DAD Integration

ENGR 1182.03
Pre lab
Wavelengths vs. Features Size

The wavelength of a sinusoidal wave is the spatial period of the wave—the distance over which the wave's shape repeats. The smaller the wavelength of the wave the higher the energy of the wave.
Fluorescein Detection

Side view where Acrylic chip is sitting on top of the DAD

Acrylic chip

Detection well

excitation

emission

photodetector

blue LED
Absorption of Light

Light of energy $h \nu_{ex}$ is absorbed and excites an electron from $E_0$ to $E_1$ or to a higher energy level.
Relaxation and Emission

- Excited electron "relaxes" to the $E_1$ state and then gets back to $E_0$ by "emission" (releasing) of energy
  - $E_1 - E_0 = h\nu_{em} < h\nu_e$
- This energy of emission is in the form of light.

Electronic Energy Levels
Fluorescein emission will ALWAYS be at a longer wavelength than the excitation.

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Blue spectrum

Green spectrum
Signal to Noise Ratio (SNR)

- In any sensor circuit we must be concerned with detecting unwanted signals which would invalidate our measurements.
  - These unwanted signals are called “noise.”

- A figure of merit of a sensor circuit design is the relative strength of true signal divided by unwanted signal detected: signal-to-noise ratio.
  - The higher the SNR the better the performance of the sensor circuit we have.
Optical Considerations for SNR

- Alignment of the LED and detector is very important for a high quality sensor circuit.
- Reflection off internal surfaces needs to be minimized.
- Outside excitation sources must be shielded from the photodetector.
SNR: LED / Detector alignment

A critical angle of blue LED is chosen such that it maximizes the exposure of detection well to the blue LED excitation so that photodetector senses green emission from the fluorescein in the detection well only.
SNR: Reflections from internal surfaces

- Since we have a stacked layer of materials to assemble our LOC, surface of the each layer can act as a reflecting surface.
- Reflections occur at those surfaces and they erroneously increase the signal seen by the detector.
- Those reflections can be minimized by no air pockets between surfaces(layers).
- Detection well should be fully filled with fluorescein so that no air gaps remain.
- Keep surfaces clean and smooth to avoid reflections.
SNR: Outside excitation sources

- We are interested in *only* the signal from the direct emission of fluorescein.
  - Room light contains all wavelengths and will create significant error.

- Notice the DAD uses a lot of black.
  - Black absorbs light and reduces reflection
Learning Objectives of Lab

- Students will finish building and calibrating the Fluorescein Detection Circuit by connecting the DAD to the Binary Voltmeter circuit.

- Learn the importance of calibration.