Sandia National Laboratories

Exceptional service in the national interest

Patent Info:
US Patent Pending

Technology Readiness Level: 7
Sandia National Laboratories has demonstrated a full-scale system prototype in an operational environment.

Technological Benefits:
Sandia's EFOS system represents miniturization of current laser interferometry pressure pulse detection techniques.

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National Nuclear Security Administration

U.S. DEPARTMENT OF ENERGY

Embedded Fiber Optic Sensors (EFOS)

Sandia's EFOS system enables measurement of apparent particle velocity time histories in low to high shock regimes and for non-shocks

Applications and Industries

- Aerospace - propulsion systems, "smart" materials
- Automotive - engine design and health monitoring
- Defense - design and/or evaluation of systems using energetic materials
- Medical - transducers for medical procedures involving pressure pulses (minimally invasive)
- Seismology, oil and gas - monitor pressure in wells

Technology Summary

Current laser interferometry pressure pulse detection techniques use the shock induced change in index of refraction to track detonation and/or shock fronts in a single fiber optic by reflecting laser light off of the boundary created between the unshocked material and the shocked material. However, this technique cannot be used in regimes where there isn't a strong enough shock front to reflect the laser light above the noise floor. Other embedded fiber techniques use a chirped fiber Bragg grating to track a shock position versus time by correlating a known spectrum of light to a calibrated position. The two systems described above use a single fiber and measure only time-of-arrival for a strong shock. Sandia has developed a novel Embedded Fiber Optic Sensor (EFOS) system able to measure apparent particle velocity time histories in low to high shock regimes and for non-shocks. The apparent particle velocity traces give both time-of-arrival data and can be transformed into pressure time histories, a capability unique to the Sandia EFOS system.

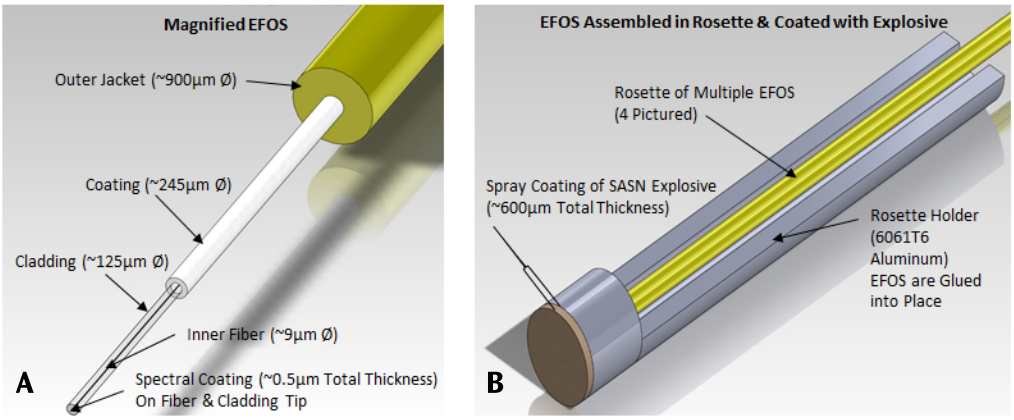

Figure 1. (A) Magnified image of Sandia's EFOS system and (B) magnified image of EFOS assembled in rosette and coated with silver acetylide-silver nitrate (SASN) explosive

Many explosives and/or combustion events have short run-up distances requiring sub-millimeter measuring techniques. Sandia's EFOS system utilizes Corning SMF-28 9/125-µm diameter fibers (but not limited to glass fibers) placed at known distances from a target surface and connected to infrared detectors coupled with Photonic Doppler Velocimetry (PDV). The PDV system uses the Doppler shifted beat frequency of reflected infrared laser light as compared to a reference leg of the laser source with a heterodyned signal. The probes detect apparent particle velocity traces similar to that seen in traditional laser interferometer particle velocity measurements that help interrogate the transient phenomena of explosives or shock waves, but at the microscale and potentially smaller.

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