

Short-Path Near-Infrared Laser Detection of Environmental Gases by Wavelength-Modulation Spectroscopy

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Abstract : The detection of environmental gases, $^{12}\text{CO}_2$, $^{13}\text{CO}_2$, and CH_4 , using near-infrared semiconductor lasers with a short laser path length is studied by means of wavelength-modulation spectroscopy. The developed system is compact and has high sensitivity enough to detect the absorption peaks of isotopic $^{13}\text{CO}_2$ of a 3-% CO_2 gas at 2 μm with a path length of 2.4 m, where its peak size is two orders of magnitude smaller than that of the ordinary $^{12}\text{CO}_2$ peaks. In addition, the detection of $^{12}\text{CO}_2$ peaks of a 385-ppm (0.0385-%) CO_2 gas in the air is made at 2 μm with a path length of 1.4 m. Furthermore, in pursuing the detection of an ancient environmental CH_4 gas confined to a bubble in ice at the polar regions, measurements of the absorption spectrum for a trace gas of CH_4 in a small area are attempted. For a 100-% CH_4 gas trapped in a 1 mm^3 glass container, the absorption peaks of CH_4 are obtained at 1.65 μm with a path length of 3 mm, and also the gas pressure is extrapolated from the measured data.

Keywords : environmental gases, Near-Infrared Laser Detection, Wavelength-Modulation Spectroscopy, gas pressure

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