IDENTIFICATION OF PLASTICS

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Objectives:

To examine chemical and physical **properties** of some plastics

Concepts:+

Density
Polymers
Characteristic IR vibrations
Cross-linking

Techniques:

Melting Point
Density Determination
Beilstein Test

Equipment:

Melting Point Apparatus
IR Spectrometer
Copper Wire

CHEMISTRY – A Material Science

Chemists create variety of new polymeric materials with combinations of properties that are **desirable**

- PLASTICS

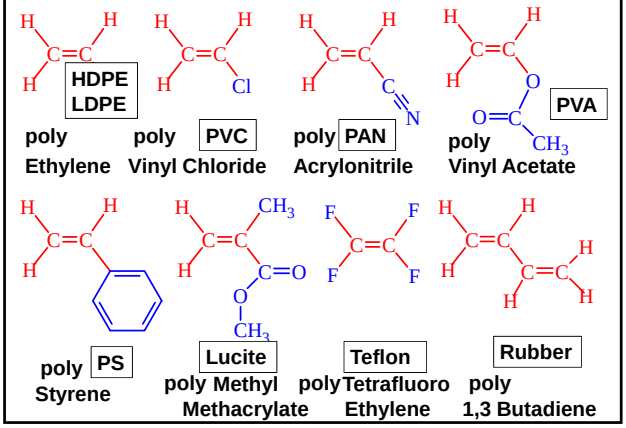
PLASTIC is normally defined as:

a ***carbon-containing polymer*** that can be formed into a desired, ***persistent shape***.

Plastics **are always** ***polymers,*** **but not all polymers are plastics**

e.g., silly putty, jello, asbestos.

Ethylene Based *Polymers - Plastics*



PROPERTIES

What **properties characterize** plastics?

Appearance:
- transparent / translucent / opaque
- native color; color possibility

Chemical composition:
- elementa
- identity of monomers, molecular weight
- repeating units
- additives: pigments, hardeners,

Mechanical properties:
- density
- tendency to cold flow
- tensile strength
- machining properties
- hardness
- flexibility
- shape memory
- molding properties

Electrical Properties:
- DC conductivity / resistivity
- AC properties
- refractive index
- dielectric constant

Chemical Properties:
- smell
- solubility in (or reactivity towards)
  - caustic aqueous media (acids, alkalies)
  - hydrocarbons Aliphatic/Aromatic
  - alcohols ketones esters
  - oils (vegetable, mineral, animal)

Behavior with Heat:

Melting Point / Softening Point / T_g
Burning Behavior
Specific Heat
Thermal Conductivity
Thermal Expansion
Glass Transition Temperature

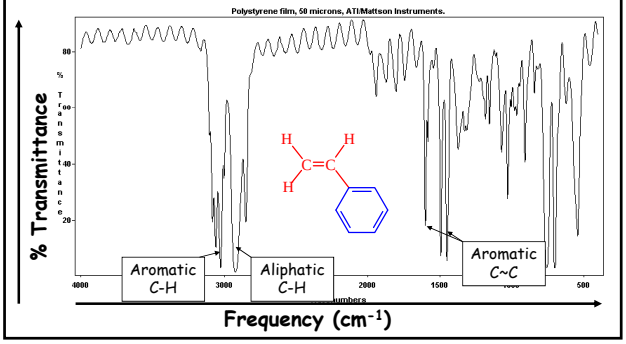
Some terms used specifically to characterize thermal properties of plastics:

THERMOSETTING: able to be molded, but **not** reshaped by heating (usually highly *crosslinked*)

THERMOPLASTIC: able to be molded and reshaped with heat treatment

Spectroscopic Properties:

Characteristic absorptions in Infra red and other regions of the electromagnetic spectrum



The packaging plastics
DISTINGUISHING CHARACTERISTICS

1 **(PETE) POLYETHYLENE TEREPHTHALATE**
Monomer contains C, H and **O**,
BENZENE ring and ***ESTER*** **LINKAGES**
C=O bonds (1720 cm^{-1})

