March 15, 2021
Enpower Greentech Inc.
Softbank Corp.

Enpower Greentech Inc. and SoftBank Corp. Successfully Verify 450+ Wh/kg Energy Density Battery and Succeed in Development of Core Technologies for Longer Battery Life

In March 2020, Enpower Greentech Inc. ("Enpower Greentech") and SoftBank Corp. ("SoftBank") signed a joint research agreement for the development of lightweight, large capacity, and high specific energy density next generation batteries, with applications for IoT and cellular base stations. Both companies have just successfully verified a high energy density (450+Wh/kg) lithium metal battery, and are also pleased to announce the successful development of core technologies that will extend the service life of lithium metal batteries. The core technologies developed thus far include an ultra-thin coating film (<10nm), which prevents dendrites[1*] from forming on the surface of lithium metal, and an electrolyte, which achieves both high voltage and high coulombic efficiency (charge-discharge efficiency) [2*].

Lithium metal used in the 450Wh/kg cell has long been considered the paragon of anode materials; however, dendrites that subsequently form during the charge/discharge process often diminished battery capacity in a short time span. By coating the surface of the lithium metal with an inorganic substance (an "inorganic lithium metal-coating technology"), Enpower Greentech and SoftBank managed to prevent dendrite formation by blocking direct contact with the liquid electrolyte and creating a stable solid electrolyte interface (SEI) film[3*]. To verify this, both companies used a lithium metal electrolyte covered with an ultra-thin (<10nm) inorganic film. Collecting charge/discharge data on a coin-type lithium symmetric cell (a battery used for lab measurements), we were able to maintain a consistently low overvoltage even after 500 hours of continuous operation. In the future, both companies aim to apply this method to the 450Wh/kg cell to achieve an even longer battery life. For more details on the experiment, please refer to the Appendix.

Enpower Greentech is a US startup company engaged in the research, development, and commercialization of next-generation batteries, including all-solid-state cells. The company also has a research base in Japan ("Enpower Japan"). In 2015, they began developing high-capacity electrolyte materials, including solid electrolytes. Furthermore, since October 2017, Enpower Greentech has been collaborating on developing all-solid-state cell materials with a research team led by Professor John Goodenough of the University of Texas at Austin and a Nobel laureate in chemistry. Professor Goodenough made the following remarks regarding the results of the joint research by SoftBank and Enpower Greentech.

Prof. Goodenough's remarks:
"I am pleased to see the excellent work of the Enpower and SoftBank team on the development of advanced battery technologies and on applications that contribute to the SDGs (Sustainable Development Goals). My research team is honored to contribute to this worthwhile effort from a fundamental materials science perspective, and I wish the Enpower and SoftBank team every success in this endeavor."

SoftBank is currently undertaking a variety of initiatives aiming to narrow the digital divide, secure communication systems in the event of disasters, and reduce CO2 emissions. SoftBank believes that high-performance batteries will be essential in supporting the many technologies and devices that are necessary to tackle these challenges over the long term. A 450Wh/kg battery, which is expected to be achieved using the material technologies jointly developed by Enpower Greentech and SoftBank, would have twice the energy density of lithium-ion batteries on the market today. This battery will be applied not only to IoT devices and cellular base stations, but also to "Sunglider" ,a solar-powered unmanned aircraft system designed for stratospheric communications (using High Altitude Platform Station, or HAPS, technology). A solution being developed by SoftBank's subsidiary HAPS Mobile Inc., Sunglider will fly in the stratosphere 20 km above ground.

Enpower Greentech and SoftBank will continue to conduct various research activities into high-capacity next generation batteries to solve social issues through its business activities.

1* Dendrite: Needle-shaped crystals of lithium metal grow when the battery is repeatedly charged/discharged. If dendrites continue to grow unchecked, it can cause a short circuit between the cathode and anode, leading to combustion and other problems.

2* Coulombic efficiency (charge/discharge efficiency): The ratio of the discharge capacity during a discharge to the charge capacity during a charge. The higher the coulombic efficiency, the more charge capacity can be used for discharge without waste it, resulting in a longer battery life.

3* Solid electrolytes interface (SEI) film: a film with lithium-ion conductivity formed at the interface between the anode and the electrolyte in a lithium-ion battery (LIB) or secondary lithium metal battery in the event of a charge/discharge.

■Prototype battery using SoftBank and Empower Greentech core technology

(Size: 90mm×60mm×2.8mm)

