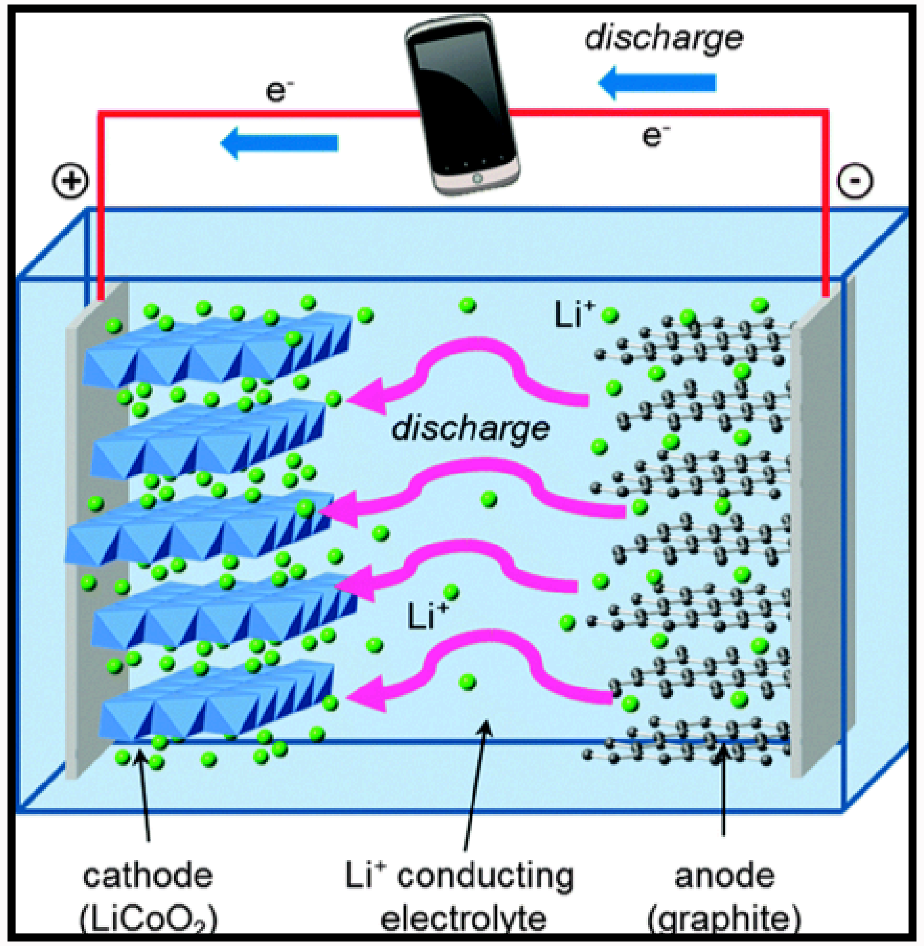
CHEMICAL CORE CASE STUDY

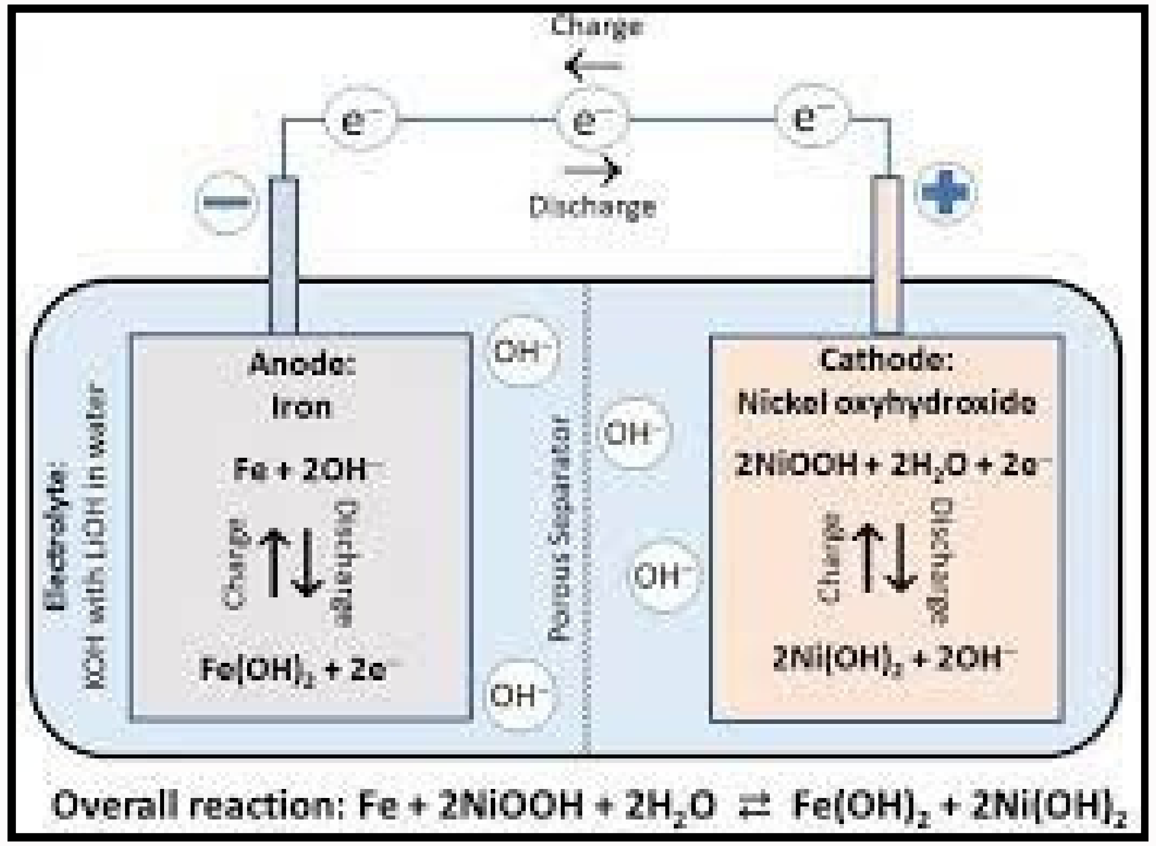
AJANTA

Advancing Electric Vehicle Battery Technologies: Transitioning to Nickel-Rich Cathodes and Exploring the Potential of Solid-State Batteries

- **ARUNIMA BHATNAGAR**
- **HASIKA PENNA**
- **BHAVYA SINGH**
- **ABHISHEK CHAUHAN**

Lithium ion battery and Ni rich battery





Composition:

- **Cathode** (Positive Electrode): Lithium cobalt oxide (LiCoO2)
- **Anode** (Negative Electrode): Typically made of graphite
- **Electrolyte**: Lithium salt in a solvent

Composition:

- **Cathode** (Positive Electrode): Nickel-rich material, often a combination of nickel, manganese, and cobalt (NMC or NCA).
- **Anode** (Negative Electrode): Typically made of graphite.
- **Electrolyte**: Lithium salt in a solvent.

- **Ni-rich batteries** represent a significant advancement in lithium-ion battery technology, addressing the growing demand for **high-energy-density** solutions in **electric transportation** and renewable energy sectors.
- Ongoing research aims to improve **safety**, **increase energy density**, and enhance the overall **performance** of lithium cobalt oxide batteries.

THE SHIFT

Higher Energy Density

- Ni-rich batteries can store more energy in the same physical space or weight.
- Critical for weight-sensitive applications like EVs and aerospace.

Cost Reduction

- Nickel-rich cathodes are generally less expensive than cobalt-based cathodes

Thermal Stability

- Ni batteries reduce thermal risks, minimizing overheating and fires..
- Ni batteries ensure safer rapid charging in high-performance applications like electric vehicles.

Supply Chain Diversification

- Cobalt, crucial in Li-ion batteries, faces price volatility due to scarcity and geopolitical factors.
- Ni-rich cathodes diversify the supply chain, boosting stability in battery production.

Performance

- Nickel-rich cathodes meet the growing demand for high-performance batteries, especially in electric vehicles

Sustainability

- Diverse supply chain, abundant nickel, ensures battery industry sustainability, fostering growth.
- Ni-rich cathodes reduce cobalt, making batteries eco-friendly, addressing mining impacts, and promoting responsible sourcing.

Solid State Batteries

As it sounds, **Solid State Batteries** are batteries that use **solid electrolytes (lithium phosphorous sulfide) and solid electrodes** instead of liquid or polymer gel as found in lithium-ion or lithium polymer batteries.

It has principles similar to that of a traditional battery but with a solid electrolyte component that facilitates the movement of ions between positive and negative electrodes.

