

High-Resolution

5,000 - 8,800,000

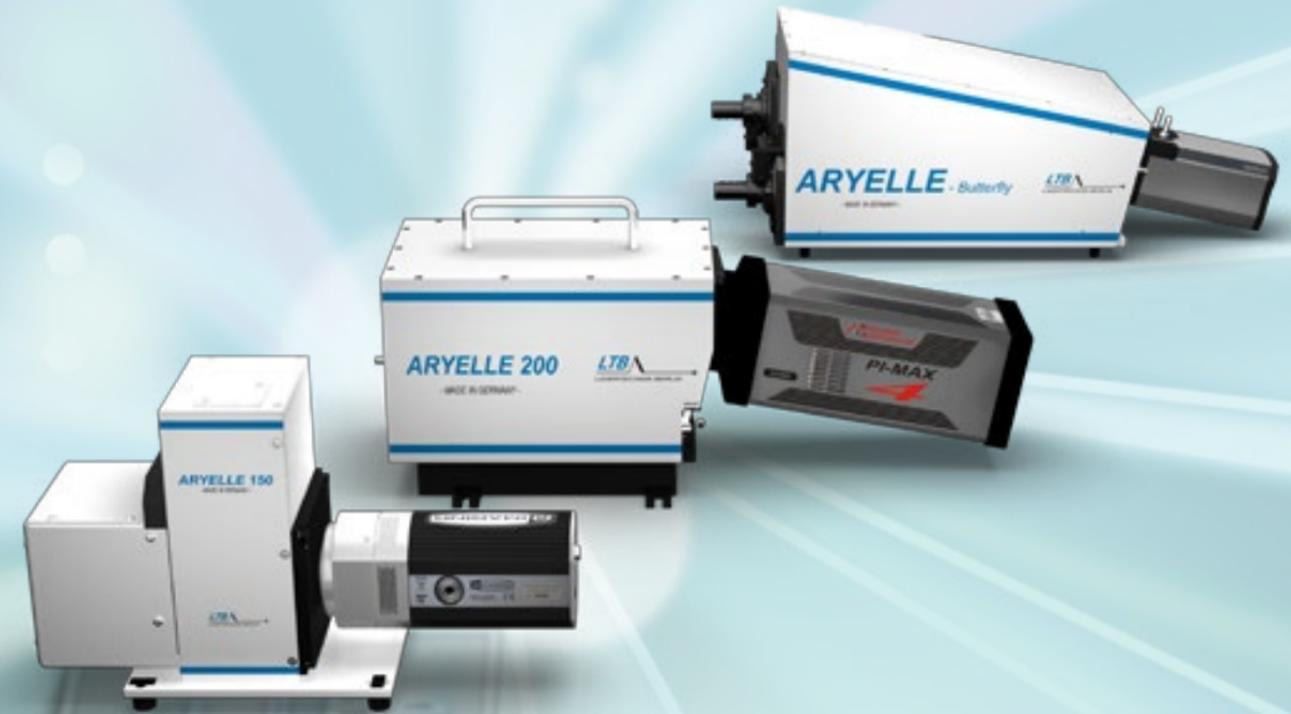
LTB Lasertechnik Berlin GmbH

established in 1990, is an innovative developer and manufacturer of short-pulse lasers in the whole optical spectral range, different spectrometers and laser-based measuring techniques, marketing its products worldwide.

We provide you:

- Laser sources for the industrial analytics and medical diagnostics
- Highest-resolution spectrometers for the development and production of lasers, esp. diode lasers and laser diodes, and for the laser lithography
- Laser-based measuring techniques for the spectroscopic material analysis, process analytics and medical diagnostics (LIF, LIBS and Raman)

