Research on innovative batteries

Project title | Development of all-solid-state lithium-ion secondary batteries

Institutions：Hitachi Zosen Corporation

Research outline

Objective

All-solid-state lithium-ion secondary batteries possess advantageous characteristics, such as high energy density, wide operating temperature range, low risk, and long lifetime. They are expected to solve challenges faced by conventional lithium-ion batteries with liquid electrolyte. There are high expectations for their successful application in space, particularly for use in extreme temperatures unachievable with conventional batteries. The objective of this study is to achieve increased tolerance to extreme environments, larger size, and higher capacity through prototyping and evaluating all-solid-state lithium-ion secondary batteries. Ultimately, we hope to attain innovative battery technologies to apply to future missions in planetary exploration.

Contents

The aim of this study is to develop technology with spacecraft applications. We have made the following developments to achieve performance surpassing prior models:

1) Study and prototype an all-solid-state lithium-ion secondary battery that can operate stably under extreme environments. Specifically, we studied and prototyped a battery that can withstand extreme temperature fluctuations, exceeding 100 °C, while maintaining stable operation during the required period.
2) Study and prototype a larger, higher capacity secondary battery. Specifically, we studied and prototyped battery structures and packaging to achieve a size and capacity that greatly exceed past achievements.
3) Various evaluations of prototype batteries. We evaluated the prototyped batteries under severe environments, such as extreme high and low temperatures and vibrations, to assess their performance characteristics.

Battery Characteristics and Research Objectives

As the battery uses inorganic solid-state electrolytes, it has the following features

● High safety

The battery does not produce flammable gases.

● High energy density

As cells can be layered in a single battery package, high voltage and high capacity are possible.

● Broad range of usable temperatures

In contrast to lithium-ion batteries with liquid electrolyte, as the electrolytes do not freeze or evaporate, the battery is operable in both cold and hot conditions.

● Long operating lifetime

Side reactions are suppressed because only lithium ions are transported, allowing for stable operation with less degradation.

Research at the JAXA Space Exploration Innovation Hub Center aims to implement capabilities that extend beyond current accomplishments (Temperature range: -40℃ -+100℃, capacity: several ampere hours) in capacity and environmental tolerance to extreme temperature range.

Application Areas, Commercialization Plans

Going forward, we are in the process of examining the application of batteries to three different fields in which growth is expected

【Storage batteries for use in the power grid】

To stabilize the output of unstable renewable energy, such as wind power generation and solar power generation, a storage battery is installed as a system linkage.

【Stationary storage batteries】

For reducing the load on the power grid, stationary storage batteries are installed in homes or small-scale commercial facilities in order to store electricity generated by solar panels, and nighttime power.

【On-board batteries】

As an indispensable part of many next-generation vehicles, such as electric and fuel-cell vehicles.

In addition, we are considering potential uses in space.

【Storage batteries for use in space】

As equipment on missions to extreme environments where it would be difficult to operate conventional batteries.