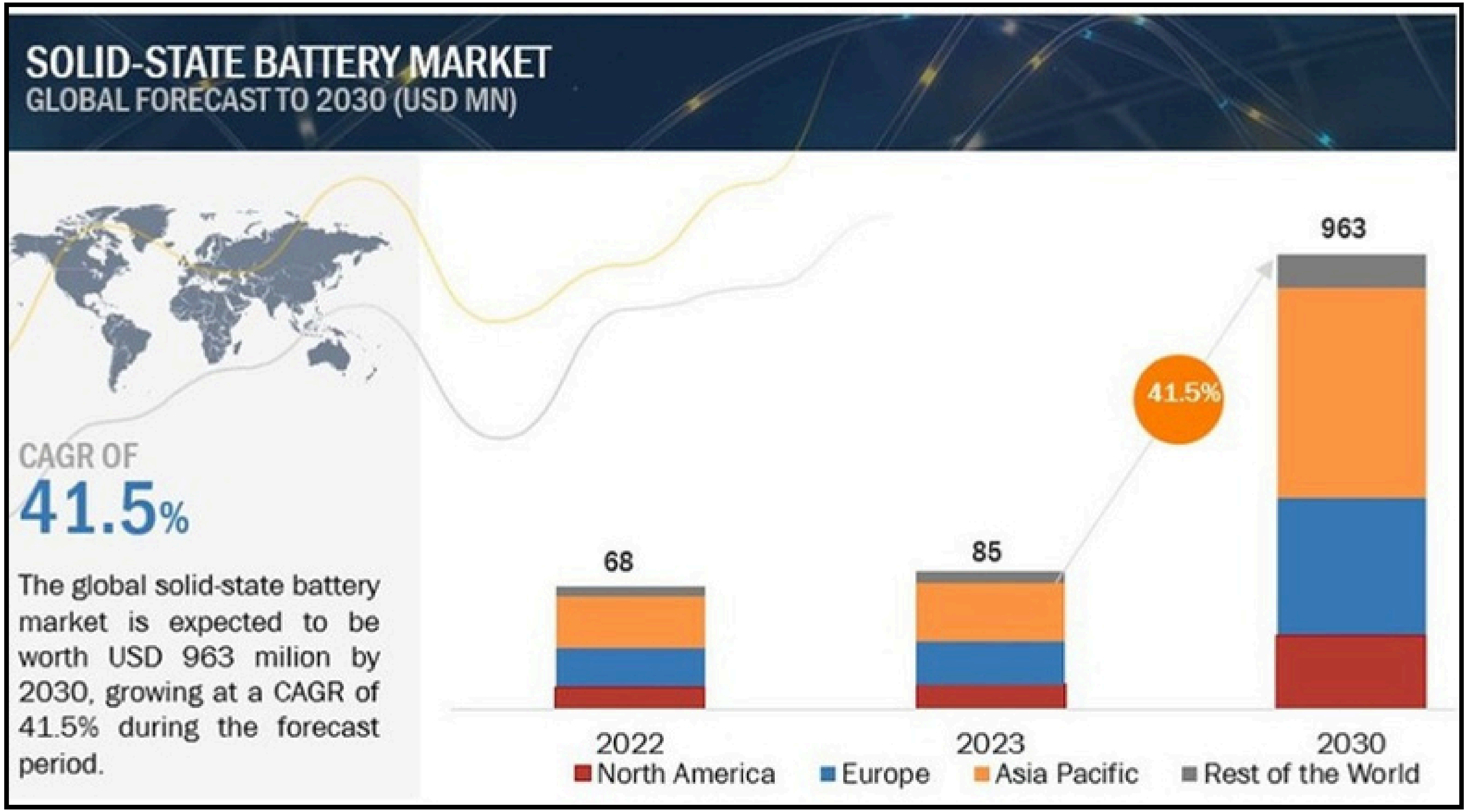
Technology of the future

Solid State batteries have in the recent years stolen the spotlight from traditional batteries. With an expected **CAGR** of **41.5%** till 2030, it is expected to take over the EV market.

Why Solid State Batteries

- Improved Safety
- Higher Energy Density
- Longer lifespan
- Elimination of Cobalt
- Faster Charging of EVs
- Lower Carbon Footprint

Solid-State Battery Market



Driving Demand for Solid State batteries is lead by the following factors

- Demand for Miniaturized and compact electric components
- Increasing research and development
- Rising demand for alternate technology to be used in the EV industry

The growth of this market can be attributed to the increasing investments in the development of solid-state batteries and partnerships between technology providers.

Electric vehicles and consumer electronics applications are expected to grow at impressive growth rates during the forecast period.

Agreements and partnerships would offer lucrative opportunities for market players in the next five years.

