High Temperature Film Capacitors

SAND2007-6950C

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Team members:

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Project Duration: FY__ to FY08

DOE FreedomCAR and Vehicle Technologies Program
Advanced Power Electronics and
Electric Machines Projects
FY08 Kickoff Meeting

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Knoxville, Tennessee

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This presentation does not contain any proprietary or confidential information

The Problem

- **The DC bus capacitors are currently the largest and the least reliable component of fuel cell and electric hybrid vehicle inverters. Capacitors represent up to 23% of both inverter weight and inverter cost and up to 35-40% of the inverter volume. In addition current thin polymer film capacitors have a ceiling operation temperature (105 °C)**

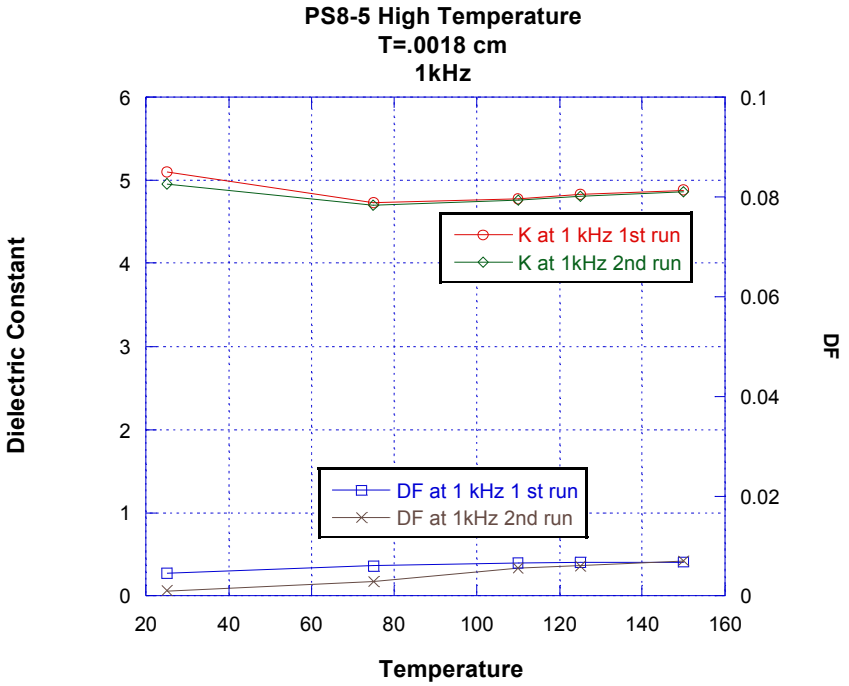
Description of Technology

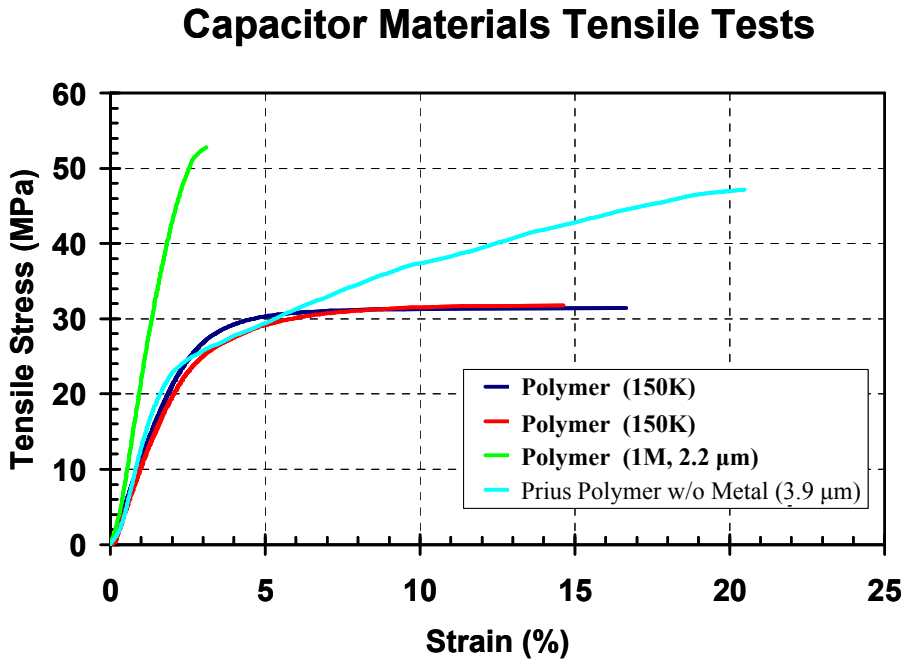
- **Our objective is to develop and engineer novel polymeric material systems for use as next generation polymer dielectric materials that can be used as a replacement technology for DC bus capacitors in hybrid electric vehicles (HEV) and fuel cell vehicles.**