2 **(HDPE) HIGH DENSITY POLYETHYLENE**
Hydrocarbon - only C and H

3 **(V) POLYVINYL CHLORIDE**
Monomer contains C, H and **C-Cl bonds**

4 **(LDPE) LOW DENSITY POLYETHYLENE**
Hydrocarbon - only C and H

5 **(PP) POLYPROPYLENE**
Hydrocarbon - only C and H

6 **(PS) POLYSTYRENE**
Hydrocarbon - only C and H
Monomer contains **BENZENE ring** but ***no*** C=O bonds.

7 **(OTHER)**

1. **Six Properties of 6 plastics**
Work in assigned pairs
   1. ***Melting Behavior (Qualitative)***
   2. ***Burning Behavior***
   3. ***Test for Chlorine (Beilstein)***
   4. ***Density***
   5. ***Appearance***

Each pair will be assigned one plastic for which they will determine *and post*:

   6. ***Melting or Softening Point (Quantitative)***

No reason to do these tests in any preferred sequence. - TA's will assign you to a rotation sequence to avoid pileups at facilities

1. **Melting Behavior - *Qualitative***
   How readily does sample *melt*?
   How *fluid* does it become?
   Color changes on melting?
   Other notable observations!
2. **Burning Behavior**
   Does sample burn only *in flame*, or once started, continue *when removed*?
   Nature of *flame*? - Clear, Sooty, etc.
   Residue after burning? *Smell* afterwards?
3. **Test for Chlorine (Beilstein)**
   Copper wire mounted in glass rod. If **Cl** is present, reacts with Cu and imparts characteristic ***green*** copper color to flame

4. Density

Place sample in four liquids of known density in containers provided in hoods

Does sample sink or float in each?

Mineral Oil	~0.8 g/mL
Alcohol	0.93 g/mL
Water	1.00 g/mL
Salt Water	1.2 g/mL

Allows the bracketing of density between two of the above values.

E.g.

If sample ***sinks*** in **alcohol** but ***floats*** in **water**, its density is between 0.93 and 1.00 g/mL

5. Appearance/Feel

Translucent/Transparent/Opaque?
Stiff/Flexible

6. *Quantitative* Melting/Softening Point (2)

Controlled heating - melting point apparatus
What happens? At what Temperature?

2. Identification of Unknown

WORKING ALONE FROM THIS POINT FORWARD

Perform ***all 6 tests***, **(including quantitative melting point) on an *assigned unknown***

(or on an unknown you have brought in if it is one of the packaging plastics)

and

compare the results with those you obtained on the authentic sample of the ***same plastic***.

Determining the Density of a Film

It is difficult to use the float/sink method on thin films.

If you choose to use your own sample, it is preferable to

- cut a piece of plastic film in a shape whose area is easy to calculate (e.g., a rectangle),
- measure the thickness, *****
- calculate the volume, **V**, and
- weigh the sample, **m**
- compute the density, **m / V**

A micrometer and caliper are available to measure the thickness of the film.

*** measure multiple thicknesses to increase precision**

3. Infrared Spectroscopy – on unknown film

IF you brought in your own thin film –

USE YOUR OWN SAMPLE

1. Does IR spectrum provide a unique identification of the type of plastic?
2. Is the film made of one of the six basic plastics or not? Is it a mixture? Is it one of the posted plastics?

Spectra will be posted in Lab

3. Identify as many group vibrations as you can by consulting the list of group vibrational frequencies.

Table will be posted in Lab

NEXT LECTURE/EXERCISE

Vitamin C in Food Products

SUSB – 018

Do – Pre-Lab

TEST EXERCISE – 100 POINTS

When you return:

QUIZ 2 on SUSB-028, SUSB-015, SUSB-012 and SUSB-014