ULTRAFAST CHARGING, LONG LIFE AND COST-EFFECTIVE LITHIUM-ION BATTERIES FOR STATIONARY ENERGY STORAGE

PROJECT SUMMARY

The development of safe and durable energy storage solutions is crucial for large scale penetration of photovoltaic (PV) and successful micro-grid operation. Significant improvements can be made over currently available battery technologies to target the specific needs for Singapore's stationary energy storage applications and adopting greater resilience to Singapore's unique climate.

This project aims to:

- Deliver ultrafast charging, long cycle life and cost-effective lithium-ion batteries (LIBs) for stationary energy storage for PV and micro-grid applications;
- Improve safety of current state-of-the-art lithium-ion batteries; and
- Develop the portfolio of the industrial partner's products.

Specifically, this will be achieved using the PI's proven and patent-protected Ti-based based anode material which will be developed at semi-industrial scale to demonstrate the large-scale production ability and commercial viability. Where necessary, next generation commercially viable cathode materials will be paired with Ti-based anode, ensuring optimum performance delivery.

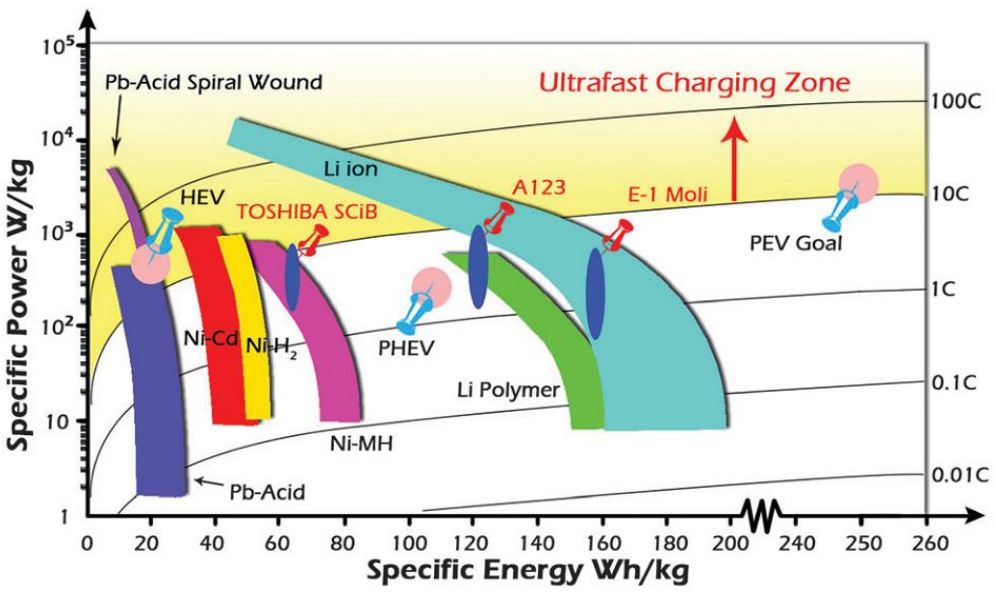

Figure 1. Next-generation ultrafast charging LIBs are highly desirable to meet the future demands for PV and micro-grid applications.

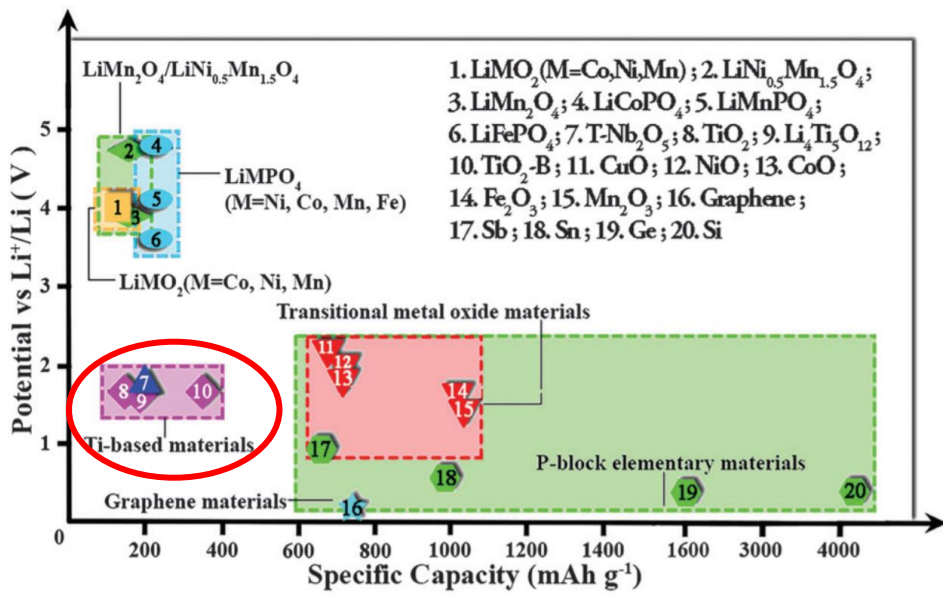

Figure 2. Ti-based anode materials with high intercalation voltage and fast ion diffusion kinetics can be considered as a promising candidate to achieve safe and ultrafast charging LIBs.

