Luis Echegoyen’s Laboratory Instruments

PREM Seminar
Danisha M Rivera-Nazario
Maira R. Cerón
Electrochemical Workstations

Three potentiostats
Electrochemical studies in a three-electrode system.

- Cyclic Voltammetry
- Potential Control Electrolysis
- Square Wave Voltammetry
- Electrochemical Impedance Spectroscopy

What can you study and explore?
Redox properties of electroactive materials.
Calculate electrochemical band gaps (HOMO-LUMO).
Electrochemical reactions.
Film conductivity.
Electrochemical Workstations
Electrochemical Workstations

Electrochemical Quartz Crystal Microbalance Oscillator

Study the mass gain at the surface of working electrodes.

Dynamic experiment

\[ \Delta m = -\frac{\Delta f}{C_f} \]
Spectroscopy

UV-vis-NIR
Absorption spectroscopy

Experiments
• Liquid samples
  • Films
• Solid samples
  • Spectroelectrochemistry

What can you study and explore?
Absorption properties.
Study energy transfer processes.
Calculate optical band gaps (HOMO-LUMO).
Spectroscopy

![Graph showing absorbance versus wavelength for F3-F1-F1 and F3-F1-F2](image)
What can you study and explore?
IR absorption spectrum.
Identify specific functional groups.
Study self-assembled monolayers.

Experiments
• Solid samples
• Films
• Variable Incident Angle ATR

FT-IR
Absorption spectroscopy
Resonant frequencies

Spectroscopy
Spectroscopy

Raman Spectroscopy
Absorption spectroscopy
Scattered light

Experiments
• Solid samples
• Liquid samples
• Suspensions
  • Films

What can you study and explore?
Studies vibration of the atoms.
Chemical and structural information of the sample analyzed.
Relative amount of materials.
Layer thickness and crystallinity.
Spectrometry

Matrix Assisted Laser Desorption Ionization Time-of-Flight Mass Spectrometry (MALDI-TOF MS)

Soft ionization technique

What can you study and explore?
Average and exact mass of compounds.
Isotopic distribution.
Chemical composition.
Spectrometry
Spectrometry

---

**2H-Porphine**

---

**Zn-Porphine**

---

$m/z$
Chromatography

Techniques used to separate two or more components in a mixture. It relies on the different interaction between each compound and the solid adsorbent material (stationary phase) of the column chromatography carriage by the mobile phase.

High-Performance Liquid Chromatography (HPLC): Is composed of a pump that pass a pressurized mobile phase containing the sample mixture through a column filled with stationary phase.
**Recycling HPLC**: Used to separate samples with very similar retention times, principle is to inject the sample into the column as many times as necessary to separate overlap peaks.
**Solar Cell Fabrication**

**UV-ozone:** clean surfaces of substrate by irradiating the surface with low pressure Mercury lamp creating enough energy in the Ultra Violet spectrum range.

**Spin coater:** used to deposit uniform thin films to flat substrates. Usually a small amount of coating material is applied on the center of the substrate, which is either spinning at low speed or not spinning at all. The substrate is then rotated at high speed in order to spread the coating material by centrifugal force.
Solar Cell Fabrication

**Glovebox**: Device fabrication or chemical reactions air sensitive or moisture sensitive

**Glovebox**: is a sealed container that is designed to allow one to manipulate objects where a separate atmosphere is desired
Solar Cell Fabrication

**Metal Evaporator:** used to evaporate metals under vacuum, the vacuum allows the vapor particles to travel directly to the substrate, where they condense back to a solid state. Shutter which controls the thickness of the layer deposited on the substrates.

**Organic Evaporator:** used to evaporate organic compounds under vacuum.
**Solar Simulator:** is a device that provides illumination approximating natural sunlight. The purpose of the solar simulator is to provide a controllable indoor test facility under laboratory conditions, used for the testing of solar cells, sun screen, plastics, and other materials and devices.

\[
\eta_p = \frac{J_{SC} V_{OC} FF}{P_0} m
\]
EQE and IQE: A solar cell's quantum efficiency value indicates the amount of current that the cell will produce when irradiated by photons of a particular wavelength.

Profilometer: used to measure a surface's profile, in order
Other instruments...

Arc reactors

Endohedral fullerene preparation

What can you study and explore?
Explore the preparation of different incarcerated species inside of fullerene cages.

Soot (carbonaceous material)
Other instruments...

Contact Angle Goniometer

Surface Characterization

What can you study and explore?
Wettability of a surface.
Surface tension.
Solvent Purification System

Moisture-free organic solvents
Other instruments...

Thermogravimetric Analysis (TGA)

Thermal analysis

What can you study and explore?

- Changes in chemical and physical properties as function of temperature or time.
- Thermal stability.
- Solid-gas reactions.
- Predict material composition.
Photochemical reactor: the use of light to effect chemical reactions. Uses high intensity medium pressure metal halide lamp, standard lamps have a pure mercury spectra. Controls the exposition to a desired range of wavelengths.

Other instruments...

1a-c

- **Route A**
  - hv (0°C)
  - 5eq of 1

- **Route B**
  - o-DCB, 100°C
  - 1eq of 1

2a-c

- [5,6]-open
- [6,6]-open

3a-c

- R= Br
- R= H
- R = OC₆H₁₃