A 10 A-hr Prototype Lithium-Ion Battery System for Electric/Hybrid Vehicle Applications

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In this work a prototype testing results of Li-ion battery system that utilizes a novel thermal management system using PCM is presented [1-3]. The prototype capacity is ~10 A-hr with a 14.8 V nominal voltage and comprises of 20 18650 Li-ion cells incorporating the thermal management system and IC safety boards that consist of over voltage and overcharge/discharge protection circuit.

Tests were first carried out to verify the manufacturer claims for the individual Samsung 18650 and LG 18650 cells and the following results were obtained:

T: temperature in °C, C: capacity in A-hr

I Rate	C (charge) A-hr		C (discharge) A-hr	
	Sg	LG	Sg	LG
C/1	1.68	1.44	1.68	1.31
C/3	1.81	1.92	1.81	1.90
C/6	N/A	1.9	N/A	1.95

I Rate	ΔT (charge) °C		ΔT (discharge) °C	
	Sg	LG	Sg	LG
C/1	3.2	2.0	23.1	16.6
C/3	1.2	1.0	7	7.3
C/6	N/A	0.2	N/A	3.6

The prototype was designed for a Zappy scooter from zapworld that uses lead acid battery as its power source. Tests were carried out on both the lead acid battery and the Li-ion battery on a bench-scale and compared with the lead acid battery specifications.

A brief comparative analysis of the battery block with respect to the lead acid battery used in the present scooters, from the customer's perspective, as follows:

Lead Acid Battery	Li-ion battery
Requires 8 hours of charging time.	Requires 2 hrs of charging time.
Claims up to 13 mph speed for a scooter.	Offers 17 mph speed for the same scooter.
Weight: approx. 6.1 Kgs	Weight: approx. 1.45 Kgs
2 years of lifetime.	4 years of lifetime.
Maintenance required.	No maintenance.
Driving Range: 8 miles	Driving Range: 10 miles

The criteria for the selection off the PCM material were set as follows:

- Melting point at practical range of operation
- High latent heat & heat of fusion
- Thermal conductivity
- Minimum super cooling
- Non toxic & non corrosive

Tests for thermal behavior were then conducted for charge/discharge cycles with Samsung 18650 and the results showed that at 1C discharge rate the system ΔT was around 13°C. The output graph of temperature (in °C) against time (in seconds) for four charge/discharge cycles is given in Figure 1.

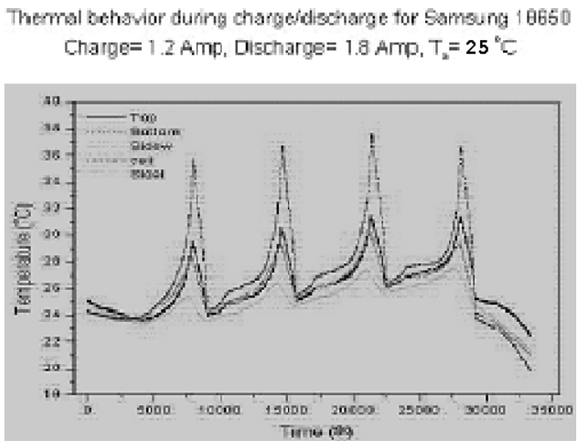

Figure1

More testing is underway. So far promising results have been obtained. The proposed thermal management system has proved to be much more efficient than expected. Computer simulation results of the battery prototype will be also presented and compared to test results.

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References

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