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Life Cycle Assessment of Ni-Co hydroxide and reduced graphene oxide electrodes

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PURPOSE OF THE ABSTRACT

Amongst novel devices designed to achieve high energy density and high-power output, electrodes based on nickel-cobalt hydroxide that can be fabricated using electrodeposition technique are particularly promising. Ultimately driven by sustainable energy development, environmental performance of this energy storage device has come to attention, and hence the analysis of potential environmental trade-offs of some optional synthesis steps are undertaken to enhance its technical properties.

An optional use of reduced graphene oxide (rGO) improves the electrode properties while it adds to materials and energy use and associated environmental impacts. Hence, the current study and analysis is set out to investigate if an addition of rGO to nickel-cobalt composite is environmentally beneficial and if the newly developed electrodeposition route for fabrication of these electrodes is overall competitive with more established synthesis alternative consisting of coprecipitation. A Life cycle assessment (LCA) study was carried out to compare environmental impacts of different types of electrodes. The inventories of the electrodes are developed for a current density of 1A/g at a 20% capacity fade, across 8 impact categories of the Recipe Midpoint environmental impact assessment method. Additional scenario analysis considers greater allowance for a capacity fade of 30%.

Results suggest that at 20% net technical improvements resulted by the addition of rGO are outweighed by added impacts from GO synthesis, while the addition of rGO is desirable when capacity retention fade allowance was increased to 30%. Moreover, a contribution and an additional sensitivity analysis revealed that the choice of GO synthesis route is detrimental to impacts of rGO-integrating electrode, and more eco-efficient production route of GO would make the addition of GO preferable for both baseline and 30% capacity fade scenarios. Electrode synthesised via more mature co-precipitation technique appears to have still lower environmental impacts then electrodeposited electrode but ideas for further improvement exist.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS
Life Cycle Assessment | Electrodes | Ni-Co hydroxide | Reduced Graphene Oxide

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