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Quinone-based Bioinspired Battery With Iota-carrageenan Hydrogel

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The growing interest in sustainable energy storage solutions has driven research into environmentally friendly materials, with gel-based electrolytes emerging as promising alternatives due to their safety, mechanical flexibility, and efficient ionic transport.[1] In this context, iota-carrageenan, a natural polymer derived from red algae, stands out as a biodegradable and low-cost option for electronic devices. We report the development of a bioinspired organic redox battery employing iota-carrageenan hydrogel as the electrolyte matrix, incorporating quinone-based redox molecules such as 2,6-DPPEAQ (an anthraquinone phosphonate derivative) and potassium ferricyanide. We used flexible carbon fiber electrodes with chemically induced surface defects and oxygenated functional groups, favoring rapid electron transfer and efficient redox cycling.[2-3] Thus, we achieved a cell potential of 0.95 V in an alkaline medium (1.0 mol L^{-1} KOH), surpassing the 0.61 V recorded under neutral conditions (1.0 mol L^{-1} KCl). Galvanostatic charge/discharge tests confirmed exceptional stability at ±0.5 mA, maintaining consistent performance over multiple cycles and rest periods. This sustainable battery platform highlights the potential of marine-derived biomaterials for applications in sustainable electrochemical systems, contributing to advancing of biodegradable and bioinspired batteries as greener alternatives in energy storage technology.

References

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