DEVELOPMENT OF SODIUM-ION BATTERY PACK FOR STATIONARY STORAGE SYSTEMS

PROJECT SUMMARY

- Project aimed at developing innovative stationary storage systems (100-1000 kWh) to address intermittency of micro-grids using solar energy.
- Na-ion battery was identified in view of several advantages as compared to state-of-the-art Li-ion battery storage system.
- Prior to fabricating such medium sized battery packs (100-1000 kWh) to address micro-grid challenges, we proposed in this programme to develop small size Na-ion battery packs.
- Project also aimed to demonstrate high rate performance (5C, 12 min discharge), long cycle life and high safety of Na-ion cells.

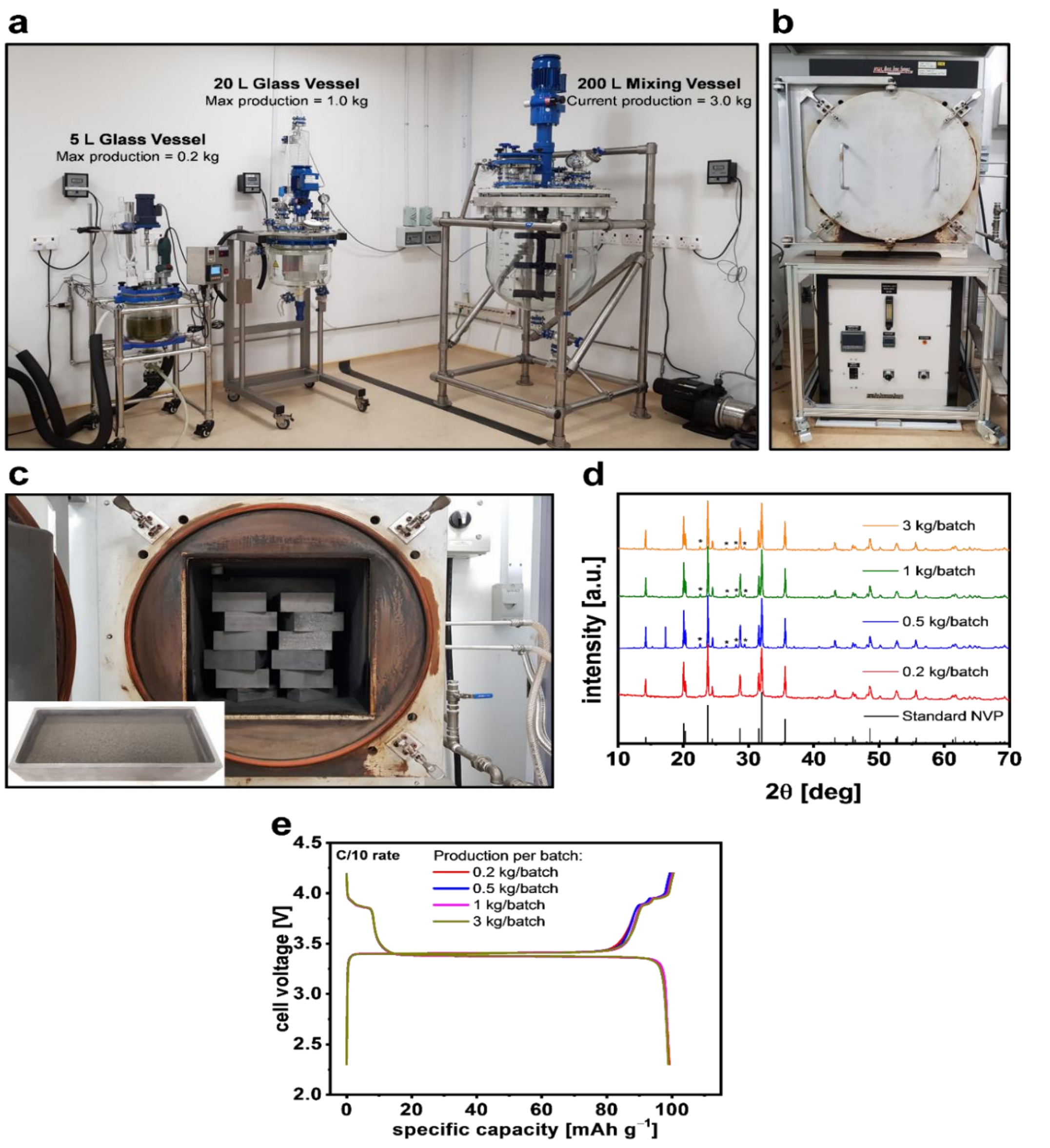

Fig 1. (a) 5L, 20L and 200L reactors for kilo-scale cathode material production @ 3-4kg/batch; (b, c) Retort furnace for calcination at inert atmosphere; (d) X-ray diffraction patterns confirming predominantly pure-phase formation and (e) reproducible storage performances shown upon scale-up production.

