rap.ID Single Particle Explorer® Application Note

Layer Analysis of a Paint Sample with LIBS

Paint analysis

Paint analysis is often performed after accidents to evaluate the type and model of the car. In most cases, only small fragments of paint will be available. Therefore, characteristic features of different paint samples, such as their layer structure and chemical composition, have to be analysed and compared with a reference sample or a database. Common methods to identify the source of a paint fragment are microscopy, IR spectroscopy, Raman, and EDS or mass spectrometry. As an alternative method, Laser-induced Breakdown Spectroscopy (LIBS) implemented in an optical microscope offers a combination of both the benefits of optical imaging as well as elemental analysis.

LIBS for investigating layered samples

LIBS is a type of atomic emission spectroscopy. A short laser pulse is focused on the sample's surface and generates plasma, which atomizes and excites an area with a diameter of approximately 15 µm. The energy promotes electrons in the plasma. During plasma breakdown, the energy dissipates in the form of characteristic element specific atomic emission lines.

By repeatedly ablating material with the laser pulse on the same area of the sample, the different sample layers become accessible for spectral analysis without the need of cutting the sample. The spectral signature of each ablation was acquired with a spectrometer.

Elemental analysis of different layers of paint

Four different layers of a paint sample were characterized by their LIB spectra and the results can be seen in Figure 1. The uppermost layer (layer 1) only created a very noisy LIBS signal, characteristic for an organic layer. A carbon peak is clearly visible in the spectrum. The second layer containing Glimmer mineral particles shows the spectral signature of aluminium. A barium spectrum was observed in the third layer, superimposed by a titanium spectrum in the lowermost layer of the paint sample (layer 4). Applying over 300 LIBS pulses on the same lateral sample position created a hole in the paint reaching to the steel substrate (layer 5).

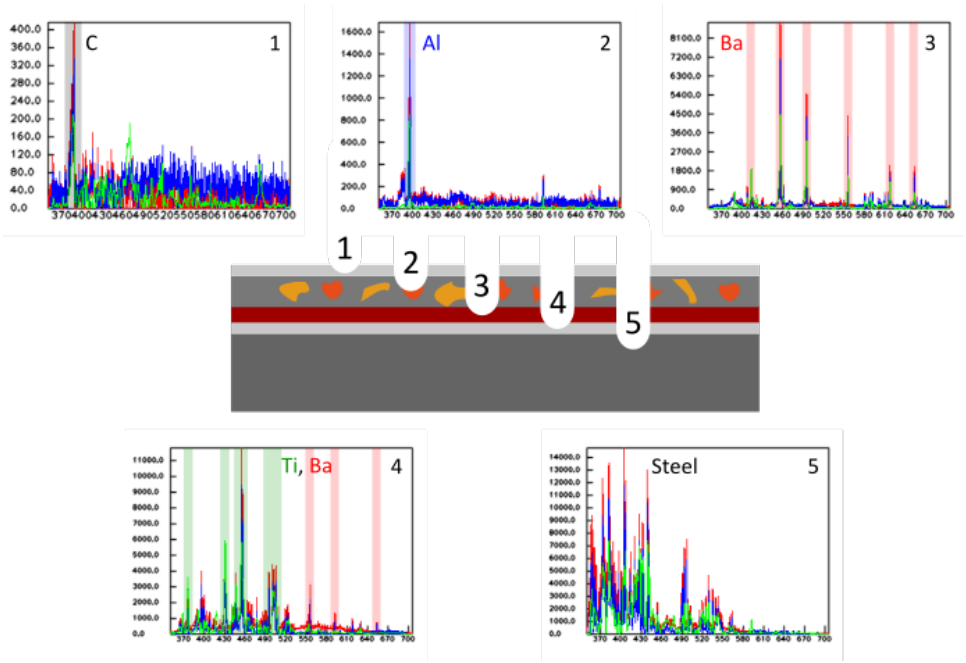

Fig. 1: LIBS analysis of a paint sample. Repetitive exposure of the sample to the laser beam reveals a layered composition of the sample: top organic layer (1), followed by aluminium (2), barium (3), titanium (4) and a steel core (5).

Conclusions

LIBS was used to characterize four different layers of a paint sample:

- Characteristic spectra of each layer were obtained without cutting the sample; the laser pulse itself was used for ablation.
- Hundreds of spectra were collected in minutes (one LIB spectrum is collected at 1 sec)
- LIBS is sensitive for a wide range of elements, including lighter elements.

These results can be used to identify the type and model of a car.

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