

A NEW INSTRUMENT IN ANALYTICAL SPECTROSCOPY – LASER ELEMENTAL ANALYZER (LEA)

SOLAR TII Ltd (Minsk, Belarus) reports here the principally novel development of an atomic-emission analyzer – the LEA-S500. The LEA's key feature is the originally-designed laser which is used as an excitation source. The first Analyzer model was designed for the analysis of both conducting (metals and alloys) and non-conducting (glass, ceramics, films, etc.) materials.



Fig.1. External view of LEA-S500 Laser Analyzer.

Due to the extensive work carried out in the research of the LEA's application range, we have recently developed the analysis techniques that can be used to analyze the elemental and bulk chemical compositions in different materials using the LEA. A variety of the relevant tasks have stimulated the development of the Analyzer's original configuration and advanced Software.

Analyzer brief description.

Fig.1 gives the Analyzer's external view.

The specifically developed Q-switched Nd:YAG laser is used as a spectrum excitation source. The laser generates an average power of 1 W at 1064 nm and provides a peculiar temporal kinetics for pulse repetition. Treatment of the material surface with pulses creates the specific conditions for the plasma cloud formation. Under these conditions the near-surface layer plasma density and erosivity reduce giving rise to an increase in the intensity of spectral lines with high excitation energies, the background level decreasing too and the spectral lines becoming narrower (Fig.2).

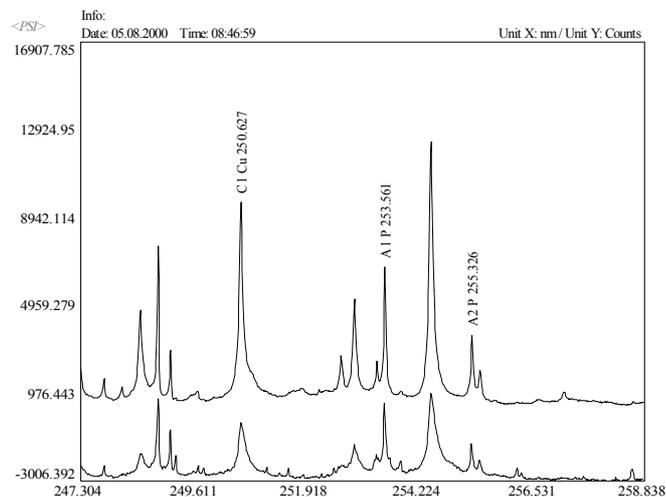


Fig.2. Spectra of one and the same sample subjected to treatment with a conventional (bottom curve) and original (top curve) laser.

The sample compartment, where spectrum excitation occurs, is equipped with a special pump to permit both air exhaust (down to 10^{-1} Pa) and creation of the required atmosphere (argon, for instance) in the breakdown region. Air exhaust allows for the increase in the detection sensitivity of some volatile and difficult to excite elements, as, for instance, in carbon, whose concentration is very important for the steel analysis (Fig.3).

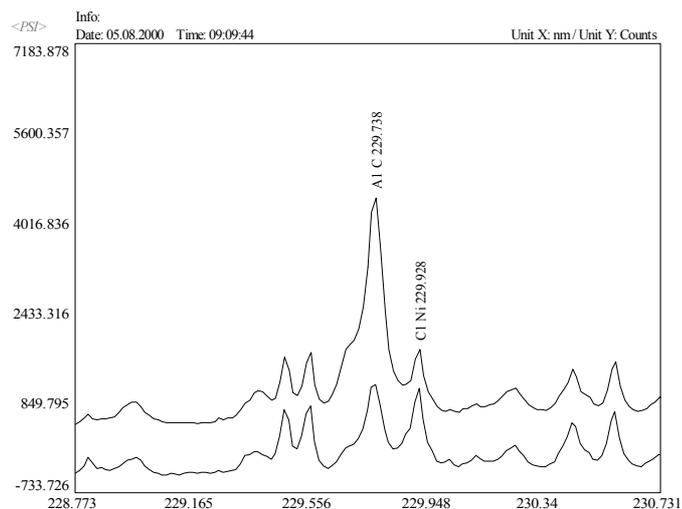


Fig.3. Spectrum section of a steel sample containing 0.71% C (CIII 229.689) with air exhaust (top curve) and with no air exhaust (bottom curve).

consideration of the base material, subtraction of buffer material spectra, etc.), the comprehensive information about materials can be obtained. Moreover, with suitable techniques in use, one can simultaneously analyze such waste materials as swarf, metallic dust or others.

