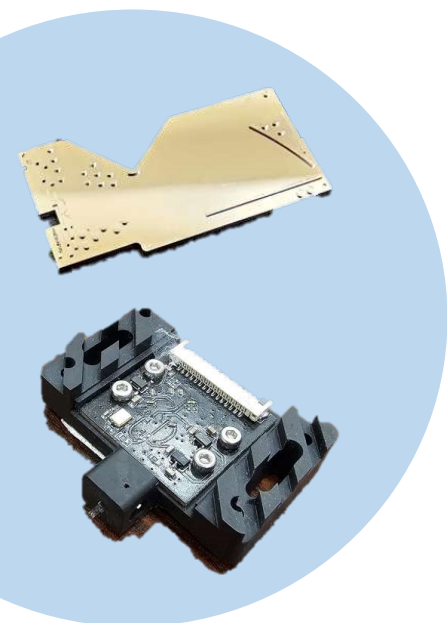**spectrochip** | **SPU SYSTEM**

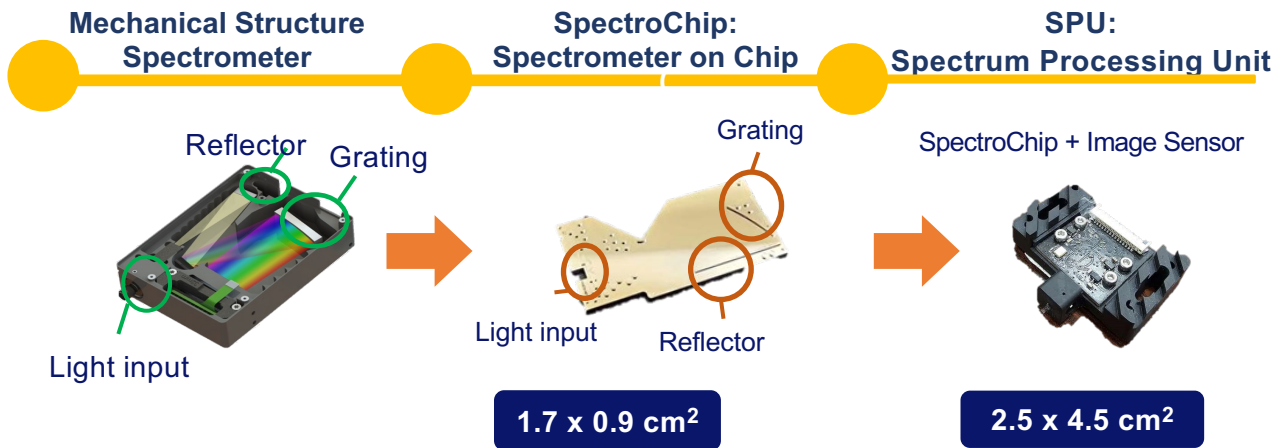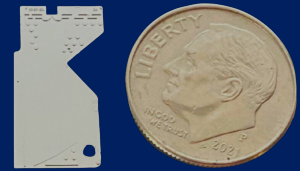*Bringing Changes in Full Spectrum*

SpectroChip/SPU Modules & Solutions

Micro-spectrometers with Built-in SpectroChip Technology

Water Quality

Food Safety

Controlled Substance Detection

HealthCare

Agriculture

Veterinary

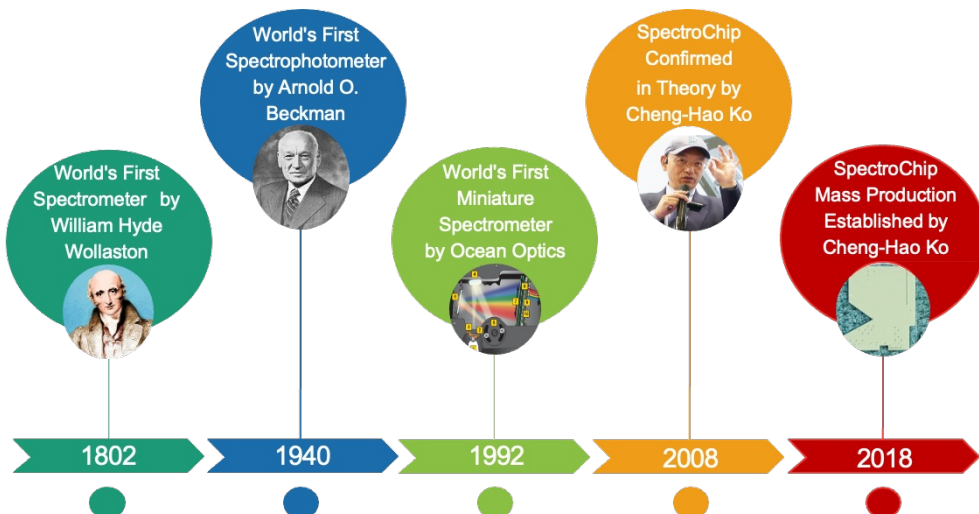High-Tech Production & Recycling

SpectroChip – A Breakthrough Technology Revolutionizes the Field of Spectrometry

0.5 nm X-ray lithography to pack the full optical function of a spectrometer into a fingernail-sized chip

Mechanical Structure Spectrometer

Reflector Grating

Light input

SpectroChip: Spectrometer on Chip

Grating

Light input Reflector

1.7 x 0.9 cm^2

SPU: Spectrum Processing Unit

SpectroChip + Image Sensor

2.5 x 4.5 cm^2

SpectroChip Advantages

- No assembly
- No alignment
- High accuracy
- High sensitivity
- Small form factor
- Monolithic wafer-based mass production

World's First Spectrometer by William Hyde Wollaston — 1802

World's First Spectrophotometer by Arnold O. Beckman — 1940

World's First Miniature Spectrometer by Ocean Optics — 1992

SpectroChip Confirmed in Theory by Cheng-Hao Ko — 2008

SpectroChip Mass Production Established by Cheng-Hao Ko — 2018

SpectroChip/SPU Technology—Offering Solutions and Services for Many Industries

The miniature form factor of SpectroChip & SPU modules enables compact designs of accurate spectrum sensors, as individual sensors or sensor hubs/arrays, in many industrial applications. It also supports efficient integration with other systems including data security, communication, IoT, AI chips, etc.

