■ Vol.5 Producing Lithium-Ion Batteries

Producing Lithium-Ion Batteries

The fifth report covers lithium-ion batteries (LiBs), which will play a major role in the realization of a clean, renewable energy society. ITOCHU has worked together with Group companies to concentrate marketing, technical development, raw material procurement, and logistics capabilities. In this way, ITOCHU and Group companies are cooperating to establish a supply chain that will increase the presence of LiBs.

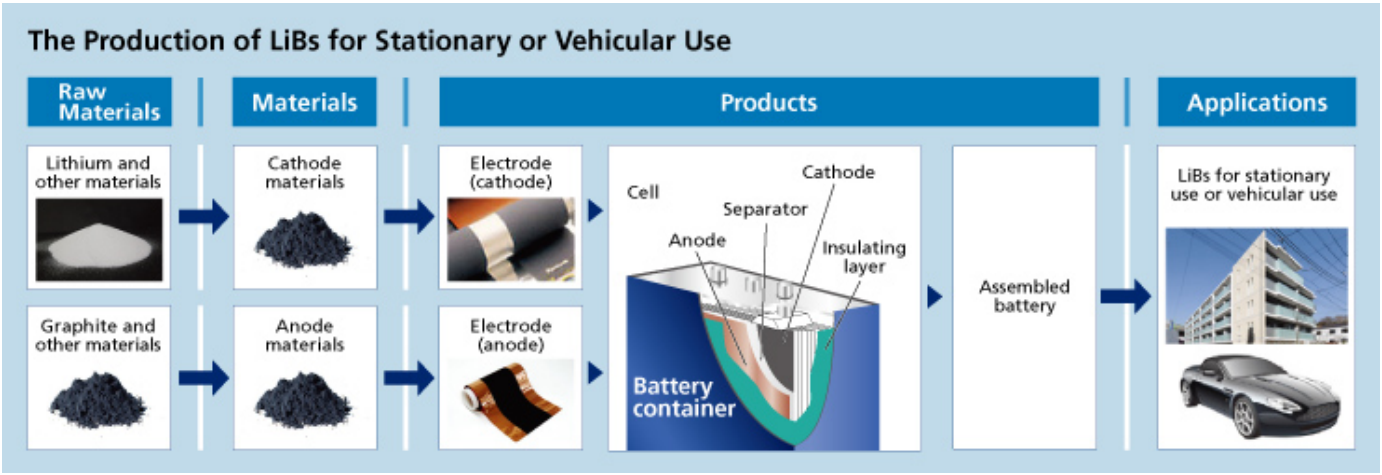
*About the picture
From 2010 to 2012, demonstration tests were conducted for FamilyMart's "Tsukuba Kenkyu Gakuen-ten." These tests demonstrated the successful storing of energy from photovoltaic (PV) power generation and the rapid charging of electric vehicles (EVs).

Front-Line Report: Hideaki Miyata

President and Representative Director,
Social System Design Co., Ltd.
Professor Emeritus,
The University of Tokyo
Representative Director,
The SB Research Group, Incorporated Association
Representative Director,
Forum for East Japan Smart City Project

Prologue

Small LiBs for electronic equipment, which were first commercialized in 1991 by Japanese manufacturers, have become commodities. Now, change on a larger scale is being driven by an unfolding paradigm shift—that electricity can be stored. Large LiBs for stationary or vehicular use are about to change business, and the world. I went to the front lines to investigate how the ITOCHU Group is tackling this challenge.



Akira Yoshino, the inventor of LiBs, said that maybe it would have been better not to use the name "batteries." With LiBs, the mechanism for the storage of electricity is entirely different from conventional batteries. In LiBs, charging and discharging occur through the movement of lithium ions in the gaps between the cathode and the anode when voltage is applied, rather than through a chemical reaction as with conventional batteries.

Raw Materials

Lithium Resource Development

Geothermal brine well in southern California

Currently, three companies that produce lithium at brine lakes in South America have a combined share of about 70% of the global lithium market. Simbol Materials (SIM), based in California, has independently developed innovative, breakthrough technology to recover and commercialize lithium from spent geothermal brine used in geothermal power generation facilities. SIM's exclusive production method, which is not influenced by the weather, makes it easy to expand facilities in comparison with the method used in South America, which requires solar evaporation. Accordingly, SIM's method facilitates further gains in cost competitiveness through increased production capacity.
ITOCHU, which invested in SIM in June 2010, is now working to provide lithium compounds for various applications. These applications include cathode materials and the electrolytes in electrolytic solution, which are core components of LiBs, as well as other commercial applications.