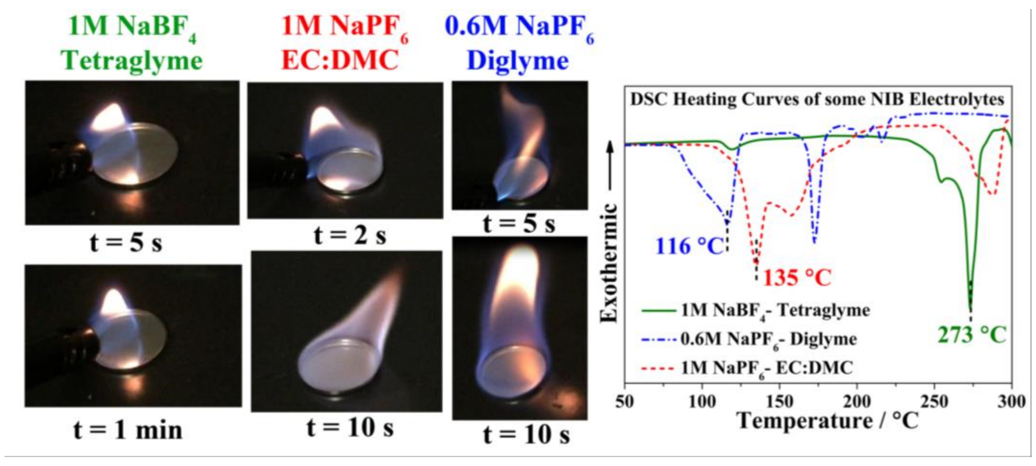

Fig 2. Glyme-based electrolyte introduced for Na-ion cells: Non-flammable (left) and high thermal stability (right) compared to conventionally used carbonate-based electrolyte by other competing teams.

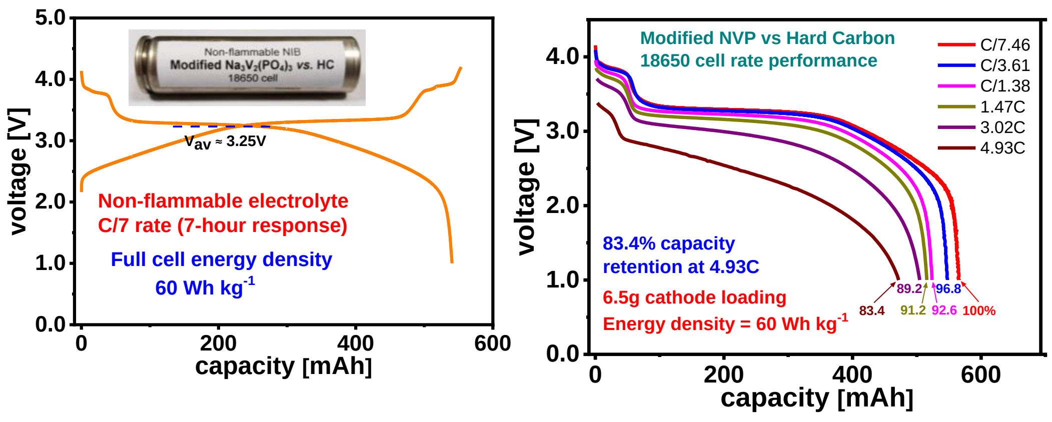

Fig 3. Zn-doped $Na_3V_2(PO_4)_3$ cathode vs hard carbon anode showing energy density of 60Wh/kg in 18650 format (6Ah cell shows 80Wh/kg in pouch cell format). Fast discharge at ~5C (about 12 min) retains 83.4% capacity

PROJECT OUTCOMES

- Set-up kilo-scale lab facility for mass production of electrode materials (3-4 kg/batch) – a unique facility in Singapore for translational battery research.
- Introduced a novel tetraglyme-based electrolyte for Na-ion battery with following characteristics:
  - (i) non-flammable
  - (ii) high thermal stability
  - (iii) non-dendrite sodium plating.

  - favoring higher safety than conventionally used carbonate-based electrolyte.
- Compared to pristine Na3V2(PO4)3 vs hard carbon, Zn-doped Na3V2(PO4)3 vs hard carbon Na-ion cells show:
  - (i) higher storage capacity
  - (ii) higher rate performance
  - (iii) lower internal resistances
  - (iv) lower heat generation.

  - improved storage performances.
- Achieved following performance matrices in Zn-doped Na3V2(PO4)3 vs hard carbon 18650 (metal can) Na-ion cells:
  - (i) energy density of 60Wh/kg (~80Wh/kg in pouch cells)
  - (ii) 83.4% capacity retention at 5C (12 min) during discharge
  - (iii) long cycle life, 1000 cycles retaining 78% capacity.

