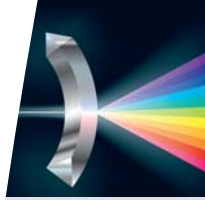




**High Speed  
Diode Array Spectroscopy**

**Spectrometer Systems**  
for Industrial UV/VIS/NIR Applications



# Learning from Light

It is amazing! Analyzing the composition of optical radiation provides valuable information about light and matter. Optical parallel spectroscopy measures the intensity of light for each wavelength. The process is contactless, non-destructive and fast.

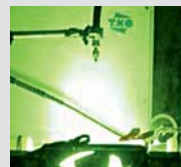
Interaction with matter influences the spectral composition of light entering the spectrometer. These minute changes are recorded by the measuring instrument and reveal the characteristics of the studied material.



Colour



Film Thickness



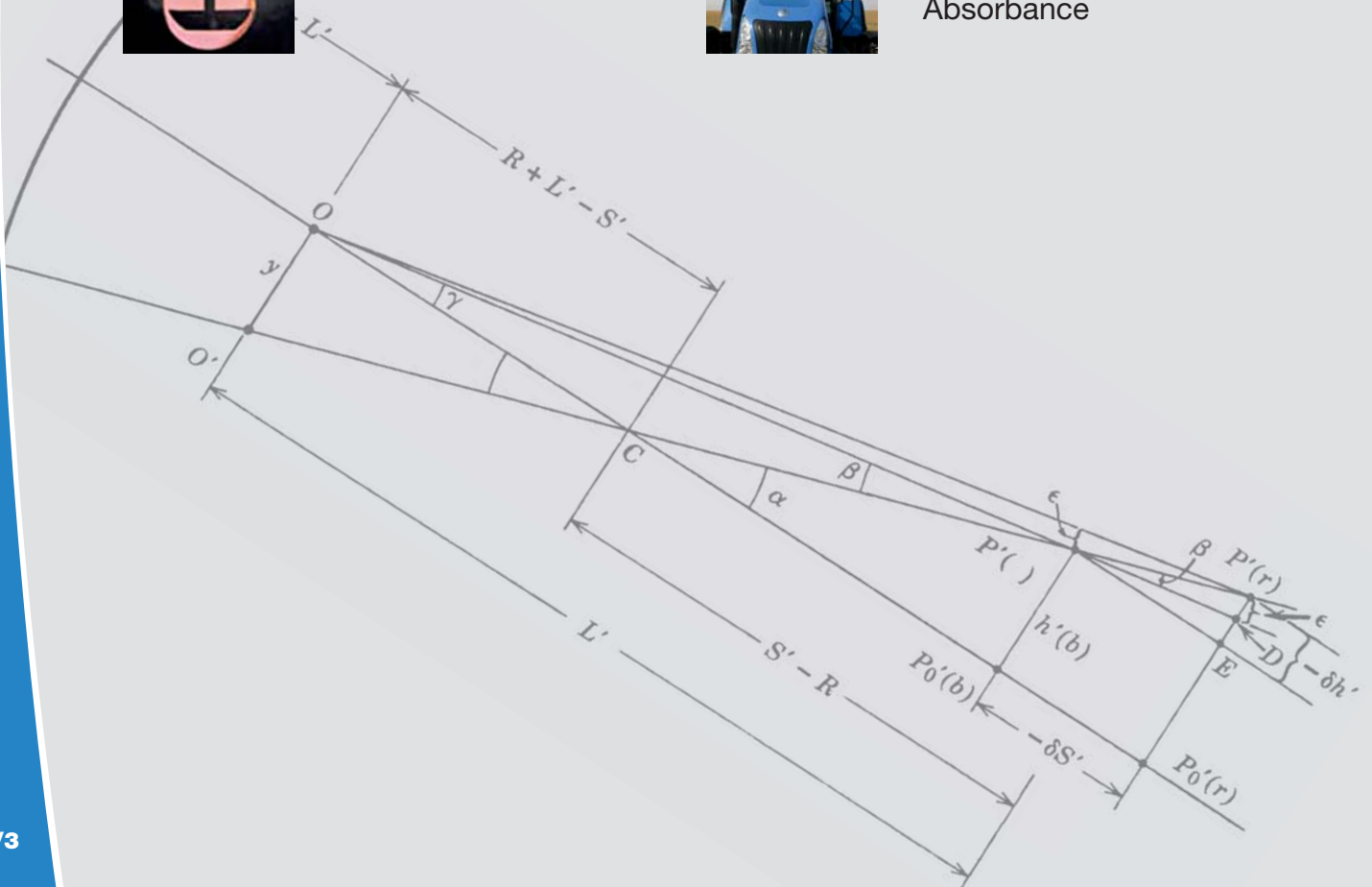
Emission



Concentration



Transmission, Reflection, Absorbance



# With a vision...



tec5 has been certified according to ISO 9001 since 2000.



