Long-path gas cell infrared spectroscopy of volatile organic pollutants

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Volatile organic carbon (VOC) pollutants such as chlorinated hydrocarbons have been frequently found in soils and geological formations close to semi-conductor and cleaning industries. Coventionally, these compounds were measured for their concentrations in environmental samples by means of gas chromatography (GC) and/or GC-MS. However, these measurments need sampling of gas or water samples on site and subsequent transportation of them to the analytical facility and also time consuming analyses. In order to develop a new methodology for rapid multi-phase detection of VOCs which is capable of future on-site analysis, we have tested a long-path gas cell infrared (IR) spectroscopy for standard VOCs.

The following 6 chlorinated hydrocarbon standard gas samples of 0.1, 1 and 10 ppm (volume ratio) were made by putting the reagent solutions in a bottle purged with N_2 gas : 1,1-DCE, *cis*-1,2-DCE, *trans*-1,2-DCE, TCE, PCE, 1,1,1-TCA. Each standard gas was introduced in a long-path gas cell, filled with either N_2 or air, with a path length of 10 m set in an FT-IR spectrometer. IR sepctra were recorded by 128 scans with a wavenumber resolution of 1 cm^{-1}.

Different IR absorption maxima were obtained for 1,1-DCE (868 cm^{-1}), *cis*-1,2-DCE (695 cm^{-1}), *trans*-1,2-DCE (829 cm^{-1}), TCE (850 cm^{-1}), PCE (920 cm^{-1}) and 1,1,1-TCA (727 cm^{-1}). By plotting absorption intensities at these peak positions against their concentration, good linear relations were obtained for all the standards. The detection limit was about 0.1 μL/L (0.1 ppmV), but the quantitative measurement can be safely expected for concentrations over 1 ppm.

These results indicate a promissing capability of this gas FT-IR method as a new tool for the rapid detection of VOCs in the environment. It should be noted that this system can be transported on a car enabling on site analyses.

Isotope Ratios in the Outer Solar System

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The mass spectrometer on the Galileo Probe into Jupiter's atmosphere enabled the determination of isotope ratios for several major elements. Deuterium was measured directly and can also be calculated from the isotopes of He measured in the slolar wind and on Jupiter. D/H has also been determined in cometary HCN and H_2O, and through CH_3D/CH_4 in the atmospheres of Uranus, Neptune and Titan, and as HD/H_2 on Jupiter and Saturn. A comparison of these different determinations provides an illuminating perspective. The Galileo determination of $^{15}N/^{14}N$ on Jupiter has been confirmed by infrared spectroscopy from the Cassini Spacecraft and provides the first measurement of the solar value of this fundamental ratio. It is distinctly different from the value measured in comet Hale Bopp's HCN and from the trerrestrial value. The differences are consistent with the different molecular carriers expected in each case.

References

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