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for industrial applications

Spectrometers

UV-VIS-NIR range

OES - LIBS - LIBS-Raman - laser characterization - LIF



ARYELLE 150*



ARYELLE 200*



ARYELLE 400 / Butterfly*



DEMON*



ELIAS*

| | ARYELLE 150* | ARYELLE 200* | | ARYELLE 400 / Butterfly* | | | | DEMON* | ELIAS* | | | |
|---|-------------------------------|-------------------------|-----------------|--|-----------------|-----------------|-----------------|-------------------------|----------------------------|-------------------------|--------------------|--------------------|
| Aperture | f/7 | f/10 | | f/10 | | | | f/10 | f/50 | | | |
| Spectral resolution capability λ /min. measurable FWHM | 5,000 - 11,000 | 7,000 - 15,000 | | 9,000 - 50,000 | | | | 75,000 - 150,000 | 2.25 million - 8.8 million | | | |
| Wavelength range max. | 190 - 1,100 nm | 175 - 1,100 nm | | 175 - 1,100 nm | | | | 175 - 1,100 nm | 157 - 1,100 nm | | | |
| Simultaneous inspection range | up to 600 nm | up to 600 nm | | up to 450 nm | | | | 1 - 10 nm | 8 - 400 pm | | | |
| Standard configuration 16 bit A/D conversion* | | | | UV-versions | | VIS-versions | | | I | II | III | |
| Detector | EMCCD (14 bit A/D conversion) | CCD | ICCD | CCD | ICCD | CCD | ICCD | CCD | ICCD | CCD | CCD | |
| Slit width | 35 x 35 μ m | 50 x 50 μ m | 50 x 50 μ m | 50 x 50 μ m | 50 x 50 μ m | 50 x 50 μ m | 50 x 50 μ m | 25 x 3,000 μ m | 25 x 3,000 μ m | 25 x 1,000 μ m | 25 x 1,000 μ m | 25 x 1,000 μ m |
| Spectral resolving power λ /min. measurable FWHM | 6,000 | 9,000 | 8,000 | 30,000 | 14,000 | 15,000 | 9,400 | 75,000 | 75,000 | 2,250,000 | 3,200,000 | 8,800,000 |
| Wavelength range | 220 - 800 nm | 200 - 750 nm | 200 - 750 nm | 190 - 330 nm | 190 - 330 nm | 330 - 850 nm | 275 - 750 nm** | 190 - 900 nm | 190 - 900 nm | 190 - 550 nm | 190 - 550 nm | 190 - 550 nm |
| Resolution FWHM | 36 - 133 pm | 22 - 83 pm | 25 - 94 pm | 6 - 11 pm | 13 - 24 pm | 22 - 57 pm | 29 - 80 pm | 2.5 - 12pm | 2.5 - 12pm | 85 - 240 fm*** | 60 - 170 fm*** | 22 - 63 fm*** |
| Gate width | - | - | 5 ns | - | 5 ns | - | 5 ns | - | 5 ns | - | - | - |
| Step width | 100 ns | 100 ns | 1 ns | 100 ns | 1 ns | 100 ns | 1 ns | - | 1 ns | - | - | - |
| Absolute accuracy | spectral resolution / 4 | spectral resolution / 4 | | spectral resolution/4 | | | | spectral resolution / 4 | | spectral resolution x 4 | | |
| Dimensions [L x W x H] (Spectrometer without Detector) | [210 x 120 x 85] mm | [260 x 160 x 185] mm | | [438 x 200 x 232] mm / [450 x 280 x 240] mm | | | | [750 x 310 x 230] mm | | [1,400 x 310 x 250] mm | | |
| Weight (Spectrometer without Detector) | 2 kg | 7.3 kg | | 12 kg / 20 kg | | | | 25 kg | | 50 kg | | |

Extremely compact and cost-efficient high-resolution spectrometer for the material / elemental analysis in industry by means of LIBS and Raman spectroscopy

ARYELLE 150 is an inexpensive echelle spectrometer with fibre coupling for different CCD- and EMCCD image detectors. It is characterized by a high sensitivity and a high imaging quality. The dispersion unit with grating and prism can be easily configured for different applications.

- Applications:
- Laser-induced breakdown spectroscopy (LIBS)
 - Spectroscopic process control
 - Raman spectroscopy
 - Absorption spectroscopy
 - Gas chromatography

Compact high-resolution spectrometer for the material / elemental analysis in industry by means of LIBS and Raman spectroscopy

ARYELLE 200 is a compact echelle spectrometer with fibre coupling for different CCD, EMCCD, ICCD and CMOS image detectors. It is characterized by a high sensitivity and a high imaging quality. The dispersion unit with grating and prism can be easily configured for different applications.

