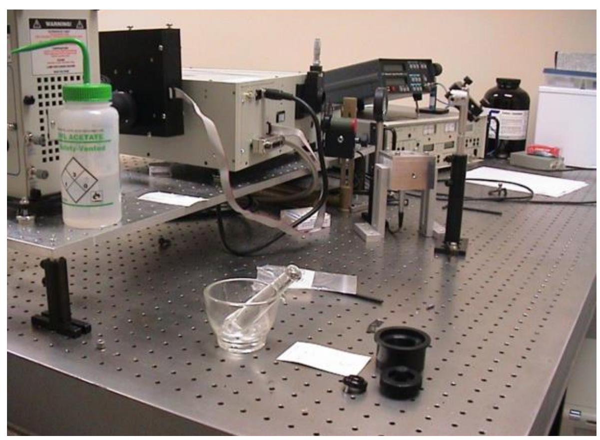
Facilities

Photoacoustic Spectrometer: Photoacoustic (PA) technique has widely been used to investigate samples with relatively low fluorescence quantum efficiency. The major advantage of this technique is that "as received" samples in any state can be investigated with greater sensitivity. The principles and applications in various fields are well documented in the literature [for example, A. Rosencwaig, Photoacoustics and Photoacoustic Spectroscopy, John Wiley & Sons, New York, 1980.). Briefly, the sample is excited to higher electronic excited states by intensity modulated light radiation. Nonradiative decay to the ground state leads to heat generation modulated at the same frequency, which in turn leads to pressure oscillations in the gas that surrounds the sample. The pressure oscillations are sensed by a microphone, processed and plotted as a function of wavelength. The strength of the acoustic signal is proportional to the amount of light absorbed by the sample and then there is a close correspondence between PA spectrum and the conventional optical absorption spectrum.

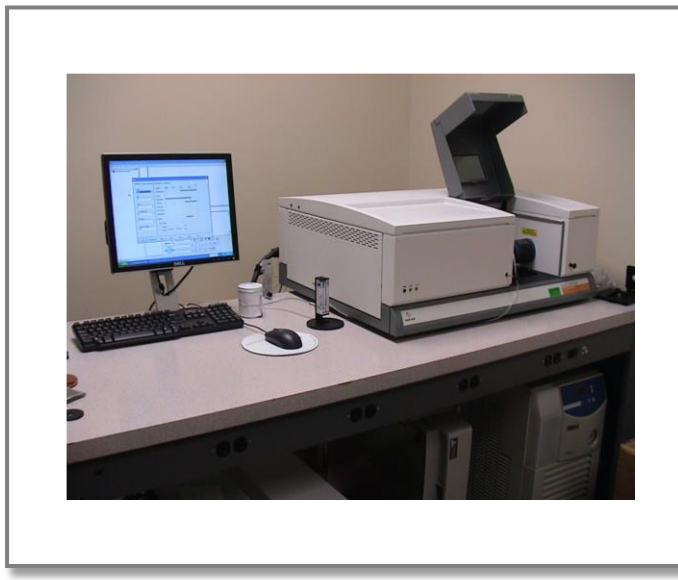
The PA experimental set up is shown in the above picture. The light beam from a 300W Xenon lamp (Oriel Corporation) is wavelength-selected using a monochromator (Cornerstone, Oriel Corporation). The wavelength-selected beam is intensity modulated using a mechanical chopper (SRS), whose frequency can be varied. The modulated beam is then focused onto the sample which is kept in an airtight cell. The photoacoustic cell is equipped with a Bruel&Kjaer microphone (3Hz to 20 kHz). The signal generated as a result of absorption will be monitored by the microphone, which is then amplified and then acquired by a lock-in amplifier (SRS 530). The final data acquisition is done by a PC. Since the PA signal depends on the power of the light output, normalization of the PA spectrum is important. Normalization of the PA spectra to constant input intensity was achieved by using the PA spectrum of the carbon black obtained in the wavelength of interest.



Varian 7000 FTIR Spectrometer System with MTEC Model 300 Photoacoustic Spectrometer System (NIR and MIR Regions)

The state-of-the-art step-scan research spectrometer system capable of handling solid, liquid, and powder samples contains features including:

