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Professor Jae-Suk Lee's research team develops polymer composites with a large specific surface area and dense crystal structure

□ GIST (President Kiseon Kim) School of Materials Science and Engineering Professor Jae-Suk Lee's research team developed polymer composites with a large specific surface area and dense crystal structure, which was applied to a pseudo-capacitor electrode to confirm its applicability as an energy storage device.

- The polymer composites developed in this study not only has high crystallinity affecting electrical conductivity but also increase redox response * due to their large specific surface area. Therefore, it is expected to contribute to application and performance improvement in electronic devices, energy storage, and conversion devices.

* redox reaction: an oxidation/reduction chemical reaction in which the oxidation number of atoms is changed

□ Conductive polymers are receiving attention for various future electronic materials because they are flexible and light. However, it has the disadvantage of hindering the movement of electrons because of the chain entanglement of macromolecules and irregular structures inside. In addition, since the mechanical strength is weak compared to other metal-based materials, research has been conducted to compensate for these disadvantages.

- The research team grew graphene oxide (GO), a 2D nano material * , using a synthesis technology that polymerizes high-crystalline polymers with precursive monomers connected to two conductive monomers. The crystal structure of this new composite material was also analyzed by ultra-high pressure electron microscopy, which observed face-centered cubic lattice (FCC) ** . These molecular-level crystal structures increase the electron transport inside the polymer and affect its conductivity. Therefore, it can be expected to be applied to various electronic materials.

* 2D nano material: materials with a very thin nanoscale (1 to 100 nm) thick two-dimensional structure

** Face-centered cubic lattice: A crystal structure in which one atom is arranged at each vertex of the cube and at the center of each face

- The researchers measured the specific surface area of the material through nitrogen adsorption and desorption isotherms * and was able to confirm that the non-surface area of the compound increased by up to 22 times compared to the non-surface area of a simple polymer.

* nitrogen adsorption and desorption isotherms: an analytical technique to describe the physical adsorption of gas molecules on solid surfaces and to measure the specific surface area of a substance using the Brunauer-Emmett-Teller (BET) theory

- The large specific surface area is advantageous for the movement of electrolyte when used as electrode material of pseudo-capacitor, and the area where oxidation-reduction reaction occurs is increased. Therefore, a large amount of energy storage is possible. The CV measurements were able to analyze the electrochemical properties, and the composite material developed by the team showed a higher capacitance than the other control polymers in the experiment.
- The large specific surface area and dense crystal structure of the 2D nano material enables rapid energy charging and discharge while increasing energy storage. Therefore, the development of a new composite material combining the synergistic effects of polymers and 2D nano materials are expected to have a positive effect on energy storage devices.

- Professor Jae-Suk Lee said, "The study identified the development and possibility of new materials for energy storage system through the combination of high-crystalline polymers and 2D nano materials, which was confirmed by crystal structure analysis and measurements of the electrochemical properties. In the future, this will be applicable to a variety of electronic devices as well as energy storage devices."

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