- Applications:
- Laser-induced breakdown spectroscopy (LIBS)
 - Spectroscopic process control
 - Raman spectroscopy
 - Absorption spectroscopy

Powerful high-resolution spectrometer for the material and elemental analysis with LIPS and Raman spectroscopy in industry and science.

ARYELLE 400 is an echelle spectrometer that can generate spectra of relatively arbitrary dimension with high wavelength stability, spectral resolution and radiation throughput. It is used for the highly resolving spectral measurement of plasma emission lines. The lines can be detected simultaneously within a large spectral wavelength range. LTB also provides complete systems including laser system, beam guidance and sample chamber.

- Applications:
- Laser-induced breakdown spectroscopy (LIBS)
 - Spectroscopic process control
 - Raman spectroscopy
 - LIBS-Raman spectroscopy in one instrument

Very high resolution and optical throughput for the production and quality control of diode and solid state lasers

DEMON is an echelle spectrometer for the highly resolved spectral measurement of emission and absorption lines from the UV into the NIR range. By applying a CCD/ICCD array detector, the lines and their spectral vicinity within the corresponding inspection range can be recorded simultaneously.

- Applications:
- Plasma spectroscopy (ICP, MIP, LIBS)
 - Spectrometric process control
 - Precise absolute wavelength determination of emission lines
 - Manufacturing and quality control of diode and solid-state lasers
 - Isotope spectroscopy

Highest-resolution commercial spectrometer series, for the characterization of lasers in the microlithography

ELIAS is an echelle spectrometer with an extremely high resolution capability. It is used for the highly resolving spectral measurement of emission and absorption lines, particularly of laser lines. The line profiles can be detected simultaneously within their spectral vicinity with a signal-to-noise ratio of up to 40,000 by means of a CCD. Besides the high-resolution spectral measuring of laser lines, the intensity dynamics of up to 4 orders is of the utmost importance.

- Applications:
- Excimer laser lithography
 - Measuring of the spectral and temporal stability of diode lasers, solid-state lasers and emission lines of lamps

* Other configurations within the range of a/m values possible
 ** Spectral gaps within the given range
 *** Depending on the adjusted wavelength

LIBSlab

Chemical multi-elemental analysis with LIBS in modular benchtop design



Why LIBS?

- Qualitative and quantitative multi-elemental analysis
- For solid, liquid and gaseous samples
- Almost non-destructive
- No sample preparation necessary
- Short measurement times
- Sample mapping

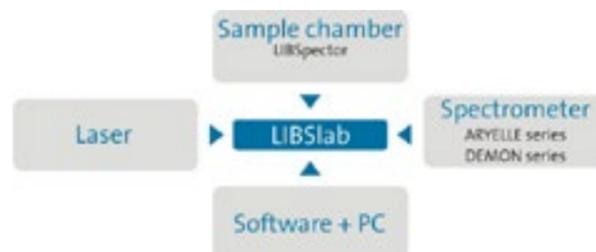
The LIBSlab is a compact and easy to use measuring instrument for the qualitative and quantitative multi-elemental analysis by means of laser-induced breakdown spectroscopy (LIBS). Due to its modular design, the LIBSlab provides individual configuration options to meet your requirements for a flexible use of LIBS technology in the scientific and industrial sectors.

LIBS technology

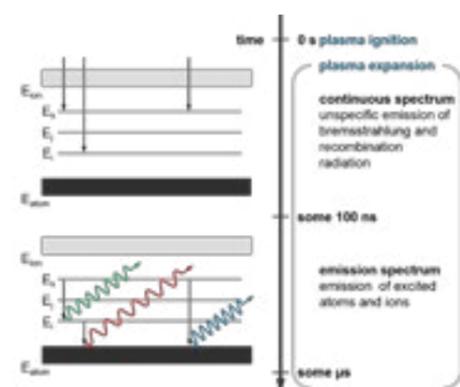
Laser-induced breakdown spectroscopy (LIBS) is a type of atomic emission spectroscopy, utilizing laser ablation and the subsequent atomic emission from the generated plasma for elemental analysis. Laser ablation is at present the only analytical method that offers direct sampling from any kind of material (solids, liquids, gases) without sample preparation. Short pulse laser radiation that is focused on the surface of a sample causes a local heating of some 10,000 °C and leads to the generation of a light emitting plasma - consisting of atoms and ions of the ablated material. The spectral analysis of characteristic atomic and ionic emission lines allows the determination of the atomic composition of the sample.

