NANITE™ for Better Well-bore Integrity and Zonal Isolation

U.S DoE CONTRACT NO: DE-FE0014144

DoE NETL
Technologies Review Meeting
August 16–18, 2016
Pittsburgh, Pennsylvania

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Acknowledgements

- **NETL / DOE**
  - Bill Fincham (Program Manager)
  - Roy Long (Offshore Technology Manager)

- **JIP Partners and Industry Cementing Experts**
Oceanit Overview

- Founded 1985 in Hawai'i
- 160+ Employees
- Multi-Disciplinary Staff (25% PhDs)
- Awards
  - 2014 Oceanit Spin-Out IBIS Networks wins East meets West
  - 2013 Pacific Edge Commitment to Green Employer of the Year
  - 2012 ASCE Outstanding Civil Engineering Achievement Award – Best Study & Research Project
  - 2011 U.S. Army Corps of Engineers – Project Excellence Award
  - 2010 Army SBIR Quality Award for FLASH
  - 2009 Pacific Business News Finalist – Most Innovative Company
  - 2008 NASA's Nano 50 Award for Nanoconcrete
  - 2007 Pacific Business News “Best in Business” large business
  - 2006 National Tibbetts Award
  - 2006 Best Places to Work in Hawaii
  - 2005 AFRL’s Technology Transfer Team of the Year Award for HANDS
  - 2005 Top 10 Best Places to Work in Hawaii
  - 2004, 2005 Surfrider Foundation’s “Environmental Company of the Year”
  - 1997 US Chamber of Commerce Blue Chip Enterprise Award
Program Overview

- 2 Major International Oil Companies
- 1 National Oil Company
- 1 Independent Oil Company
Benefit to the Program

- Annulus formation in the casing string can lead to reduced well efficiency, aquifer contamination, or well failure.
- Poor cementing can lead to well integrity and performance failures (Deepwater Horizon disaster in the Gulf of Mexico).
- Fracking should not begin until the wellbore has been properly cased and cemented.
- Pressure exerted during the fracking process can cause the cement to crack.
- Conventional techniques used to inspect the integrity of cementing behind multiple casing strings have proven to be inaccurate, insufficient, and unreliable.
- Continuously monitoring the integrity of cement plugs throughout their lifetime using conventional approaches is not a viable option.

**Impact:** Improve the economics of drilling by helping to increase blowout prevention and resolve environmental concerns.
Primary Project Goal

• Demonstrate how real-time sensing of Nanite can improve long-term wellbore integrity and zonal isolation in shale gas and applicable oil and gas operations.

• Transform conventional cement into a smart material responsive to pressure (or stress), temperature, and any intrinsic changes in composition.

• Demonstrate Nanite’s electrical and acoustic responses; improved chemical and physical properties; and durability.

Smart Materials + Detection Methods + Data Analysis =
Large amount of new information regarding cement location and condition

• Investigate 2-3 interrogation mechanisms/modes.
Material Design, Formulation, and Optimization
**Nanite Load Sensitivity**

**Mechanical load monitoring**

*Base cement response to load*

*Nanite response to load*

*Cracking and failure detection*
Baseline Monitoring and Calibration of Curing Process

Monitoring Early Stage Curing

- Nanite can be used as a wait-on-cement indicator

![Graphs showing monitoring data](image)

Monitor Nanite curing

![Graph showing compressive strength evolution](image)

Compressive strength evolution
**Electrical Resistivity Tool**

**Hardware Design Goals:**
- High resolution / Low noise
- High sample rate
- Compact, low power, portable
- Inexpensive

**Optimization of Electrodes:**
- Geometry
- Materials
- Fabrication
- Casting
Subscale Proof Testing

- Development of multipurpose hydraulic pipe expansion test fixture
- Nanite for use with acoustic cement bond log tools
- Formation and cement salinity measurement
- Through-casing resistivity logging tools
- Plug-and-abandonment

NANITE™ Smart Cement

Videos found at

http://www.oceanit.com/products/nanite
Key Accomplishments

- Developed and optimized a nanomaterial admixture to imbue well cement with sensing characteristics and enhanced mechanical properties.
- Assessed the properties of Nanite cements according to API specifications.
- Characterization of Nanite’s electrical properties and the development of a specialized resistivity measurement tool.
- Established processes for reliable and repeatable detection of compressive loads applied to Nanite samples, detection of fractures, and curing state.
- Evaluated Nanite’s suitability for acoustic interrogation modes.
- Currently performing subscale testing focusing on rapid technology field trial potential.