TEACHERS' EDITION

Determining the Chemistry of the Formation of Polystyrene or Poly(methyl)methacrylate Using Infrared Spectroscopy with ATR Attachment

Introduction:

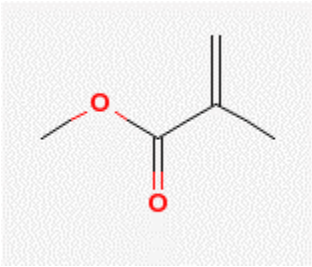
The electromagnetic spectrum has many different types of light other than just the visible light we see everyday. These types of light vary in wavelength (the distance from crest to crest in a wave). The wavelength of light affects the energy that each photon (individual packet of light) has. The shorter the wavelength, the greater the energy a photon of light has.

Spectroscopy is the study of the interaction of light with molecules or atoms. The specific interaction that a molecule has with light depends on the types of bonds in the molecule and the energy o the light. Shorter wavelengths of light in the ultraviolet and visible regions (~200-800nm) can cause bonding electrons to change orbitals when the light is absorbed; much longer wavelengths in the microwave region (~100,000-1,000,000nm) can cause bonds to rotate when the light is absorbed. The wavelengths of light between the visible region and microwaves are known as infrared (IR) (~1000-10,000nm) and can cause bonds to vibrate and/or rotate when the light is absorbed.

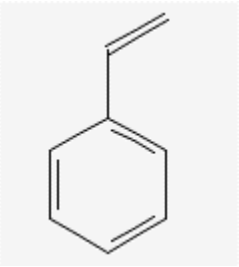
All of the interaction IR light has with molecules are based on very specific "selection rules." The selection rules allow for identification of molecules based on the absorbance pattern of the wavelengths of light in the IR region. Also, the absorbance of IR light follows Beer's law (at low enough concentrations), which means the concentration of molecules can be determined from the absorbance if a calibration curve is prepared.

Purpose:

Polymers are materials that get used everyday. Plastic, styrofoam,



Methylmethacrylate



Styrene

Safety:

Observe standard Good Laboratory Practice (GLP) when using a strong base such as sodium hydroxide as well as when using adipoyl chloride and hexamethylene diamine. Avoid skin contact with the base and avoid vapors to avoid burns and irritation. Wipe up and wash off any spills immediately. Wear protective gloves and goggles at all times. Work under a hood when preparing solutions of adipoyl chloride and hexamethylene diamine.

Instrumentation:

- Model M500 Infrared Spectrophotometer
- Model 57 ATR Attachment
- Grams/AI Software

Supplies:

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Samples:

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Procedure:

Instrument Setup:

- Follow the specific instrument procedures in the manual for initial instrument set up
- Make sure the instrument warms up for at least an hour before beginning scans.

Data Collection:

NOTE: All scans can be performed on the 3 minute scan cycle. Longer cycles will not improve results a noticeable amount and will only increase analysis time.

- Run background scan from 4000 to 600 cm^{-1}.
- Save the background scan and set it as the background scan. Make sure the instrument is set up to ratio future scans against the background scan.

Qualitative Data Collection:

Quantitative Data Collection:

Calculations: