PRESS RELEASE

AsahiKASEI

Asahi Kasei Europe GmbH
October 10, 2019

Creator of a Rechargeable World – Asahi Kasei Honorary Fellow Akira Yoshino Received the Nobel Prize in Chemistry 2019

Düsseldorf, October 10, 2019 – Dr. Akira Yoshino, Honorary Fellow at Asahi Kasei, has won this year's Nobel Prize in Chemistry, the Royal Swedish Academy of Sciences announced on October 9 in Stockholm. Yoshino, 71, a professor at Meijo University, Japan, shares the prize with two other scientists for their development of lithium-ion batteries – Professor John B. Goodenough from the US and chemist M. Stanley Whittingham from Great Britain. Their invention is used as rechargeable batteries for mobile phones, laptop computers and other devices. It can also store significant amounts of energy from solar and wind power, making possible a fossil fuel-free society, and will be an important driver for the electrification in the automotive industry.

When Yoshino arrived at the news conference venue in Tokyo on Wednesday evening, the Asahi Kasei staff that had gathered gave him a standing ovation. "I was more befuddled than I was happy", Yoshino said of his initial feelings.

"Dr. Akira Yoshino created the foundation of today's lithium-ion technology and industry. His inventions can be found in smartphones that connect people around the world and are enabling the emergence of electric vehicles. We are very proud and grateful to have Yoshino still with us at Asahi Kasei", said Hideki Tsutsumi, Managing Director Asahi Europe GmbH.

“I am greatly honored to receive this year’s Nobel Prize in Chemistry, together with the pioneering scientists John B. Goodenough and M. Stanley Whittingham. It was gratifying that the Royal Swedish Academy said my invention significantly impacted society,” commented Dr. Akira Yoshino. “I am humbled that my invention is contributing to solutions for a better and sustainable world.”

With the spread of mobile electronic devices such as the Sony Walkman from the 1970s, the need for lightweight and compact rechargeable batteries to replace the common and non-rechargeable primary cells increased. Lithium was identified early on as a powerful anode material for rechargeable batteries. However, the easy inflammability and susceptibility to short circuits with the cathode posed great challenges to science and for a long time prevented the practical use of lithium-ion batteries.

Good Sense of Smell

“There was a lot of R&D on portable electronics in the 1980s, and so small and lightweight batteries, with high energy density and rechargeability were also needed. But nobody really knew what kind of rechargeable battery was going to be needed. The big buzzword at first was “portable”, soon joined by “cordless” and “wireless”. I just sort of sniffed out the direction that trends were moving. You could say I had a good sense of smell”, Yoshino told about these early years.

Unlock the Mass Market for Portable Electronic Devices

Yoshino's development of a small, lightweight, rechargeable battery with a sufficient storage capacity has helped to unlock a mass market in portable electronic devices, ranging from camcorders to laptop computers. His rechargeable batteries are used in nearly five billion mobile phones worldwide today and have enabled the emergence of electric vehicles. Prior to his invention of the lithium-ion battery (LIB), users had to discard batteries when the energy contained in their materials ran out, which posed a challenge to manufacturers developing portable electronic products.

The commercialization of the rechargeable lithium-ion battery was driven forward in the early 1990s by Sony and a joint venture between Toshiba and Asahi Kasei. The lithium-ion battery opened the path for mobile electronic devices such as smartphones or notebooks to spread rapidly worldwide and, with its application in electromobility, represents an important future technology for the automotive industry as well. Mobility in everyday life would be impossible without the successful commercialization of this technology. By combining existing and original technologies, Dr. Akira Yoshino made the lithium-ion battery in its current form possible in 1985.

Early Research Work

The origins of Yoshino's invention can be found in his early research into electrically conductive polymers, carried out after joining Japanese chemical company Asahi Kasei in the early 1970s. His breakthrough came when he realized the value of the properties of polyacetylene and lithium cobalt oxide discovered at that time. In 1977 Japanese chemist Hideki Shirakawa demonstrated that the first is conductive, and two years later in 1979, US physicist John Goodenough discovered that the latter is stable in air. Yoshino understood that using a polyacetylene anode and a lithium cobalt oxide cathode could make his invention more stable than other rechargeable batteries in development at the time.

Historic discoveries occur by chance. It was December 1982, and Yoshino's workplace was undergoing a year-end office cleaning. With nothing to do that afternoon, Yoshino picked up an overseas research paper that he had ordered a while ago but had not had a chance to read.
Flipping through the pages, Yoshino came across a surprise find. John B. Goodenough, an Oxford University professor, had written in a 1980 paper that a material called "lithium cobalt oxide" works as a powerful positive electrode for rechargeable batteries. The only problem was that there was no negative electrode to match it, Goodenough had said.
"What if I used polyacetylene?" Yoshino thought. The following month he carefully followed what Goodenough had written to create lithium cobalt oxide himself and combined it with the polymer. It worked. He could charge the battery and it discharged electricity smoothly. It was the breakthrough he had waited for. The basic foundation of the lithium-ion battery was established.

He also introduced a thin polyethylene-based porous membrane to act as a separator between materials, serving as a safety mechanism: when the battery overheated, the membrane melted. This halted the operation of the batteries before they caught fire. The membrane, which serves as the chemical equivalent of a safety fuse, is still used today to lessen the risk of LIBs catching fire.

First Rechargeable LIB

Dr. Yoshino invented a completely new combination of carbon (C) for the negative electrode and lithium cobalt oxide ($LiCoO_2$) for the positive electrode, developed the fundamental technology for the LIB which uses aluminium as positive current collector material, and fabricated the world’s first LIB cell. He also developed other technologies that were essential for the successful commercialization of the LIB, including technology for fabricating electrodes, technology for assembling batteries, and other technology that made the LIB possible as a small, lightweight rechargeable battery.

