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Selective and Highly Sensitive Measurement of $^{15}NH_3$ Using Photoacoustic Spectroscopy for Environmental Applications

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Abstract : Isotope analysis has found numerous applications in the environmental science discipline, most common being the tracing of environmental contaminants on both regional and global scales. Many environmental contaminants contain ammonia (NH_3) since it is the most abundant gas in the atmosphere and its largest sources are from agricultural and industrial activities. NH_3 isotopes ($^{14}NH_3$ and $^{15}NH_3$) are therefore important and can be used in the traceability studies of these atmospheric pollutants. The goal of the project is the construction of a photoacoustic spectroscopy system that is capable of measuring $^{15}NH_3$ isotope selectively in terms of its concentration. A further objective is for the system to be robust, easy-to-use, and automated. This is provided by using two telecommunication type near-infrared distributed feedback (DFB) diode lasers and a laser coupler as the light source in the photoacoustic measurement system. The central wavelength of the lasers in use was 1532 nm, with the tuning range of ± 1 nm. In this range, strong absorption lines can be found for both $^{14}NH_3$ and $^{15}NH_3$. For the selective measurement of $^{15}NH_3$, wavelengths were chosen where the cross effect of $^{14}NH_3$ and water vapor is negligible. We completed the calibration of the photoacoustic system, and as a result, the lowest detectable concentration was 3.32 ppm (3□) in the case of $^{15}NH_3$ and 0.44 ppm (3□) in the case of $^{14}NH_3$. The results are most useful in the environmental pollution measurement and analysis.

Keywords : ammonia isotope, near-infrared DFB diode laser, photoacoustic spectroscopy, environmental monitoring
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