

SORTING PLASTICS BY INFRARED SPECTROSCOPY¹

LAB IR 4

INTRODUCTION

Plastics are very polluting when burned and do not decompose in landfills. Therefore, the best way to dispose of plastic waste from your home is to recycle it. However, since each plastic has a different purpose, they must be sorted into different kinds before they can be reused. This is very labor intensive and thus expensive. A coding system was developed for plastic containers that identifies the material that a plastic product is made of and helps recyclers sort the plastic by composition. These codes are the familiar number inside a triangle found on the bottom of most plastic containers. The plastic identification numbers are given in Table 1.

Table 1. Plastic identification numbers

Number	Plastic Type	
1	PET or PETE	Poly(ethylene terephthalate)
2	HDPE	High density Polyethylene
3	PVC	Poly(vinyl chloride)
4	LDPE	Low density Polyethylene
5	PP	Polypropylene
6	PS	Polystyrene
7	Other plastics	

In this laboratory, a method for sorting plastics will be developed based on how different plastics interact with infrared light. Infrared light has a wavelength of 770 nm to 1000 μm , which corresponds to a wavenumber range of 12,900 to 10 cm^{-1} . In this experiment, infrared light with wavenumbers from 600 to 4000 cm^{-1} will be used.

When infrared light encounters a material, some of it may be absorbed by the chemical bonds in the material. Each type of bond absorbs specific wavenumbers of infrared light. For examples of this, see Table 2.

In this experiment, a sample of a plastic will be placed into a beam of infrared light. Some of the light will be absorbed. The absorption of infrared light will be indicated by a valley (called a peak) in a graph called a *spectrum*. Spectra of known plastics will be used to find a peak or group of peaks that is unique to each type of plastic and that can be used to identify unknown plastics.

Table 2. Examples of wavenumbers of infrared light absorbed by the plastics in Table 1.

	Bond	Wavenumber (cm⁻¹)
Alkane	C-H	2850 - 3000
-CH₂-	C-H	1465
-CH₃	C-H	1375 & 1400
Aromatic ring (C₆H₅)	C-H	3050 - 3150 700 - 1000
	C=C	1400 - 1600
Ester C=O and a O-R group, R is a hydrocarbon	C=O	1730-1750
	C-O	1000-1300
Chloride	C-Cl	600 - 800

PURPOSE

1. To learn the principles of infrared (IR) spectroscopy.
2. To learn how to identify unknown substances using IR spectroscopy.
3. To identify unknown plastic samples.

PROCEDURE

1. Use the plastic identification codes to separate the plastic samples by plastic type. Plastics without codes are considered "unknowns".
2. Use the instructions provided for the Thermo Mattson Satellite FTIR to obtain infrared spectra of the known plastics.

3. Use the spectra of the known plastics that your class obtains and the spectra provided with this experiment to identify a peak or group of peaks that is unique to each type of plastic and that can be used to identify unknown plastics.
4. Obtain spectra of unknown plastics and determine their identity using the peaks identified in step 3. ¹

¹ Schumm, Paul #27 A Search for Automated Plastics Recycling Separation.
<http://www.terrificscience.org/lessonexchange/polymers.shtml>. November 11, 2001