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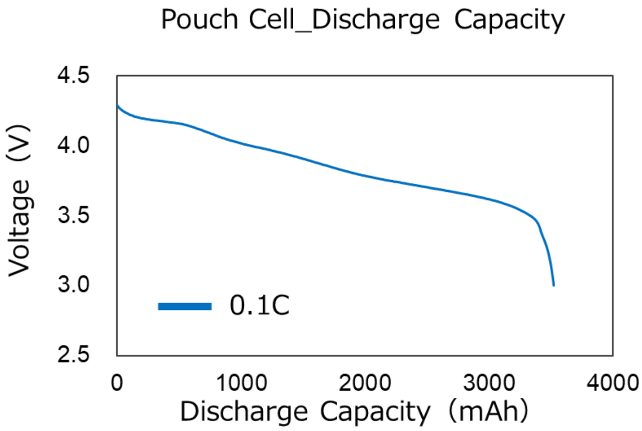
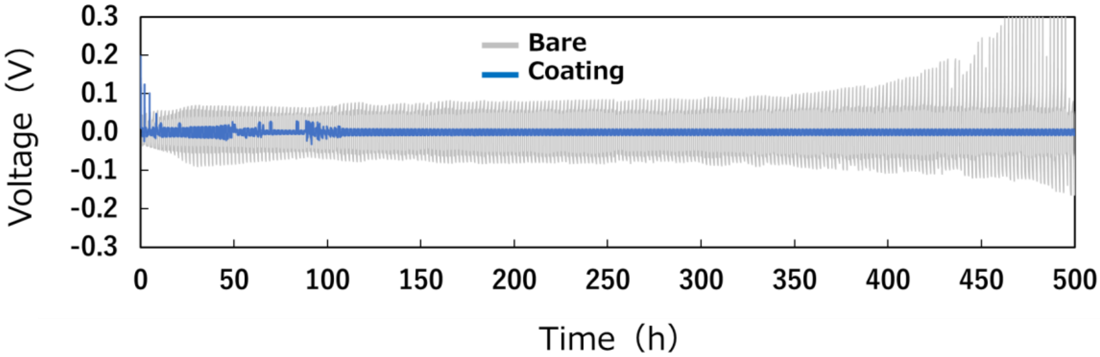
Appendix

■Discharge Capacity of 450 Wh/kg cell



Disc. Energy：13.4Wh
Cell Weight：29.7g
Energy Density：451Wh/kg

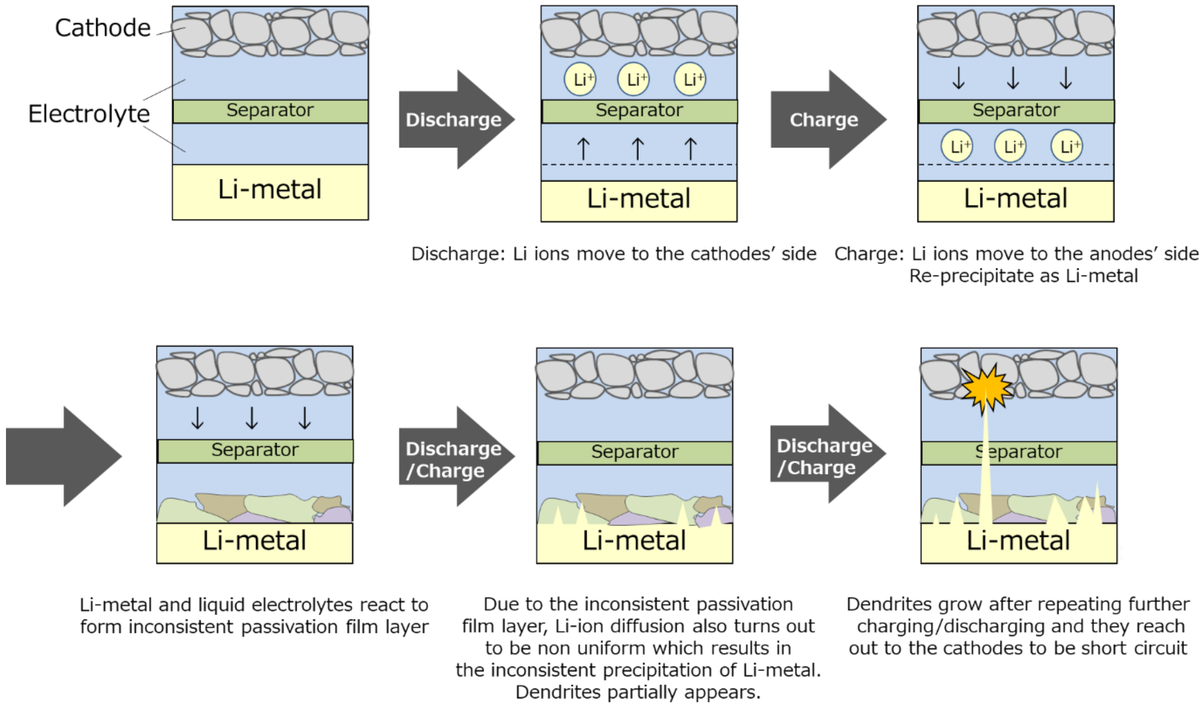
■Data from a 500-hour test (equivalent to 300 cycles) with a coin-type lithium symmetric cell



■Problems and Solutions for Lithium Metal Anodes

The evolution of devices has made it desirable to increase the capacity of batteries, but it is difficult to achieve this with existing battery materials (graphite, etc.), and next-generation materials, such as lithium metal anodes, offer a solution.

One of the issues of lithium metal batteries is short cycle life. The cause of this is the reaction between the lithium metal anode and the electrolyte. Lithium metal has a very strong reducing power, which decomposes the electrolyte and forms a non-uniform passive film on the surface of lithium metal, which leads to dendrite formation that can also cause short circuits.



In order to suppress the reaction between the lithium metal anode and the electrolyte, it is necessary to reduce contact between the electrolyte and the lithium metal surface, as well as prevent the decomposition of the electrolyte. For example, coating the lithium metal surface with an ion-conducting material prevents the electrolyte from coming into contact with the lithium metal surface and enables the lithium ions to diffuse evenly. This will suppress the formation of dendrites and extend the life of the lithium metal battery.