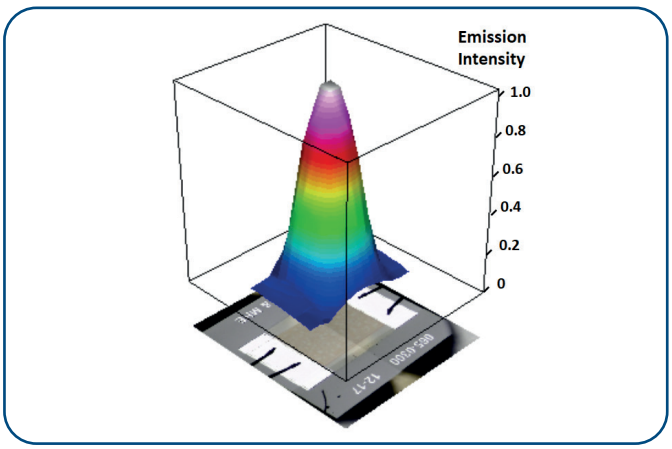

Application Note AN M168

Infrared Emission Spectroscopy on Micro Samples

Keywords	Instrumentation and Software
FTIR	INVENIO R/X, VERTEX
Emission	Unique bypass optical path, DigitectTM detector position
Micro emission research	Opus Wizard, OPUS 3D
Microscope emission solutions	Hyperion microscope, Step-scan amplitude modulation

Introduction

Using FTIR spectrometers to determine materials' emission spectra in a wide infrared spectral range is an important analysis technique in many research fields. Both, thermal emission resulting from heat, as well as emission caused by quantum mechanism (such as photo- or electroluminescence), act as a source in FTIR emission experiments.

High detection signals can often be reached when the materials are bulk and emit intense infrared radiation. Detection can become a challenge for some advanced emission investigations that are based on submillimeter size devices. For example, in the case of thin film based light emitters [Ref.1,2] or micro infrared diodes [Ref.3] etc. the total amount of radiation from such small areas is quite limited. Another challenge is to collect exclusively the emission from the area of interest of the sample itself, such that thermal background emission will not mask the signal of interest. In this application note, we introduce a unique and comprehensive Bruker solution nicely fulfilling these demanding requirements.

Typically, the Bruker Hyperion infrared microscope is used to measure samples with micron level spatial resolution in conventional transmission, reflection, and ATR measurement modes. In these modes, the infrared radiation from the integrated Globar or tungsten source of an INVENIO or VERTEX spectrometer passes the interferometer and is finally focused on the sample located on the Hyperion sample stage per objective or condenser. The sample absorbs a certain amount of IR radiation while the remaining radiation will be reflected and/or transmitted, collected again by the objective and then finally sent to the microscope detectors (Fig.1).

Such a classical optical path can be smartly "inverted" for emission or luminescence measurement mode such that the light emitted from the sample on the Hyperion sample stage is sent to the spectrometer where it will be finally analysed in the INVENIO/VERTEX detector compartment.

Figure 1: INVENIO with Hyperion microscope.

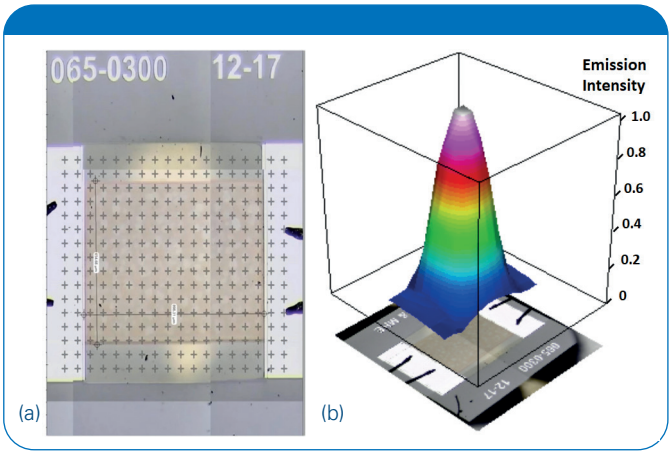

Figure 2: (a) Photo of a 0.65 mm² MIR emitter heated by constant 6V voltage supply (up to 500°C), taken by a Hyperion microscope. A mapping grid covering the entire emitting area has been selected with high lateral resolution. (b) 3D view of the relative total emission intensity (0-1) over the emitter area in mid-infrared spectral range whereas for each grid point a separate mid infrared spectrum is created.

Measurements

With the motorized Hyperion sample stage, one can easily perform single point microscope emission measurements but also line and area mapping are possible. Fig. 2 shows the emission profile of a MIR emitter (0.65 mm²) measured using a Hyperion microscope coupled to an INVENIO spectrometer. The 3D view in OPUS visualizes the total emission intensity distribution of the emitting area. Outstanding performance of the Hyperion microscope combined with utmost sensitivity of INVENIO or VERTEX spectrometer deliver a perfect solution for such advanced measurement tasks. The INVENIO spectrometer is further featuring the optical direct emission beam path such that the emission signal bypasses the sample compartment and can be directly guided to a highly sensitive internal detector.

State-of-the-art Bruker Step-Scan amplitude modulation (AM) technique is a valuable option, especially for micro-photoluminescence applications. By modulating the excitation laser for example, the PL signal from micro samples will be modulated with the same frequency and can be amplified via a lock-in-amplifier. In the meantime, the constant thermal background contribution is filtered out, which could otherwise conceal the weak PL signal. In Ref[1], Chen et al reported the MIR-PL spectra on ~30 µm dual-gate hBN/BP/hBN device measured by Bruker Vertex+Hyperion systems using the Step-scan AM method and proving an extraordinary achievable sensitivity.

Summary

Bruker research level FTIR spectrometers INVENIO and VERTEX are excellent and unique tools to determine emission or luminescence properties in infrared spectral range not only for bulk materials, but also for micron size samples with adapted Hyperion microscope. State-of-the-art Bruker step-scan amplitude modulation technique provides in addition the possibility to eliminate the unwanted thermal background contribution and allows to amplify the weak emission signal via lock-in amplifier, further enhancing the sensitivity for micro emission measurements.

References

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Bruker Scientific LLC
Billerica, MA · USA
Phone +1 (978) 439-9899
info.bopt.us@bruker.com

Bruker Optics GmbH & Co. KG
Ettlingen · Germany
Phone +49 (7243) 504-2000
info.bopt.de@bruker.com

Bruker Shanghai Ltd.
Shanghai · China
Tel.: +86 21 51720-890
info.bopt.cn@bruker.com

www.bruker.com/optics