Uniqueness of Project and Impacts

- Developed a polymer film with k = 5 and DF < 0.01 over a temperature range from RT to 150 °C. We have demonstrated the fabrication of large (8.5” x 11”) sheets of 2 um thick polymer film.
- Capacitors generated using the Sandia developed material will be ½ to ¼ of the size of the current capacitors used in a HEV inverter. The new capacitors will have a larger operational temperature range (150 °C)
- A Technical Advance has been filed and a Patent Application will be filed.

Accomplishments to Date
(for projects funded in prior FYs)





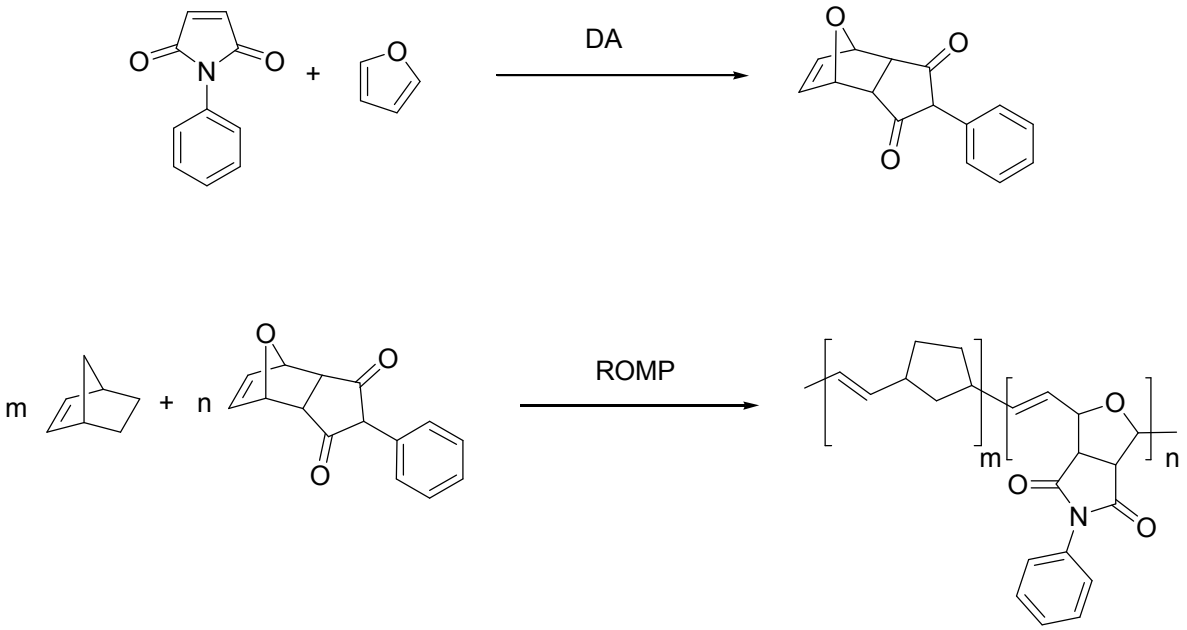
- Electrical characterization of a free standing Sandia developed polymer from room temperature to 150°C
- Mechanical characterization of a free standing Sandia developed polymer compared to the Toyota Prius® dielectric material
- Demonstrated lab scale production of polymer films (8.5” x 11”) using solution casting drawdown techniques