...of providing high quality spectroscopic solutions for a multitude of applications, our five founders established the company in 1993. Today, tec5 is operating worldwide with subsidiaries in the USA and UK; global representatives are positioned to better serve local markets.

As an industry leading company in UV/VIS and NIR spectroscopy with an established focus on market needs and customer requirements, tec5 specializes in research, development and manufacturing of suitable components and systems. Our high quality products range from standard OEM electronics modules to complete application specific solutions.

At tec5 we pair our core competencies in high speed diode array readout technology, optical, mechanical, electronic and software engineering with excellent customer service and support. Our engineering team leverages many years of experience utilizing the highest performance development tools. The array of products is complemented by service of initial conception, project planning, hardware design, software creation, system implementation, user training and after-sales support.

Close cooperation with professional component manufacturers provides direct access to all key technologies for optical process spectroscopy.

Our technology extends into many application areas. Industrial optical spectroscopy is instrumental in helping industry maintain optimal quality in the production process and reduce cost. The environment benefits from faster and more accurate measurement methods. Moreover, research and development labs use the technology to create new materials, streamline processes and ensure product efficiency.

tec5 is proud to be at the forefront in the field of optical spectroscopy and to provide cutting edge solutions - today and in the future.

tec5 AG

## Products

- Spectrometer systems
- Electronics modules
- Spectral Sensors
- Custom solutions
- Software

## Examples of Applications

- Process control
- Quality inspection
- Environmental monitoring
- Precision farming
- Research and development

## Industries

- Chemical
- Pharma
- Food
- Printing

- Semiconductor
- Glass
- Agriculture
- Solar

- Optical
- Lighting

# UV/VIS/NIR Spectrometer Systems for Process and Laboratory



Concentration of liquid, gaseous and solid samples

Colour measurement

Reflection and transmission

Quality control

Monitoring light emission, solar spectrum and plasma

Film thickness

End-point detection

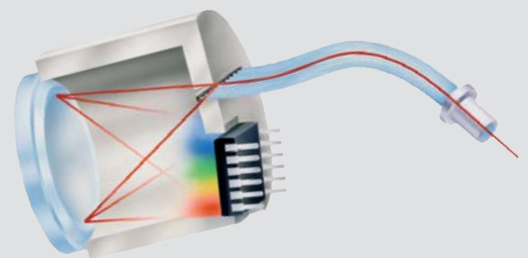
Reaction monitoring

Monitoring of extraction and distillation processes

## Detector Array Technology

tec5 systems are designed to meet highest demands in UV/VIS/NIR spectroscopy. Based on detector array technology they are able to acquire a full spectrum in milliseconds or even less. In addition, the rugged design of the monolithic Spectral Sensors from Carl Zeiss allows reliable and accurate data acquisition in rough environments, without any need of recalibration.

Only high-quality, low noise detectors with a high dynamic range are used. Dark current sensitive NIR and CCD devices are thermoelectrically stabilized for drift free operation. With these features they are ideal devices for high performance process and production control.



