# TECHBRIEF

## DOWNHOLE LASER SYSTEM WITH AN IMPROVED LASER OUTPUT PRODUCTION AND DATA COLLECTION

### OPPORTUNITY:

This patent-pending technology establishes a novel system and method for laser induced breakdown spectroscopy (LIBS) applications. The technology is available for licensing and/or further collaborative research from the U.S. Department of Energy's National Energy Technology Laboratory.

### CHALLENGE:

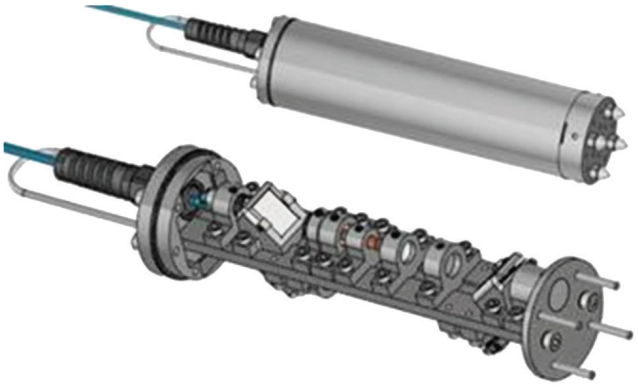
Low-cost, efficient monitoring of remote locations has and continues to be highly sought in the industry. For example, drilling production or injection wells for oil/gas extraction or carbon dioxide ($CO_2$) storage always has the potential for leakage into the surrounding formations and environment. The ability to measure the subsurface fluids in and around the injection/production area before and after subsurface activities becomes more important when there is a suspected leak. Current downhole monitoring systems rely on bulk parameters such as pH and conductivity. Lab based systems can provide trace element measurements of subsurface fluids but require fluids to be taken from the field and digested prior to measurement. A system that can provide trace element measurements in real time while deployed in the subsurface is potentially of great value.

Current diode pumped solid state (DPSS) laser systems used for laser induced breakdown spectroscopy applications in fluid system measurements have numerous limitations. First, the systems are susceptible to dimensional changes caused by temperature and pressure swings in fluctuating environments in downhole applications. A second issue is the size of the laser spark that is produced in the fluid for measurements affecting signal strength. The third issue is the efficient collection and transmission of the plasma emission for analysis.

### OVERVIEW:

NETL researchers have developed a system and method for laser induced breakdown spectroscopy (LIBS) applications. The system is a device for a remote sensor using a low peak power optical pump. The system incorporates three optical features to address the issues described above.

First, a lens arrangement for pump beam overlap control provides control of output pulse characteristics. The beam overlap control allows for dictating laser output beam size and energy content, allows for control of the laser output, and reduces system temperature and pressure sensitivity. Second, a beam expansion control (a beam expander) provides control for characteristics of the laser spark. The beam expansion control provides efficient use of pulse energy, lowering energy requirements for pulsed



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laser and provides for a “hotter,” more compact spark. Third, spectral emission control (divergence control) controls divergence and alignment tolerance, thus reducing lost light of collected spectral emission.

The spectral emission control reduces the size of spark image on the face of the signal return fiber, reducing alignment sensitivity and coupling more light into the fiber for the data collection system. This invention provides a system and method for laser induced breakdown spectroscopy (LIBS) applications. In one embodiment of the system, the system is a device for a remote sensor using a low peak power optical pump.

## ADVANTAGES:

- Allows controllable variation in laser output pulse
- Allows for more light collection with a small initial laser pulse for spark production
- Provides more collected light to analyze
- Reduced sensitivity to thermal expansion

## APPLICATIONS:

- Sensor and Controls Systems
- Combustion Technology & Fuel Cells
- Environmental

## PATENT STATUS:

U.S. Patent Pending (non-provisional patent application)

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