Sectioning. Coatings for ceramics, paper, glass, metals.

One more important application of the Analyzer is the analysis of simple and multi-layer coatings, i.e. the layer-to-layer analysis (sectioning). Such different materials as metals with electroplates, glasses with mirror multi-layer coatings, dyes on paper, glaze on ceramics were analyzed.

Both quantitative and qualitative analyses can be carried out with use of the calibration-free analysis technique. This technique also permits the thicknesses of coatings and layers to be determined together with their compositions.

Figure 5 presents an example of the spectra for a multi-layer coating on the Al_2O_3 substrate.

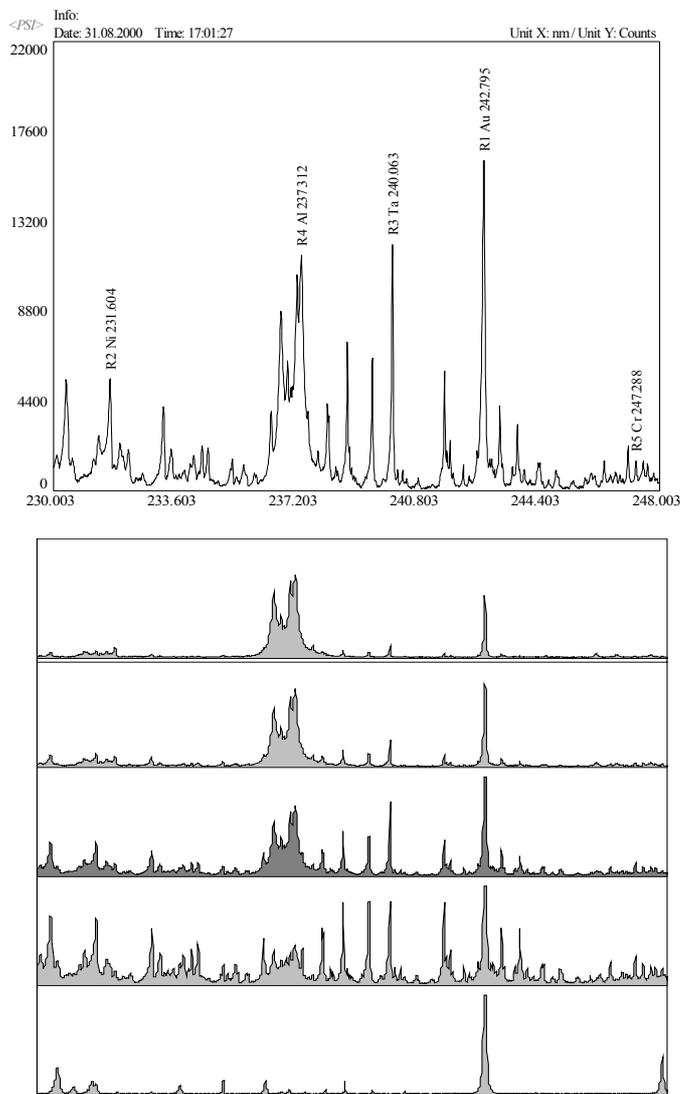


Fig.5. Five spectra for a multi-layer coating (Au, Ta, Ni, Cr on Al_2O_3) illustrating different concentrations of the elements in different coating layers.

Nonconducting materials: trace concentrations of catalysts in a plastic.

One of the main advantages of the LEA is its ability to analyze nonconducting materials directly, eliminating the complicated sample preparation step. Consider the case when the catalyst trace concentration is to be determined in a plastic.

A fragment - a transparent polyethylene tube, obtained with the aid of a barium-based catalyst - was used in the analysis. It was necessary to determine the barium concentration in the finished product. For the better accuracy of the results, the tube was made frosted. With this type of material the breakdown occurred at pulses whose intensity was considerably lower than that for the transparent material. The same sample preparation procedure was employed for the analysis of the glass surface.