PROJECT OUTCOMES

3 key outcomes of the project

1. **Materials development and optimisation of its performance**
   - Developed a metal oxide-based battery using a patented titanium-dioxide (TiO_2) nanotube as the anode and lithium nickel manganese cobalt (NMC) as the cathode.
   - Kilogram-scale production of fast-charging Ti-based materials can be achieved. ~20kg materials have been produced and adapted in this project.
   - Achieved over 45% reduction in anode material cost (exceeding target of 30%) by using TiO_2 (S$1.32/Ah) compared to conventional fast-charging material ($Li_4Ti_5O_{12}$) (~S$2.48/Ah). This would lower the cost of mass-production of anode material from S$273/kg to S$210/kg.

2. **Battery prototype development and evaluation**
   - The fabricated single battery prototype (~15 Ah) achieved a power and energy density of 1,100W/kg and 74Wh/kg respectively (exceeding target of 800W/kg and 65Wh/kg).
   - Identified potential solution such as development of specific electrolyte to address the gassing issue arising from continuous cycling to improve long-term stability.

3. **Battery test-bedding at Durapower's factory**
   - The battery module based on Ti-based anodes was fabricated by a 12S1P configuration. To modulate the power supply under elevator emergency, battery module at current rate of 1C-3C and 5C pulse was tested and demonstrated.

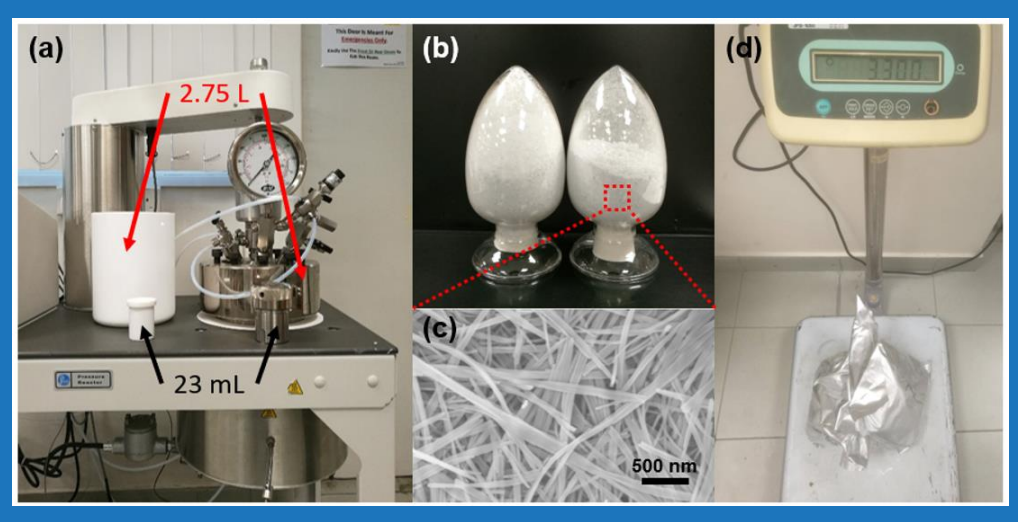

Figure 3. The production is increased from 0.1 g/batch to 0.5 kg/batch.

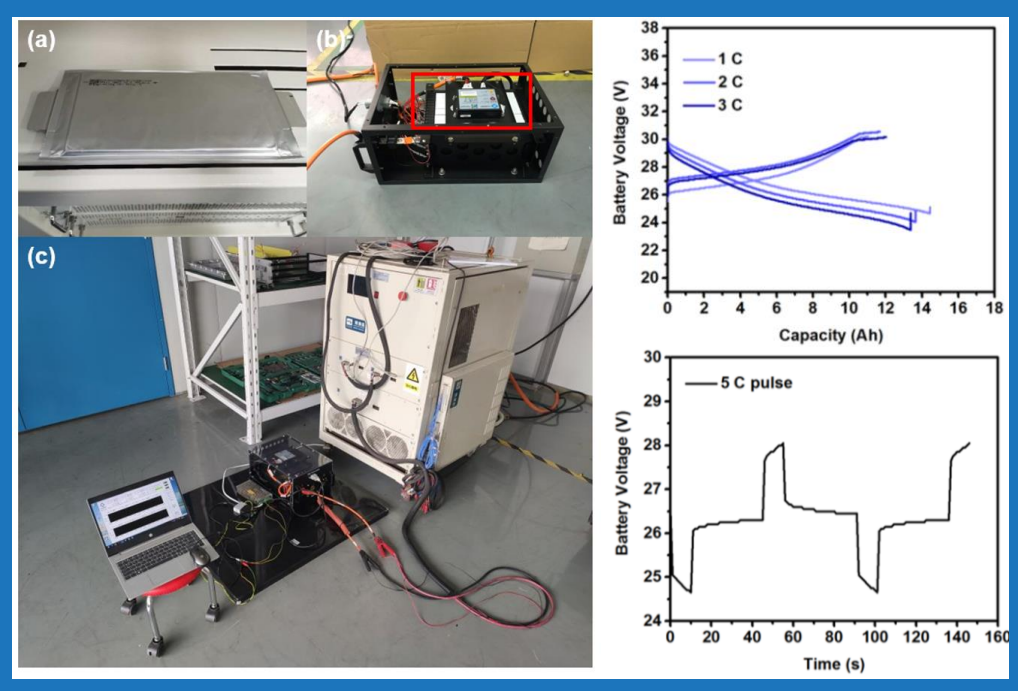

Figure 4. The single battery and battery module with 12S1P configuration were successfully fabricated (Figure a and b). The 1C-3C discharge/charge and 5C pulse has been tested.

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