



Project Accomplishment Summary

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PROJECT ACCOMPLISHMENTS SUMMARY

Cooperative Research and Development Agreement (#1609.04)

between Sandia National Labs and General Electric

Note: This Project Accomplishments Summary will serve to meet the requirements for a final abstract and final report as specified in Article XI of the CRADA.

Title: Design & Reliability Optimization of a MEMS Micro-hotplate for Combustion of Gaseous Fuel

Final Abstract:

This report will detail the process by which the silicon carbide (SiC) microhotplate devices, manufactured by GE, were imaged using IR microscopy equipment available at Sandia. The images taken were used as inputs to a finite element modeling (FEM) process using the ANSYS software package. The primary goal of this effort was to determine a method to measure the temperature of the microhotplate. Prior attempts to monitor the device's temperature by measuring its resistance had proven to be unreliable due to the non-linearity of the doped SiC's resistance with temperature. As a result of this thermal modeling and IR imaging, a number of design recommendations were made to facilitate this temperature measurement

Background:

The lower heating value (LHV) of gaseous fuels can be measured with a catalyst-coated microhotplate calorimeter. GE created a silicon carbide (SiC) based microhotplate to address high-temperature survivability requirements for the application. The microhotplate devices delivered to Sandia National Laboratories consisted of several diced die measuring approximately 1/4" x 1/8". The devices consisted of non conductive SiC membranes that had been suspended from frames of single crystal silicon. The devices had two different suspended membrane sizes- 1 mm and 2 mm square. Doped SiC had been deposited and patterned over the membranes to provide electrically conductive traces in a variety of different patterns. Finally, gold was deposited over these traces to provide contact pads and reduce the device's resistance.

Description:

The primary goal of this effort was to determine a method to measure the temperature of the microhotplate. Prior attempts to monitor the device's temperature by measuring its resistance had proven to be unreliable due to the non-linearity of the doped SiC's resistance with temperature. In this work, thermal modeling and IR imaging were utilized to determine the operation temperature as a function of parameters such as operation voltage and device sheet resistance. A number of design recommendations were made according to this work.

Benefits to the Department of Energy:

This work directly addressed energy production efficiency and emissions control. Real-time measurements of LHV according to this research can be used to increase energy production efficiency and reduce emissions.

Economic Impact:

A 5% increase in marginal capacity of natural gas turbines translates to \$1.1B annual savings in energy production. The underlying LHV technology optimized herein allows the marginal capacity to be increased by allowing real-time adjustments to turbine and reciprocating engine operational parameters.

Project Status:

Completed

ADDITIONAL INFORMATION

Laboratory/Department of Energy Facility Point of Contact for Information on Project

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Company Size and Points of Contact

General Electric falls into the large company category.

Points of Contact:

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CRADA Intellectual Property

US2007089485 and JPN2007101528 (A) Lower Heating Value Sensor

Technology Commercialization

The reliability of the measurement was lower than expected due to the silicon carbide platform and changes in flow rate with heating value. Also, the expected market size ultimately did not suit GE's interests. This means that the LHV sensor in its present form will not be commercialized by GE. Future work on non-SiC platforms, and the addition of micro gas chromatography equipment would resurrect the commercialization effort.

Project Examples

Hardware, test data and reports were created in this project that could be used as tangible evidence of progress.

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This summary has been approved for public release by Sandia and General Electric

Sandia National Laboratories

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Sandia National Laboratories

By DW Payne 7/29/2011
Manager
WFO/CRADA Agreements

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General Electric

By Jill W. Kastner 8/19/2011
Title: Technology Leader

Date

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In order to expedite the process, if we do not receive your signed reply by 09/09/2011
we will assume your concurrence for the release of this document to the public.