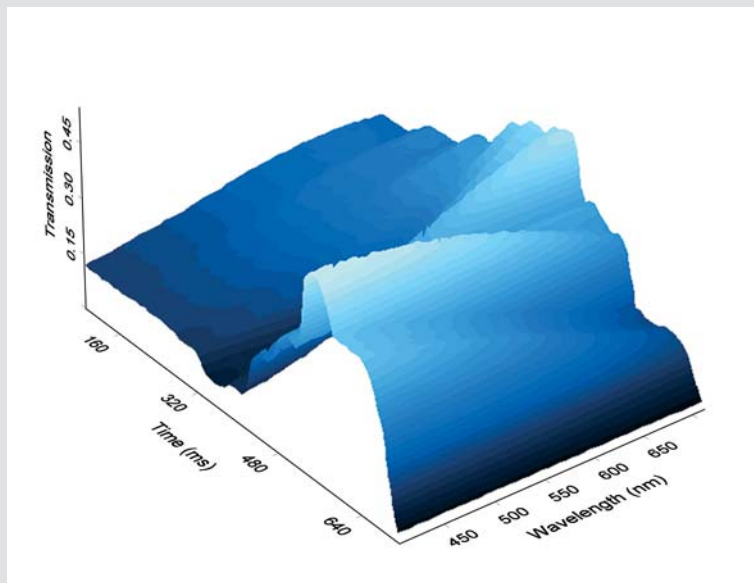
MMS optical scheme

- Fast and continuous measurements
- Modern multiplexer technology for multichannel applications
- Standard fiber-optic connection
- Multicomponent analysis
- Drift free operation by internal referencing
- Complete system solutions

# MultiSpec<sup>®</sup> – Modular Instrument Family of Fast Diode Array Spectrometer Systems

MultiSpec systems offer a flexible housing concept in 19" industrial design. Multiple detectors and different light sources can be combined to cover a wide range of application needs. tec5 electronics guarantee stable and robust data processing, using high speed USB or Ethernet interfaces. The integrated spectrometer modules use high-quality optics without moving parts resulting in outstanding long-term stability. With standardized fiber-optic connectors these spectrometer systems can be integrated directly into the production process providing reliable real-time results. MultiSpec systems are successfully applied by many well-known companies.

- Available spectral ranges from 195-2500 nm
- Reliable Spectral Sensors with high efficiency from Carl Zeiss



## MultiSpec<sup>®</sup> NIR

MultiSpec NIR instruments offer various spectral ranges between 900 nm and 2500 nm. tec5 uses latest (extended) InGaAs technology with a high dynamic range of up to 16 bit, excellent signal to noise ratio and wavelength stability. The detector array based design allows the acquisition of complete spectra within milliseconds.

## MultiSpec<sup>®</sup> UV-VIS

Solarization-free UV stable spectrometers and optical fibers allow spectroscopy down to 195 nm. The MultiSpec systems can be equipped with various light sources including deuterium/halogen, Longlife halogen and Xe flash lamps. Highest stability is assured by consequent use of precision lamps with prealigned sockets.

## MultiSpec<sup>®</sup> CCD

The back-thinned, back-illuminated CCD technology combines very high sensitivity over the full spectral range from UV to NIR. These CCD arrays are especially suitable for low light level detection like fluorescence, film thickness, plasma or diffuse reflection measurements. With their capability to detect even smallest amounts of light, short exposure times can be achieved for high speed process control.



MultiSpec<sup>®</sup> with reflection head RP-7

# CompactSpec<sup>®</sup> – Process Spectrometer System for Rough Environment

CompactSpec II is a robust UV/VIS/NIR instrument in a stainless steel cabinet (IP 54/65) with an industrial PC and a TFT touch screen monitor. Based on fast and reliable detector array and light source technology with high endurance, it is ideal for demanding process applications. An electronic or optical multiplexer allows multichannel operation. The units and systems are easily adapted to inline measurements in pipes and reactors by fiber optics in combination with probes or flow-through cells. The instrument is temperature controlled by a Vortec cooling unit, using pressurized air.

## CompactSpec<sup>®</sup> II EEx

CompactSpec II EEx uses a pressurized enclosure which allows the operation in hazardous areas inside Ex zones 1 and 2.



VinSpec<sup>®</sup> SP – Inline inspection of colour and film thickness

## Awarded Solutions for the Solar Industry

We are proud to offer innovative solutions for the green energy business. tec5 technology is already successfully used by leading solar cell manufacturers at various stages of wafer and solar cell production for applications including

- Inline process control for the thickness of the antireflective coating at PV wafers
- Inline analysis of wet chemical processes
- Intensity control of sunlight and flash simulators
- Quality control of solar glass

## Our Technology – Your Advantage

- High throughput
- High quality standards
- Low production cost



# MultiSpec<sup>®</sup> – Spectroscopy Software and Other Software Products

MultiSpec Pro is a powerful software package for Windows platforms with various data display, processing and output options, optimized for process applications. It is offered by tec5 in a basic version and optional additional modules for e.g. chemometric prediction, colour measurement and process communication.