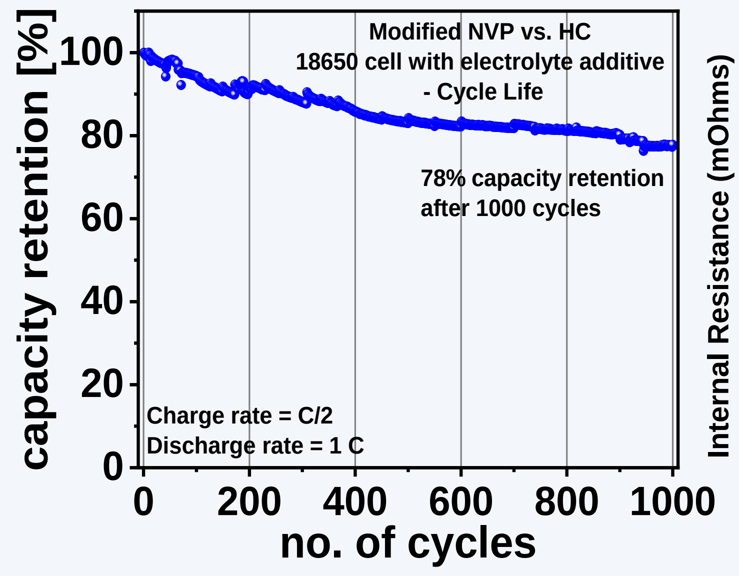

Fig 4. Long cycle life performance of Na-ion cells – retaining 78% capacity after 1000 cycles.

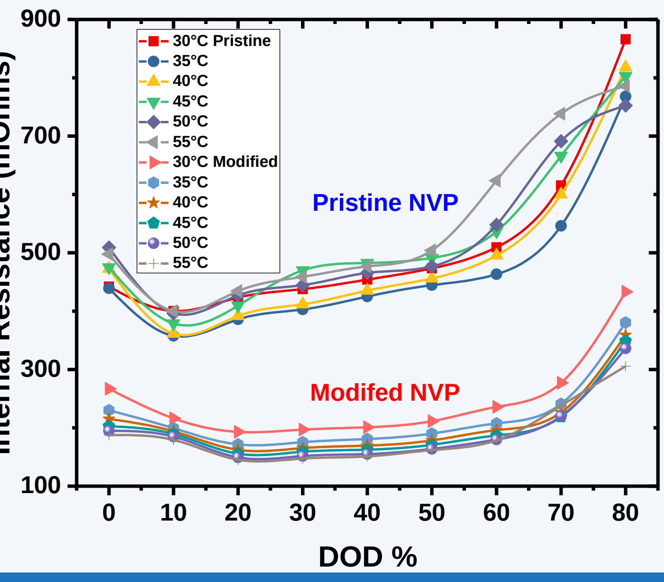

Fig 5. Zn-doped Na3V2(PO4)3 vs hard carbon 18650 Na-ion cell shows lower internal resistance.

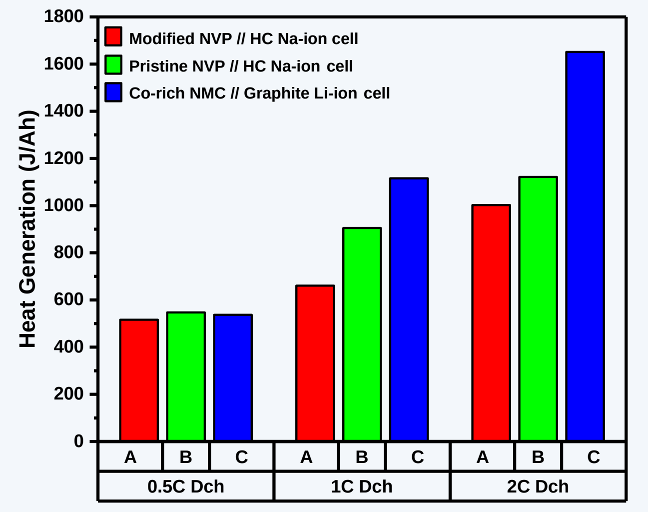

Fig 6. Zn-doped Na3V2(PO4)3 vs hard carbon 18650 Na-ion cell generates lower heat compared to pristine Na3V2(PO4)3 vs hard carbon cell.

Next steps for this project

- Aims to demonstrate deployment of Na-ion battery technology in various applications, (E-Bike, 100-200Wh; E-Scotter, 1-2 kWh).
- Test Na-ion cells at high shock/vibration conditions to suit specialty applications such as PMD and lift systems in HDB/Commercial buildings.
- Demonstration of performance of ESS using Na-ion battery technology @ 0.5-3MWh capacity in 3-5 years.

PRINCIPAL INVESTIGATOR

Palani Balaya, *Associate Professor*

CO-INVESTIGATOR

Lu Li, *Professor*

NUS National University of Singapore

PARTNERS

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