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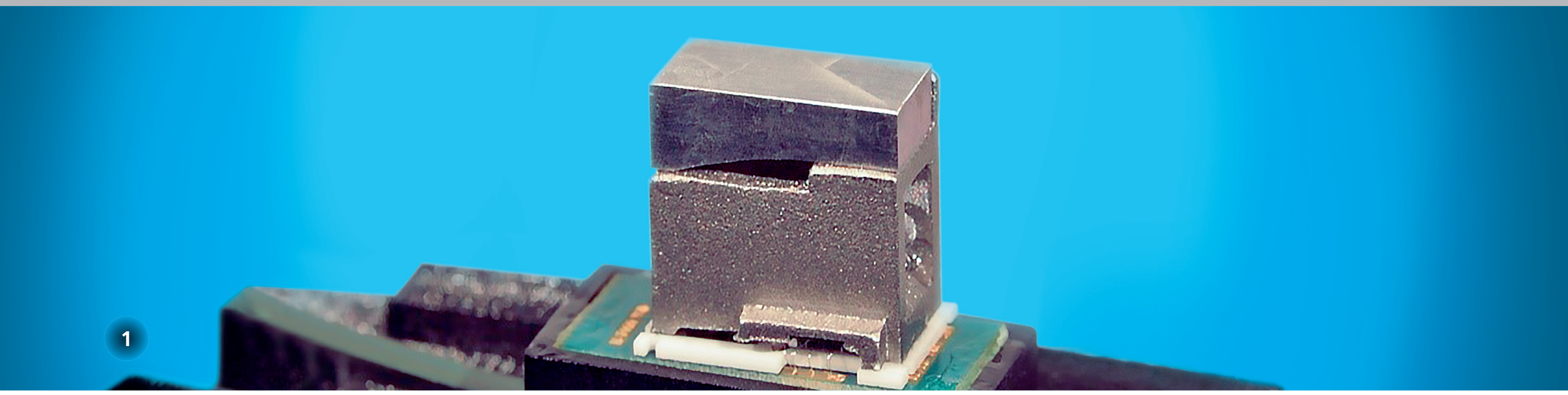

1 Assembled optical bench of the scanning mirror micro spectrometer

SCANNING MIRROR MICRO SPECTROMETER (SMMS)

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Motivation

Compact and ultra-compact systems for nearinfrared (NIR) spectral analysis enabling the integration into portable devices or even mobile phones may contribute significantly to the development of future systems for sensing and testing applications. Besides size, more and more technological aspects become relevant for high volume fabrication. Competitive production needs reduced complexity of the core components, simple electronics and low requirements for the assembly and integration process.

The scanning mirror micro spectrometer is based on a simple 1D-scanner mirror. A fixed grating is illuminated and diffracts the light. A small wavelength interval is reflected back onto the scanner mirror plate. After passing the refocusing mirror and the exit slit the intensity is captured by either a single detector or an arrangement of multiple detectors. In comparison to the well-known scanning grating technology, the main advantage is the double spectral range which is captured for a defined MEMS deflection range. Either half the deflection enables the same spectral range or double the range can be addressed with the same deflection. Furthermore the grating can be selected and adjusted for modular spectral range, resolution or blaze.

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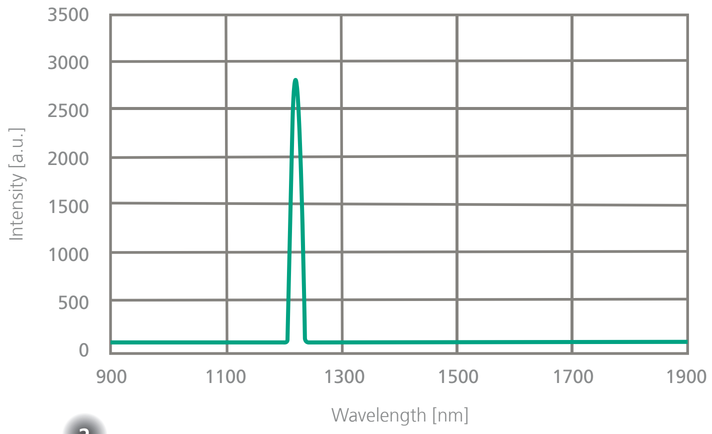

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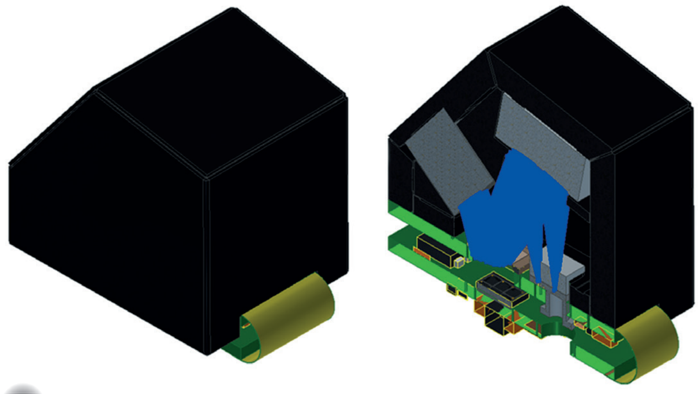

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2 Spectral measurement of the SMMS reveals 10 nm resolution (FWHM – full width at half maximum)

3 Design of the scanning mirror micro spectrometer (SMMS)

Description

The new SMMS system features the same spectral range from 950 nm to 1900 nm using an uncooled InGaAs detector. The system volume remains at 2.1 cm^3. The spectral resolution of 10 nm comes along with half the MEMS deflection of ±5° (mech.) only.

Function

The incident radiation from the entrance slit passes the collimation mirror on the scanner mirror before it is diffracted by the fixed grating in the optical path. Changes of the scanner mirror deflection adjust the angles α and β in the spectrometer. Due to the grating equation

$$n \lambda = g (\sin\beta - \sin\alpha)$$

diffracted light of a selected wavelength interval meets the MEMS mirror plate again towards the refocusing mirror and finally the detector behind the exit slit. The detector signals are amplified and converted in the approved way. The spectrum becomes available for the target application.

Field of application

NIR spectral analysis is favorable for the evaluation of organic matter. This includes food, cloth, plastic material but also living cells. Application may be found in the field of nutrition, life science, health or medical but also in materials processing or quality monitoring for plastics, petrochemical, recycling or other measurement tasks which benefit from mobile, fast and reliable analysis in the field.

Future developments

Applying multiple detectors with adjusted spectral sensitivity each behind a mating exit slit will enable broad band spectrometers from visible to nearinfrared range. Some examples are shown in table 1. Compact systems collect more spectral information and open new applications for portable spectral measurement systems.

Table 1: Potential spectral ranges for optional SMMS designs

	Detector 1 [nm]	Detector 2 [nm]	MEMS deflection	Detectors
Option 1	950 - 1900	-	< 5°	Ext. InGaAs
Option 2	400 - 800	800 - 1600	< 9°	Si & InGaAs
Option 3	475 - 950	950 - 1900	< 10°	Si & ext. InGaAs