Graphene-Bio-based Binders for next Generation Anodes in Li-ion Battery

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Abstract

The lithium-ion (Li-ion) rechargeable battery is a rapidly growing key technology toward a fossil-fuel-free economy. The Li-ion technology is a key enabler for portable electronics and electric transportation. The Li-ion batteries (LiB) provide high energy and power densities, while retaining enhanced cyclability suitable for such electric vehicle (EV) transition. Currently, there is a significant demand in Li-ion battery production. This facilitates a strong need in improving LiB efficiency due to increasing performance demands in the EV batteries and upcoming possibility for resources shortage of rare metals. Also, such a rapid increase in manufactured LiB modules for various applications could have an environmental impact and facilitating developing of new technologies in recycling. In this regard, an introduction of novel bio-based binders for LiB anodes, such as nanocellulose and starch, combined with graphene could offer both improvement in sustainability and anode performance, specifically in the case of next generation silicon-based anodes.
In this study, we have prepared LiB anode composites using slurry formulations consisting of a novel anode active material, such as expanded graphite decorated with nano-silicon and coated with graphene to prevent Si expansion during the charging/discharging process. Bio-based binders formulations consisting of nanocellulose, starch and graphene were used. The obtained results show that introduction of graphene led to improved anode conductivity and provided improvement of rheological and adhesion properties of bio-based anode formulation. The results indicated that the graphene flakes bonded with nanocellulose additives can create wrap-like structure embedding the nano-silicon active materials. The electrochemical data presented capacity values of around 800 mAh g^{-1} along with coulombic efficiency data exceeding 98% along 100 cycles.