Materials

Cathode Material Production

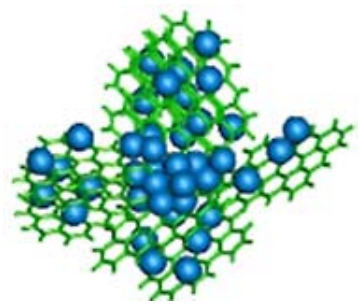
Location: Toda Kogyo Corp.
Capital / business partnership agreement concluded in December 2012. Equity-method affiliate of ITOCHU. Toda Kogyo and ITOCHU are operating a joint venture that is engaged in the manufacture and sale of cathode materials in North America and China.

Raw materials are mixed and placed in the container, which is then transferred to the firing machine, which functions like an oven.

In addition to lithium, cathode materials also contain manganese, cobalt, nickel, and other components. The performance and lifespan of LiBs are determined by which of these components are combined to make the cathode materials. Accordingly, the design and production of cathode materials plays a central role in the production of LiBs. The production processes for cathode materials are dissolution, reaction, drying, mixing, firing, and pulverization. Any contamination by foreign substances will have a critical influence on the product's lifespan and safety. Consequently, this contamination must be avoided. That is why production sites are kept as clean as food factories, including high-precision checks that use electromagnets to prevent contamination by iron.
In Japan, lithium and other raw materials for cathode materials are almost all imported. accordingly, ITOCHU's procurement supply chain, which handles lithium from SIM, has a key role to play in supporting Toda Kogyo's world-class production technologies.

Anode Material Production

Location: Kureha Battery Materials Japan Co., Ltd. (KBMJ)
Established as a joint venture between ITOCHU and KUREHA Corporation in April 2011. Equity-method affiliate of ITOCHU. In 2012, KURARAY Co., Ltd., and The Innovation network Corporation of Japan became shareholders. In addition to the production of anode materials, KBMJ also has one of the world's top shares in the production of the binder that is used in the production of electrodes.



Cluster structure

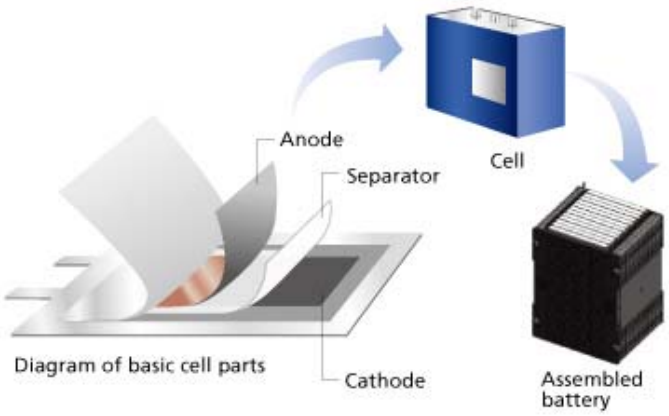
When voltage is applied to charge LiBs, lithium ions move from the cathode to the anode. Performance characteristics, such as the charge capacity, power, and durability of the battery, depend on how the lithium ions are stored in the molecular structure of their destination, the anode.
Anode materials look like black carbon powder, and the processes for anode production —granulation, heat treatment, pulverization, and firing—are completely automated. These processes incorporate KBMJ's valuable know-how, and by designing and producing a distinctive space known as the cluster structure, KBMJ is manufacturing products that meet the increasingly advanced needs of LiBs. In the future, KBMJ will strive to use its abundant experience and technical capabilities to develop anode materials made from coconut shells and other plant-derived materials. In this way, KBMJ plans to address growing demand and the need to reduce costs.

Electrode Production

Anode parts (left), and coating equipment for LiB electrodes (right) made by HIRANO TECSEED Co., Ltd., in which ITOCHU has invested. ITOCHU sells coating equipment and all types of other LiBs production equipment in Japan and overseas.

