Ionothermal synthesis of activated carbon from waste PET bottles as anode materials for lithium-ion batteries†

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Received 27th October 2022 , Accepted 28th November 2022

First published on 2nd December 2022

Abstract

Waste polyethylene terephthalate (PET) bottles have become a significant post-consumer plastic waste with attendant environmental problems. Hence, ionothermal synthesis has been used to prepare activated carbon (AC) anode materials from waste PET for both high performance and sustainable lithium-ion batteries (LIB). Particularly, using choline chloride deep eutectic salts (CU-DES) does not require post-synthesis washing and thereby reduces the complexity of the process and produces materials with unique low-surface area, higher levels of graphitization/ordering, and high nitrogen doping in the obtained ACs. The results show that the AC produced using CU-DES (PET-CU-A-ITP2) gave good electrochemical performance. Even though the material possesses a low surface area (~23 $m^2 g^{-1}$), it displays a gravimetric capacity (GC) of ~460 mA h g^{-1} and a coulombic efficiency (CE) of ~53% in the 1st cycle and very good cycling performance with a capacity retention of 98% from the 2nd to the 100th cycle. The superior electrochemical performance of the PET-CU-A-ITP2 anode was found to be due to its better graphitization/ordering and dense structure which results in higher capacity, formation of less solid electrolyte interphase, and higher CE. These results show that dense carbons can be exploited as high-performance anodes in LIBs. Also, this research presents both a pathway for waste PET management and a waste-energy approach that could offer cheaper and greener LIBs to meet the sustainable development goals.