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Professor KwangSup Eom's joint research team has developed a lithium-ion battery that increases the travel distance of electric vehicles by three times

□ GIST (President Seung Hyeon Moon) – A joint research team led by Professor KwangSup Eom of the School of Material Science and Engineering, Professor Han-Ik Joh of Konkuk University, and Professor Thomas F. Fuller of Georgia Tech has developed a lithium-ion battery that increases the travel distance of electric vehicles by three times.

◦ If this battery is commercialized, it is expected not to have significant performance degradation for 7 years while being charged once a day.

□ Currently, graphite (cathode) and lithium metal oxide (anode) are used as electrode materials for commercial lithium ion batteries. Both materials have relatively low energy storage capacities, and the current technology has reached its theoretical capacity *, which limits the ability to increase the electric storage capacity of electric vehicles.

* Theoretical capacity: The maximum lithium storage capacity (= charge storage capacity) inherent in an electrode material for a lithium ion battery can not be experimentally higher than this. For example, in the case of graphite, one lithium ion is stored per 6 carbon atoms, which is calculated as 374 mAh/g.

◦ To increase the distance traveled by electric vehicles, it is necessary to install more batteries. However, because this increases the weight of the vehicle and the fuel consumption, there is a limit to improve mileage by adding more batteries. Therefore, it is necessary to develop new batteries using new electrode materials with larger electric storage capacity per weight and volume.

□ The researchers focused on sulfur-metal (molybdenum) compounds as a new electrode material for lithium-ion batteries that can achieve up to six times the capacity per weight (three times the energy density) of current lithium-ion batteries while maintaining more than 90% of initial performance during 2,500 charge / discharge cycles.

◦ The researchers focused on improving the capacity and stability of the battery by converting a nanoscale material using a micron-sized material that can be fabricated through a simple process. A key method was "in situ electrochemical nano pulverization *" that allows electrode active materials to be converted into nanoscale after cell production in real time.

> * This technology developed by the researchers is the only one of its kind in the world, and it is very easy to commercialize because no additional complex processes are needed (Metal Sulfide Secondary Battery, Korea Patent Applied: 10-2017-0181620).

□ The researchers also focused on high-capacity 'silicon negative electrode' and 'sulfur-metal compound anode' as a new electrode material for lithium ion batteries and have developed a new high-capacity and stable battery consisting of 'sulphur-metallic compound anode'-'lithium/silicon cathode' through electrochemical treatment of the anodes in the sulfate compound. The new batteries have been found to have a storage capacity of about 1,150 mAh/g per weight, about six times higher than the lithium-ion batteries that are currently commercialized (150 - 200 mAh/g water level), and their energy density has increased by approximately three times, taking into account the voltage used (1.5 - 2.0 V).

□ Professor KwangSup Eom said, "The latest research indicates that the performance and stability of the new lithium-ion battery using high-capacity and ultra-low-cost sulfur-metal compound material has been improved to near-commercial levels, and it is expected that the field of the secondary battery will grow rapidly by commercializing it as all equipment-driven (EV) and energy storage system (ESS) through further research and development."

□ The joint research led by GIST School of Material Science and Engineering Professor KwangSup Eom and Konkuk University Professor Han-Ik Joh was supported by the National Research Foundation of Korea, and the results were published online on December 24, 2018, in *ACS Nano* (2017 citation index: 13.7), a well-known journal of the American Chemical Society (ACS).

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