Cathode parts are created by coating cathode materials, in a thickness of several tens of microns, onto thin aluminum plates that have been formed into a roll. In the same way, anode parts are created by coating anode materials on thin copper plates. At this stage, the coating technology depends on precision coating machinery.

Fabrication



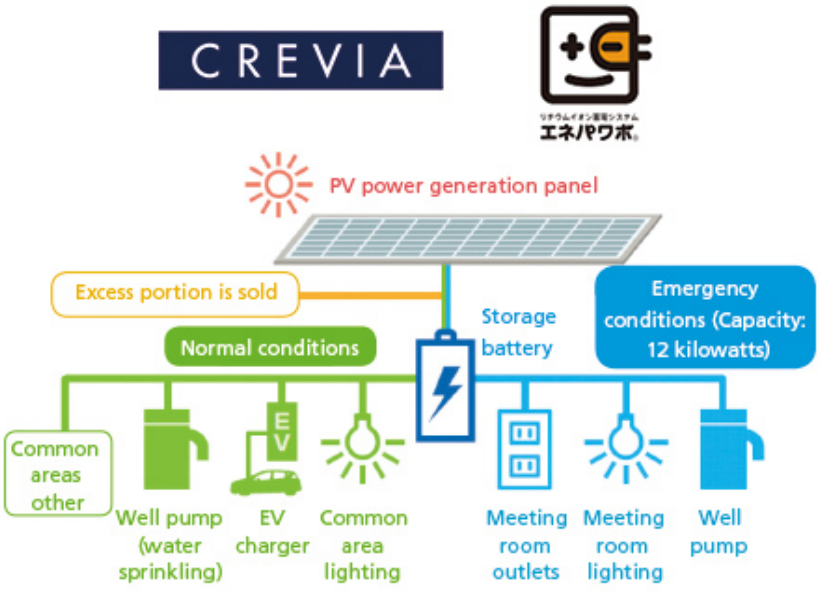
An insulator, called the separator, is sandwiched between the cathode and the anode, which have been cut to the size of the product. The electrolyte solution is added, and the unit is folded like an aluminum pouch. This completes the basic parts of the laminated LiB.
With batteries for stationary or vehicular use, cells are made by aligning several basic parts and putting them in an aluminum box or a similar container. One cell has a voltage of 4 volts. Cells are connected in series to provide the needed capacity and the assembled battery is finished. Computerized control is essential to ensure that charging and discharging are conducted in a safe and efficient manner.

Stationary LiBs

In recent years, a growing number of companies have decided to install LiBs as standard equipment in new residential buildings. For example, ITOCHU Property Development's CREVIA Futakotamagawa condominium building, which was completed in March 2011, incorporates LiB technology. A PV power generation panel providing about 10 kilowatts has been installed on the roof of this fivestory building, which has 51 condominium units. On the side of the ground-level parking lot, there is an energy management system that uses a 24-kilowatt LiB. This provides the electricity for the common areas of the condominium building, and the excess portion of the electricity is sold. There is also a popular car sharing program using EVs.
In addition, an energy storage system from ITOCHU ENEX has been installed at CREVIA Senkawa, which was completed in January 2013. If there is a power failure, it can be used as an emergency power source to provide power for lighting and outlets in the meeting room and to operate a pump that supplies well water.
ITOCHU ENEX's energy storage system is for general household use. By combining LiBs with solar power generation systems and fuel cells (Ene-Farm), ITOCHU ENEX is proposing lifestyles that offer energy self-sufficiency, from energy generation to energy storage. Installations of these systems are beginning to increase.
These LiBs were procured by ITOCHU.

