Axetris‘ EMIRS broadband technology made for liquid measurements

Food purity and quality to ensure the public's health

The continued urbanization has resulted in a decentralization of agricultural goods being produced. This has led to longer delivery chains and thus increased the requirements for food quality control. With Axetris Infrared Sources, food producers can now keep control over the quality of their products and produce in a simple and affordable way.

To ensure that every single delivery is flawless, food producers must review their goods as early as possible in the production process. This poses a challenge especially for emerging countries, as the analysis of goods in a professional laboratory is hardly affordable and suitable for everyday use and is therefore not an option for farmers and producers.

An affordable and portable solution

Mid-Infrared Spectroscopy based on Transmission Spectroscopy or Attenuated Total Reflectance (ATR) technique offers an affordable and user-friendly solution. These straightforward techniques enable us to design tools, which are compact, robust in handling and provide reliable measurements. Furthermore, sample preparation, consumables or reagents are not required, and a measurement is conducted within seconds. Thus, much broader and earlier control with minimal running costs is possible, reducing risks in the value chain and ultimately ensure higher food quality.

How does it work?

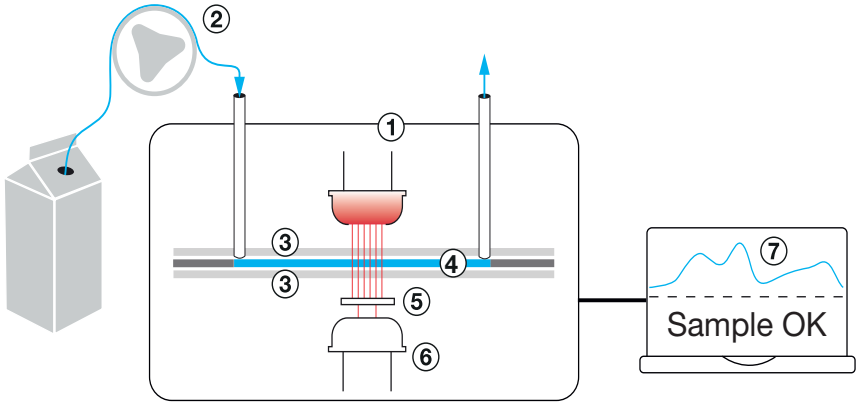
Mid-Infrared Spectroscopy is a widely accepted sample characterization and quantification technique that's used regardless of the sample form (gas, liquid, paste-like or solid). The technique is used extensively in applications requiring qualitative or quantitative analysis, providing information regarding molecules and their bondings. Such information can be used to calculate concentrations or to compare chemical fingerprints of samples. The infrared spectrum of a sample is recorded by letting a beam of infrared light interact with the sample. When the frequency of the IR is the same as the vibrational frequency of a bond, absorption occurs. Examination of the light gathered at the detector reveals how much energy was absorbed at each frequency.

The measurement method is non-destructive and doesn't require sample preparation or reagents. Typical measurement is conducted within a minute and can be done on-site.

Advantages of Axetris‘ Infrared Source for MIR Spectroscopy

- ✓ True black body radiation (2 to 14 µm)
- ✓ High modulation depth over a wide frequency range for time resolved measurements
- ✓ Optimized reflector for an easy integration with maximum efficiency
- ✓ Low power consumption allows the design of a cost-optimized electronics

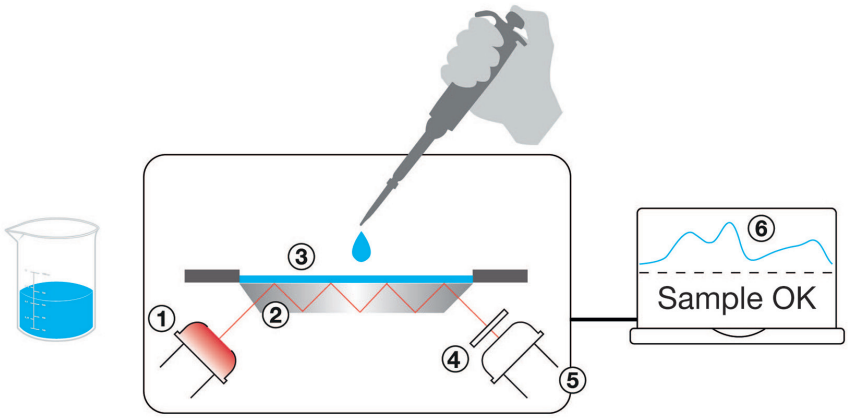
Transmission Spectroscopy:



1. *Infrared Source EMIRS200*
2. *Dosing system with pump*
3. *Broadband window*
4. *Thin spacer between the windows*
5. *IR Band pass filter*
6. *Pyroelectric (line array) detector*
7. *HMI (measurement and analysis)*

In transmission spectroscopy light travels through a medium to detector. The radiation is absorbed depending on the media and the thickness of the sample cell. Depending on the chemical composition of the sample, the spectral fingerprint will change accordingly. The sample can be brought to the cell by bypass stream or manually. In cost-sensitive applications multi-channel, line array or Fabry–Pérot interferometer (FPI) approaches can be applied, i.e. thermopiles or pyroelectric detectors with band pass filters or interferometers are used to read the information.

