

## Ball Wave develops ultra-miniature high-performance gas chromatograph

*This ground-breaking new technology is a product of R&D  
collaboration at JAXA Space-Exploration Innovation Hub*

Ball Wave Inc., headquartered in the city of Sendai in Japan's Miyagi Prefecture and led by CEO Shingo Akao, has been working with the Japan Aerospace Exploration Agency (JAXA) to conduct collaborative research under the **Open Innovation Hub for Expanding Humanosphere and the Domain of Human Activity through Solar System Frontier Development<sup>(1)</sup>** program organized by JAXA Space Exploration Innovation Hub Center (commonly known simply as **JAXA Exploration Hub**). The official theme of this research collaboration is **Development of a high-sensitivity, high-precision portable gas chromatograph<sup>(2)</sup> capable of analyzing many volatile substances**; its objective is to design a portable sensor—for use both in space and on Earth—capable of detecting various gases and volatile organic compounds with high sensitivity and high precision.

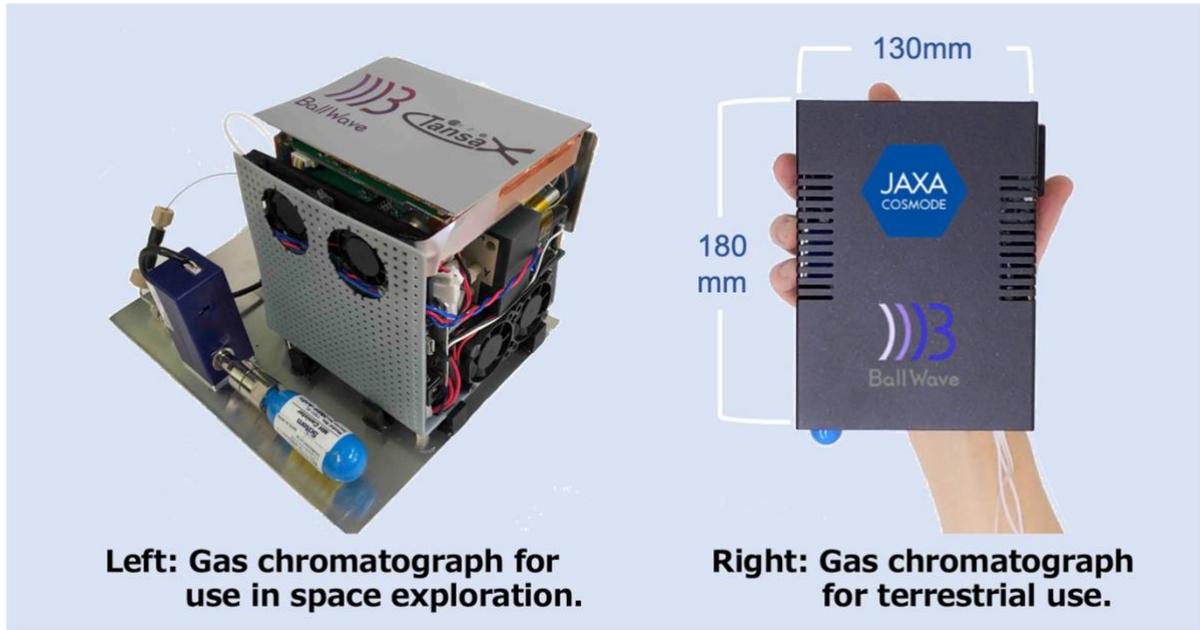
Today, Ball Wave Inc. is excited to announce that this research has produced a ground-breaking technological achievement: the development of a working prototype of a portable gas chromatograph. JAXA and Ball Wave Inc. will present this work on September 11, 2021 at the autumn 2021 meeting of the Japan Society of Applied Physics.

(1) This program was selected as a **Project to Facilitate the Construction of Innovation Hubs** by the Japan Science and Technology Agency, which provided support over a five-year period (from June 1, 2015 to March 31, 2020). The research discussed here was a collaborative effort based on this project.

(2) When a blend of two or more gases passes through a specialized flow path—consisting of a hollow tube wrapped around a reel and known as a *column*—the various components of the mixture naturally separate in time. A *gas chromatograph* is an analytical instrument that exploits this temporal-separation phenomenon to identify and measure the concentrations of the constituents of gaseous mixtures. Conventional gas chromatographs are large instruments typically installed in tabletop configurations; although portable versions have been developed, their sensitivity and precision are generally inferior to those of larger instruments.

The Ball Wave-JAXA research collaboration exploited two revolutionary new high-sensitivity sensor technologies developed by Ball Wave—the *ball-SAW sensor<sup>(3)</sup>* and the *metal-MEMS column<sup>(4)</sup>*—to construct a portable gas chromatograph with dimensions of just 100×100×100 mm and a weight of about 1 kg (left image below), suitable for use in space exploration.

Moreover, the success of this project inspired the development of a second complementary instrument: a palm-sized gas chromatograph for terrestrial use (right image below), for which Ball Wave has begun to provide prototypes.



(3) A sensor, developed by Tohoku University Professor Emeritus Kazushi Yamanaka and collaborators, based on the phenomenon of *surface acoustic waves* (SAWs)—elastic surface oscillations that can concentrate and propagate across solid surfaces—traveling on the surface of spheres.

