PÔSTER - RESUMO - DISPOSITIVOS ELETRÔNICOS, ELETROQUÍMICOS, SUPERCAPACITORES E BATERIAS

ENGINEERING LIVING MATERIALS FOR EPS-DRIVEN YEAST BIOBATTERIES

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Engineering living materials offers a route to integrating biological components as active electrochemical elements within electrochemical and bioelectronic systems. These materials emerge as promising solutions for more sustainable energy storage and energy conversion applications, such as biobatteries, by exploiting biologically mediated redox processes under mild conditions. Among bio-derived materials, extracellular polymeric substances (EPS) produced by Saccharomyces cerevisiae combine redox activity, ionic conductivity, and stable interfacial film formation, enabling efficient extracellular electron transfer at neutral pH [1]. Despite their widespread presence in biological systems, the electrochemical potential of EPS remains relatively underexplored for energy-related applications.

Here, we present a progressive design framework for EPS-based biobatteries. First, a yeast biobattery was demonstrated by coupling EPS with a ferricyanide cathode in phosphate-buffered saline (pH 7.4) electrolyte, delivering stable voltages of ~350 mV for up to 12 h [2]. This initial configuration established EPS as an active electrochemical component capable of sustaining continuous power generation within a redox battery architecture. Following proof-of-concept

validation, the system was subsequently redesigned as an all-silk wearable biobattery, comprising ~95% biodegradable materials and improved mechanical robustness, reaching discharge voltages above 1.1 V when three modules were connected in series [3]. The use of silk-based substrates enabled a closed and flexible architecture, improving device containment and operational stability while preserving the underlying EPS-driven electrochemical mechanism.

Finally, coupling EPS with a copper anode under neutral aqueous conditions enabled active modulation of copper redox chemistry, lowering anodic onset potentials, delaying passivation, and enhancing electrochemical performance. In this configuration, EPS acts at the electrode–electrolyte interface, stabilizing redox intermediates and promoting partially reversible behavior in aqueous media. The resulting Cu–EPS biobattery achieved higher open-circuit voltages (~470 mV), increased power density, extended discharge times, and stable cycling behavior, exhibiting secondary-battery characteristics within a largely biodegradable platform.

This work establishes EPS as a central electrochemical design element within the engineering living materials paradigm, enabling successive advances in performance, integration, and sustainability, and opening pathways for low-power energy storage applications such as wearable electronics and sensors.

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