Conducting polymer doped Graphene oxide for lithium extraction using membrane capacitive deionization

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The escalating global demand for lithium driven by the of burgeoning electric vehicle and portable electronics necessitates the development of highly selective and efficient recovery technologies from diverse water sources [1]. In brine and wastewater recovery, where Li^+ co-exists with a high concentration of competing ions, an opportunity for circular economy lies dormant. Capacitive deionization (CDI) is an electrochemical process showing great promise in the selective extraction of Li^+ from diverse streams. However, the exploration of advanced electrodes that impart superior selectivity is crucial for achieving high selectivity and adsorption rates [2]. In this study, we investigate the membrane CDI (MCDI) performance for lithium extraction using a polypyrrole (PPy) conductive polymer doped on hydroxyl (-OH), carboxyl (-COOH), and amine ($-NH_2$) functionalized graphene oxide (GO). The aim of this work is to establish the difference in electrochemical performance and electrosorption affinity of these functionalized composites towards Li^+ extraction. Conductive PPy was synthesized through an oxidative polymerization process, with Biphenyl-disulphonic acid (BPDSA) as an electron donor, and subsequently doped on functionalized GO ex-situ (Ppy/GO-OH, -COOH, or $-NH_2$). Initial results show a comparable difference amongst all electrodes, PPy/GO-OH had the highest adsorption capacity of ≈24 $mg.g^{-1}$, PPy/GO-COOH had the fastest adsorption rate 2 $mg.g^{-1}min^{-1}$, and PPy/GO-NH_2 was the most effective overall, with 21 $mg.g^{-1}$, 0.97 $mg.g^{-1}.min^{-1}$, and an impressive specific capacitance of 168 $F.g^{-1}$. These findings highlight the incredible potential of composite 2D and conductive polymer electrodes for electrochemical Li^+ recovery using MCDI.

References

[1] A. Kumar, H. Fukuda, T. A. Hatton, and J. H. Lienhard, ACS Energy Letters, issue. 6 (2019), vol. 4, pp. 1471–1474.
[2] X. Zhao, X. Song, S. Yang, Y. Hou, Y. Wang, and H. Y. Yang, Green Energy Resources., issue. 4 (2023) vol. 4, article 100043.

Figures

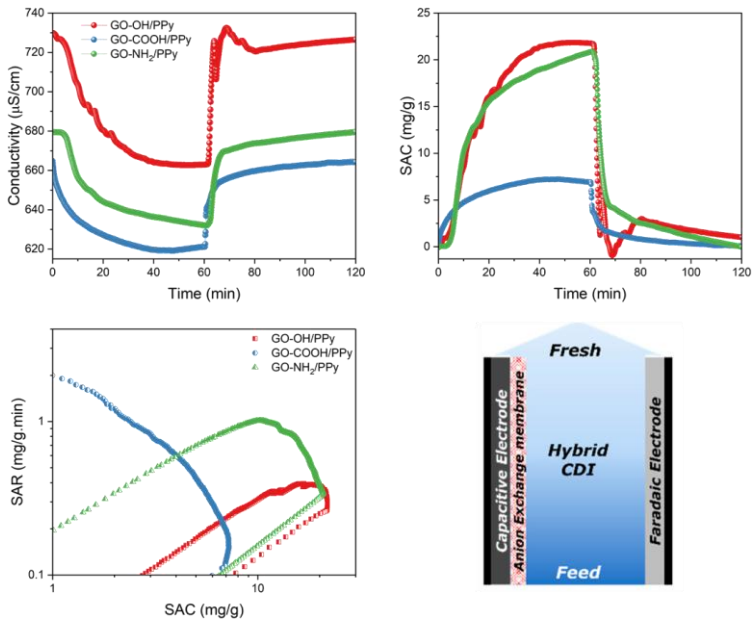

Figure 1: Conductivity, Salt adsorption capacity (SAC), and Salt adsorption rate (SAR) along with a schematic of the configuration