A Self-Healing Flexible "Jelly-like" Zinc-Ion Battery: Empowering Wearable Devices and Safe Energy Storage

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The quest for low-cost, safe, and environmentally friendly rechargeable flexible batteries is crucial in propelling the next wave of energy-storage innovations, particularly for implementation in wearable electronics and biomedical devices. Current commercial Li-ion batteries face challenges concerning rigidity, safety, and scarcity of lithium resources. This study introduces a groundbreaking self-healing "jelly-like" capacitive battery, combining the high energy density of batteries with supercapacitor-like rapid charge-discharge capabilities and long lifespan while addressing safety concerns. Central to our innovative design is a non-toxic, eco-friendly, and ultra-strong viscoelastic PAM gel electrolyte, modified with additives such as ethylene glycol and chitosan through multiple trials to optimize its mechanical and electrochemical properties. Moreover, high-strength acid-treated carbon cloth cathode and abundant zinc anode are used, offering high storage capacity, extended cycle life, and enhanced safety. The acid-treated carbon cloth can also act as a high-performing porous flexible current collector and be coated with V-doped Manganese dioxide to exhibit a high specific capacity of 300mAh/g at 1A/g. Combining these elements, we produced a self-healing flexible battery that can withstand extreme conditions such as 180° bending, puncturing, freezing, and cutting while maintaining normal functionality, exhibiting unparalleled mechanical and electrochemical performance. Seamlessly integrated into the strap of a smartwatch, this battery ensures uninterrupted functionality. This breakthrough provides a strategic solution to lithium safety and rigidity challenges, with potential applications spanning across the realms of biomedical devices and wearable electronics.

Awards Won:
The Scientific and Technological Research Council of Türkiye TUBITAK: 1st Prize Award
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: Full Scholarship from King Fahd University of Petroleum and Minerals(KFUPM) (and a $400 cash prize)
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: NOT TO BE READ -- $400 cash prize for each Full Scholarship from King Fahd University award recipient