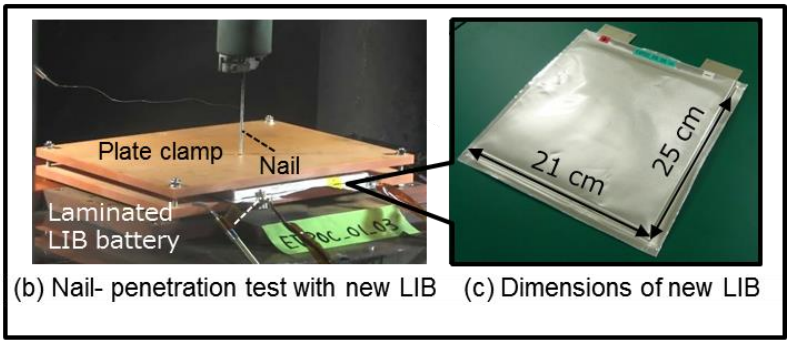
Successful development of a highly safe lithium-ion secondary battery prototype using a new, hardly combustible electrolyte

Basic performance confirmed on 100Wh laminated battery and incombustibility verified through nail penetration test

Conventional LIB

Verification with the new LIB prototype developed

(a) Nail- penetration test with organic-electrolyte LIB



(b) Nail- penetration test with new LIB (c) Dimensions of new LIB

Nail penetration test

Tokyo, February 16, 2018 --- Hitachi, Ltd. (TSE: 6501, Hitachi) and the Institute of Multidisciplinary Research for Advanced Materials of Tohoku University (IMRAM) today announced the successful development of a high-safety prototype lithium-ion secondary battery (LIB) using a new, hardly combustible electrolyte with a flash point higher than conventional organic electrolyte solutions. Battery performance characteristics such as charge and discharge, etc. were confirmed using a 100Wh-capacity laminated battery(1). Further, the incombustibility of the prototype LIB was also demonstrated using the nail penetration test(2), which causes combustion in LIBs using conventional organic electrolyte solutions. The newly developed technology will make it possible to ensure safety while increasing the capacity and energy density of LIBs for vehicles and consumer products, etc.

LIBs are utilized in a variety of ways, such as a power source for small mobile terminals like smartphones and tablets, power source for electric vehicles and in the supply-demand adjustment of renewable energies. The typical LIBs, however, use organic solutions with flash points of 20℃ or lower as the electrolyte, which have the risk of igniting under abnormal circumstances. Current battery systems(3) are therefore provided with reinforcement material and cooling mechanisms to suppress combustion, but such mechanisms have also hindered the development of more compact systems.

IMRAM has been investigating electrolytes with high flash points for LIBs since 2011

as part of efforts towards the development of hardly combustible, highly safe LIBs[(4)]. In this latest endeavor, Hitachi and IMRAM used the new electrolyte that they co-developed to produce a laminated LIB prototype, and confirmed basic operations as a battery. In addition, the nail penetration test, a safety test for batteries, was applied to demonstrate the incombustibility of the prototype LIB. The new technology developed is outlined as below.

1. Technology on electrolyte materials that simultaneously features a high flash point and high lithium-ion (Li-ion) conductivity

Electrolytes for LIBs are required to have a high flash point to secure safety, as well as a high Li-ion conductivity to ensure smooth charge and discharge reactions. In this latest development, a four-fold increase in conventional Li-ion conductivity (internal comparison) was achieved through simulation analysis of Li-ion conduction behavior in the new electrolyte to discover liquid components that promote Li-ion conduction, as well as realizing a flash point of over 100℃ higher than that of conventional organic electrolyte solutions.

2. Battery-manufacturing technology using the new electrolyte

A laminated battery was prototyped using the new electrolyte developed. Repetitive charge and discharge at battery capacity values meeting the design specifications[(5)] were realized by improving the electrochemical stability of the electrolyte using interfacial modification technology, and suppressing the decomposition reaction of the new electrolyte at the surface of the cathode and anode which reduces battery capacity. Further, it was possible to suppress the accumulation of electrolyte material and occurrence of voids and cracks which lower battery reliability, through optimal design of the electrolyte material distribution in the nano/micro-scale order and by optimizing the manufacturing condition, resulting in the successful prototyping of a laminated battery with high energy density and battery capacity of 100Wh.

The safety of the prototype battery was verified using the nail penetration test in which combustion did not occur as the heat generated by internal short circuiting was suppressed. As a result, it will be possible to reduce reinforcements or cooling mechanisms required in conventional batteries for safety reason, and allow more compact systems and more competitive pricing.

Hitachi and IMRAM will continue to work on enhancing battery performance such as higher energy density and shorter charge/discharge time, with view to the

commercialization of the newly developed LIB.

(1) “Laminated battery” is a battery in which the cathode, anode and layer stack of the new electrolyte are covered by aluminum laminate sheets and sealed through thermal adhesion.
(2) “Nail penetration test” is a method of forced internal short circuit testing, simulating a short circuit that causes the battery to generate heat or fire. In the test, a nail is inserted from outside into the battery charged to a charge depth of 100%, to forcefully generate a short circuit within the battery.
(3) “Battery system” is a system that integrates multiple lithium-ion rechargeable batteries, battery cooling and safety mechanisms and battery control circuits.
(4) S. Ito, A. Unemoto, H. Ogawa, T. Tomai, I. Honma, J. Power Sources 208 (2012) 271-275.
(5) The maximum electric capacity at which the developed battery can charge and discharge. The value is determined in accordance with type and quantity of the cathode and anode materials used for developing the battery and the operating conditions of the battery.

About Hitachi, Ltd.

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society's challenges. The company's consolidated revenues for fiscal 2016 (ended March 31, 2017) totaled 9,162.2 billion yen ($81.8 billion). The Hitachi Group is a global leader in the Social Innovation Business, and it has approximately 304,000 employees worldwide. Through collaborative creation, Hitachi is providing solutions to customers in a broad range of sectors, including Power / Energy, Industry / Distribution / Water, Urban Development, and Finance / Government & Public / Healthcare. For more information on Hitachi, please visit the company's website at http://www.hitachi.com.

# # #

Information contained in this news release is current as of the date of the press announcement, but may be subject to change without prior notice.