4 modules = LIBSlab

By individually combining and customizing the 4 modules - sample chamber, spectrometer, laser as well as software and PC - the LIBSlab can easily be adapted to customer needs, thus opening a wide range of applications.



Modular hardware and software components of the LIBSlab.



Scheme of a typical LIBS plasma process.

Applications

- Laboratory measuring instrument
- Quality control
- Material characterization
- Scientific and industrial applications



LIBSpector – compact sample chamber for the LIBS analysis of solid, liquid and gaseous samples.



High-resolution echelle spectrometer series ARYELLE and DEMON made by LTB Lasertechnik Berlin.

Sample chamber

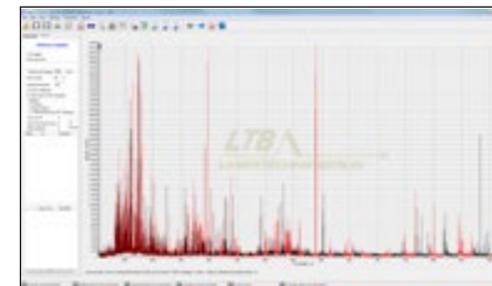
The LIBSpector is a compact sample chamber for the LIBS analysis of solid, liquid and gaseous samples. It comes with a laser class 1 housing and is equipped with safety interlock, laser protection window for observation and exhaust flange for safe use. No additional laser safety precautions are therefore required at installation site. The beam of the laser, whose head can be incorporated in the chamber housing, is directed to the sample via telescope optics and generates a light emitting plasma. The plasma light is guided to the spectrometer via mirror and fiber optics. Sample mapping is provided by an integrated motorized and software-controlled XYZ stage. For precise sample positioning and focusing, a pilot laser and a real-time video monitoring based on a high-resolution CMOS camera are installed. Several sample holders for solid, liquid and gaseous substances provide universal application capability and can be adapted to your individual requirements.

Spectrometer

All spectrometers made by LTB Lasertechnik Berlin are based on a dispersion unit with echelle grating and prism and feature high-spectral sensitivities and excellent imaging qualities. The LIBS emission spectrum of a sample can be measured simultaneously from the UV to the NIR range by using a high-resolution spectrometer from the ARYELLE and DEMON series. In combination with different CCD-, EMCCD-, ICCD- and CMOS-detectors the spectrometers provide a wide range of customer applications.

Laser

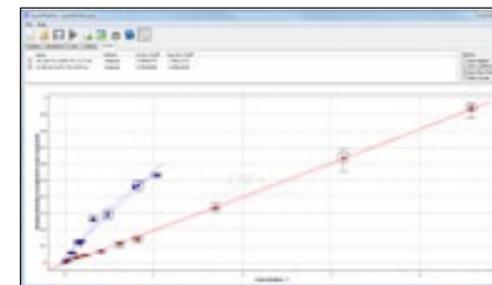
For plasma generation, various Nd:YAG and excimer lasers with different wavelengths and pulse energies can be applied. The choice of the optimal LIBS laser setup depends on your individual application and can be made by yourself. Many years of experience gained with diverse laser types and manufacturers enable us to give you competent advice.



User interface of the operating and evaluation software Sophi.

Software and PC

The operating and evaluation software Sophi developed by LTB Lasertechnik Berlin provides access to all device functions of the spectrometer-detector unit, the LIBSpector and laser via notebook or PC-based user interface. After transforming the detector information into wavelength-dependent intensity values, all lines of the gained LIBS spectrum are automatically analyzed with the integrated NIST atomic data base and qualitatively assigned to the corresponding elements. For quantitative multi-elemental analysis of unknown samples, calibrations with reference materials are a precondition. The implemented script-based control allows the automatization of recurring measuring and evaluation procedures and provides you maximum flexibility. Recalibration of the wavelength scale of the spectrometer-detector unit are easily performed with the auto-calibration function by using the included mercury lamp.



Calibration curves for quantitative analysis.

