Chemically tuning graphene for aqueous zinc-based electrochemical energy storage applications

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We present a one-step method for preparing hydrophilic graphene enriched with carboxyl groups via a straightforward anodic exfoliation strategy, carried out in aqueous medium with common salts/bases as the electrolyte. This approach yields highly oxidized (O/C ratios ~0.25) but still electrically conductive graphene (~10^2-10^3 S m^{-1}) with control over the populations of different types of oxygen functional groups, not just carboxyls. The obtained material is shown to be advantageous for its use in aqueous zinc-based electrochemical energy storage, both as an active cathode material and as a protective layer for the Zn anode [1]. For one thing, the carboxyl-enriched graphene is processed into a dense film and the results show that it outperforms the standard anodic graphene as well as reduced graphene oxide derived from common routes (e.g., Hummers method) in terms of capacity and rate capability. To further improve its performance, this graphene is combined with a redox-active biomolecule (flavin mononucleotide) to act as a spacer between nanosheets and provide extra capacity. For another, the carboxyl-enriched graphene is shown to act as an effective coating layer for the Zn metal electrode, extending its cycle life for longer than is usually attained with other carbon-based materials [3]. Overall, the present work provides a convenient, environmentally friendly approach to chemically tunable graphenes for their versatile use in aqueous zinc-based electrochemical energy storage and possibly other applications.

References

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Figures

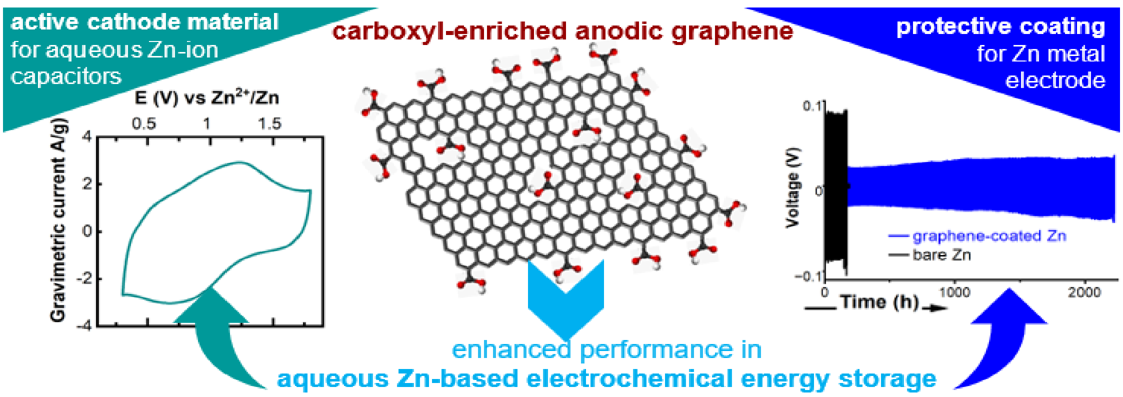

Figure 1: Schematic view of the synthesized graphene and its performance as both an active cathode material and a protective coating for the Zn metal electrode in aqueous Zn-based electrochemical energy storage.