Project Objective for FY08

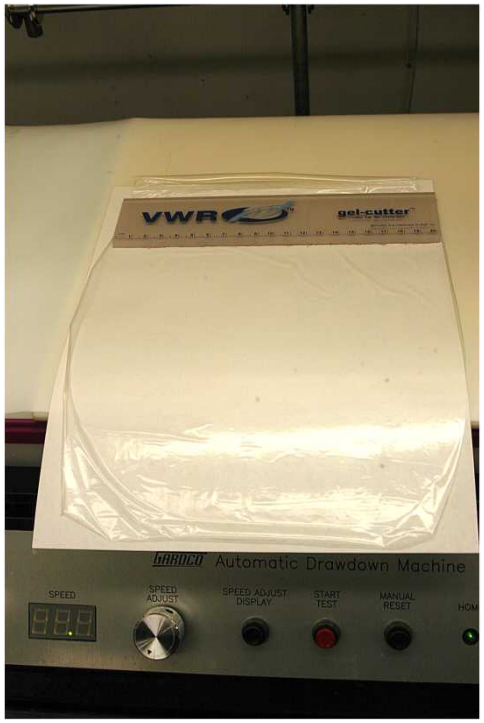
- Optimize the polymer film stoichiometry for the polymer developed in FY07 by modifying copolymer amounts. These polymer films will be evaluated electrically and mechanically to quantify both properties.
- Begin working with a commercial capacitor manufacturer to transition technology to industry and produce capacitors
- Write close-out report

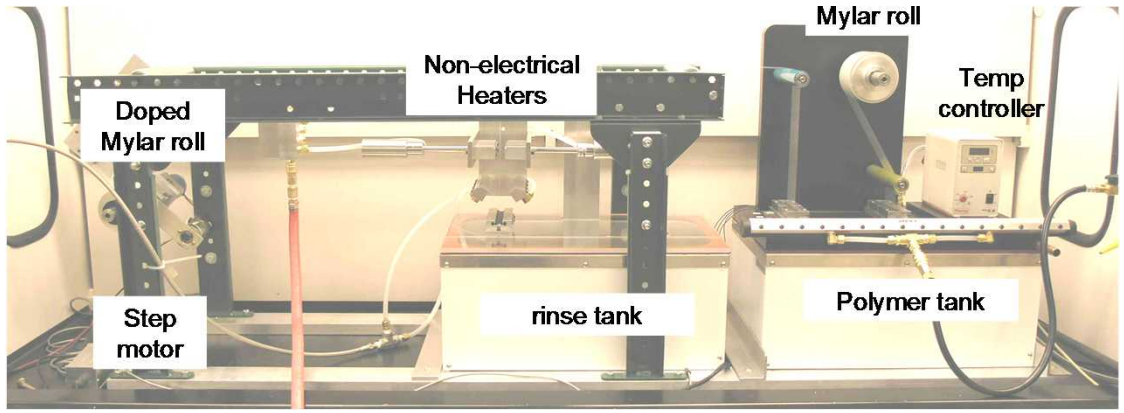
Technical Approach for FY08

- **Optimize the stoichiometry by modifying the m to n ratio in order to obtain the lowest cost, highest k, lowest DF while still maintaining desirable materials properties**