CREVIA Futakotamagawa

Installation of energy storage system



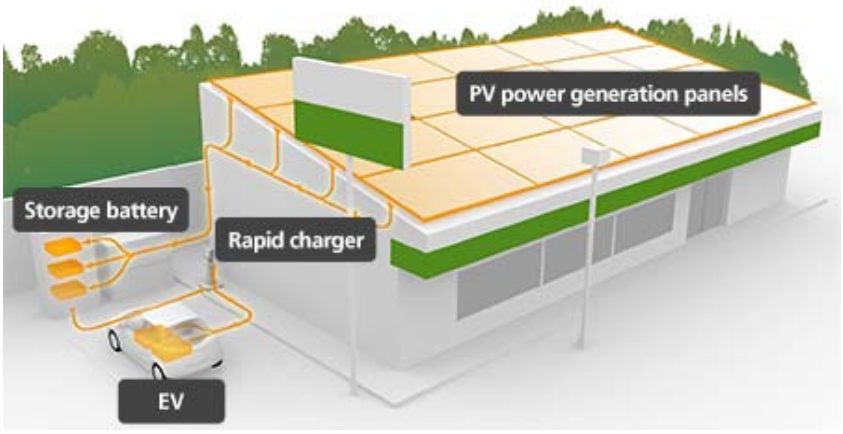
Overview of CREVIA Senkawa energy storage system

Applications

LiBs for Vehicles

Japan is a leader in the competition to develop EVs, but the adoption of EVs is still in the early stage, and sales in Japan are about 20,000 vehicles a year.
However, adoption could increase rapidly in the near future in China and other countries, where the rapid progress of motorization has led to simultaneous worsening of air pollution and provided support for the adoption of EVs. Assuming that 10% of passenger cars produced worldwide are eco-friendly, the market for vehicular LiBs would be more than 10 times larger than the established market for the small batteries used in electronic devices.
Since 2010, ITOCHU has been supplying LiBs to demonstration projects involving the switch to EVs by public transportation institutions associated with the Ministry of the Environment and local municipalities. From 2010 to 2012, with the cooperation of a convenience store in Tsukuba City, ITOCHU successfully conducted a demonstration test of a charging station for EVs using solar power generation as the source of electricity.

LiB-powered electric bus in operation in Akita Prefecture



Test conducted at Tsukuba City convenience store

Column

A Bright Future With Clean Energy

To optimize the energy supply, a range of separate initiatives is necessary because the relevant factors vary, not only by application but also by region. These factors include the state of infrastructure, the geographic area of a country, and access to sources of fossil fuels and clean energy. For example, the United States covers a large geographic area and its infrastructure is aging, so frequency adjustment and other techniques will contribute to the optimization of supply. In Russia, which covers a large area and in which infrastructure has not caught up to economic growth, distributed sources of electrical power will make a contribution in the short term.
Moreover, to foster the use of clean energy it will be necessary to achieve cost competitiveness that is comparable to that of fossil fuels. In the United States, electricity bills vary by state, but they are extremely inexpensive. U.S. startup companies and large corporations are competing fiercely in the area of dramatic cost-cutting technologies.
The ability of clean energy and electricity storage technologies to withstand actual usage conditions have been demonstrated for 10 years. Adoption has been delayed, but Pike Research forecasts that in 2018 the industry will have a scale of about ¥1 trillion. Over the next 10 years, clean energy is expected to become the primary source of energy and to make a contribution to a sustainable world.

Naoki Ota
CTO of 24M Technologies, Inc. (a venture company spun off from MIT)
Former CTO of Ener1/EnerDel, Inc.

Concluding the Observation
Toward a Society Based on Local Consumption of Locally Generated Power

Hideaki Miyata
President and Representative Director,
Social System Design Co., Ltd.

The future of nuclear power generation is unclear, and as a result the introduction of renewable energy on a large scale will be indispensable for the resolution of Japan's energy and environmental problems. Accordingly, I believe that the effective use of land and the introduction of large-scale energy storage facilities are the most important issues. For example, multiple public institutions in Tohoku have begun to introduce PV power generation facilities and LiBs. Even in Japan, with its limited geographical area, there is about 400,000 hectares of fallow or abandoned land. About 30% of energy demand could be met simply by installing PV power generation panels on this land. The power generated by solar cells fluctuates with the weather, and as a result it will gradually become necessary to install nearby energy storage facilities.
During my research for this report, I was able to see outstanding technology and meet amazing researchers and engineers at every stage of the Japanese LiBs supply chain. In strategically nurturing this new industry, an extremely important issue will be how to ensure competitiveness throughout the long supply chain—which extends from the procurement of raw materials for LiBs to the construction of energy management systems. A general trading company has a significant role to play in this regard, and moving forward I would like to see ITOCHU tackle these issues on a companywide basis.