Photoacoustic Spectroscopy: Light in and Sound out

Research Advisor: Dr. Han J. Park

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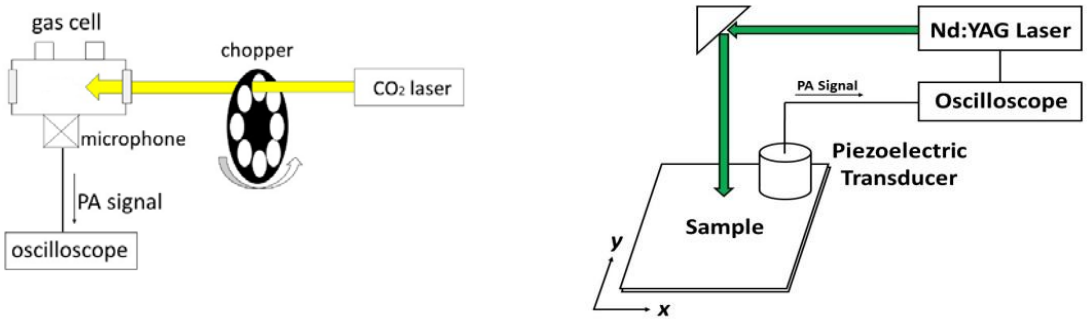
Photoacoustics is the generation of acoustic waves by modulated optical radiation. Alexander Graham Bell accidently found the photoacoustic effect in 1880. Photoacoustic spectroscopy records the heat release via pressure changes, following the conversion of absorbed energy into heat. photoacoustic spectroscopy does not measure transmitted light intensities, sample opacity and scattering difficulties do not limit this analytical method. Photoacoustics can be used to determine different thermophysical and acoustic properties of a system, such as density, sound velocity, thermal diffusivity, and viscosity.



PROJECT 1: Photoacoustic spectroscopy will be used to test the photoacoustic properties of an optically thick and potent greenhouse gas. Detection of trace amounts of the gas is also implemented. The conditions in which the gas is tested, gas cell length, temperature, concentration, and power of the laser, will be varied in order to determine their effect on the photoacoustic signal, and an ideal condition to detect trace gas amounts. A detection limit will be determined for greenhouse gas.

PROJECT 2: Photoacoustic microscopy is an emerging technique that utilizes the photoacoustic effect When a monochromatic beam of light excites the material, it causes thermal excitation or expansion, which is responsible for the creation of acoustic waves. Wave production leads to the increase of pressure inside the sample, and resulted fluctuations can be recorded using ultrasonic transducer. A precise collection of ultrasound acoustic waves can provide a lot of information about the absorption contrast at any location in the sample. Photoacoustic imaging is mainly used in order to provide functional or physiological parameters of the living or dead tissue. In this research, the fundamentals of photoacoustic imaging will be studied, using the high power pulsed Nd:YAG laser and phantoms made from carbon black and nano structures.

The students will learn how to build up experimental setup with optics, operate lasers and analyze data. The students will also be encouraged to present their work at the 69th Southeastern Regional Meeting of the American Chemical Society (SERMACS) held in Charlotte, NC in 2017.