Technical Approach for FY08

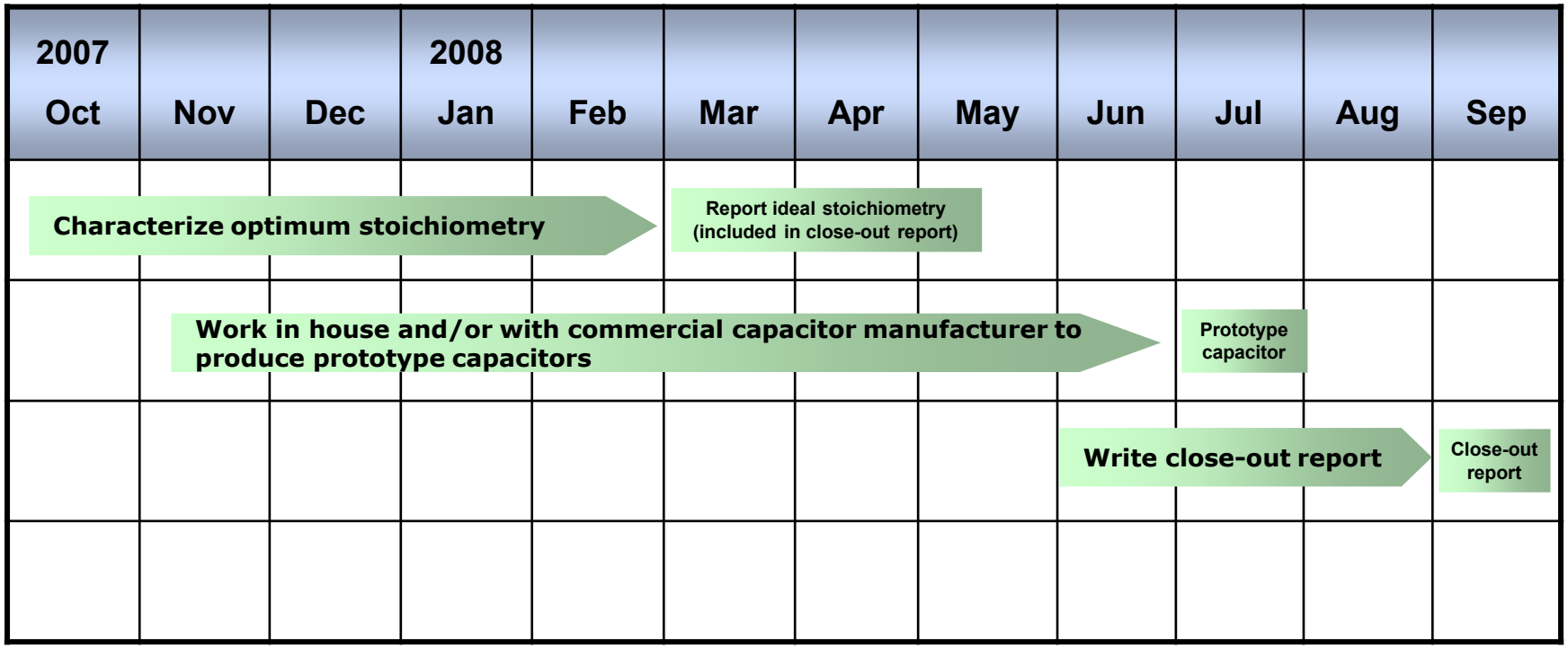




* In house pilot plant capacitor fabrication facility. Designed and built by Joseph Lenhart, Lothar Bieg, John Schroeder, Don Green (SNL); Scott Burmeister (Burmeister Inc.), Phillip Cole

- **Begin working in house and/or with a commercial capacitor manufacturer to demonstrate and characterize capacitors made with the Sandia developed Material**

Timeline


2007
Oct
Nov
Dec
2008
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Characterize optimum stoichiometry
Report ideal stoichiometry (included in close-out report)
Work in house and/or with commercial capacitor manufacturer to produce prototype capacitors
Prototype capacitor
Write close-out report
Close-out report

The Challenges/Barriers

- Selecting the correct industrial partner to move forward with
  - Each company has different expertise and skills
- An outside synthesis house may be required to generate the Sandia developed polymer depending on the polymer quantity needed to produce prototype capacitors need to scale up of polymer will require

Beyond FY08 (if decided)

- FY09
  - Fabricate prototype capacitors with next generation polymer formulations, commercialization of current polymer formulation based capacitors
- FY10
  - commercialization of next generation polymer formulation based capacitors

Questions