

WIRELESS MICROWAVE ACOUSTIC SENSOR SYSTEM FOR CONDITION MONITORING IN POWER PLANT ENVIRONMENTS

Project DE-FE0007379TDD

DOE / NETL Program:

*Advanced Fossil Energy Research: Novel Developments In Sensors And Controls
For Fossil Energy Power Generation And Fuel Production Technologies*

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NETL, Morgantown, WV, March 14, 2012.

OUTLINE

1. Project Background

- Technology & Applications
- Achievements under other projects
- UMaine & Environetix

2. Current Project

- Monitoring Power Plant Environments
- Tasks, Timeline & Milestones
- Participants

3. Summary Statement

1. Project Background

Technology & Applications

Harsh Environment Applications

➤ New **High Temperature** Sensor Applications **up to 1300°C / 2400°F)**

- ✓ Power plants
- ✓ Energy generation
- ✓ Industrial processes
- ✓ Aerospace industry
- ✓ Combustion engines
- ✓ Gas/oil extraction
- ✓ Space applications



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NASA: Gas Sensor

Air Force: Thin Film

Air Force: Packaging

**Environetix:
Prototype System**

**Wireless Systems for Harsh
Environment SAW Sensors**

**Device Fabrication & Test
At UMaine Facilities**

Power Plant

Air Force: Adhesion

**Adhesion Tests on Bladed
Turbine Rotor by VEXTEC**

**Reliability, Resolution, &
Accuracy of T Sensor**

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- Maine Team → working on HT μ ~ technology since 1999
- Topics include:
 - Microwave acoustic material characterization & device design
 - Thin film R&D for HT applications
 - Wireless communication: in turbine engine & harsh environments
- Interdisciplinary Research Center
 - Physics, Chemistry, Electrical & Computer Engineering, Chemical & Biological Engineering
 - 2005 Research Building (18 M\$) with 3500 ft² micro/nano fab clean room
 - Well instrumented for Materials Science and RF work
 - Over 70 people: faculty, tech staff, graduate /undergrad students



- UMaine spin-off high tech company (June 09)
 - Currently six employees + administrative support
 - Located Target Technology Center, Orono, ME
 - Funded by DoD SBIRs, Maine State
 - Wireless product/services for harsh environments



Device Fabrication & Test At UMaine Facilities



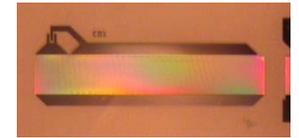
photolithography



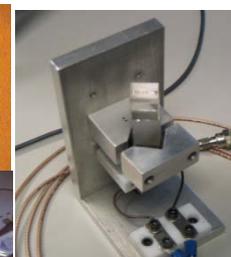
Cutting, grinding and polishing



device packaging



thin film deposition



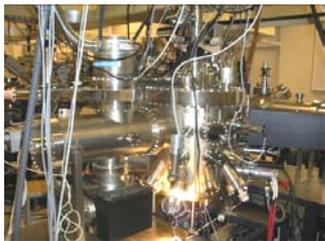
Device design, fabrication, and Test



dry etch



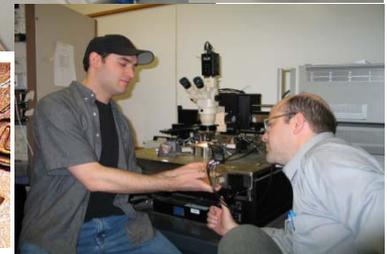
wet etch



Film
 Characterization



High Tech
 Testing Facility



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Monitoring Power Plant Environments

➤ Project objectives:

- Develop & demonstrate performance of:

Wireless Microwave Acoustic Temperature & Pressure Sensors

Embedded in equipment/fossil fuel power plant environments →

✓ Steam headers, Reheat lines, Water walls, Burner tubes, Power Turbines

- Select best applications through interactions w/ OEM, NETL
- Investigate HT thin films → from 700-950 to 1200°C operation and 750 psi
- Develop appropriate packaging for the applications identified
- Select & adapt wireless interrogation system for power plants
- Identification & development of integrated temp.& pressure wireless microwave acoustic sensor arrays
- Test prototype arrays in power plant environments

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Tasks

Project contains 4 major tasks / subtasks, as follows:

1. **TASK 1 – Project Management & Planning**
2. **TASK 2 – Synthesis & Processing of Novel SAW Sensor Nanocomposite Thin Film Materials for Harsh Environment Wireless Operation up to 1200°C**
3. **TASK 3 – Investigation of Materials & Techniques for Embedding Wireless Temperature Sensor Arrays and Sensor Interrogators into Power Plant Components**
4. **TASK 4 – Research & Development of Real-time Wireless Temperature / Pressure Sensor Arrays for Online Assessment of Power Systems**

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- **Mauricio Pereira da Cunha**, *Professor of Electrical & Computer Engineering and Member of LASST (PhD in Electrical Engineering, McGill University, 1994)*. Principal Investigator who is responsible for overseeing the entire project. Areas of expertise include microwave acoustic materials research and characterization, wave propagation, wireless communication, and sensor development.
- **Robert J. Lad**, *Professor of Physics and Director of LASST (PhD in Materials Science, Cornell University, 1986)*. Co-Principal Investigator responsible for assisting in monitoring the project. His area of expertise includes ceramic and semiconductor thin film growth and characterization, electrical transport measurements, and high temperature materials.

UMaine Technical & Support Staff

- **David Frankel**, *Senior LASST Scientist (PhD in Physics, Stanford Univ. 1978).*
- **Scott Moulzolf**, *LASST Research Scientist (PhD in Physics, U.Maine 1999).*
- **George Bernhardt**, *LASST Research Scientist (PhD in Physics, U.Maine 1994).*
- **Roby Behanan**, *LASST Research Engineer (MS in Electrical Engineering, U. South Dakota, 2005).*
- **Thomas Moonlight**, *LASST Research Engineer (BS in Mechanical Engineering, U.Maine 2002).*
- **Patricia Paul**, *LASST Administrative Officer.*

Environetix Technical & Support Staff

- **Donald McCann**, *Technical Manager and Project Engineer (PhD in Electrical Engineering, U.Maine 2010).*
- **Thomas Pollard**, *Principal Project Engineer (PhD in Electrical Engineering, U.Maine 2012).*
- **Eric McCarthy**, *Research Technician (MS in Electrical Engineering, U.Maine 2009).*
- **George Harris**, *Technical Engineer (BS in Engineering Physics, U.Maine 1978).*
- **Joe Arsenault**, *Financial Administrator (M.S. in Mathematics, U.Maine 2002, M.S. in English, U.Maine 2004)*

- Project Started Jan 01st, 2012.
- Task 1 – Project Management & Planning
 - Review of Project Management Plan (PMP) with program officer
 - Kick-off meeting
- Task 2 - Novel SAW Sensor Nanocomposite Thin Film Materials for Harsh Environment
- Task 3 - Embedding Wireless Temperature Sensors & Interrogators into Power Plant Components

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Summary

This presentation addressed:

- 1. Overview → technology state-of-the-art & accomplishments**
- 2. Targeted applications for NASA, Air Force, and Energy sector**
- 3. Introduced UMaine & Environetix capabilities and partnership in the project**
- 4. Discussed the current project**
 - ✓ Objectives**
 - ✓ Tasks, Timeline, and Milestones**
 - ✓ UMaine and Environetix personnel**
 - ✓ Current activities and progresses**

For further information, please contact:

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