



Military Power Sources Committee: Information Paper on Silicon Anode Batteries

Silicon anodes are the next great advancement in rechargeable lithium-ion (Li-ion) batteries. This technology offers higher capacities and lighter weights than the lithium-ion technologies in use today, meaning longer run time, and more importantly for the military, less weight required for warfighters to meet mission requirements. A strong presence of domestic working solutions related to silicon anode from raw material to actual production can be leveraged to make quick gains in the energy storage sector.

U.S. experts in energy, economic, and defense state that it is strategically important for U.S. industry to have more of a leadership role in the development and production of Li-ion batteries. To avoid repeating the mistakes of the past and reinstate the US as leader and not a follower, U.S. federal government needs to develop and implement, with adequate funding, a strategy by which the silicon anode technology can become and be maintained as a domestic capability from its research and development phase through mass production.

The Problem

The U.S. was once a leader in advanced battery technologies, but this has slowly atrophied to where the U.S. is totally dependent on other countries for the design and production of state-of-the-art technologies. China not only dominates the production of most lithium-ion batteries, but they also control most of the supply chain. Notably, of the few cell producers that are in the U.S. all of them are currently reliant on China for materials, who vastly leads the world in production of battery-grade graphite used for anodes in nearly all Li-ion batteries.

Developing a domestic supply chain and production capacity for commercial batteries based on use of a graphite anode material that is competitive with Chinese production capacity would be an exercise in futility, as the US cannot overcome the huge competitive that the Chinese already have. The alternative is to invest in the next state of the art lithium-ion technology where the graphite is replaced with silicon, a material in which the Chinese are not in control of the supply chain. While leading manufacturers have already integrated silicon as a minority component of graphite anodes which even at a minimal level has resulted in an increase in a nominal increase battery capacity, using silicon as the dominate material would increase battery capacity up to 50%. Fortunately, over the past decade multiple silicon-dominant-anode battery technologies have been developed which could enable the U.S. to gain a competitive advantage in Li-ion battery production. Without immediate and significant funding for scaling the manufacturing processes needed to implement silicon-dominant technology, which is an equipment-heavy industry, energy security will continue to be significant risk in the U.S. The lack of a coherent national strategy to nurture and protect this technology – it will become dominated by the Chinese.

The Solution

One way to break the Chinese dominance in the lithium-ion supply chain and production is to leapfrog over what is available today and drive towards a new technology with a new supply chain that is not as dependent on the Chinese. The solution is replacement of the graphite by silicon in the anode. Silicon is in production worldwide in support of semiconductors, solar, high strength alloy, and silicone material manufacturing, with 14% already occurring in North America. It would also enable the leveraging on investments already made by cell manufacturers and OEMs.

As with any strategy, investment must be targeted. The MPSC hosted a symposium of domestic experts in silicon anode technology in January 2021 to determine where such investments should be targeted. The following areas were identified:

- Subsidies for U.S. sourced silane and silane produced using renewable energy to expand raw material production in the U.S. and reduce cost of materials
- Research towards eliminating costly additives which are currently required to enable silicon dominant anodes
- Research towards silicon dominant technologies which do not require high pressure packaging, so as to enable increased use in commercial and military applications
- Ensuring that there are multiple silicon anode providers who can manufacture materials to ensure a robust domestic supply chain for high performance batteries
- Investing in manufacturing strategies/technologies in the development/maintenance of domestic production capabilities that are cost competitive to traditional lithium ion technologies.

Implementing the Solution

- Provide access to a combination of public and private funding to accelerate the domestic production of silicon anode batteries through the:
 - Increased basic research into innovative solutions
 - Use of Government programs dedicated to design and prototyping of equipment that can be used to reduce the cost of cell production, and specifically precursor material and Si particles
 - Funding of raw material manufacturing cost-down initiatives for silicon
 - Establish a consortium of government, academia, and private industry with the common goal of sharing information
- Provide incentives for establishment of domestic sourcing and production
- Build relationships between industry and the Government with the goal of giving industry the confidence to take risks and support stable business strategies

Conclusion

Cell manufacturers must quickly leverage all the know-how of current silicon anode producers to commercialize this leading cell technology quickly and domestically. The current trend of electrifying everything from transportation to military application will only increase our Nation's demand for batteries and if the US does not invest in the next generation of Li-ion batteries we will be beholden to other countries for our supply. Domestic production and especially domestic production of next generation of technology will not only ensure our national security but has the potential for job growth, energy security, a circular economy, and overall economic prosperity is palpable. We are at the precipice of a revolutionary opportunity, and we are aware of our shortcomings and the risks before us, but we have the resources and all we need to do is apply ourselves.

About the MPSC

The mission of the Military Power Sources Committee (MPSC) is to provide a forum by which, its members can present a unified voice for critical energy storage issues. The Military Power Sources Committee (MPSC), which consists of organizations that design, develop, and manufacture power sources, for the Department of Defense, alongside such organizations as NATTBatt and the Battery Materials Technology Coalition (BMTc), believes strongly that the U.S. requires a robust, domestic energy supply chain, especially as it pertains to Lithium-ion batteries, and that the U.S. must invest in domestic materials and manufacturing technologies to ensure continued, uninterrupted prosperity.

For more information about the committee and our activities, please contact James Trevey at jtrevey@forgenano.com, or Marc Gietter at sagelyconsultant@gmail.com. Whether you agree or disagree, provide us feedback so we continue to refine our goals as we pursue them since future U.S. dominance in advanced battery technologies benefits all of us.