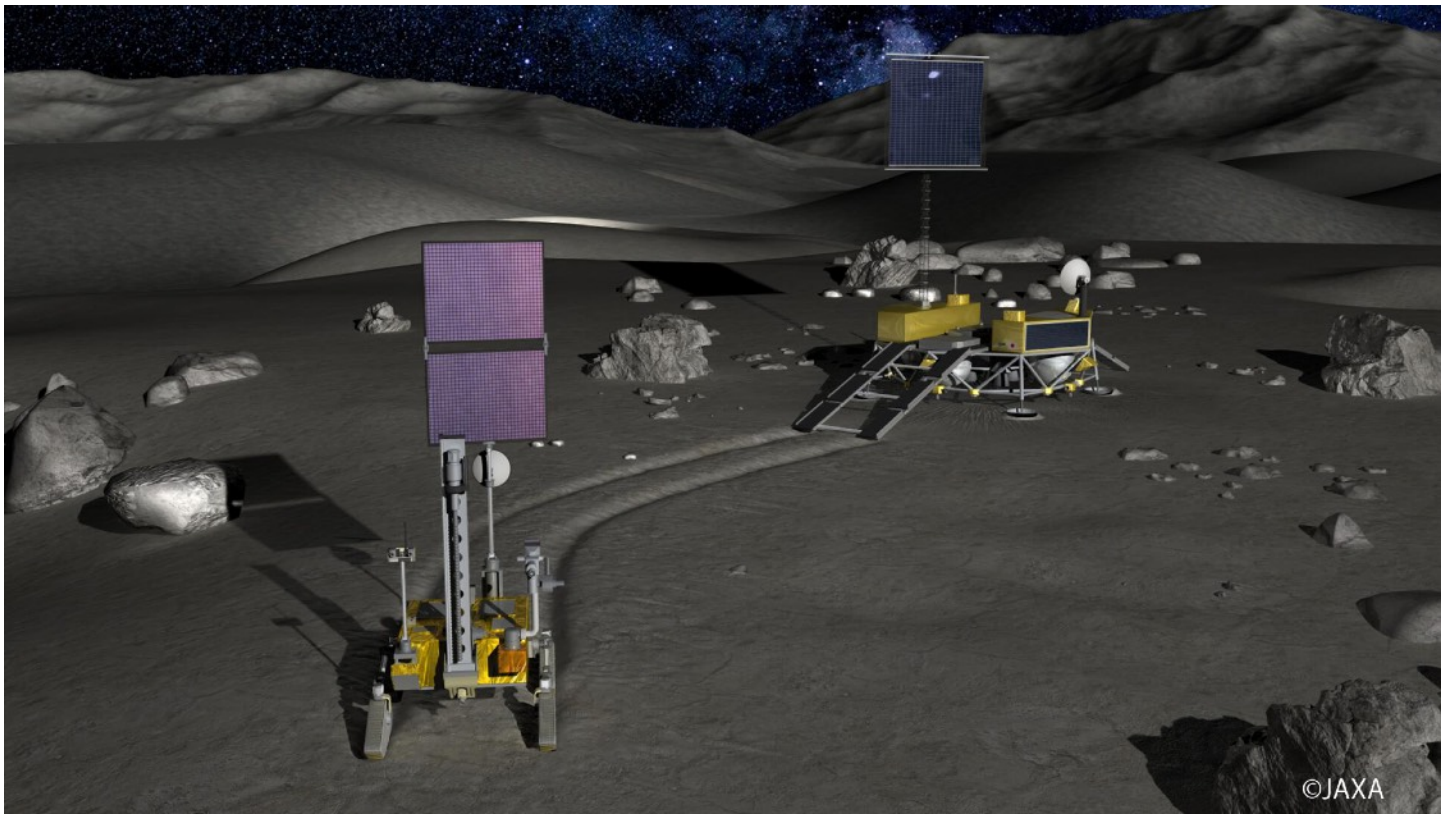
Ball Wave Selected for JAXA Space Exploration Innovation Hub's Request for Proposal

Towards practical realization of highly sensitive and accurate portable gas sensor for volatile detection