## Benefits

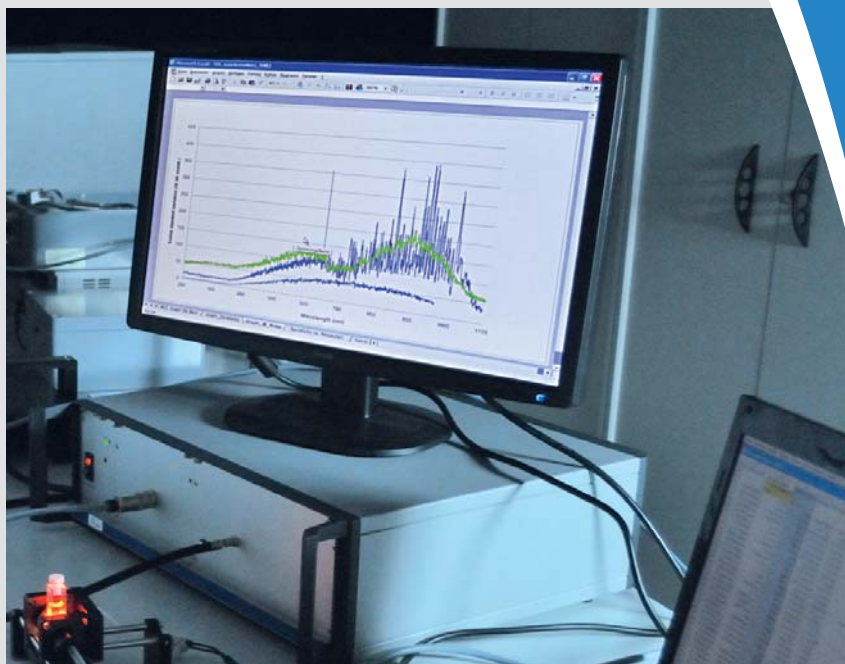
- Continuous measurement with automatic data/result storage
- Simultaneous handling of various windows containing spectra, charts, results or other information
- Direct data export to ASCII or JCAMP format
- System diagnostic protocols (GMP)

## Optional Modules

- Chemometric prediction based on Unscrambler<sup>™</sup>, GRAMS<sup>™</sup> or SensoLogic models
- Colorimetric processing (CIELab)
- System control featuring e.g. user management, logfile and intensity monitoring
- Multi-channel operation
- Data preprocessing including bubble and particle compensation

## Process Communication

tec5 spectrometer systems can be equipped with analog (4-20 mA) / digital I/Os, Profibus or OPC interface to transfer results and status information to a process control system. In addition the system can be remotely controlled by a host system (SPS, PLS).



## Software Tools, Drivers and SDK's

**Software Development Kits** for easy integration into customer specific applications, with direct support for C#.net, C++, Visual Basic and Delphi as well as a function library for LabVIEW<sup>®</sup> are available. In addition the library SDPROC32 is offered with ready-to-use dialogue boxes for spectral data acquisition, configuration and parameter setting on a high level of abstraction.

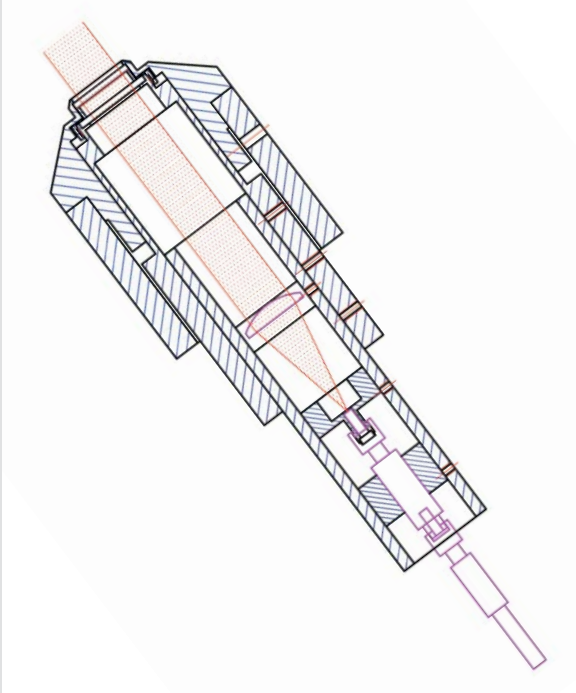
**TFPro Film Thickness Software** is an application designed to determine the thickness of transparent layers by analyzing white light interference. It provides spectrometer system control, data acquisition and processing, as well as many different display options and TTL outputs.

**GRAMS/AI<sup>®</sup>** driver links tec5 hardware to GRAMS software suite from Thermo Galactic by the My Instrument interface. This spectroscopy software can be extended by many add-on modules and complies to 21 CFR Part 11.



