Mechanical-ECT Coupling Approach

In FY18, we implemented the above computational scheme using:  
• High-fidelity battery level data as input to module level simulations, the approach provides alternatives to developing time-consuming material models, if the user chooses to do so.
• Mechanical response at abuse-temperatures
  • All composite level test data available that is only obtained at high-temperature effects.
  • For the first time, in FY18, we collected stress-strain data at temperatures as high as 120°C, making the constitutive models relevant to simulate 
  • in-service conditions.

High-Speed Digital Image Correlation Data

In addition to the 10 stress-strain curves, high speed digital image correlation data (obtained at 20000 fps) showing complex fracture evolution patterns at high strain-rates was also collected.  
• We are pursuing Approach 1 of the multi-cell validation of the MECT models for this complex data set as a very challenging task.

Mechanical Response at Abuse-Temperatures

If for this dataset, the mechanical response was dominated by the properties of the prismatic cell case.  
• The temperature response was controlled very well during the propagation simulations – thermal aspects of the cells contributed to the mitigation strategy.  
• These models do not capture failure of the separator and anode material on the cathode side; therefore, the experimental data was not used at this time.  
• Coupling ECT simulations currently being implemented using the above approach and Multi-cell simulations outlined above.

Other Validation Studies Underway

• GSP module tested in earlier phase
• Experimental data already available  
• Multi-cell level module mechanical-temperature simulations were completed under CAEBAT
• Coupling with ECT simulations currently being implemented using the above approach and Multi-cell simulations outlined above.

MILESTONES

FUTURE WORK

• In FY19, the team will complete validation studies for multi-cell case data.  
• We plan on making a database of mechanical response for cell components at various strain-rates and temperatures available.  
• To the best of our knowledge, the high strain-rate data and high-temperature data presented in here is the most comprehensive characterization of mechanical properties of battery electrodes.  
• We are planning a few more publications to include results from complex loading, high strain-rate tests.  
• Beyond 2020, with decommissioning of CAEBAT underway, we are working to disseminate the CAEBAT database into various focused material programs initiated by the DOE.

SUMMARY

• Beyond 2020, with decommissioning of CAEBAT underway, we are working to disseminate the CAEBAT database into various focused material programs initiated by the DOE.

• These models do not capture fracture of complex loading, high strain-rate results.

TECHNICAL ACCOMPLISHMENTS

Sample Results - Blunt-rod Test Simulations

• 4S5P modules tested in earlier phase
• Experimental data already available  
• Multi-cell level module mechanical-temperature simulations were completed under CAEBAT
• Coupling with ECT simulations currently being implemented using the above approach and Multi-cell simulations outlined above.

MULTI-CELL VALIDATION CASE STUDIES

• Four different sets of experimental data are currently being used towards multi-cell validation of the MECT models.

EPILOGUE

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