Yoshino's first rechargeable LIB was produced in 1983. In 1985, Asahi Kasei filed the original

Japanese patent application for the battery, beginning its road to commercialization. Yoshino has continued to work on his innovation, boosting battery performance and refining its safety features throughout his extensive career. Further patents helped to protect these solutions, and today Yoshino is named as inventor on 56 Japanese patents and six European patents.

Important Patents

Asahi Kasei licensed Yoshino's basic LIB patent to other manufacturers including Sony, which introduced the technology into the market in 1991. "My inventions have led to many patents for my company", said Yoshino. "The patents are not used to keep people out, rather we license our patents to encourage many other manufacturers to use our technology. Some of my latest innovations are for batteries for electric vehicles – and these, I hope, will change the world again."

By now, the lithium-ion battery has been widely adopted in various electronic devices as a safe lightweight rechargeable battery, enhancing portability as the digital age began in the 1990s, ushering in the IT revolution and our current society of mobile connectivity.

The global market for lithium-ion batteries will amount to roughly 40 billion € this year, estimates say. The scale is expected to grow 50% to about 60 billion € in 2022.

Impressive Career

Yoshino, now an honorary fellow at the Japanese technology company Asahi Kasei, was not a battery expert when he joined the company in 1972. He was among the 350 new hires that year but was one of a handful of researchers with master’s degrees.

Akira Yoshino was born on January 30, 1948 in Fujisawa, Kanagawa Prefecture, Japan. From 1970 he studied chemistry at the University of Kyoto. Parallel to beginning his master's degree in chemistry, he joined Asahi Kasei in 1972. He received his doctorate in engineering from the University of Osaka in 2005. After joining Asahi Kasei in 1972, Akira Yoshino worked for many years in the laboratory in Kawasaki before being appointed Head of the Ion Battery Development Department in 1992. After further positions as Head of the Ion Battery Group and the Development Department for Battery Materials, he became General Director of the Yoshino Laboratory named after him at Asahi Kasei in 2005. Since 2010 Akira Yoshino is Head of the Lithium Ion Battery Technology and Evaluation Center (LIBTEC). In 2017 he was appointed professor of the Scientific and Technical College at Meijo University in Tokyo. In the same year, he became Honorary Fellow at Asahi Kasei.

With his experiments and the combination of existing and proprietary technologies, Akira Yoshino was able to prove the practical application of the lithium-ion battery. His contributions also enabled the following characteristics of the battery:

- Light, compact and space-saving design
- High cell voltage of 4 volts and more
- Low self-discharge rate
- High-current capability

Akira Yoshino is an honorary research fellow at Asahi Kasei and head of the Lithium Ion Battery Technology and Evaluation Center (LIBTEC) and is actively involved in the further development of lithium-ion battery technology even after retirement.

Still Curious about New Challenges

Dr. Yoshino has a message for young scientists: “Since we live in a society flooded with so much

information, it may be hard for young scientists to appreciate that there are many fields where unknown things are waiting to be discovered. There are many opportunities for groundbreaking R&D. With a clear objective and persistent effort, the possibilities are endless. As for me, I intend to remain on the front line of research, taking on challenges in new fields"!

Contributions to the Development of the Lithium-Ion Battery (excerpt):

- 1999: *Chemical Technology Prize*
  Chemical Society of Japan
- 2004: *Medal with Purple Ribbon*
  Japanese Government
- 2012: *IEEE Medal*
  The Institute of Electrical and Electronics Engineers (USA)
- 2013: *Global Energy Prize*
  The Global Energy Association (Russia)
- 2014: *Charles Stark Draper Prize*
  The National Academy of Engineering (USA)
- 2016: *NIMS Award*
  National Institute for Materials Science (Japan)
- 2018: *The Japan Prize*
  The Japan Prize Foundation
- 2019: *European Inventor Award*
  European Patent Office

Please refer to the Nobel Prize Academy for more information:
https://www.nobelprize.org/prizes/chemistry/2019/press-release/
https://www.nobelprize.org/uploads/2019/10/advanced-chemistryprize2019.pdf
https://www.nobelprize.org/uploads/2019/10/popular-chemistryprize2019.pdf

About the Asahi Kasei Corporation
Asahi Kasei Corporation is a globally active diversified technology company with operations in the Material, Homes, and Health Care business. The Material division encompasses fibers & textiles, petrochemicals, performance polymers, performance materials, consumables, battery separators, and electronic devices. The Homes division provides housing and construction materials to the Japanese market. The Health Care division includes pharmaceuticals, medical devices, and acute critical care devices and systems. With approximately 39,283 employees around the world, the Asahi Kasei Group serves customers in more than 100 countries and achieved sales of 17.6 billion euros (2,170.4 billion yen) in the fiscal year 2018 (April 1, 2018 – March 31, 2019).

Asahi Kasei is "Creating for Tomorrow" with all operations sharing a common mission of contributing to life and living for people around the world. For more information, visit www.asahi-kasei.co.jp/asahi/en/ and https://automotive-asahi-kasei.eu/.

Company Contact Europe:
Asahi Kasei Europe GmbH
Sebastian Schmidt
Am Seestern 4, 40547 Düsseldorf
Tel: +49 (0) 211-2806-8139
Mail: sebastian.schmidt@asahi-kasei.eu

Press Contact:
financial relations GmbH
Henning Küll
Louisenstraße 97, 61348 Bad Homburg
Tel: +49 (0) 6172/ 27159 – 12
Mail: h.kuell@financial-relations.de