**GRAMS/AI<sup>7</sup>**

# Customer Specific Instrumentation/ OEM Production



In close cooperation with our customers and taking advantage of their application specific experience, tec5 develops and produces custom designed components, sub-assemblies or complete instrumentation for many different optical measurement tasks with an emphasis on optical spectroscopy.

- Contract development
- Conception, design, prototyping
- Batch production

## Mobile Spectrometer Solutions HandySpec® Field and AgroSpec®

**HandySpec** is a family of portable instruments using a PDA with a Win CE based operation software. Various measuring heads can be adapted to the application. The HandySpec Field version is designed to measure the spectral characteristics of plants and soil. The sensor head allows to pick up the reflected light from the ground as well as the light emitted from the sun for referencing.

**AgroSpec** is an IP65 protected NIR spectrometer system designed for the harsh conditions on harvesters or mobile field use. Equipped with the NIRON reflection head the system is ideal for online measurements within a fermenter service pipe of Biogas plants.



NIRON reflection head with integrated light source and internal white reference



Tractor-based Operating Electronics for the YARA N-Sensor, including processing electronics and Spectral Sensors in IP65 housing.



AgroSpec®



HandySpec®

# Fiber Optic Accessories

## Probes, Flow Through Cells and Fibers

With the development of fiber-optic systems the analysis has moved directly to the process. Continuous measurements can be made in-situ without sampling.

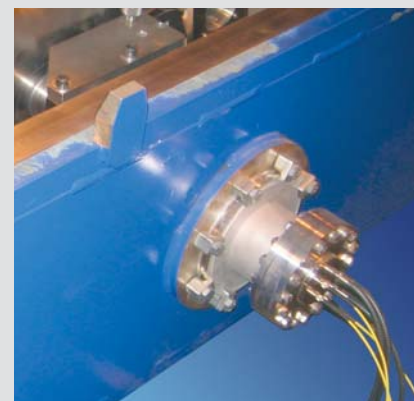
The standardized fiber optic connectors offer a maximum flexibility through a wide variety of available measuring heads or optics for reflection and transmission. tec5 offers complete solutions to ensure that the accessories and the spectrometer system are well matched. In cooperation with product partners we design special probes/fiber optics to meet our customer's needs when there is no commercial product available.



## Multiplexing UV-NIR Measurements

tec5 instruments in combination with the optical multiplexer MUX-FSM, which is based on latest piezo technology, allow the measurement of up to eight channels. Therefore, the cost per measurement point is reduced dramatically. Short switching time of 20 ms, low intensity loss, outstanding reproducibility and long life time are key features of this multiplexer.

For UV/VIS applications the electronic Spectral Sensor Multiplexer MUX-8A provides unique advantages. In multi-point operation spectra of up to 8 channels can be read out simultaneously. When sample and reference data are acquired at the same time for referencing of e.g. a Xe flash lamp, variations and drifts of the light source are compensated perfectly. The tec5 multiplexer has no moving parts and is fast and reliable.



MultiSpec® with multiplexer MUX-FSM

# Components for OEM Solutions

tec5 has been developing electronics for detector arrays for years in close cooperation with manufacturers of detector arrays and Spectral Sensors. As a result, our customers make use of our high performance technology by including OEM components in their state-of-the-art spectroscopic devices.

Our products are based on PC oriented interface technology for operation with standard computer equipment. NMOS, CCD and InGaAs photodiode arrays are supported.

Customers take advantage of tec5 high-quality OEM electronics subunits for spectral data acquisition with an outstanding performance/cost ratio.



## Building Blocks

The hardware and software follow a modular architecture with space-saving mechanics for compact product design. Even multichannel, multi wavelength configurations are realized easily in customer instruments.



## Design for Speed

Fast readout with high dynamics

Process synchronization (flash control, trigger input, digital I/O)

High throughput PC interfaces

## Short Time-to-Market with tec5 Technology

- Proven high-end components
- Software development kits
- Direct support for system integrators
- Continuing development
- Customization available

# Customer Advantages



- Far-reaching know-how in optical spectroscopy and many years of experience with applications
- Modular standard components, systems and customer specific instruments
- Complete solutions with high-quality products, competitively priced
- Prototyping, single unit and serial production
- Competent consulting and excellent technical support
- Close cooperation with technology leaders
- Outstanding know-how in operation of photodiode arrays and single detectors

## Worldwide Distribution





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