Application Note AN M152

FTIR Microscopy in Automotive Industries: Large Sample Analysis

In this decade the automotive industry has seen much change. From the renaissance of the electrical car to the rise and fall of diesel engines. In the advent of Industry 4.0 and the advancing interconnection between automotive suppliers, the requirements regarding analytical solutions are also changing.

Suppliers are required to assess product quality on demand and provide failure analysis as well as identification of defects as quick and efficient as possible. To add even more difficulty to an already challenging task, the range of samples, their shape and size grew exponentially over the years. The reason for this increase is the constant introduction of new materials and technologies into this vivid and contested market.

From bulky plastic assembly groups to delicate electro-mechanical components and even parts of combustion engines, the scope of inspected samples is bigger than ever before and each sample has its own specific requirements.

Defects may be microscopically small or, even worse, obscured by other parts of the sample. In worst cases, large samples must be disassembled to get a hold of concealed product failures.

Keywords	Instrumentation and Software
Large Samples	LUMOS FTIR microscope
Electronics	OPUS spectroscopic software
Technical Cleanliness	OPUS/3D/Video for imaging
Surface Analysis	ATR-Complete spectral library

But what if there was a way to analyze hard to reach samples spot on and without a costly sample preparation? Meet the LUMOS.

What is the LUMOS?

The LUMOS is a sturdy FTIR microscope that is self-explanatory in its workflow.

If offers an excellent optical inspection of microscopic samples and yields valuable chemical information as well.

For inexperienced users it offers a helpful software assistant that guides the user through the measurement process and quickly delivers analytical results. Every step of the way, only necessary information is displayed while the interface remains clear.

Although convenience and ease of use are the central elements of the device, Bruker never compromises on its technical features and quality. You can always rely on a flawless visual image, high IR sensitivity and long life-cycle.

And the best part: routine analysis only takes minutes, including inspection, measurement and evaluation.

What can the LUMOS do for you?

In this application note we want to present examples from Bruker's automotive industry partners, in which FTIR microscopy and the LUMOS were crucial to solve the analytical task.

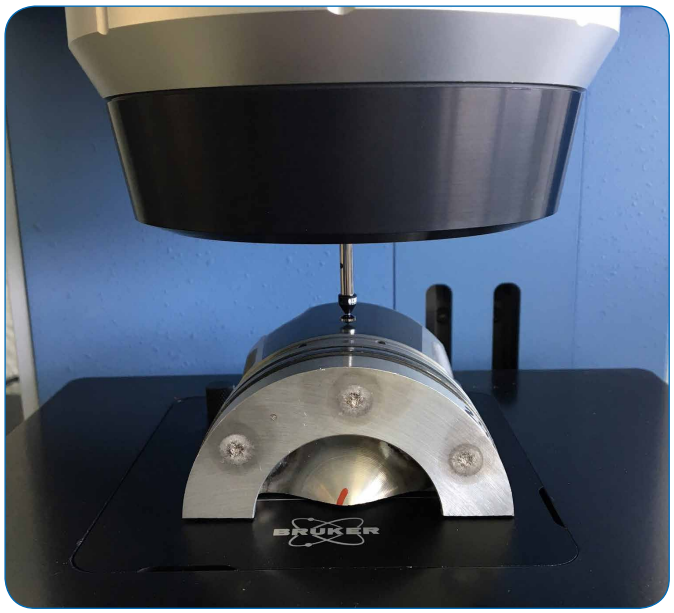

Figure 1: Halved piston from a diesel combustion engine.

Example #1: Surface Analysis of a Piston from a Combustion Engine

This piston from a diesel engine has only been in operation for a short time. To assess the impact the brief usage had on its graphite coated surface, the piston was investigated by FTIR microscopy. Since the preparation for a sample piece made entirely of metal is particularly difficult, the large working distance of the LUMOS proved advantageous. The piston was only halved, and the surface directly analyzed by ATR FTIR.

The seemingly clean surface was thoroughly inspected using polarizing filters, which revealed the presence of a fiber-like residue. It was crucial to identify the source of the residual dirt and therefore a spectral library search was performed.

The contamination was successfully identified as rayon fibers and the manufacturer subsequently pinpointed the contamination's origin.