(4) A fine-processed column of high durability, developed at Tohoku University, that uses tiny planar column elements—fabricated using the ultra-miniaturized processing methods of modern *micro-electro-mechanical system* (MEMS) technology—to convert brittle, fragile silicon into a robust metal-like substance.

The new space-exploration gas chromatograph might be used for continuous monitoring of interior atmosphere in manned spacecraft, or could be mounted on rovers or other space vehicles tasked with exploring the Moon, Mars, or other small planets, where it could be used for quantitative, in-situ analyses of atmospheric gases and gases emitted by heating of soil samples. The fruits of this research initiative may well lay the groundwork for major progress in areas such as the optimal utilization of space resources and related life-science questions.

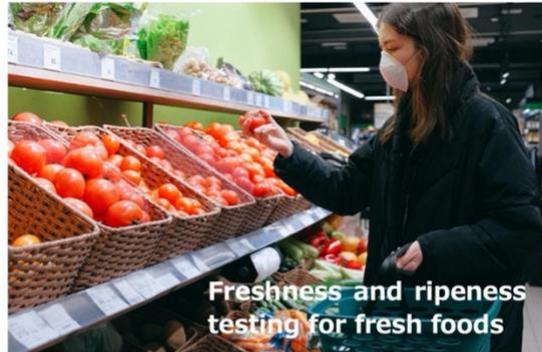
Meanwhile, as detailed below, the new palm-sized gas chromatograph for terrestrial use has potential applications spanning a wide range of fields—from energy and industry, to agriculture, forestry, and fishing, to health care—and may play a key role in building safe, secure, clean, and sustainable future societies. Ball Wave has received permission from JAXA to use the **JAXA COSMODE** logo for this terrestrial-use gas chromatograph.

**Energy / Industry:** Component analysis for evaluating the energy content of natural gas; component analysis of gases emitted from binders or electrolytes during production or use of lithium-ion batteries; VOC analysis; detection of offensive odors

**Agriculture, forestry, fishing:** Reduced food loss via early detection of degradation in fresh fish, fruits and vegetables, and cooking oils; aroma analysis for monitoring of production

processes for alcoholic beverages, soy sauce, and other products

**Health care:** Detection of toxic gases in residential areas and contaminants in soil; detection of illnesses via analysis of bodily gases: breath, body odor, intestinal gases



■ About the JAXA Space Exploration Innovation Hub Center



The Exploration Hub is a center for collaborative research initiatives involving corporations, universities, and research institutes. The Hub is committed to the *long-term* objective of applying the fruits of research to the challenge of space exploration, while simultaneously working in the *near term* to pursue practical commercialization opportunities on Earth and to select problems with the potential to generate—and make practical use of—innovation.

Space Exploration Innovation Hub Center website: <http://www.ihub-tansa.jaxa.jp/>

JST Project to Facilitate the Construction of Innovation Hubs website: <https://www.jst.go.jp/ihub/>

■ About Ball Wave Inc.

Ball Wave Inc. is a startup company founded to develop the technology of the **ball-SAW sensor**—a chemical sensor<sup>(5)</sup> that blossomed from technical seeds sown at Tohoku University—for purposes such as trace moisture analysis and high-speed, high-sensitivity detection of multiple gas species, and helping to lay foundations for safe, secure, clean, and sustainable future societies. Ball Wave develops, manufactures, and sells measurement instruments—such as trace-moisture analyzers and gas chromatographs—equipped with **ball-SAW Sensors**. In addition to the high temperature, pressure, and corrosion resistance of crystal spheres, these sensors boast over 100 times the sensitivity of conventional technologies and significantly faster response times.



Website: <http://ballwave.jp/>

(5) A sensor technology for capturing chemical transformations of substances

#### ■ About JAXA COSMODE

**JAXA COSMODE** is a *brand* created in 2008 for advanced technologies arising from Japanese aerospace R&D and products created by research collaborations between JAXA and private-sector corporations. Its goal is to inject glimpses of the allure of space exploration into the common routines of everyday life. Since 2013, its domain has expanded beyond advanced technologies to include merchandise based on JAXA-owned images or movies with compelling views of the cosmos or the Earth as viewed from space.



Website: <https://aerospacebiz.jaxa.jp/success-story/>

#### ■ About Ball Wave's FalconTrace Series Trace-moisture Analyzers

Ball Wave's **FalconTrace** series of instruments is capable of measuring trace moisture content at levels ranging from parts per million to parts per billion—the sensitivities demanded for quality control of industrial gases in fields such as semiconductor manufacturing and lithium-ion battery production. The **FalconTrace** series offers a three-product lineup. The flagship instrument is the **FT-700WT**, the most powerful of Ball Wave's ultra-miniature moisture-content sensors. The **FT-400WT** is a mid-range instrument that allows real-time

measurements. Finally, the **FT-300WT** is a smaller, general-purpose instrument designed for portability without sacrificing high-speed operation. Ball Wave is currently engaged in mass production and sales of these instruments to a wide range of industrial customers, including manufacturers of semiconductor production equipment and producers of lithium-ion batteries.



FalconTrace FT-700WT



FalconTrace FT-400WT



FalconTrace FT-300WT

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