Sodium-oxygen batteries and micro-supercapacitors derived from electrochemical graphene bio-inks

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Electrochemical exfoliation has proven to be a versatile method for the preparation of high-quality graphene, allowing the use of different electrolytes, electrolyte additives and co-electrolytes in order to obtain graphene nanosheets with varying degrees of oxidation and/or functionalization that can be tailored to target numerous applications. Here, we have obtained high-quality graphene via electrochemical exfoliation using a small, innocuous biomolecule in the dual role of exfoliating electrolyte and aqueous dispersant. Water-based inks derived from this straightforward process were employed for the preparation of graphene aerogels and inkjet-printed interdigitated patterns, which were respectively employed for Na-oxygen batteries as cathodes and for micro-supercapacitors (MSCs) as electrodes. Na-oxygen batteries assembled with the aerogel cathode and a glyme-based electrolyte exhibited a full-discharge capacity of ~3.5 mAh cm^{-2} at a current density of 0.2 mA cm^{-2}. In addition, shallow cycling experiments (0.5 mAh cm^{-2}) showed a capacity retention of 94% after 50 cycles outperforming other graphene-based cathodes previously reported. MSC electrodes printed onto alumina-coated flexible polymer substrates and tested with polymer gel electrolyte exhibited areal capacitances up to ~160 mF cm^{-2}, competitive with those of similar graphene-based devices.

References

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Figures

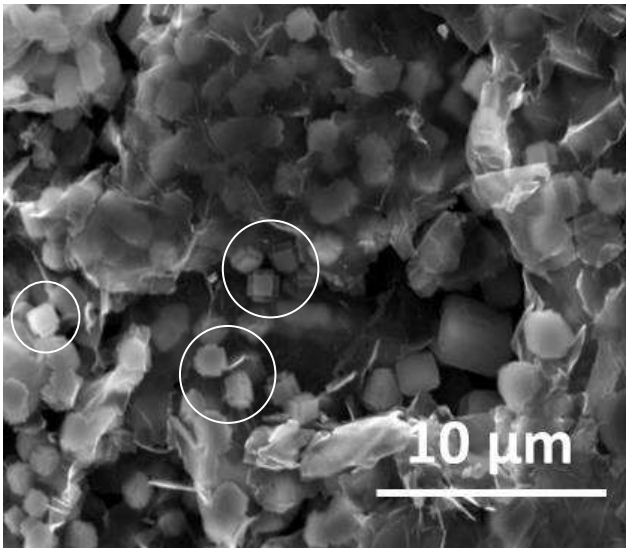

Figure 1: Scanning electron microscopy image of graphene aerogel cathode in a Na-oxygen battery showing NaO_2 discharge products (encircled particles).