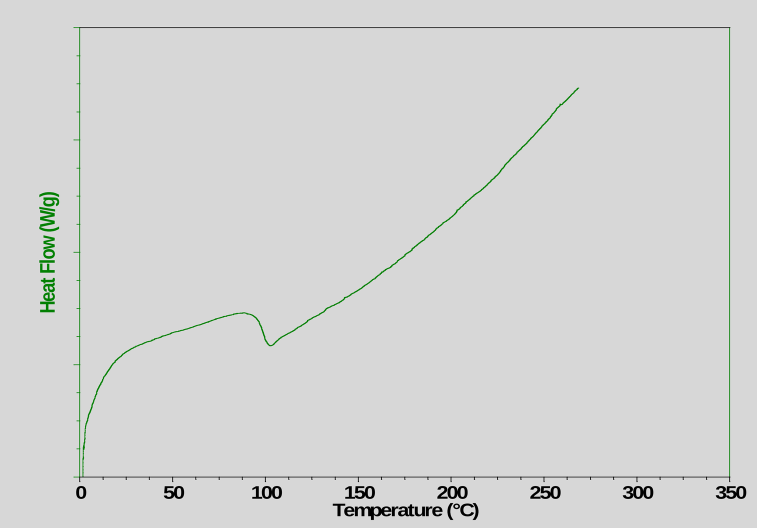


Results – Thermal Test

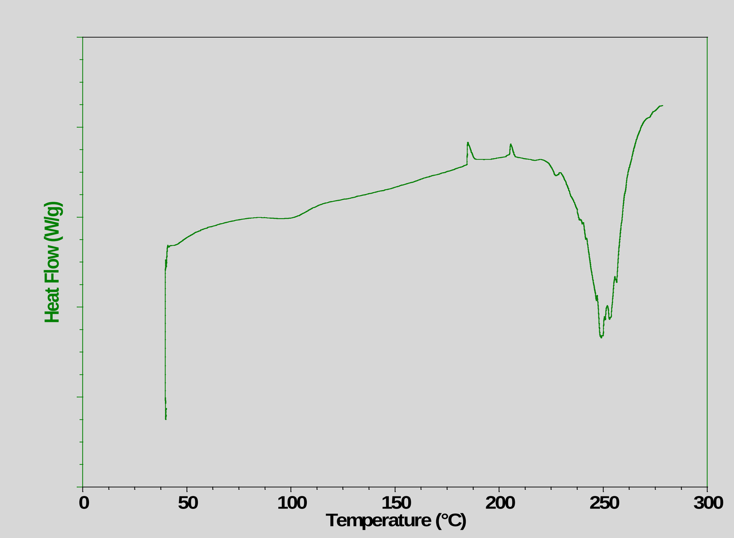
High Density Polyethylene



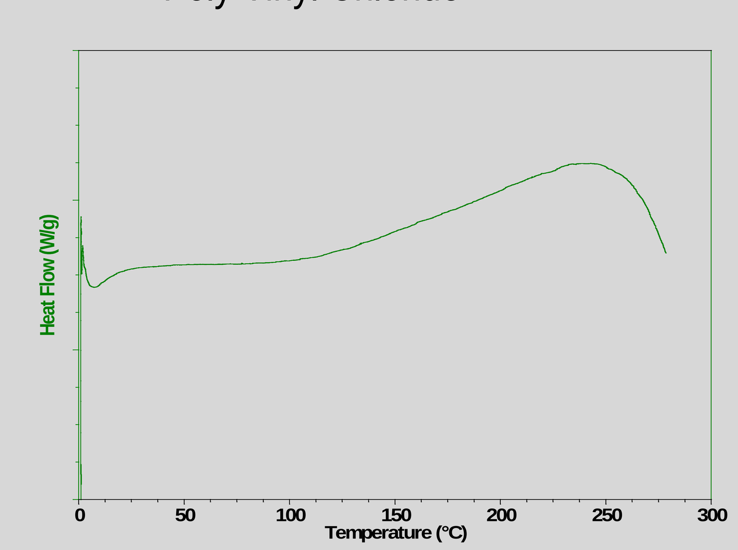
Polystyrene



Polypropylene



Poly Vinyl Chloride



Conclusions

During testing it was observed that the density methods as well as the burn testing methods were consistent with expected results; however when using more sophisticated date analysis, there were a few inconsistencies. For example, while using the Poly DSC machine to interpret thermal properties, there were variations in the melting point and glass transition point for PVC. There could be several reasons for the inconsistent results. The Polymer reference chart used was intended for homopolymers - those with the same repeating base. Factors that could have contributed to the difference in my results were molecular weight/size of the sample, source of the sample (was it commercial or pure), and conditions of crystallization when the polymer was made. Samples used in the project were not tested for purity. Additionally, there are other ways to identify polymer characteristics that were not used. Infrared Spectroscopy testing is a highly accurate means of profiling, screening samples, and identifying chemicals. If possible this method will be used in future polymer projects.

The above mentioned research will have a significant effect on student learning. The process and results can be duplicated with students throughout the year. The lesson will have a two-fold affect on students. While learning to use various scientific concepts to characterize polymers, students will also relate what they learn to recycling and solid waste disposal.

References / Acknowledgements

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