HAMAMATSU
PHOTON IS OUR BUSINESS

High-Performance Spectroscopy for Field-ready LIBS Systems

Laser-Induced Breakdown Spectroscopy (LIBS) has rapidly progressed from a laboratory technique to a mainstream solution for fast, elemental analysis across industries ranging from metals production to energy, environmental monitoring, recycling, and advanced materials. This shift has been driven by improvements in compact, high-performance components, especially lasers and spectrometers that allow LIBS systems to be portable while maintaining laboratory-level precision. Hamamatsu's new WS Series spectrometers support this latest generation of LIBS instrumentation, delivering high resolution, broad spectral coverage, exceptional speed, and stability required in rugged compact systems.

Why spectrometer performance is critical in LIBS

LIBS is a versatile analytical method that uses a brief, intense laser pulse to generate a microplasma at the surface of a sample. As this plasma cools, excited species relax to lower energy states, emitting discrete spectral lines unique to each element. By capturing these emissions with a spectrometer, the material's elemental fingerprint can be identified in seconds, often with no sample preparation. Early plasma emission (within the first hundred nanoseconds) is dominated by intense broadband light, so detectors typically capture emissions after a short delay of around one microsecond when the sharp atomic and ionic lines become visible.

Choosing the right spectrometer is therefore crucial. It must resolve fine spectral features, capture extremely short-lived signals, and deliver broad enough coverage to include the emission lines of interest.

Several features set LIBS apart from other elemental analysis approaches:

No sample preparation
LIBS can analyze raw, in-place materials without grinding, dissolving, or chemical treatments.

Speed
A complete measurement often takes only a few seconds.

Access to light elements
Elements like hydrogen, lithium, beryllium, carbon, nitrogen, and oxygen are readily detected. This is an area where other portable techniques struggle.

Flexible measurement strategies
LIBS can scan across a surface, probe different depths, and examine thin coatings without interference from underlying substrates.

Broad applicability
The technique works across metals, plastics, glasses, soils, biological matrices, ceramics, paints, semiconductors, and more.

A typical detection limit for many heavy metals is in the low parts-per-million range, making LIBS powerful for both qualitative identification and quantitative measurement.

Advances that enabled LIBS in the field

For many years, LIBS was confined to laboratory settings because the hardware required was bulky, power-hungry, and sensitive to environmental change. The turning point came with innovations in compact laser technology. Today's field-ready devices rely on small, battery-operated lasers capable of delivering several millijoules of energy in nanosecond pulses at high repetition rates while remaining stable over wide temperature ranges. This performance level is essential for achieving the fast, repeatable plasma generation needed for high-quality field data.

Modern handheld LIBS systems now match or exceed the capabilities once limited to mobile spark-Optical Emission Spectroscopy (spark OES) units and, in many applications, complement or surpass handheld X-ray fluorescence (XRF). These tools have gained strong adoption in industries such as welding, petrochemical processing, alloy production, and mineral resource exploration.

Where laser-induced breakdown spectroscopy is used today

LIBS has established itself as a powerful tool across industries that demand rapid, on-site elemental analysis. Its ability to measure carbon in steels and stainless alloys is one of its most important advantages, particularly in sectors such as oil and gas, petrochemicals, and metal fabrication, where weldability, corrosion resistance, and material certification are needed. Operators can verify alloy chemistry directly on piping, valves, and fabricated components, calculate carbon equivalency in seconds, and inspect materials throughout manufacturing and maintenance workflows. The same strengths make LIBS invaluable in scrap recycling, where fast sorting, discrimination between grades such as 316 and 316L, and detection of trace contaminants directly influence profitability and regulatory compliance.

Beyond traditional alloy analysis, LIBS has become essential in the electric vehicle and battery materials industry. Its unique capability to measure lithium in soils, rocks, and brines in real time has positioned it as a key technology for both exploration and recycling as demand for battery metals accelerates globally. These capabilities extend into academic and research environments as well.

The WS Series: Spectrometers designed for the future of LIBS

LIBS technology naturally benefits from spectrometers that can be tailored to specific analytical needs. Because each application depends on particular emission lines, many developers choose instruments optimized for selected wavelength regions rather than relying on a single, full-range device. Targeted configurations are increasingly common such as instruments designed for fluorine detection in PFAS screening, beryllium in soils and dust, or combinations of light elements such as sodium and boron in mineral analysis. Focusing on the spectral windows that matter most not only improves sensitivity but can also reduce cost and system complexity.

Hamamatsu Mini-spectrometer WS series, C16449MA-01.

Hamamatsu's WS Series spectrometers were created with this flexibility in mind, combining the performance characteristics required for modern LIBS with the freedom to choose the spectral coverage and resolution best suited to each application. The series includes a broadband model, the C16449MA-01, spanning 190 to 1100 nm with 1 nm resolution, and a high-resolution version, the C16449MA-02, covering 200 to 600 nm with 0.45 nm resolution, for applications that demand finer spectral discrimination. Beyond these standard models, Hamamatsu can also customize both wavelength range and resolution, allowing LIBS developers to obtain optimized performance for their target elements.

The WS Series brings together the attributes that matter most for LIBS applications and beyond:

High spectral resolution

IBS relies on resolving narrow emission lines from complex plasmas. WS spectrometers deliver the fine resolution needed to distinguish closely spaced transitions, improving both qualitative identification and quantitative accuracy.

Broad wavelength coverage

With options spanning key UV, visible, and NIR regions, the WS Series can capture emission lines for virtually any element including the light elements that define LIBS' unique capability.

High throughput for faint, fast signals

The plasma emission window is short. The WS Series offers excellent optical efficiency, ensuring more photons reach the detector and enabling lower detection limits.

Exceptional speed and dynamic range

LIBS signals vary widely in intensity. The WS platform accommodates strong and weak lines within a single measurement, supporting advanced chemometric analysis and robust field performance.

Outstanding wavelength stability

Stable calibrations are essential for real-world LIBS deployments. The WS Series maintains its wavelength precision even under changing environmental conditions.

Compact and robust form factor

Built for integration into handheld, portable, and industrial systems, WS spectrometers combine durability with small size, ideal for field-ready LIBS instruments.

A new generation of LIBS enabled by better spectroscopy

Over the last decade, LIBS has matured into a powerful, field-deployable technology that serves traditional industries while expanding into energy, environmental stewardship, and advanced materials. As applications broaden, the need for compact, stable, high-performance spectrometers continues to grow.

Hamamatsu's WS Series is engineered to meet these demands, providing the performance and reliability required for precise elemental analysis in portable and integrated LIBS systems. Designed for flexibility and long-term stability, it enables developers to build instruments that perform consistently in both laboratory and field environments.

Learn how Hamamatsu's WS Series spectrometers can increase the performance of your LIBS instrumentation, whether handheld, laboratory-based, or process-integrated. Contact our team at info@hamamatsu.eu or visit www.hamamatsu.com for technical specifications, samples, and expert guidance.