NIMS Award Goes to Koichi Mizushima and Akira Yoshino

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National Institute for Materials Science

Abstract

The National Institute for Material Science (NIMS) (President: Kazuhito Hashimoto) has chosen the winners of NIMS Award 2016 as follows.

<<Winners>>

Koichi Mizushima
(Toshiba Research Consulting Corporation)

Akira Yoshino
(Asahi Kasei Corporation)

<<Reason for winning>>

Discovery of cathode material for the lithium-ion battery ($LiCoO_2$) and development of the lithium-ion battery

Koichi Mizushima proved that lithium cobaltite ($LiCoO_2$) is an effective cathode material for secondary batteries. Akira Yoshino developed a prototype lithium-ion secondary battery using $LiCoO_2$ as a cathode, carbon material as an anode, and propylene carbonate as an electrolyte. The development of the lithium-ion secondary battery contributed to the expansion of the markets of various mobile electronic devices, including cell phones, digital cameras, handy video recorders and laptop computers. Studies to develop higher-capacity, larger batteries are still ongoing through the development of materials and devices. The two researchers developed the lithium-ion battery through their material studies, producing an enormous impact on the industry and pioneering a new horizon in the field of battery research. Their achievements received high commendations in the environmental and energy materials field, which is the theme of NIMS Award 2016.

The award ceremony and award winners' lectures will be held on the first day of NIMS WEEK 2016, which is held at the Tokyo International Forum for two days from October 20 (Thursday) to 21 (Friday).

[NIMS Award]

The NIMS Award is an international award that has been presented by NIMS since FY2007 to researchers who have made an outstanding accomplishment in materials science and technology.

In line with the theme of this year—"environmental and energy materials"—award recipient candidates are nominated from top scientists around the world, and the selection committee consisting of unbiased experts determined the winners through careful consideration.

[NIMS WEEK 2016]

Since its establishment 15 years ago in 2001, NIMS has held NIMS Conference (an international academic meeting) and NIMS Forum (a technological exhibition). NIMS has set a week in October as NIMS Week, starting from this year, and will hold various events in the short period. This program will mark its first year with two events at the Tokyo International Forum for two days from October 20 (Thursday) to 21 (Friday) under the tile of "Innovative NIMS" (first day) and "Interactive NIMS" (second day).

NIMS WEEK 2016
Winners of NIMS Award 2016

Koichi Mizushima (Senior Fellow at Toshiba Research Consulting Corporation)
Akira Yoshino (Adviser at Asahi Kasei Corporation / President at Lithium Ion Battery Technology and Evaluation Center (LIBTEC) / Visiting Professor at the Research and Education Center for Advanced Energy Materials, Devices, and Systems, Kyushu University)

Winner 1

Name: Koichi Mizushima
Affiliation: Senior Fellow at Toshiba Research Consulting Corporation

[Field of study] Environmental and energy materials
[Title of research achievements] Discovery of a suitable cathode material for the lithium-ion battery ($LiCoO_2$)
[Outline of research achievements] The lithium (primary) battery with a metal lithium anode creates a high energy density. However, researchers in the 1970s had difficulty in developing a secondary battery because of durability and safety issues caused by dendrite formation during recharging. Most researchers saw sulfide materials as hopeful substances for the cathode but the voltage they create was insufficient for secondary batteries. In 1980, Mizushima and J.B. Goodenough (then Professor at Oxford University) discovered that the layered salt-rock oxide lithium cobaltite ($LiCoO_2$) generates an electrical potential that exceeds 4V and that it can remove and provide lithium ions in a reversible manner in a wider range of compositions in comparison to metal lithium. They proved that lithium cobaltite ($LiCoO_2$) can be used as a cathode for the batteries, enabling the use of an anode made of material that does not contain metal lithium.