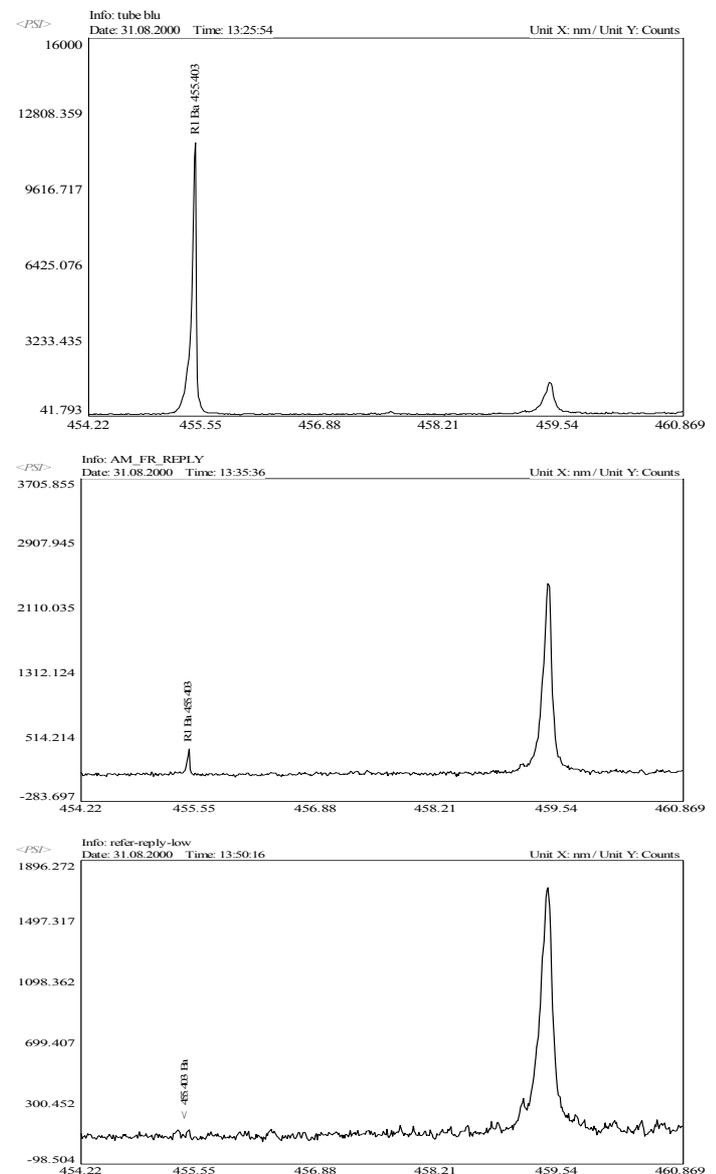


Fig.6. 455.403 nm Ba line. Ba concentration: (1) ~ 50 ppm, (2) 5 ppm, (3) < 1 ppm. Different Y-axis scales.

From the analysis carried out it was concluded that the catalyst impurities (traces) are uniformly distributed over the entire bulk of the material. About ten pulses with a pulse

energy of 30 mJ were sufficient to carry out the analysis. The barium detection limit in such objects was nearly 1 ppm. Figure 6 shows the spectrum sections for several samples with different Ba concentrations.

Besides, a small concentration of Mg was also detected in the near-surface layer of the sample. This implies that it is always advisable to control the so called unexpected impurities during an analysis. This function is also Software-supported.

Contact:

BELARUS

SOLAR TII, LTD

15/2, Akademicheskaya str.,
Minsk 220072,
Republic of Belarus
Phone: +375 (17) 284 02 00
Fax: +375 (17) 284 06 38
E-mail: laser@it.org.by
Web: www.solartii.com

JAPAN

Tokyo Instruments, Inc.

6-18-14, Nishikasai,
Edogawa-ku,
Tokyo 134-0088, Japan
Phone: +81 3(3686) 4711
Fax: +81 3(3686) 0831
E-mail: sales@tokyoinst.co.jp
Web: www.tokyoinst.co.jp

GERMANY

PROSCAN elektronische Systeme GmbH

Lechstrasse 40,
D-86937 Scheuring, Germany
Phone: +49 (8195) 999-511
Fax: +49 (8195) 999-512
E-mail: solar@proscan.de
Web: www.proscan.de