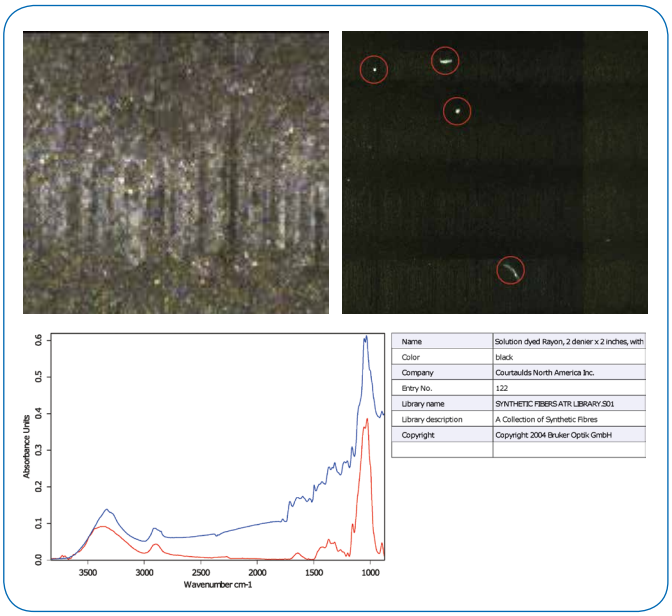

Figure 2: Microscopic visual image of the coated surface before (top; left) after polarizing filters were applied (top; right). Fibers on surface are clearly visible. Identification result for the rayon fibers (bottom).

Example #2: Defect in Electrical Motor Housing

Electrical motors are getting increased attention, but are prone to failure since they are under continuous strain. In this example, an electrical motor failed due to an unknown defect. Figure 3 shows how the ATR crystal makes use of its slim design to fit inside a spring retainer. For the measurement the complete motor housing was put directly onto the sample stage without further sample preparation.

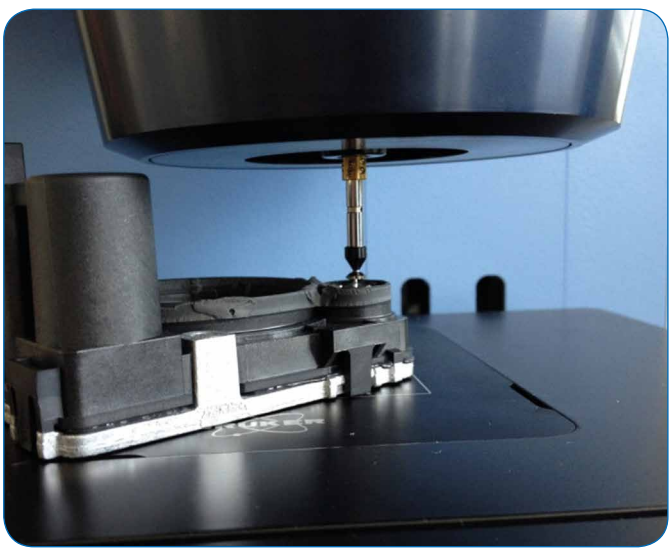

Figure 3: ATR crystal measures inside a spring retainer of an electrical motor housing.

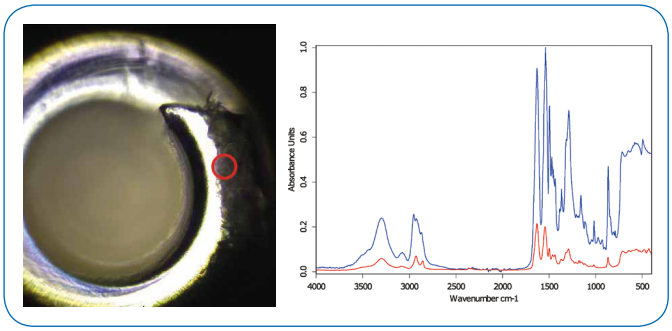

Figure 4: Left: Spring retainer with contaminant (red circle). Right: Spectra of organic particle (red) and metal surface (blue).

In figure 4 (top) you can see the inside of the retainer and the contact spring winding along the inner wall.