(1) 125 W High intensity water cooled ceramic IR source (range 9,600-50 cm^{-1}), PERMATRAC 2™ A 60 degree Michelson air bearing interferometer, a design found only on the highest quality research grade spectrometers. The PERMATRAC 2™ interferometer is dynamically aligned by patented Piezo-stack technologies. The PERMATRAC 2™ interferometer in combination with the 125 W water-cooled source deliver an unprecedented 160 mW of IR power to the sample position.(2) 0.10 cm^{-1} resolution at 4,000 cm^{-1}. (3) Step scan capability - provides scan speeds from 800 Hz to 1 step every 250 seconds. In the amplitude modulation mode the FTS 7000 can be used with source (e.g. chopper) or sample modulation with an external lock-in amplifier. Phase modulation is also available, at frequencies up to 1000 Hz. Phase modulation measurements are performed in conjunction with DSP. Step scan also includes operation in time resolved spectroscopy mode "TRS", with 5 microsecond time resolution and event trigger. (4) Digital Signal Processing (DSP3) for modulation experiments. Provides three modes of operation; DSP1, DSP2 and DSP3. DSP1 demodulates the sample response in a step-scan photoacoustic measurement with phase modulation. It is a replacement for the Varian demodulator board or a lock-in amplifier for PAS applications, providing the sample in-phase and in-quadrature response to the phase modulation of the spectrometer. In addition, it provides for the simultaneous demodulation at odd harmonics of the phase modulation frequency, up to the ninth harmonic, providing the sample response to five effective phase modulation frequencies in one measurement. DSP2 demodulates the sample response to simultaneous phase modulation and a lower frequency sample modulation. DSP2 replaces the function of two lock-in amplifiers working in series, providing the in-phase sample response to phase modulation, and the in-phase and quadrature sample response to sample modulation. DSP3 demodulates the signal generated by a photo-elastic modulator (PEM) running at 37 KHz, for either linear dichroism or circular dichroism measurements. DSP3 replaces the function of from one to five lock-in amplifiers, dependent on the experiment. Typical applications are PEM-IRRAS measurements, dynamic infrared linear dichroism (DIRLD) and vibrational circular dichroism (VCD). Includes an electronic bandpass filter and external detector cable. DSP3 is designed for use with a 37 KHz PEM. PEMs at other frequencies are not supported.



Cary Eclipse Fluorescence Spectrometer

The Cary Eclipse is a computer-controlled, ratioing fluorescence spectrophotometer with dual monochromators and measurement modes for fluorescence, phosphorescence, chemiluminescence, and bioluminescence. The system uses Cary's unique pulsed lamp technology, like the other Cary spectrophotometers, which gives the Eclipse room light immunity in fluorescence mode. This revolutionary technology allows for easy reagent addition or the use of large, bulky sample handling accessories since the sample compartment can be open during sample measurements. Moreover, the lamp is on only during sample measurement, which preserves the lamp life (guaranteed for 2 years of operation) and minimizes photobleaching effects. The short lamp pulse eliminates the release of ozone into the laboratory and the completely enclosed lamp module provides superior efficiency and safety during lamp replacement. The narrow 2 microsecond Xenon lamp pulse (fwhm) and peak power equivalent to 75 kW offer enhanced sensitivity, while still minimizing photobleaching effects. Increased energy throughput results from all reflective, quartz-over coated optics and the use of Schwarzchild collection optics to precisely image and focus the lamp. The excitation and emission monochromators are 0.125 m Czerny-Turner design with an f3.6 focal length and have a limiting resolution of < 1.5 nm. Specifications for the monochromators include:

Wavelength Range: Mechanical, 190-1100 nm, Zero order selectable
Operational, 200-900 nm with standard PM tube, Zero order selectable
Wavelength Accuracy: ± 0.5 nm at 541.6 nm, ±1.5 nm over entire range
Wavelength Reproducibility: ±0.2 nm
Gratings: 30 x 35 mm, 1200 l/mm, blaze at 370 nm (excitation) and 440 nm (emission)
Filters: Excitation includes: open and shutter settings
2 bandpass filters (250-395 nm and 335-620 nm); 2 cutoff filters(550 nm, 695 nm); Emission includes: open and shutter settings: 1 bandpass filter (250-395); 4 cutoff filters (295 nm, 360 nm, 430 nm, and 550 nm) 3 % attenuator.

The horizontal beam and slit image reduces the amount of sample required for analysis requiring as little as 0.50 mL in a standard 3.0 mL cell. Guaranteed 750:1 RMS using 350 nm excitation, 10 nm slits, 1 s signal averaging 500:1 RMS using 500 nm excitation, 10 nm slits, 1 s signal averaging Sample and reference signals are detected by high performance R928 photomultiplier tubes (PMTs) that are standard. The PMTs can operate with a gain of Low, Medium, or High, with manual adjustment from 400-1000 V in increments of 1 V. The non-measurement, phase stepping wavelength drive eliminates scan speed errors by synchronizing the lamp pulse and scan motors so that no measurements are taken while the monochromators are moving. The time drive mode also synchronizes the lamp pulse to data acquisition. Allowable data intervals include: 0.15-30 nm; 9.3711-140.0566 cm^{-1}; 1.5-300 A, 0.0012-0.0174 eV. Data collection rates in points per minute per cell are 4800 points/1 cell; 6 points/4 cells; and 55 points/4 cells with minimum SAT and Dwell Time.

Hitachi TM-1000 Scanning Electron Microscope

We have a Hitachi TM-1000 scanning tabletop electron microscope for faculty research and student training.

Specifications of the SEM include:
Magnification: 20~10,000× (digital zoom: 2, 4×)
Accelerating voltage: 15kV
Observation mode: Standard mode/charge-up reduction mode
Specimen traverse: X:15 mm, Y:18 mm

Maximum sample size: 70mm in diameter

Maximum sample thickness: 20mm
Electron gun: Pre-centered cartridge filament.