Lithium-ion battery energy storage safety 90 kWh

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C.Y.W., T.L., B.D.M. and E.S.R. wrote the manuscript. S.G. designed and built the cells. T.L. and X.G.Y. designed the experiments. T.L. built the test stand and carried out the experiments. Y.L. optimized electrolytes in coin cells. C.Y.W., N.V.S. and B.D.M. designed and performed 3D numerical simulations. All authors contributed to development of the manuscript and to discussions as the project developed.

a, LiB with an embedded nickel foil for internal heating. Before each charging, current goes through the internal heating structure and heats up the cell to 65 ?C in less than one minute. After reaching the target temperature, the charging channel starts to take in energy and maintains thermal balance throughout the charging process. b, Cell and heating-foil temperatures versus heating time. A heating rate of 0.75 ?C s-1 was achieved when applying 3.3 V on the heating channel.

a, b, Lithium plating detection with voltage relaxation method for 4.2 mAh cm-2 LiBs and 3.4 mAh cm-2 LiBs. c, d, Coulombic efficiency during cycling. e, f, Change of resistance attained by EIS tests. Baseline electrolyte was used in these tests.

a, Experimental and simulated voltage profiles for baseline cells. b, Simulated lithium deposition potential for baseline cells. c, Experimental and simulated voltage profiles for cells with dual-salt electrolyte. d, Simulated lithium deposition potential for cells with dual-salt electrolyte.

a, Lithium plating detection with voltage relaxation method for 3.4 mAh cm-2 LiBs with enhanced ion transport. b, Coulombic efficiency during cycling. c, Change of resistance attained by EIS tests.

Effects during C/3 discharge on 4C charge - C/3 discharge cycling under otherwise the cooling condition of 140 W per m2K, indicative of dramatic shortening in time for the battery to cool down to below 40 ?C. Note that a heat transfer coefficient of 300 W per m2K is still attainable by strong aspirated air convection. a, Cell temperature curves. b, Cell voltage curves. c, Spatial temperature nonuniformity, Tmax - Tmin, as a function of time.

a, Typical shape and interpretation for cell impedance in the complex plane. b, Equivalent circuit and the mathematical expression to fit the experimental results. c, EIS results and fitting curve for baseline cell under ATM cycling with 3C charging to 80% SOC. d, EIS results and fitting curve for cell with enhanced ion-transport under ATM cycling with 4C charging to 70% SOC. e, EIS results and fitting curve for cell with enhanced ion-transport under ATM cycling with 4C charging to 75% SOC.