(SD2021-377) Pressure-stabilized dual inlet gas mass spectrometry

Tech ID: 32533 / UC Case 2021-Z08-1

BACKGROUND

Mass spectrometers for high precision gas isotope measurements (e.g., noble gases, carbon, nitrogen) are typically equipped with a dual inlet system in which one side contains the unknown sample gas and the second side contains a known standard. Repeated comparisons of the two gases allows precise determination of differences in the gas composition.

TECHNOLOGY DESCRIPTION

Researchers from UC San Diego invented a method to measure relative differences in 4He mole fraction (4He/M) between two large samples of air using a custom mass spectrometer inlet system. Novel elements of this invention include continuous-flow removal of reactive gases via titanium gettering immediately upstream of the mass spectrometer inlet and the use of an actively controlled open split for balancing pressures upstream of a shared capillary directed towards the mass spectrometer. Gas handling techniques, the inlet system and the continuous-flow getter oven are described in detail in a pending patent application.
Sample and standard gas are delivered from compressible volumes comprising metal bellows. Pressure in each bellows can be adjusted by compressing the bellows using a motor system. The pressures are typically adjusted to yield equal beam strengths for sample and standard. This is important because the ratio of the beam currents of two or more isotopes typically varies with the beam strength, even for a constant isotopic mixture. Over the course of an analysis, the bellows empty gradually while the motor position is fixed. Thus, the gas pressure changes, leading to apparent changes in the isotopic ratio, and these changes are not necessarily equal for sample and reference, leading to apparent changes in the difference in isotopic ratio between sample and reference over time. These changes need to be corrected for based on extensive prior calibrations, which adds complexity and reduces the integrity of the results.
This invention resolves the problem of signal-pressure dependence by actively stabilizing the pressure in the bellows by progressively compressing the bellows during the analysis to offset the impact of gas loss.

APPLICATIONS

This is a clear improvement over the existing bellow system, which eliminates issues of signal pressure dependence that current generation dual inlet systems struggle with. This invention provides an improved inlet system that will improve performance. Crucially, the inherent nonlinearity of mass spectrometers imposes bias and error, and this invention bypasses this issue by keeping the gas pressure in the mass spectrometer constant over time. This provides a substantial improvement in measurement precision.
This invention also extends the capabilities of existing mass spectrometers allowing precise measurements of relative changes in the mole fraction of gases without additional work.

ADVANTAGES

Suitable for other noble gases (He, Ne, Ar, Kr, Xe and Rn) applications.

STATE OF DEVELOPMENT

One application allows for the precise measurement of Helium in Earth's atmosphere.

This invention a new method for high-precision measurements of changes in the 4He mole fraction of atmospheric air, which can be directly related to changes in He/N2 ratio. The method relies on monitoring of the 4He+ ion beam in a mass spectrometer during sample–standard switching. The ion beam is stabilized by flowing sample and standard air through a single capillary into the MS from an actively pressure controlled open split such that variability of the 4He+ ion beam directly reflects differences in the helium mole fraction of the gas mixtures. Measurements of the helium mole fraction can easily be converted to δ(He/N2) if O2/N2,

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OTHER INFORMATION

CATEGORIZED AS

- Environment
  - Sensing
- Sensors & Instrumentation
  - Analytical
  - Environmental Sensors
  - Physical Measurement
  - Scientific/Research

RELATED CASES

2021-Z08-1

Ar/N2 and CO2 concentrations of the sample are determined as well.

INTELLECTUAL PROPERTY INFO

Patent pending. UC San Diego is seeking companies interested in commercializing this technology.

RELATED MATERIALS

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