GREEN TECHNOLOGY ACCELERATOR CENTER

CASE STUDY

Cell Prototyping and Evaluation for Silicon-based Anodes

Founded in 2010, Besstech, LLC (Battery Energy Storage Systems – Technologies) is a lithium-ion component design and engineering company located in Troy, New York. Their solutions are applicable to both traditional Li-Ion batteries and to solid-state thin-film batteries. The mission of Besstech, LLC is to improve the battery systems manufactured by assemblers and OEMs, providing them with high-performing electrodes.

CHALLENGE

The objective of this project was to independently evaluate the performance of Besstech, LLC's battery anode and conduct a high level literary research assessment of the environmental impacts of Besstech, LLC's Si-based battery anode as compared to a conventional graphitic anode.

Besstech, LLC requested New York State Pollution Prevention Institute (NYSP2I) at Rochester Institute of Technology (RIT) to evaluate the performance of Besstech, LLC's silicon-based anodes at RIT's Battery Prototyping Center (BPC) against a conventional graphitic anode baseline. Besstech, LLC also requested a high level environmental assessment, comparing the environmental impacts of Besstech, LLC's anode material to graphitic materials.

SOLUTION

NYSP2I and RIT performed a comparative battery performance evaluation of Besstech, LLC's Si-based anode vs. graphic anodes at RIT's BPC. The performance testing utilized standard coin and pouch cell battery processing and manufacturing procedures to fabricate battery electrodes and assemble coin cells and multi-layer pouch cells. The cells fabricated in this study were electrochemically cycled to determine the rate performance and cycle life of Besstech, LLC's Si anodes in comparison to industry standard graphite materials.

Photo Credit: https://www.rit.edu/research/department/battery-prototyping-center

NYSP2I's environmental assessment included a visual inspection at end-of-life, followed by additional performance evaluation of repurposed Besstech, LLC anodes to assess recyclability potential. The materials used in the production of Besstech, LLC's anodes were compared to their conventional counterparts across 18 different environmental impact categories using SimaPro™ software. A literature review of the environmental impacts associated with the Besstech, LLC production process and material use was also performed as part of this study.

CHALLENGE

- Independently evaluate the performance of Besstech, LLC's battery anode and conduct a high level literary research assessment of the environmental impacts of Besstech, LLC's Si-based battery anode as compared to a conventional graphitic anode

SOLUTION

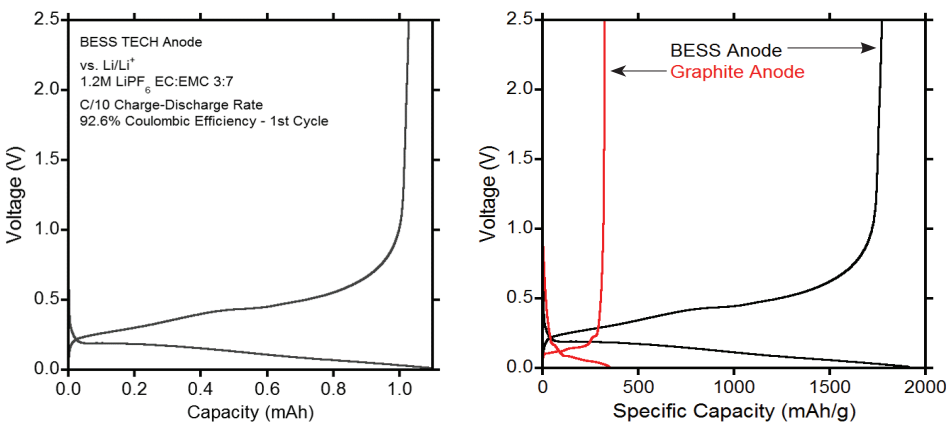
- NYSP2I and RIT performed a comparative battery performance evaluation of Besstech, LLC's Si-based anode vs. graphic anodes at RIT's BPC
- NYSP2I's environmental assessment included a materials assessment, a visual inspection at end-of-life, followed by additional performance evaluation of repurposed Besstech, LLC anodes to assess recyclability potential

RESULTS

- Besstech, LLC anodes outperformed standard graphite anode materials in their measured charge rate capability, and retained more normal capacity at higher charge/discharge rates as compared to the graphite controls
- Besstech, LLC's Si anode electrodes, utilizing a plasma enhanced chemical vapor deposition process (PECVD), are compatible with standard pouch cell manufacturing methods
- Through the use of PECVD coating, Besstech, LLC completely eliminates the use of binders and solvents used by graphitic anode manufacturing, further reducing the raw materials required, thus improving the environmental impact

RESULTS

RIT's performance testing showed that Besstech, LLC's Si anodes have measured specific capacities consistent with other published values and commercially available Si battery materials. As shown in the figures below, Besstech's Si anode has a much higher specific capacity of 1844 mAh/g, as compared to ~330 mAh/g for the graphite baseline anode. Additionally, Besstech, LLC's anodes outperformed standard graphite anode materials in their measured rate capability, and retained more nominal capacity at higher charge/discharge rates as compared to the graphite controls. It was discovered that the plasma enhanced chemical vapor deposition process (PECVD) grown Si anode electrodes are compatible with standard pouch cell manufacturing methods, and are able to be drop-in replacement for graphite materials.



(Left Figure) First cycle charge/discharge voltage profile of a representative Besstech LLC's anode vs Li/Li+

(Right Figure) Comparison of the first cycle charge/discharge voltage vs. specific capacity for the Besstech Si anode and a commercial graphite anode material.

A high level environmental assessment was performed in order to understand how Besstech LLC's Si-based anode compares to a typical graphitic anode in terms of environmental impacts. Through the environmental analysis of Besstech, LLC's Silicon based anodes, several key conclusions were drawn. Due to higher energy density when using Si-based anodes, the amount of raw material required for manufacturing of the Besstech, LLC Si-based anode is less than that of the graphitic anode for equivalent energy storage. In addition, through the use of PECVD coating, Besstech, LLC completely eliminates the use of binders and solvents used by graphitic anode manufacturing, further reducing the raw materials required for Si-based anode production, thus improving the environmental impact. Nevertheless, anode materials such as graphite and Besstech, LLC's make up only a small portion of the overall environmental impact of batteries across all 18 categories analyzed.

As an outcome of this project, NYSP2I also uncovered areas of opportunity that could further advance Besstech, LLC towards a commercialized product. Various material processing alternatives were studied, with potential to improve volumetric and gravimetric energy density of the multi-layer pouch cells Furthermore, considering life cycle phases of raw material extraction, battery production, product use, and end of life impacts through a comprehensive Life Cycle Assessment, would help to more fully define the opportunity areas for reducing environmental impact.

The results of this evaluation project will assist Besstech, LLC to further develop and commercialize their battery electrodes, utilizing product manufacturing in New York State. Success of this product line is forecasted to help create at least five New York State jobs.

TESTIMONIAL

"Success of this product line is forecasted to help create at least five New York State jobs."

– Fernando Gómez-Baquero, Ph.D., CEO
BessTech, LLC.

NYSP2I PARTNERS

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