On top of the metal a fringing particle is visible, that somehow got into the housing. Measurements were made directly within the housing on the metal surface as well as the contamination. A library search conclusively identified the foreign particle as polyamide and the related source of the contaminant was finally found.

Example 3: Circuit Board Failure

Electronics are a key „ingredient" to the automotive industry. They are indispensable from automated transmissions to engine and emission control. In this example (figure 5) the metal contact of a circuit board was contaminated, and the residue subsequently investigated.

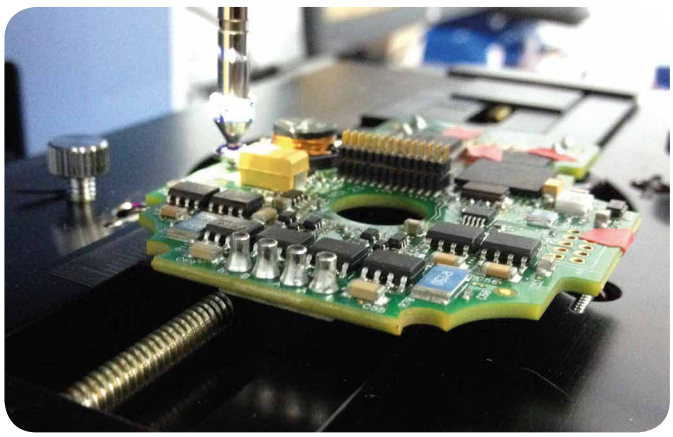

Figure 5: Damaged circuit board with ATR crystal.

Although the circuit board was not particularly large, the pollutant was quite hard to reach since other parts of the board prevented quick access. The white residue is clearly visible on top of the metal contact (red circle).

Despite the crowded space, the LUMOS easily analyzed the sample. The residue was then identified as calcium citrate (figure 6, left) which was most likely introduced during a cleaning process. Characterization of the unknown particle yielded valuable results to further improve technical cleanliness during production.

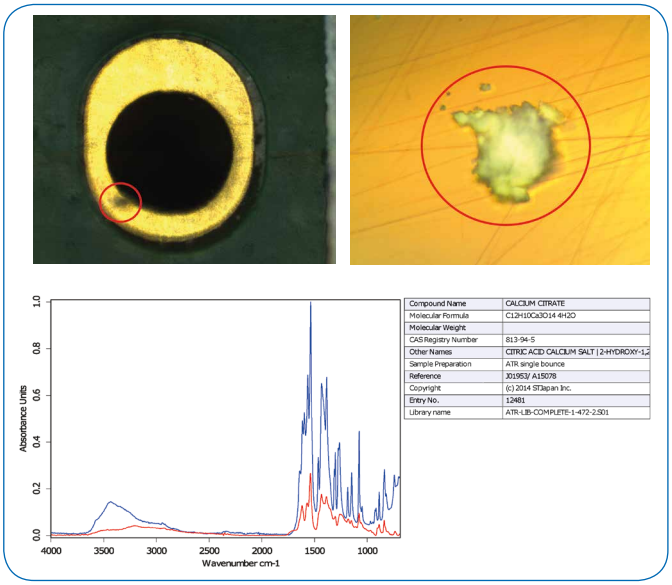

Figure 6: The metal contact (top left, magnified) was contaminated by an unknown white particle (top right, red circle). Spectral library search (bottom) of the residue's spectra. Contaminant was identified as calcium citrate).

Conclusion

These are just three examples, in which complex product defects were analyzed spot-on with the LUMOS FTIR microscope. ATR is the method of choice in these cases, because it is quick, flexible and does not need lengthy sample preparation. The results are evaluated in a matter of seconds while the measurement process is mostly automated and requires little to no effort.

Bruker Optics Inc.
Billerica, MA · USA
Phone +1 (978) 439-9899
Fax +1 (978) 663-9177
info.bopt.us@bruker.com

Bruker Optik GmbH
Ettlingen · Germany
Phone +49 (7243) 504-2000
Fax +49 (7243) 504-2050
info.bopt.de@bruker.com

Bruker Shanghai Ltd.
Shanghai · China
Phone +86 21 51720-890
Fax +86 21 51720-899
info.bopt.cn@bruker.com

www.bruker.com/optics