Contract No. G-017-037
"Improved Directional Drilling Technology for the Bakken Formation"
Submitted by **Laserlith Corporation**
Principal Investigator: Wallace Tang

PARTICIPANTS

Sponsor	**Cost Share**
Laserlith Corporation	$200,000
North Dakota Industrial Commission	$200,000
Total Project Cost	$400,000

Project Schedule – 12 months
Contract Date – June 22, 2009
Start Date – June 1, 2009
Completion Date – June 30, 2010

Project Deliverables:
Status Report: September 30, 2009 √
Status Report: December 31, 2009 √
Status Report: March 31, 2010 √
Final Report: June 30, 2010

OBJECTIVE/STATEMENT OF WORK:
The objective of this project as originally submitted is to increase the efficiencies of horizontal drilling in the Bakken Formation through a redesign of drilling tools by including the use of miniature gyroscopes in the drilling assemblage. The result of the project will be a prototype miniature MEMS gyroscope demonstrated at temperature typical in the drilling environment. High-temperature shock-resistant MEMS gyroscopes enable the directional sensor to be positioned next to the drill bit, resulting in a reduction of backtracking, more accurate navigation and time-savings. The original request from Laserlith was for $500,000. The Commission funded only Phase I of the project. The goal for Phase I is to develop the micromechanical sensing element, select the specialized high temperature semiconductor foundry and design the sensor circuit. The deliverable for the 1-year Phase I project is the test data demonstrating the ability of the micromechanical sensor to operate in the simulated down-hole temperatures.

STATUS
The September 30, 2009 quarterly report was received. A copy of the non-confidential report has been posted on the Industrial Commission website. It states in part: "The main focus of the last quarter was to design a basic MEMS gyroscope and perform temperature sensitivity analysis on it to study the effects of temperature. FEA modelers were used to study thermal-structural interactions for fixed-fixed flexure structures and simplified gyroscope frames.

In the first simulation, the fixed-fixed flexure, one of the basic and critical parts of the gyro was studied. This was performed for temperatures ranging from 0 to 200 degrees C. The maximum displacement observed is a 0.6% deflection of the total thickness of the structure.

As each study confirmed thermal compatibility, the next level of complexity was added to create a more realistic representation of the actual gyro. The same input parameters for the simulation were used. The results showed that the beams had made less out-of-plane deformation (maximum of 0.1%) along its length. Structural deformation of the device layer is reduced since the substrate will expand along with the flexure as opposed to the last study where the anchors were fixed.

The next step toward demonstrating the thermal robustness of the MEMS gyroscope design was to include a full structure simulation at a temperature of 200 degrees C. The total deformation at this temperature was considered negligible. All of these results confirm that the thermal effects the gyro would encounter in a drilling environment will not affect its performance."

The December 31, 2009 quarterly report was received. A copy of the non-confidential portion of the report has been posted on the Industrial Commission website. During the past quarter the high temperature gyroscope designs were completed. Computer simulation results indicate that the gyro sensor design will not buckle under the harsh thermal conditions and should operate successfully. An initial MEMS fabrication run was also performed to produce MEMS test structures within design specifications for linewidth and sidewall quality. An initial circuit design has been developed for driving the gyroscopes and sensing changes in capacitance in the range of picofarads.

The March 31, 2010 quarterly report was received. A copy of the non-confidential portion of the report has been posted on the Industrial Commission website. During the past quarter additional testing and process development of gyroscopes from the initial MEMS fabrication run were completed. This work includes testing the electrical properties and the mounting and packaging of the sensor. Data gathering from testing has aided in adjusting the design for the upcoming fabrication run. The control circuit design was completed and is currently being fabricated. A vacuum test chamber for the gyroscope has been built which will be used to create a test setting typical of a drilling environment.

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