The market growth in Asia Pacific is attributed to the huge presence of key consumer electronics, automotive, and battery manufacturers in the region.

Impact of solid state batteries on EVs

INCREASED ENERGY DENSITY:

Solid-state batteries have the potential to offer higher energy density.They can store more energy in the same or smaller space, providing electric vehicles with longer driving ranges on a single charge.

1

IMPROVED SAFETY:

2

Its design reduces the risk of leakage, overheating, and fire, enhancing the safety of electric vehicles. Improved safety is a crucial factor in promoting widespread adoption of EVs.

FASTER CHARGING:

Solid state batteries allow quicker charging without compromising the overall lifespan of the battery as they offer less resistance and heat generation while charging.

3

TEMPERATURE STABILITY:

4

Solid-state batteries are expected to be more stable across a wider range of temperatures. Thus, the use of this battery will make EVs more reliable in adverse environmental conditions.

Despite the potential benefits, for the solid state batteries to be used in commercial sector it’s important to curb challenges which include issues related to manufacturing scalability, cost-effectiveness, and ensuring consistent performance over an extended period. Ongoing research and development efforts are aimed at addressing these challenges and bringing solid-state battery technology closer to widespread adoption in the electric vehicle industry.

Challenges and Obstacles in Advancing Solid-State Batteries

PROBLEMS

Cost:

Solid-state batteries often involve the use of more expensive materials and manufacturing processes compared to traditional lithium-ion batteries. Reducing the cost of production is crucial for making solid-state batteries economically competitive.

Manufacturing complexity:

The production of solid-state batteries is more complex and requires specialized manufacturing techniques. Developing scalable and cost-effective manufacturing processes is essential for large-scale adoption.

Cycling stability:

Ensuring the long-term stability of solid-state batteries through numerous charge-discharge cycles is a critical concern. Addressing issues related to cycling stability is essential for the durability and lifespan of these batteries.

Temperature sensitivity:

Some solid electrolytes are sensitive to temperature changes, affecting their conductivity. Developing solid-state batteries that can operate efficiently across a wide temperature range, especially in extreme conditions, is crucial for various applications

SOLUTIONS

Governments and industry stakeholders can incentivize the development and adoption of solid-state batteries through financial support, grants, and tax breaks, gradually reducing the cost gap.

Invest in research and development to streamline production processes, optimize material usage, and implement automation to reduce costs.

Conduct long-term testing and invest in materials research to identify components with superior durability, and implement effective battery management systems to minimize degradation.

Invest in thermal management technologies and research to improve solid-state battery performance across a wide range of temperatures, making them more versatile

Key strategies for enhancing Supply Chain for Critical Chemicals in Solid-State Battery Production.

01

Supply Chain Transparency:
Establish transparency in the supply chain by collaborating with suppliers to share information on inventory levels, production schedules, and potential challenges, facilitating proactive decision-making.

02

Strategic Stockpiling:
Maintain strategic stockpiles of essential chemicals to act as a buffer during supply chain disruptions, ensuring continuity of production even in challenging situations.

03

Advanced Forecasting and Planning:
Utilize advanced forecasting tools and technologies to predict demand accurately, allowing for proactive planning and reducing the risk of shortages or excess inventory.

04

Supplier Relationship Management:
Foster strong relationships with key suppliers, promoting open communication, and collaboration. Regularly assess their capabilities and resilience to ensure a robust supply chain.

05

Supply Chain Technology Integration:
Leverage technology solutions, such as blockchain and real-time tracking, to enhance visibility and traceability in the supply chain, enabling swift responses to disruptions.

Integrating Solid-State Batteries into Existing EV Infrastructure

COMPATIBILITY OF SSBS WITH EXISTING EVS

01. Ssb often have different form factors and sizes compared to traditional lithium-ion batteries, requiring modifications to accommodate them within existing electric vehicle (EV) designs.

02. . Voltage and Power Output:* Ensuring compatibility with existing EV systems, including voltage and power output requirements, is crucial for the seamless integration of solid-state batteries.

03. Solid-state batteries may have different thermal characteristics, necessitating adjustments to the vehicle's thermal management system to maintain optimal operating conditions.

INNOVATIVE MECHANISMS

Universal Battery Standards:

Establish industry-wide standards for solid-state batteries to promote uniformity and compatibility, facilitating their integration across various EV models.

Collaboration with Charging Infrastructure Providers:

Work closely with charging infrastructure providers to ensure that charging stations are equipped to handle the unique charging characteristics of solid-state batteries, including higher charging rates.

Thank You