Safe and inexpensive ‘no-flow zinc-bromine battery’, improved performance and durability!

- GIST Professor Hyeong-Jin Kim’s team improves performance and durability by using a small amount of electrolyte additives
- Price competitiveness remains the same... Expected to be used in energy storage devices to store new and renewable energy

▲ [Photo] (From left) Graduate School of Energy Convergence Professor Hyeong-Jin Kim, Ph.D. student Hyeonghun Park, and researcher Geumyong Park

GIST (Gwangju Institute of Science and Technology, President Kichul Lim) Graduate School of Energy Convergence Professor Hyeong-Jin Kim’s research team succeeded in significantly improving the performance and durability of a highly stable and cheap ‘no-flow zinc-bromine battery’.

‘Flow-free zinc-bromine battery’ is not only safe because there is no possibility of ignition because it uses water-based electrolyte and has improved price competitiveness by using a ‘no-flow’ method that removes the electrolyte reservoir and pump from the existing battery.

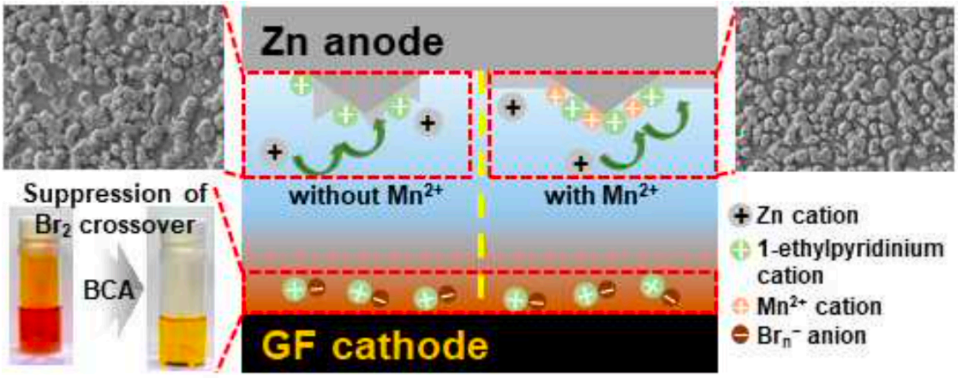
Recently, in order to solve the unstable power supply of renewable energy such as solar and wind power, energy storage systems that store electrical energy in advance and use it at the required time are attracting attention, but lithium-ion batteries are mainly used and have a risk of ignition. As a result, zinc-bromine batteries, which have no risk of ignition and are one-sixth the price, have come into the limelight.

However, in the case of zinc-bromine batteries, bromine crossover* occurs during the charging and discharging process, which reduces efficiency and voltage, and creates 'dendrites**', resulting in a shortened lifespan. In particular, flow-free zinc-bromine batteries are more vulnerable to bromine crossover, resulting in a faster decrease in performance and lifetime.

* bromine crossover: A phenomenon in which bromine dissolved in the positive electrolyte diffuses to the negative electrode, reducing battery performance

** dendrite: Branch-shaped crystals formed when metal ions are electrodeposited on the surface of a metal electrode

Accordingly, 'Bromine complex agents' that form complexes with bromine and suppress dendrite formation are being studied. The concentration of additives suitable for the two functions was different, so the performance could not be sufficiently improved.

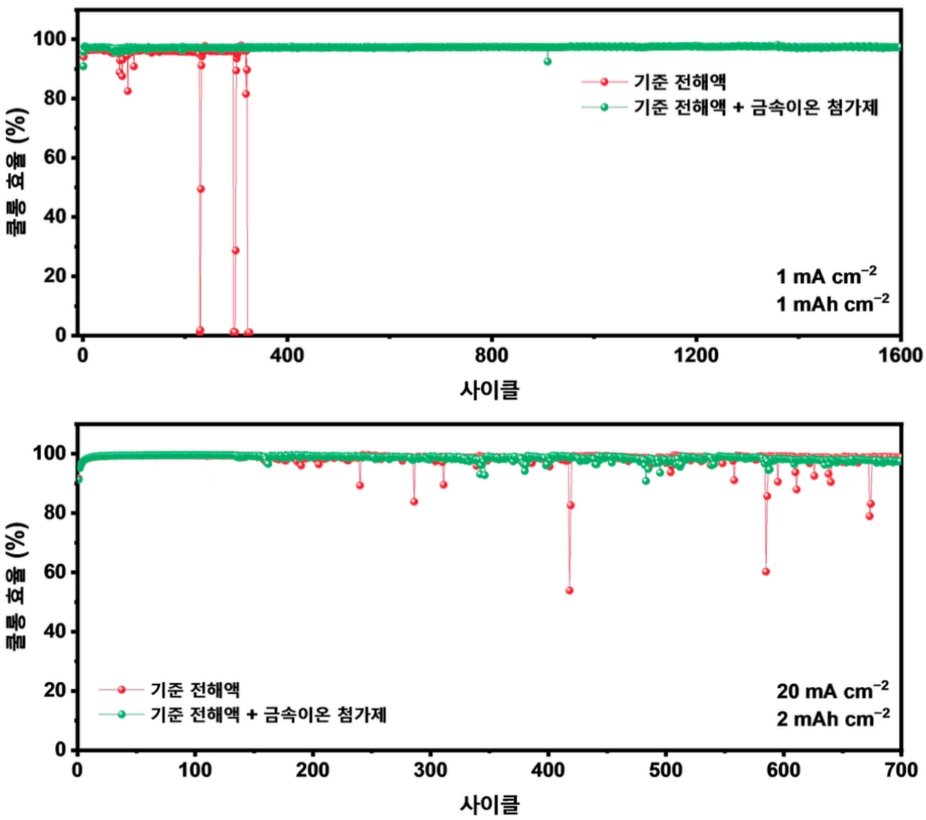


[Figure 1] Process diagram of bromine complexing agent and metal ion additive for flow-free zinc-bromine battery

The research team developed an electrolyte additive that can improve the performance and durability of a ‘flow-free zinc-bromine battery’ by adding only a small amount.

An electrolyte additive capable of selectively suppressing dendrites was used together with a bromine complexing agent to simultaneously suppress bromine crossover and dendrite formation and improve battery performance.

This additive, produced by metal ions, can be cycled over 700 times at high current density (20 mA cm^{-2}) when applied to flow-free zinc-bromine batteries. It was operated more than 1,600 times at a low current density (1mA cm^{-2}), showing a lifespan 5 to 7 times longer than before.



[Figure 2] Comparison of electrochemical performance with and without metal ion additives

The additive developed by the research team not only improves the electrochemical performance of the battery even with a small amount, but also maintains the price competitiveness of the flow-free zinc-bromine battery because it is inexpensive and easy to make. It is highly likely to be commercialized and is expected to be applied to energy storage devices in the future.

Professor Hyeong-Jin Kim said, "The additive developed through this research can very effectively prevent the causes of deterioration in battery performance and lifespan. It is hoped that it will accelerate the commercialization of flow-free zinc-bromine batteries and contribute to securing price competitiveness of future energy storage devices."

The study, led by Professor Kim and conducted by Ph.D. student Hyeonghun Park and researcher Geumyong Park with the support of a joint research project by the Korea Advanced Institute of Science and Technology and GIST. The results of the study were published online on June 22 in the *Journal of Power Sources*, an international journal in the field of electrochemicals.

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