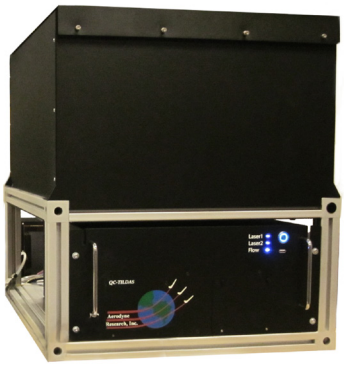
AerodyneResearch

Technology Enhancing Science

TILDAS Dual Laser Analyzer for Clumped Isotopes of CO_2 Derived from Carbonate

Direct Spectroscopic Measurement of $^{13}C^{18}O^{16}O$ with No Isobaric Interference

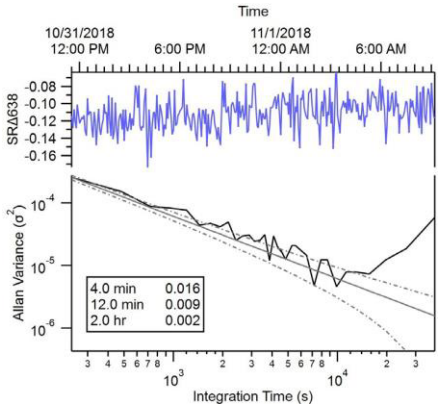


Features

- Direct measurement of $^{16}O^{13}C^{18}O$ ($^{638}\Delta$) rather than mass 47 ($^{47}\Delta$).
- Precision for $^{638}\Delta$ better than 0.02 ‰ for 4-minute measurement with less than 0.4 mg calcite.
- Precision for $^{638}\Delta$ better than 0.01 ‰ for 16-minute measurement with less than 1.6 mg calcite.
- Low operating costs.
- Suitable for CO_2 samples derived from carbonate via acid digestion.

TILDAS TECHNOLOGY

Aerodyne instruments use tunable infrared laser direct absorption spectroscopy (TILDAS) at mid-IR wavelengths to probe molecules at their strongest "fingerprint" transition frequencies. We further enhance sensitivity by employing a patented multi-pass broad-band absorption cell that provides optical path lengths up to 400 meters. Direct absorption spectroscopy allows for fast (<1 sec) absolute trace gas concentrations without need for elaborate calibration procedures. Moreover, TILDAS instruments are relatively free of measurement interference from other molecular species, enabling extremely specific detection.



Rugged, field-ready instruments

Direct absorption spectroscopy allows for highly specific and accurate gas detection

Mid-IR detection enables maximum measurement sensitivity

Applications

- Paleothermometry
- Geologic altimetry
- Burial, diagenesis and metamorphism
- Analysis of diverse concentrated CO_2 samples
- Analysis of CO_2 samples derived from marine carbonate.

Advantages

- Measurement precision comparable to much larger and more expensive IRMS instruments.
- Powerful TDLWintel software provides flexible instrument control and real-time data analysis.
- Valve control capable of complex scheduling and automatic background and calibrations.
- Optional automated sample handling systems.
- Turn-key design allows unattended operation.

Related Instruments

- Single laser isotope monitor for δ13C and δ18O of CO2
- Single laser isotope monitor for δ18O and Δ17O of CO2
- Dual laser monitor for CO2 (δ13C, δ18O) and water (δ18O, δD) isotopes
- Dual laser monitor for CO2 (δ13C, δ18O and Δ17O)

Clumped Isotopes for CO_2

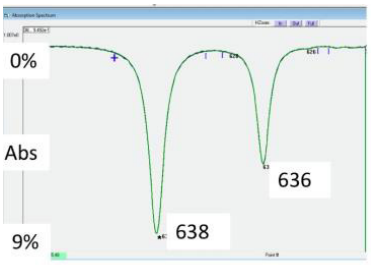
Specifications

Discrete Sample Specifications for CO_2 Clumped Isotope Monitor

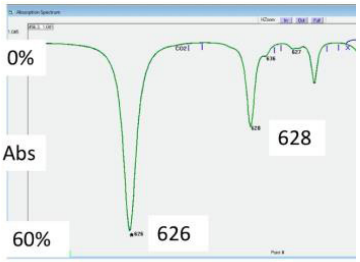
	CO_2	$\Delta^{13}C^{18}O^{16}O$
One sample: <5 µ-moles CO_2 4 min measurement	0.02 ppm	0.035‰
10 Samples: <50 µ-moles CO_2 40 min measurement	0.01 ppm	0.01‰

Note: These measurements are normalized to a working reference and the time to do so is included in the quoted measurement time. The working reference has a mixing ratio, pressure and matrix composition similar to the sample.

Infrared Spectroscopy for Clumped Isotope Determination



Laser #1 measures 638 and 636.



Laser #2 measures 626 and 628.

Data Outputs

RS-232, USB drive, ethernet

Size, Weight, Power

Dimensions: 560 mm x 770 mm x 640 mm (W x D x H)
Weight: 75 kg
Electrical Power: 250-500 W, 120/240 V, 50/60 Hz (without pump)

Installation

Benchtop system

Flushing the optics with CO_2-free gas is recommended

Instrument Operations

Operating temperature: -20 to +40 °C
Sample flow rate: 0 to 20 slpm

Instrument Components

Core instrument
Thermoelectric chiller
Keyboard, mouse, and monitor
Vacuum pump (customer specified)
Inlet sampling system (customizable)

Aerodyne specializes in collaboration and custom design. Please contact us if you would like to discuss additional measurement options and applications.

REFERENCES

Nitzan Yanay, Zhennan Wang, David L. Dettman, Jay Quade, Katharine W. Huntington, Andrew J. Schauer, David D. Nelson, J. Barry McManus, Kaustubh Thirumalai, Saburo Sakai, Anna Rebaza Morillo,Ananya Mallik, Rapid and precise measurement of carbonate clumped isotopes using laser spectroscopy, Science Advances, 26 Oct 2022, Vol 8, Issue 43

Wang, Z., D.D. Nelson, D.L. Dettman, J.B. McManus, J. Quade, K.W. Huntington, A. J. Schauer, S. Sakai, Rapid and Precise Analysis of Carbon Dioxide Clumped Isotopic Composition by Tunable Infrared Laser Differential Spectroscopy Anal Chem, 92(2), pp.2034-2042, 2020.

Nathan Perdue, Zachary Sharp, David Nelson, Rick Wehr, Christoph Dyroff, A rapid high-precision analytical method for triple oxygen isotope analysis of CO2 gas using tunable infrared laser direct absorption spectroscopy, Rapid Communication in Mass Spectrometry, 03 Sept 2022.

Vincent J. Hare*, Christoph Dyroff, David D. Nelson, and Drake A. Yarian, High-Precision Triple Oxygen Isotope Analysis of Carbon Dioxide by Tunable Infrared Laser Absorption Spectroscopy, American Chemical Society, Anal. Chem. 2022, 94, 46, 16023–16032, October 24, 2022.

Wehr, R., Munger, J.W., McManus, J.B., Nelson, D.D., Zahniser, M.S., Davidson, E.A., Wofsy, S.C. and Saleska, S.R.,. Seasonality of Temperate Forest Photosynthesis and Daytime Respiration. Nature, 534(7609), pp.680-683, 2016.

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