Winner 2

Name: **Akira Yoshino**
Affiliation: Adviser at Asahi Kasei Corporation / President at Lithium Ion Battery Technology and Evaluation Center (LIBTEC) / Visiting Professor at the Research and Education Center for Advanced Energy Materials, Devices, and Systems, Kyushu University)

[Field of study] Environmental and energy materials
[Title of research achievements] Development of the lithium-ion secondary battery
[Outline of research achievements] Yoshino invented a prototype for the current lithium-ion secondary battery by adopting an innovative combination of cathode and anode materials ($LiCoO_2$ as the cathode and polyacetylene as the anode) and by using propylene carbonate as an electrolyte. He subsequently discovered that the capacity density is significantly improved by replacing polyacetylene, which has low specific gravity, with vapor grown carbon fibers (VGCFs), and he made a great contribution to the commercialization of the lithium-ion battery. He also developed and invented various indispensable technologies for the practical application of the lithium-ion battery. For example, he invented a production method in which a sheet-like electrode with a current collector made of thin metal foil is wound like a coil after being coated with active materials on both sides. This invention made it possible to obtain a high current density even with a nonaqueous electrolyte, which is inferior in terms of electrical conductivity in comparison to aqueous electrolytes. His other inventions include the separator's "fuse" function, which shutdowns the battery in the case of excessive heat by letting the separator filter between the cathode and anode melt down and close the microscopic pores itself. He also invented a positive temperature coefficient (PTC) device that controls the

current with resistance increased by heat when the current is excessively high. The introduction of safety functions was essential for the practical application of the lithium-ion battery, which boasts high energy density. He made significant contributions to the development of such technologies as well.

[Impacts of the two researchers' achievements on academia and industry]

The discovery and application of $LiCoO_2$ accelerated exploration into cathode materials that generate a reversal intercalation reaction with lithium ions, bringing about great development in the field of ceramic chemistry. Speaking of the carbon anode that has come into practical use as a safe alternative material for the lithium metal anode for the secondary battery, the material development efforts resulted in the development of carbon chemistry. In addition, efforts for achieving a stable interface formation between the carbon anode and organic electrolyte made tremendous contributions to the development of electrochemistry and interface chemistry. Furthermore, the development of high polymer chemistry was also promoted thanks to the technological development in highly functional polymers, which played an important role in improving the safety of the battery.

With its advantages such as long service life, large capacity, low weight, small size and absence of the memory effect, the lithium-ion secondary battery played a significant role in the introduction of information technology to society. Today, lithium-ion secondary batteries are used in a wide range of mobile electronic devices, including cell phones, smart phones, tablets, digital cameras, handy video recorders, laptop computers, electric tools and power-assisted bicycles. The size of the market is reported to have reached almost 2 trillion yen as of 2014. The lithium-ion battery plays an important role as a core technology in supporting today's advanced information society, which we now take for granted. Moreover, the lithium-ion secondary battery is also becoming more and more popular as a core component for improving the driving performance of eco-friendly cars, such as hybrid cars, plug-in hybrid vehicles and electric cars, since its volume and weight are less than even half of those of the conventional nickel hydride battery. It is also seen as a promising battery device for renewable energy power generation, including solar and wind power, and for electric-load leveling. It is expected to make a tremendous contribution to the efficient use of primary energy and CO_2 emissions reduction.

(Reference) Winners of the NIMS Award in the past three years and their achievements

2013	**Prof. Hideo Hosono** (Tokyo Institute of Technology, Japan)
	"Discovery of iron-based superconductors and discovery of IGZO-TFT"
2014	**Prof. Krzysztof Matyjaszewski** (Carnegie Mellon University, USA)
	"Development of atom transfer radical polymerization (ATRP)"
	Prof. Mitsuo Sawamoto (Kyoto University, Japan)
	"Precision polymerization and precision synthesis of functional polymers"
2015	**Prof. Harald Rose** (Ulm University, Germany)
	Prof. Maximilian Haider (KIT, CEOS GmbH, Germany)
	Prof. Knut Wolf Urban (Research Centre Juelich, Germany)
	"Development of the aberration corrector for electron microscopes"

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*Correction: The text has been corrected so that the positive electrode is cathode and the negative electrode is anode.