Concept image of a lunar landing mission planned by JAXA

Ball Wave Inc., headquartered in the city of Sendai in Japan's Miyagi Prefecture and led by CEO Shingo Akao, has been selected by Japan Aerospace Exploration Agency (JAXA) Space Exploration Innovation Hub Center (hereinafter Exploration Hub) to conduct solution creating research as part of Open Innovation Hub for Expanding Humanosphere and the Domain of Human Activity through Solar System Frontier Development(1). Following a recent request for research proposals, the Exploration Hub selected a proposal submitted by Ball Wave describing a research collaboration with JAXA (hereinafter "this research") with the goal of realizing a highly sensitive and accurate portable gas sensor for volatile detection that can be used to detect many species of gases and volatile organic compounds in the context of social implementation and space exploration. The official theme of this research project is "Development of sensitive and precise portable gas chromatograph(2) for multiple volatile compounds."

(1) The Exploration Hub was selected for the Support program for starting up innovation hub (Period : 2015/6/1～2020/3/31) sponsored by Japan Science and Technology Agency (JST) and this research is based on the Support program.
(2) When a mixture of two or more gases is forced to traverse 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 components of gaseous mixtures. Conventional gas chromatographs are large instruments typically installed in tabletop configurations; although portable versions have been developed, their sensitivity and precision remain problematic.

In recent years, the field of space exploration has witnessed an intense growth of interest in the existence of volatile compounds—such as water in the vicinity of the lunar poles—and the presence of water, organic matter, and volatile compounds on asteroids. Discoveries of methane in the atmosphere of Mars, and of organic matter in the soil of Mars are also reported by the Mars-exploring rover Curiosity(3) operated by the U.S. National Aeronautics and Space Administration (NASA). However, Curiosity's measurement apparatus is extremely large scaled—weighing more than 40 kg—and it is a limitation of the present state of technology that such analytical instruments can, in practice, only be mounted on very large rovers on the scale of Curiosity or larger. For these reasons, this research will exploit two innovative sensor technologies developed by Ball Wave—the highly sensitive ball SAW sensor(4) and the metal MEMS column(5)—to facilitate the development of a portable gas chromatograph with dimensions of just 100×100×100 mm and a weight on the order of just 1 kg. Such an instrument could be mounted on rovers or other space vehicles tasked with exploring the moon, Mars, or asteroids, and could be used for quantitative, in-situ analyses of atmospheric gases and of the gases emitted by the heating of soil samples. The fruits of this research may well lay the groundwork for major progress in areas such as the optimal utilization of space resources and life science.
The sensitive and precise portable gas chromatograph developed by this research will be of value not only in space, but on Earth as well. As detailed below, the potential applications of this new technology span a wide range of sectors—from industry and energy, to agriculture, forestry, and fishing, to health care—and may play key roles in building safe, secure, clean, and sustainable future societies.

- **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.
- **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 brewing 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.

(3) Curiosity is a rover (an exploratory vehicle), with a total length of 3 m and a mass of approximately 900 kg, carried by the Mars Science Laboratory spacecraft used in NASA's Mars-exploration program.
(4) 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.
(5) A microfabricated column of high durability, developed at Tohoku University, that uses tiny planar column elements—produced using the microfabrication methods called micro-electro-mechanical system (MEMS) technology—to convert a brittle and fragile silicon structure into a robust and tough metal structure.

■About the JAXA Space Exploration Innovation Hub

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—innovations.
(Space Exploration Innovation Hub Website: http://www.ihub-tansa.jaxa.jp/)
(Support program for starting up innovation hub by Japan Science and Technology Agency 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(6) that blossomed from technical seeds sown at Tohoku University—for purposes such as trace moisture analysis and high-speed, high-sensitivity detection of multiple gases species, helping to lay the 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 more rapid responsivity.
(Website: http://ballwave.jp/)

(6) A sensor technology for capturing chemical changes of substances

■About Ball Wave's trace-moisture analyzers FalconTrace Series

Ball Wave's FalconTrace series of instruments is capable of measuring trace moisture content at levels ranging from ppm (parts per million) to ppb (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 two-product lineup: the FalconTrace offers high speed and high performance, while the reduced footprint of the FalconTrace Mini makes it easy to install at production sites. 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.

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