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Professor KwangSup Eom's research team develops lithium metal anode with superior performance

- Professor KwangSup Eom's research team develops lithium metal anodes with superior performance. From mobile phones to electric vehicles, batteries have become a necessity for everyday life. For electronic products, smaller and lighter products are preferred for portability, and, accordingly, the size of the battery must be smaller and lighter. However, as the weight of the battery decreases and becomes smaller, the energy that can be stored decreases.

- GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Materials Science and Engineering Professor KwangSup Eom's research team has succeeded in drastically reducing the weight and volume of the “lithium ion battery” by developing a high-capacity lithium metal anode that is three times lighter than the existing lithium ion battery anode.

  - The research team developed a material capable of storing a larger amount of lithium in a porous structure having a very small weight and volume while suppressing the growth of dendrite* form of lithium through the rational design of the porous structure.

    * dendrite: an abnormally growing branch on a portion of the metal surface when zinc ions are reduced and deposited on the surface of the metal electrode

- Recently, research is being conducted to use lithium metal, which has a capacity of 10 times higher than that of graphite, which is commonly used as a material for the negative electrode (consisting of a negative electrode plate and a negative electrode active material that stores lithium ions) of lithium-ion batteries, as a negative electrode material. However, when lithium metal is used as a negative electrode, it grows into a special form called dendritic during the charging process of the battery. As a result, the volume of the electrode repeatedly expands and contracts, and the life of the battery is rapidly shortened while increasing the risk of explosion.

  - To solve this problem, there is a method of storing lithium metal in the pores inside the porous structure, and this has the unique advantage of preventing repetitive volume change of the electrode compared to other studies.

  - However, in the existing research to store lithium inside the porous structure, it has been shown that the actual energy storage of the battery is reduced because the weight and volume of the porous structure itself, which does not directly contribute to energy storage, is too large. In addition, a problem has been reported that the storage of lithium is concentrated on the surface of the structure rather than in the interior of the structure because the rate of ion transfer into the porous structure is slow.

- The research team focused on this problem so that the porosity of lithium could be stably stored inside the structure, while significantly reducing the weight and volume of the structure, and a method of manufacturing an electrode that can freely control the pore diameter and the thickness or area of the electrode was devised.

  - The porous electrode were manufactured to have a porosity of 90% or more has abundant pores, so it can store more lithium in the same weight and volume compared to previous studies. In addition, in the electrode composed of nanoparticles, crystal planes having high affinity with lithium are exposed abundantly on the surface, and the pore diameter is also large at hundreds of nanometers. Therefore, lithium ions penetrate into the pores and are easy to grow, and lithium could be successfully stored in the porous structure.

- The research team combined a porous structure with a lithium cobalt oxide positive electrode to implement a lithium-ion battery with an energy storage amount per weight of 455 W h kg-1 and an energy storage amount per volume of 904 W h kg-1 with about 1.5 times the performance of existing lithium-ion batteries.

□ Professor KwangSup Eom said, "The result of this research is to secure a technology that can improve the practical energy storage of a battery by establishing a basic electrode design method and material design method for a lithium metal negative electrode. Through follow-up research, it is expected that the low energy storage, which was a chronic problem of batteries, can be drastically improved by conducting research applied to various types of anode materials."

□ This research was led by GIST School of Materials Science and Engineering Professor KwangSup Eom and performed by Ph.D. student Hayong Song with support from the National Research Foundation of Korea and the Hyundai Motor Company and was published online on January 18, 2021, in *Energy Storage Materials*, a world-class academic journal in the field of advanced materials.

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