Attenuated Total Reflectance (ATR):

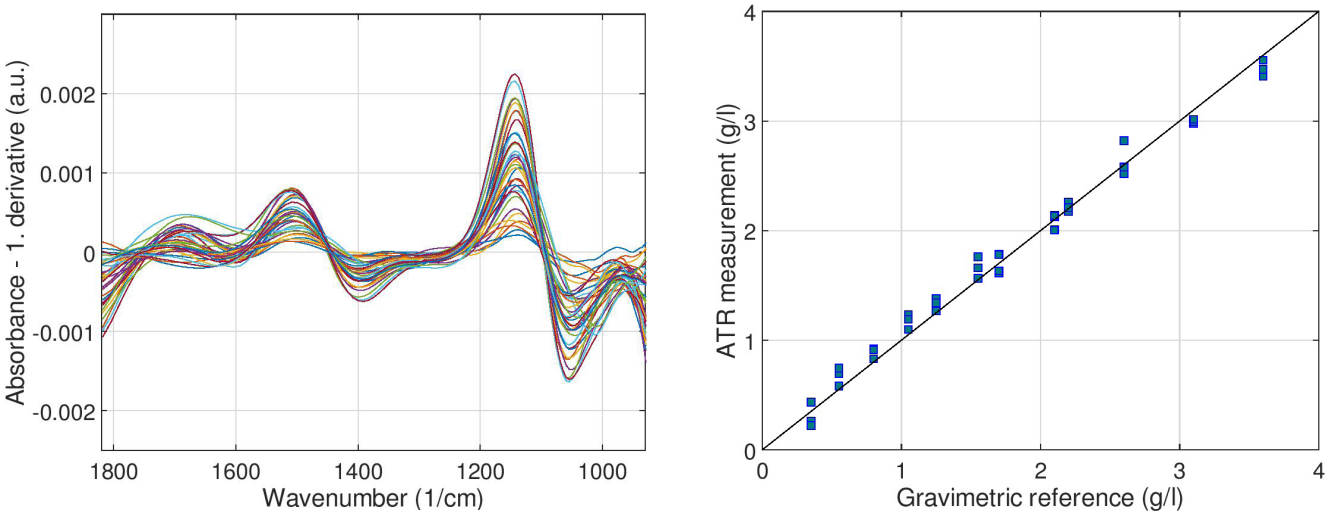


1. *Infrared Source EMIRS200*
2. *ATR crystal*
3. *Sample in contact with the crystal*
4. *IR Band pass filter*
5. *Pyroelectric (line array) detector*
6. *HMI (measurement and analysis)*

In the Attenuated Total Reflectance approach, the light is guided to a crystal, where the light will have one or multiple, total reflections and then exit to the detector. At the point of total reflection, the light will interact with the medium on the other side of the boundary. Depending on the molecules in the medium, specific frequencies of the light will get absorbed and the signal on the detector then changes accordingly.

The penetration depth of this interaction is dependent on the refractive indexes of the crystal and the medium and is typically in the range of few micrometers. Typically, the sample is brought on the crystal manually with a pipette, but the system can also be built in an immersion probe or flow-cell. The same remark regarding cost-sensitive detectors as in transmission principle is valid also for ATR.

Example: ammonium sulfate in milk measured with low-cost ATR setup



Ammonium sulfate is used in milk adulteration to mask the concentration change after water is added. The limitations of a low-price (a fraction of a standard spectrometer such as FTIR) spectrometer setup was tested by spiking UHT milk with ammonium sulfate. The setup consisted of two EMIRS200 IR sources built into a Pyreos PY0727 ATR spectroscopy evaluation kit. The IR energy from the light source was passed through a multi-reflection zinc selenide ATR crystal and received by a Pyreos PY0728 128 pixel linear array. The infrared array sensor had an integrated linearly variable filter (LVF) from 1800 to 900 cm^{-1} (5.5 to 11 µm). A chemometric model was calibrated and tested with validation samples. Above is the validation data for preprocessed spectra and concentration predictions. The root-mean-square error of prediction was 0.11 g/l—comparable to commercialized devices in the market.

Attenuated Total Reflectance (ATR):

Considering standard devices and installations	MIR Spectroscopy	NIR Spectroscopy	Mass Spectrometry
Performance and reliability			
Simple data analysis	+	0	-
High accuracy	+	0	++
Investment and operating costs			
Low initial investment	+	+	-
Low cost of ownership	++	++	-
Flexibility and application area			
Easy to use and adapt	++	+	-
Applicable in a harsh environment	+	++	-

Conclusion

Axetris Infrared Sources provide excellent emission characteristics in the entire Mid-IR range. Therefore, they offer an ideal component for process condition monitoring, detecting contaminations/adulterants and analyzing the purity of high quality products. The technology builds the basis for competitive and affordable analyzing solutions that will find their way into various existing and new applications.

The ideal tuning of all components, especially in reference to the size of the IR detector, is certainly decisive. This can be matched by the curvature of reflective surfaces, the surface quality (Reflection and Scattering) and by the ideal design of optical filters and lenses. To help our customers achieve higher optical performance (which translates into higher sensor performance), Axetris regularly undertakes optical simulations using tools such as Zemax. As a result, concrete improvements such as custom reflectors or adaptations and improvements of the overall optical design can be implemented.

The Axetris application team offers competent support in achieving the best performance integrating the IR Source into the spectrometer.

About Axetris Infrared Sources

Axetris infrared sources are micro-machined, electrically modulated thermal infrared emitters. The unique design is based on a resistive heating element integrated onto a thin dielectric membrane, which is suspended on a micro-machined silicon structure.

Infrared sources from Axetris are used in a number of gas detection applications in medical, industrial, environmental and automotive industries.

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