

# RAPID-LIBS

## In-situ monitoring of laser machining processes

For process and quality control

*RAPID-LIBS controls laser ablation processes on multi-layer systems, e.g. when drilling microvias in PCB manufacturing.*

Lasers are widely established tools in materials processing thanks to their precision, flexibility, and efficiency. However, high repetition rates of pulsed processing lasers and microscopic dimensions of the laser-cut structures pose a challenge for quality monitoring. The RAPID-LIBS measurement system from Fraunhofer IPM allows fast laser ablation processes to be monitored in situ, for example in PCB manufacturing.

### Detecting layer transitions in real time

Fraunhofer IPM relies on laser-induced breakdown spectroscopy (LIBS) for monitoring fast laser machining processes that require high levels of accuracy. RAPID-LIBS uses the plasma automatically generated during material removal in laser machining for material analysis. The plasma is generated by the high energy of the short or ultra-short pulse lasers used in these processes, with the picosecond or femtosecond pulses (usually 10 ps to 100 fs) heating the material to >10,000 K.

RAPID-LIBS captures the material-specific signature of the plasma by recording the spectral light distribution and then uses this data to

detect the target elements at the measurement point in real time.

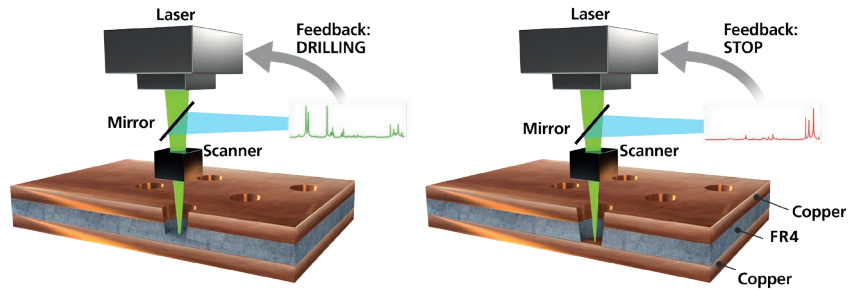
The spectra are analyzed so quickly that material transitions during laser-based processes, such as drilling, ablation, thinning or cutting, are resolved pulse by pulse, providing control signals for process control. The compact RAPID-LIBS system can easily be integrated into existing laser processing systems.

### Application example: drilling microvias

The sensor operates so quickly and precisely that it can be used for controlled laser drilling of microvias – tiny holes for through-plating – in the manufacture of printed circuit boards.

### At a glance

- Process control thanks to real-time analysis
- Full quality control
- Non-contact, optical method
- Easy integration



*RAPID-LIBS: The compact detection module can be integrated into laser machining systems.*

*Material removal with ultrashort pulse lasers produces plasma. RAPID-LIBS analyzes the elemental composition of this plasma by examining its light spectrum. This provides information about the material at the processing point. The measured value is then fed back to the system in real time.*

When manufacturing printed circuit boards, microvias with diameters of less than 150 micrometers are drilled into the material at high speed. The insulating material on copper in these multilayer systems must be removed with micrometer precision to make sure the electrical connections function correctly. Since the thickness and homogeneity of the insulation layers vary, the laser ablation must be adjusted for each drill hole. RAPID-LIBS lets you control the ablation process in PCB structuring by continuously measuring the material-specific plasma emission for each individual drilling pulse and using it to control the processing laser.

detection module via fiber. Alternatively, detection can also take place in the processing chamber. All that is required is the laser's electronic trigger; the measured values are returned directly to the laser as a TTL signal, for example.

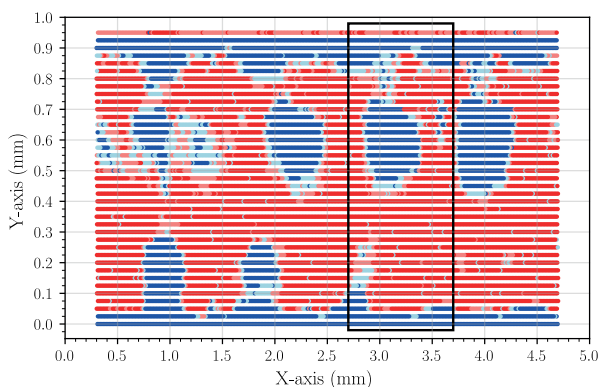
When the material is removed in layers, the signal can be stored temporarily in a register for each layer and read out as control signal for the next layer to be removed. The plasma signal is provided at clock rates of up to 2 MHz, either as a control signal for the process or as a measured value for quality documentation.

## Easy integration and process control

For integration into the existing processing system, the plasma light is decoupled after the processing laser's focus lens and after the scanner using a dichroic mirror and guided to the

## Specifications RAPID-LIBS

Dimensions	15 × 15 × 20 cm <sup>3</sup>
Evaluation time	< 1 μs
Signal transmission	TTL and analogue feedback



*The values measured during laser machining can be output as a 3D map and form the basis for further machining operations (here: red areas = copper; blue areas = no copper).*

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