Bulk Current Injection for Fast and Low-Temperature Lithium-Ion Battery Charging

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Opportunity

Seeking a licensing and development partner to scale this technology into commercial battery management systems.

Development Stage

Validated in the lab using CR1032 coin cells under both room temperature fast-charging and -10°C cold-charging conditions.

Intellectual Property

Provisional Patent Application Status: Filed

Publication

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PROBLEM STATEMENT

Lithium-ion batteries are increasingly expected to charge faster and operate reliably in cold environments, but aggressive charging creates serious performance and safety challenges. During fast charging, lithium ions may not intercalate into the anode quickly enough, increasing the risk of lithium plating, capacity loss, impedance growth, and accelerated degradation. These problems become more severe at low temperatures, where sluggish ion transport and slower electrode kinetics limit charge acceptance and often require reduced charging rates or external thermal management. Existing solutions typically rely on new battery chemistries, electrode redesign, external heaters, or conservative charging protocols that increase cost, complexity, or charging time. The industry needs a battery management approach that can improve fast-charging and cold-charging performance without changing the cell chemistry or battery manufacturing process.

SOLUTION

Researchers at Missouri University of Science and Technology have developed a new use of Bulk Current Injection (BCI) for lithium-ion battery operation. The approach applies a controlled high-frequency AC signal during charging in operating windows where lithium plating risk is elevated. This signal is designed to modify ion transport and interfacial behavior in real time, reducing degradation risk and improving usable discharge capacity under demanding charging conditions. For cold environments, the same signal can generate internal self-heating through the battery's impedance, helping bring a cell from subzero temperature toward a more favorable operating range without relying solely on an external heater. The technology can be implemented through BMS-controlled charging electronics, with no changes to battery chemistry or cell design.

VALUE PROPOSITION

BCI provides a battery operation strategy that can work with lithium-ion cells already on the market. It does not require new electrode materials, new cell chemistry, or new battery manufacturing lines. Instead, it adds a controllable electrical signal to the charging process to support faster charging, improve cold-weather charge acceptance, and reduce degradation risk under aggressive operating conditions. For electric vehicles, drones, defense systems, outdoor electronics, and grid-storage applications, this approach offers a potential pathway to better charging performance and cold-temperature reliability through integration with battery management and charging hardware.