Section of Public Relations	Dongsun Cho Section Chief 062-715-2061	Nayeong Lee Senior Administrator 062-715-2062
Contact Person for this Article	Professor Hyeong-Jin Kim Graduate School of Energy Convergence 062-715-5323	
Release Date	2021.02.25	

Professor Hyeong-Jin Kim and Professor Sungho Jeong's joint research team improves the performance of high-capacity silicon anodes

□ GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) Graduate School of Energy Convergence Professor Hyeong-Jin Kim and School of Mechanical Engineering Professor Professor Sungho Jeong's research team improved the performance and durability of the silicon anode*, which has been noted as a cathode for next-generation lithium secondary batteries.

* silicon anode: Silicon anode is the most commercially available multi-wire technology among the existing next-generation cathodes. The theoretical capacity per unit weight reaches a maximum of 4,200 mAh/g, making it an ultra-high-capacity next-generation anode with more than 10 times the theoretical capacity of conventional graphite commercial anodes.

◦ The research team introduced nanosecond laser* surface processing technology for the first time on the surface of silicon electrodes and succeeded in securing continuous performance and durability by reducing mechanical stress in the charging and discharging process.

* nanosecond laser: The difference between continuous and pulsed lasers depends on the duration at which they emit a given energy. If it emits a given energy at a constant

intensity for a long time, it is a continuous laser. If it emits a given energy for only a short time, it is a pulsed laser. The emission duration is called a pulse width, and if the duration is nanoseconds, it is called a nanosecond laser.

□ Silicon anodes are attracting attention as next-generation anodes to replace graphite anodes because they theoretically have an energy density of more than 10 times that of conventional graphite commercial anodes as well as being economical and eco-friendly materials. Competition for development is fierce in countries around the world as it is possible to use medium-to-large energy storage devices that require high energy density and power density, such as large-capacity energy storage devices (ESS) and electric vehicles. However, the non-conductive properties of silicon and the low lifespan due to volume expansion of silicon during the charging and discharging process act as obstacles to commercialization.

◦ Recently, research on materials to improve the performance of silicon anodes is underway, but for more practical performance improvements, research on technologies that have low production costs and can be mass-produced is required. There is a lack of research on practical and mass-produced technologies for the commercialization of silicon anodes.

□ The research team succeeded in reducing the mechanical stress on the silicon surface generated during the charging and discharging process by structuring the silicon electrode surface using nanosecond laser processing technology.

◦ Nanosecond laser technology applied to silicon electrode surface treatment has the advantage of being able to process a wide area of 1 square centimeter (1 cm^2) within 5 seconds compared to the existing technology that processes a narrow width of several tens of micrometers (μm). Through this, the electrode processing speed increased by more than 60 times compared to the existing laser processing technology, confirming the high possibility of mass production.

□ Professor Hyeong-Jin Kim said, "In particular, this study focuses on the convergence of battery electrode manufacturing technology and laser processing technology. Up to now, in the battery manufacturing process, lasers have been used for electrode cutting and metal-to-metal bonding. It is hoped that a short-term surface treatment can be applied to mass production to contribute to the performance improvement of lithium batteries."

□ This research was led by GIST Professor Hyeong-Jin Kim and Professor Sungho Jeong and conducted by Dr. Junsu Park with Ph.D. student Seokho Suh with support from the GIST Research Institute (GRI) and the Korea Energy Research Institute and was published online on February 11, 2021, in the *Journal of Power Sources*, a world-renowned journal of energy and fuel.

GIST
Since 1993