Novel aqueous polymeric sodium battery enables operation in water or at low temperature

March 23 2022, by Zhang Nannan

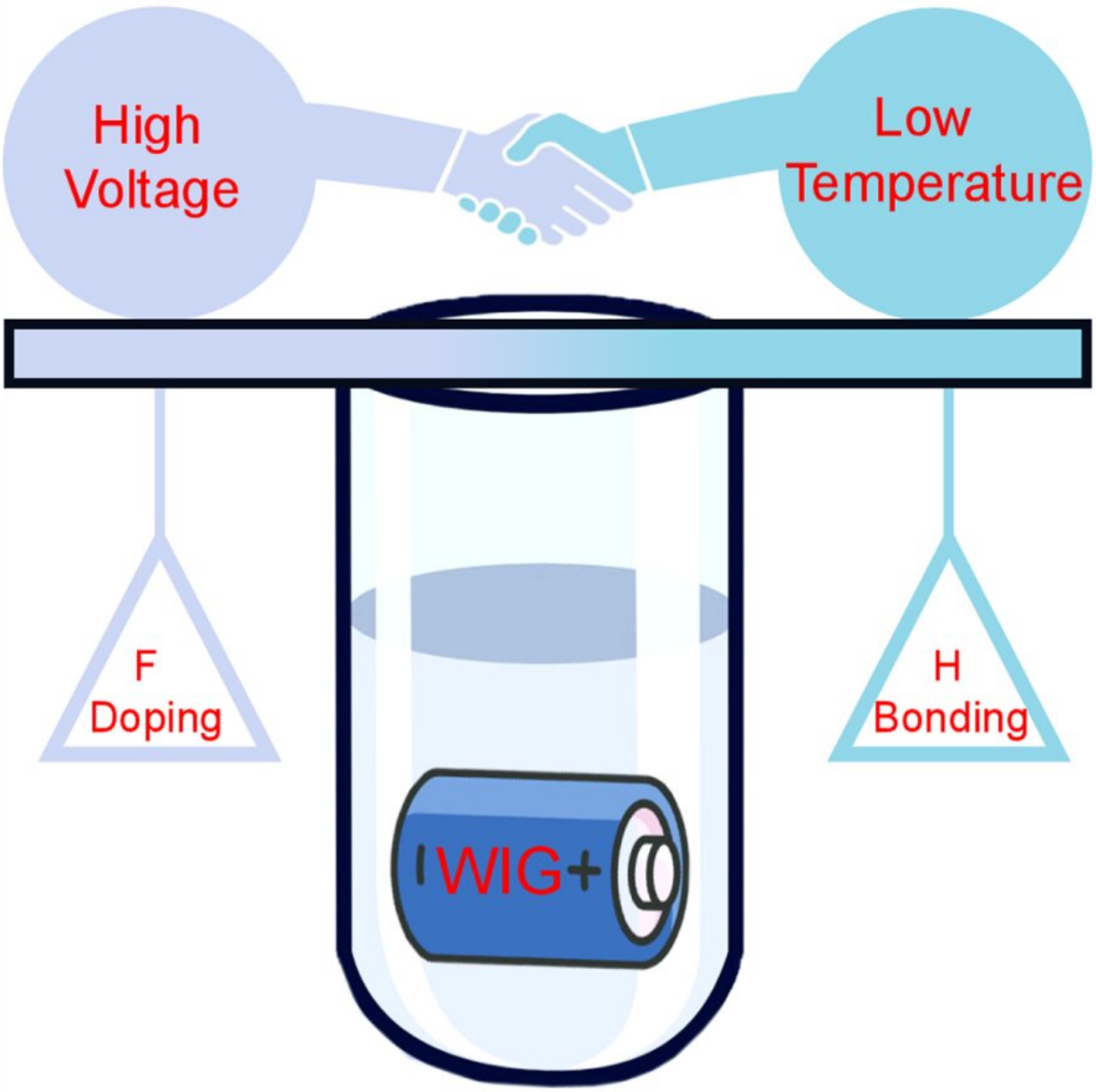

Image of the "F doping" and "H-bonding" design of "water-in-ionogel" electrolyte for low-temperature and in-water operation. Credit: SICCAS

Researchers from the Shanghai Institute of Ceramics of the Chinese Academy of Sciences proposed a novel "water-in-ionogel" aqueous polymeric electrolyte that allows a high operational cell voltage with a high H_2O content and a low salt concentration for low-temperature operation. The study was published in *Cell Reports Physical Science*.

Electric vehicles and flexible electronics are undergoing a new period of vigorous advancement in urgent need of a safe, high-energy and sustainable battery that can be hit, bent, and even soaked in water or perform under subzero temperature, all while retaining electrochemical performance.

Among various energy storage technologies, aqueous rechargeable sodium ion batteries with non-flammable aqueous electrolyte attract intensive interest in energy storage system owing to their inherent safety, nontoxicity and low cost.

Traditional "water-in-salt" electrolyte with highly concentrated fluorinated salts and molecular-crowding aqueous electrolyte via confining water molecules in a crowding poly(ethylene glycol) (PEG) network suffers from poor low temperature performance owing to its salting out at low temperature, high freezing point, and sluggish charge transport kinetics of the electrolyte-electrode interfacial interphase layer.

In this study, the water in copolymerized PEG derived poly(ethylene glycol)methyl ether methacrylate (PEGMA) and bisphenol A ethoxylate

dimethacrylate (BEMA) to form cross-linked gels, an antifreezing solid electrolyte was thus generated by altering hydrogen bonding.

In addition, a typical electrolyte additive, fluoroethylene carbonate, was introduced the PEGMA-BEMA system to form O-H…F bonds to weaken the H-bond network in aqueous solution, thereby reducing the freezing point and constructing solid electrolyte interfaces for ion diffusion at low temperature.

High energy density could be delivered by polymeric aqueous sodium ion full cell consisting of a Mn-based cathode and a hard carbon anode, according to the researchers.

More importantly, the eco-friendly aqueous polymeric battery could be free-sealed to be an ultrathin, light battery, and perform well under severe conditions, such as being bent, cut, soaked in water or put on fire.

This was the first attempt to realize a high-voltage aqueous electrolyte for low temperature operation.

In the future, the researchers will work to improve the voltage window and transport characteristics of water-in-ionogel electrolytes to achieve low-cost, sustainable energy storage that works well in sub-zero temperatures or water.

More information: Jing-Zhi Rong et al, A free-sealed high-voltage aqueous polymeric sodium battery enabling operation at −25°C, *Cell Reports Physical Science* (2022). DOI: 10.1016/j.xcrp.2022.100805

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