Photoacoustic Spectroscopy: Detecting Nicotine Vapor

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Photoacoustics(PA) 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.

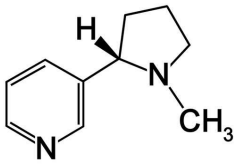

FIG. 1. Nicotine

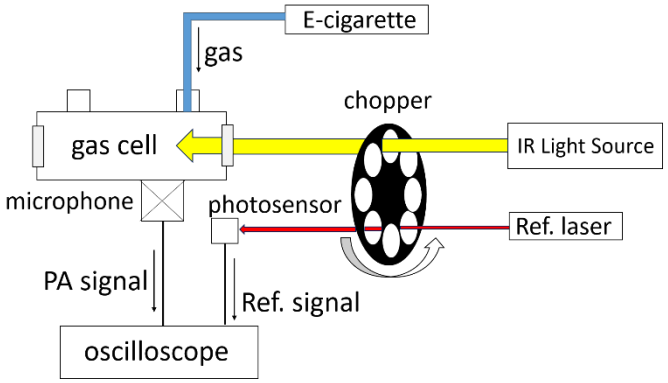

FIG. 2. Experimental set-up

The purpose of this research is to study the photoacoustic (PA) effect due to nicotine in the gas phase. Audible sound will be generated from odor, which can be useful for gas detection. Electronic cigarettes (E-cigarettes) are smoke-free nicotine delivery devices that people use to inhale an aerosol, which typically contains nicotine, flavorings, and other chemicals. Users inhale this aerosol into their lungs and bystanders may also breathe in this aerosol when the user exhales into the air. Nicotine is pale-yellow liquid with a fish-like odor and the addictive component of E-cigarettes. A recent study showed nicotine vapor can permeate the skin and enter the bloodstream at levels equivalent to inhalation of secondhand smoke. Large amounts of nicotine are lethal. For that reason, a proper analysis technique capable of detecting indoor nicotine concentration should be studied.

Nicotine in the gas phase has a large absorbance peak near 3.5 μm. The large optical absorption coefficient is seen as a strong absorbance peak at this wavelength when using an IR light source with a corresponding wavelength. The experimental system can be built inexpensively with readily available components and is useful for understanding the IR absorption properties of nicotine in the gas phase.

The student will learn how to build up experimental setup with optics, operate lasers and analyze data. The student will also be required to present the work at the 73rd Southeastern Regional Meeting of the American Chemical Society (SERMACS) held in Birmingham, AL in 2021.