



MOBILE SPECTROSCOPY FOR DETERMINING CARBON CONTENT IN STEEL

Task

To analyze the elements in metals with cordless handheld instruments, Fraunhofer ILT is developing a method and conceptual setup to use laser-induced breakdown spectrometry (LIBS) with highly integrated components; furthermore, it is investigating its analytical performance in the laboratory. Fraunhofer ILT has focused on carbon detection since determining its content in steel is not only economically important, but poses technical challenges. Concentrations down to the range of 0.01 percent are to be measured with a compact setup that can be used in a mobile handheld device.

Method

In close cooperation with laser development and metrology, Fraunhofer ILT has developed a passively Q-switched laser, spectral detection and the guidance of laser and measuring radiation for mobile use. The device's size, weight and energy management play a decisive role along with its capability to analyze materials. Key points of the development are the compromise between these boundary conditions and opposing requirements for spectral resolution, inert gas atmosphere in the sample area as well as duration, sensitivity and reproducibility of the measurement. Parameters of the LIBS detection have been tuned in such a way that the carbon spectral line can be detected and low carbon contents quantitatively verified.

1 Compact setup with laser, spectrometer and optical components for the analysis of steel (approx. 23 × 12,5 × 7 cm³).

Results

The decisive criterion for analytical performance is the detection limit for carbon in steel. The institute has achieved the world's best figure – 0.0034 percent, corresponding to 34 µg/g – for compact LIBS (cf. Opt. Express 27, 36855–36863, 2019). This result showed that mobile spectroscopy is advancing into areas that were previously not possible or only possible to a limited extent. One example is the distinction between the technically important and widely used stainless steels 1.4301 and 1.4307 (also known as 304 and 304L), which differ only slightly in their carbon content. The results show that the hand-held device can be used to test for them quickly, even when the components containing these steels have already been mounted.

Applications

Mobile, hand-held spectroscopy systems allow fast elemental analysis of metals in metal production, processing and recycling industries. Applications include the monitoring of production processes, materials identification and incoming inspection of raw materials or semi-finished products.

This project has been financially supported by the Fraunhofer-Gesellschaft.

Contact

Dr. Volker Sturm
Telephone +49 241 8906-154
volker.sturm@ilt.fraunhofer.de