LIBSorter 300

Industrial sorting of scrap metals with Laser-Induced Breakdown Spectroscopy (LIBS)

- Classification of metals and alloys
- Material flow analysis with 25 pieces/s
- Fully automated 24/7 operational mode
- Applicable at conveyor belts
- For harsh environmental conditions
- Customized setups



Unsorted scrap metals before sorting with LIBSorter 300

The industrial recycling of metallic recyclable fractions is a key component of a complete and sustainable recycling economy. In times of dwindling resources and growing demands for price increasing primary raw materials worldwide, high-quality secondary raw materials recycled from various scraps have become increasingly important for economic and ecological reasons. Accordingly, applicable sensor based analyzers like the LIBSorter 300 play a major role in industrial recycling for a fast and precise classification and sorting of scrap metals.

Material flow analysis with 25 pieces/s

The LIBSorter 300 is a robust high-performance online analyzer for the measurement of various material flows with up to 25 pieces/s in industrial recycling. By means of laser-induced breakdown spectroscopy, different chemical elements and alloys can reliably be classified in order to provide homogenous fractions out of mixed scrap metals.

Classification of metals & alloys

Short pulse laser radiation of the LIBSorter 300 is focused on the surface of scattered scrap metal pieces transported on a conveyor belt and generates a light emitting plasma at high temperatures. The chemical elements contained in the material provide a characteristic emission line spectrum like a fingerprint, which is simultaneously detected with a single measurement by the applied high-resolution ARYELLE echelle spectrometer. Multi-elemental analysis is based on the implemented spectral data base and mathematical software algorithms that feature a precise classification of a wide range of customized metal fractions.

| | | | | |
|----------------------|--------------------|--------------------|--------------------|------------------|
| 13 Al Aluminum | 24 Cr Chrome | 28 Ni Nickel | 29 Cu Copper | 30 Zn Zinc |
| 47 Ag Silver | 50 Sn Tin | 82 Pb Lead | Iron/Steel | |
| Bronze/Brass | | | | |



Classification of metals and alloys by means of laser-induced breakdown spectroscopy (LIBS) conducted with LIBSorter 300



(a)



(b)



(c)

Example for a LIBS classification of homogeneous metal fractions out of unsorted scrap metals with LIBSorter 300: nickel (a), zinc (b), aluminum (c)

Fully automated 24/7 operational mode

Equipped with efficient technical solutions for industrial applications, the LIBSorter 300 provides an industrial PC featuring script-based remote control and remote maintenance for a fully automated 24/7 operational mode. PLC, PROFINET and Ethernet are the major interfaces for a proper communication with existing industrial devices.

Applicable at conveyor belts

The LIBSorter 300 is a robust and low-maintenance analyzer that was developed especially for online analysis of materials being transported on industrial conveyor belts. The fixed optical setup with ± 15 mm depth of field provides accurate analysis of different piece sizes. For operation under harsh environmental conditions in industrial buildings, the IP 53 control cabinet is dust-tight and air-conditioned.



Mixed scrap metals that are transported on a conveyor belt for LIBS classification with LIBSorter 300 providing a rate of up to 25 pieces/s

Customized setup

As analytical system for different applications or for fast classification of complex materials on a conveyor belt, the LIBSorter 300 can be customized to fit the client's needs.

Specifications

| | | |
|-------------------------------|--|---|
| Measuring method | Laser-induced breakdown spectroscopy (LIBS) | qualitative and quantitative multi-elemental analysis non-contact measurement no or little sample preparation almost non-destructive |
| Classification of materials | Elements Non-ferrous metals Ferrous alloys Aluminum alloys and wrought aluminum alloys (5000, 6000 series) Recycling of slurries, sludge ashes, granulates Other metals and alloys possible | Ag, Al, Cr, Cu, Ni, Pb, Sn, Zn brass/bronze steel/iron |
| Rate | ≤ 25 pieces/s | |
| Depth of field * | ± 15 mm with fixed optical setup | |
| Synchronization conveyor belt | Yes | |
| Control | Industrial PC with Windows 7 Remote control Script based | |
| Communication | PLC, PROFINET, Ethernet | |
| Spectrometer * | Type Wavelength range | ARYELLE series adapted to application |
| Laser * | Nd:YAG laser, λ = 1,064 nm Laser energy and laser repetition rate adapted to application | |
| International protection code | IP 53 | |
| Operating conditions | Temperature Relative humidity | + 5 °C ... + 45 °C 70 % non-condensing |

* other specifications possible
Subject to technical changes.