Gwangju Institute of Science and Technology
Official Press Release — https://www.gist.ac.kr

Section of Public Relations	Dongsun Cho Section Chief 062-715-2061	Nayeong Lee Senior Administrator 062-715-2062
Contact Person for this Article	Professor Seung Joon Yoo School of Materials Science and Engineering 062-715-2339	
Release Date	2021.02.15	

Professor Seung Joon Yoo's research team improves next-generation hybrid energy storage technology

□ In the School of Materials Science and Engineering at GIST(Gwangju Institute of Science and Technology, President Kiseon Kim), the Professor Seung Joon Yoo and his research team clarified the correlation between redox-active electrolyte and porous electrode to improve the performance of redox super capacitor* with the professor Shannon Boettcher from Oregon University in U.S and the professor Jian-feng Li and his research team from Xiamen University in China. They also indicated the core guideline to develop the next generation hybrid capacitor.

* Redox Super Capacitor: It is hybrid energy storage system that combines the advantages of super capacitors of long cycle lifespan and high power density and the advantage of rechargeable battery of high energy density. It can solve the low energy density problem of the previous capacitors by adding a faradaic energy storage mechanism by redox reactions of liquid electrolyte into electric double layer capacitance.

◦ Hybrid Redox Capacitor can be applied widely from small devices in portable electronics to eco-friendly transportation by improving energy density of the previous super capacitors greatly.

- Various electrochemical energy storage devices are currently being developed such as lithium batteries and electric double layer capacitors (Super Capacitors). Lithium batteries have advantage of high energy density, but it has disadvantages of slow charging/discharging speed and short lifespan because of low power density. On the other hand, electric double capacitors has advantages of long lifespan and high power density, but it has limit of usage because of low energy density.

  - Multi-angled approaches and new system development are needed to solve the problems of the previous energy storage system. High-capacity hybrid redox super capacitors are recently being developed for this, which use redox-active electrolytes as the main energy storage source.

- However, there has been no research on the correlation between redox super capacitor's performance(Energy, Power, Self-Discharge*) and the collective changes in various properties of redox active electrolytes and electrode structure.

  * Self-Discharge: It refers to a phenomenon that discharge occurs slowly not being able to maintain the state of being charged. Especially, there is a chronic problem of self-discharge by unwanted cross-diffusion of redox electrolytes in redox super capacitors which use liquid electrolytes as the main energy storage source.

- The research team selected iodide dissolved in water as the model redox electrolyte to analyze the performance of the produced cell (Energy Density, Power Density, Self-Discharge) and electrochemical characteristics of iodide electrolyte during charging/discharging based on changes in various structural characteristics(Surface Area per Mass, Size of the Pore, Volume of the Pore, Space inside the Particle) of porous carbon electrode and aqueous electrolytes.

  - As a result, the research discovered that only increasing the surface area of the porous carbon electrode is not sufficient to actualize the performance of high functional redox capacitor and it is important to use carbon that has structure of layer.

  - The research team clarified several results. Pores with the size of 1nm or less are necessary for suppressing self-discharge and maximizing the electric double layer capacitance. Pores with the size of 1nm or more are effective for

improving power capacity. As volume of pores and space inside the particle get larger, redox capacity gets larger.

- Professor Seung Joon Yoo said, “In the future, with the guidelines that were established in this research, it is expected to contribute to solve environmental problems by maximizing the usage of renewable energy and developing water-based energy storage devices with high capacity and long lifespan through optimizing the correlation between various redox electrolytes and corbon electrodes.”

- This research was carried out with the support of Individual Basic Research Projects from the Ministry of Science and ICT and National Research Foundation of Korea. The result of the research was published on February 5, 2021, in *ACS Energy Letters*, the top journal in the field of electrochemistry (1st in JCR Rank) and in the field of energy.

GIST
Since 1993