Gwangju Institute of Science and Technology
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Professor KwangSup Eom's joint research team develops new batteries that can be twice as compact

☐ Every electronic devices that we conveniently use every day, such as smartphones, laptops, etc., are equipped with batteries. In particular, as the size of electronic devices gradually decreases for portability, the demand for small batteries is increasing, and recently, it has been expanded to mobility such as electric vehicles and bicycles.

☐ Gwangju Institute of Science and Technology (GIST, President Kiseon Kim) School of Materials Science and Engineering Professor KwangSup Eom led a joint research team with Hongik University Professor Jaehan Jung, and Kyung Hee University Professor Jung Tae Lee to develop a new lithium-based high-capacity battery that can be twice as compact as the existing lithium-ion battery while maintaining its electric storage capacity.

- The lithium-selenium battery developed through this study can be more than twice as small as the same electricity storage capacity based on securing stability, so if used in portable electronic devices such as next-generation mobile phones and laptops, the space occupied by the battery in electronic products is expected to be twice as small.

☐ Currently, graphite (cathode) and lithium metal oxide (anode) are used as electrode materials for commercial lithium-ion batteries. The energy storage capacity of both materials is relatively low, and the current battery cell manufacturing technology has almost reached the theoretical capacity *.

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* theoretical capacity: The maximum lithium storage capacity (= charge storage capacity) inherent in the electrode material for lithium ion batteries cannot be experimentally higher than this. For example, in the case of graphite, one lithium ion is stored for every six carbon atoms, which is calculated to be 837 mAh / cm^3 (per volume).

☐ The research team improved the storage capacity per volume by about 2 times compared to the current lithium-ion battery by using lithium-selenium battery * using selenium as the anode material for lithium batteries and lithium metal as the anode material.

* theoretical capacity of Li-Se battery: (Li negative) 2,060 mAh/cm^3, (Se positive) 3,253 mAh/cm^3

- In particular, lithium-selenium batteries have a rapidly reduced battery life due to the low stability of selenium, which is a major obstacle to the commercialization of lithium-selenium batteries. Therefore, the team focused on how to maintain this battery's capacity and improve its stability or life span.

- In particular, the core method of this study (in batteria electrochemical polymerization) * is a method of polymerizing the surface of the electrode active material by electrochemically applying an electric current to the electrolyte by adding a small amount of aniline, a monomer of a conductive polymer (polyaniline), to the electrolyte when assembling the battery cell.

* in batteria electrochemical polymerization: This technology developed by the research team is the only one of its kind worldwide and is very easy to commercialize because it does not require a complicated additional process, and a patent is currently pending

- Furthermore, through the electrochemical polymer surface treatment method, the selenium anode was formed with a conductive polymer polyaniline to form a protective conducting layer, thereby successfully stabilizing a high-capacity, highly stable lithium-selenium battery. In particular, it not only has a high volumetric capacity, but also shows a capacity retention rate of about 3 times or more when compared with the electrode material before treatment (based on 200 charge / discharge).

☐ Professor KwangSup Eom said, "This research achievement has the greatest significance in introducing a new high-capacity, highly-safe lithium-selenium battery through an electrochemical polymer surface treatment method that is very easy compared to the existing lithium-selenium battery. It is expected that it can be applied to other next-generation high-capacity secondary batteries (lithium-sulfur batteries, etc.) through further research and development."

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☐ The research was conducted by GIST School of Materials Science and Engineering Professor KwangSup Eom, integrated Ph.D. students Seungmin Leen and Haeun Lee, Hongik University Professor Jaehan Jung, and Kyung Hee University Professor Jung Tae Lee with support from the National Research Foundation of Korea and LG Chem and was published on March 5, 2020, in *Advanced Functional Materials*, a world-renowned academic journal in the field of high-tech energy materials.

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