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High-performance printed organic-based battery composed of cheap components as a reliable alternative to power small electronic devices

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Highlights

This work describes the development of a semisolid microbattery capable of powering a commercially available calculator and shows the feasibility of applying organic-based batteries in real applications.

Abstract

As mankind evolves day by day into a wireless and digital era due to the widespread use of wearables, power supply strategies must advance to fulfil all the electrical and mechanical requirements of these technologies [1]. Organic-based batteries are promising alternatives as their active compounds are composed of earth-abundant elements and possess structure tunability as well as fast electrochemical kinetics [2]. This work presents the engineering of an organic-based battery using cheap compounds and with enough power output to power a commercially available calculator. The electrochemical characterization of 2,7-AQDS and ferricyanide through cyclic voltammetry shows the coupling of these redox compounds has a theoretical voltage of 0.71 V in neutral media. Furthermore, electrochemical measurements with carbon-based electrodes activated by O_2 plasma show an almost three times increase in the heterogeneous charge transfer constant (k_{HET}) of ferricyanide while k_{HET} for 2,7-AQDS does not change. By incorporating ferricyanide and 2,7-AQDS in agarose hydrogel we could produce a semisolid microbattery with a power output of 0.15 W kg^{-1} and capable of delivering a voltage above 0.60 V for up to 30 minutes under discharge depth of -200 µA cm^{-2}. Our work presents an organic-based produced with commercially available compounds such as carbon-based conductive ink, 2,7-AQDS, ferricyanide, and agarose and demonstrate this is a reliable alternative to power small energy-demanding electronic devices. This work opens a new avenue for organic-based batteries and motivates the faster development of such sustainable batteries.

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