From simple plug-and-play spectrometer for school education or research purpose to complicated spectrum sensor hubs, SpectroChip/ SPU technology can provide unique solutions and services.

Modules in Pipelines

> **Micro VIS-NIR High Resolution Spectrometer**

> **In-situ Real-time Production Line spectrum Profiling Sensors**

> **Regular Detection Sensors (ppm or ppb level)**

> **High Sensitivity Detection Sensors (Sub-ppb levels)**

> **Compact Raman Spectrometers with SPU System embedded**

Milestones

2002:
Spectrometer SOC Project Start

2002-2017:
Developed SoC Spectrometer theory. Manufacture process development.

2018:
SpectroChip Inc (Taiwan) established. Process precision: <1 nanometer Technology patented in the United States & Taiwan.

2018-2022:
Taiwan FDA License (3 models). System validation & application development with medical centers in Taiwan. The One InstantCare system released. Ready for Covid-19 antibody test. USA FDA(510K) listed in December 2020.
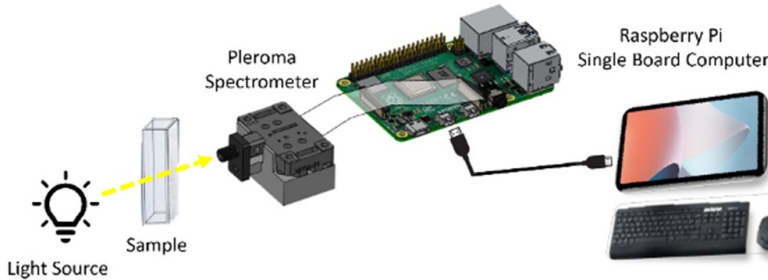
2023:
SPU System Inc (United States) was established. Partnership and business development in various industries

Pleroma Micro-Spectrometer

MSR-001

A SPU designed for Raspberry Pi applications.
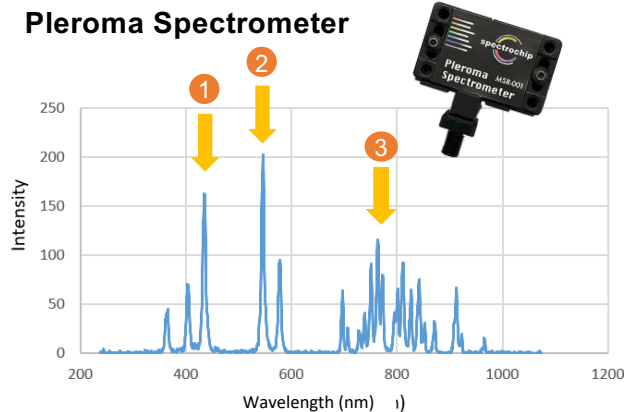

Features

- Spectral range: 300-1000 nm
- Highly accurate optical characteristics
- Direct connection to Raspberry Pi SBC
- Python source code available
- Compact design for easy integration
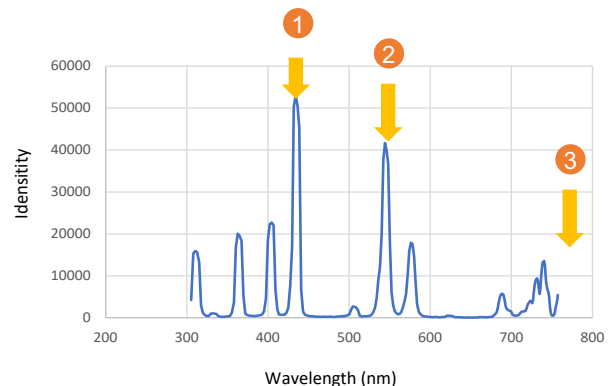- Compatible with SMA905 fiber connector

Specification

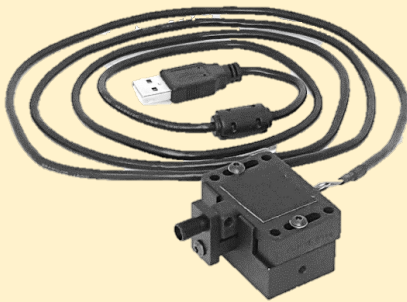| Optical	
Optical Module	SPU
Spectral Range	300 ~ 1000 nm
Spectral Resolution	5.0 nm
Spectral Accuracy	+/- 0.375 nm
Stray light	0.04%
Electrical / Mechanical / Dimension	
A/D conversion	8 bits
Integration time	0 ~ 1,000,000 µs
Data Interface	CSI camera connector
Power Consumption	158 mW
Image sensor	OV9281
Number of pixels	1280
Dimensions (WxDxH) / Weight (module only)	$44 \times 26.5 \times 11$ mm^3 / 12 g
Dimensions (WxDxH) / Weight (module + holder)	$44 \times 47.28 \times 26.25$ mm^3 / 50 g

Spectral Performance

Hg-Ar Spectrum

Pleroma Spectrometer

Wider spectral range & better resolution

Other Micro-Spectrometer

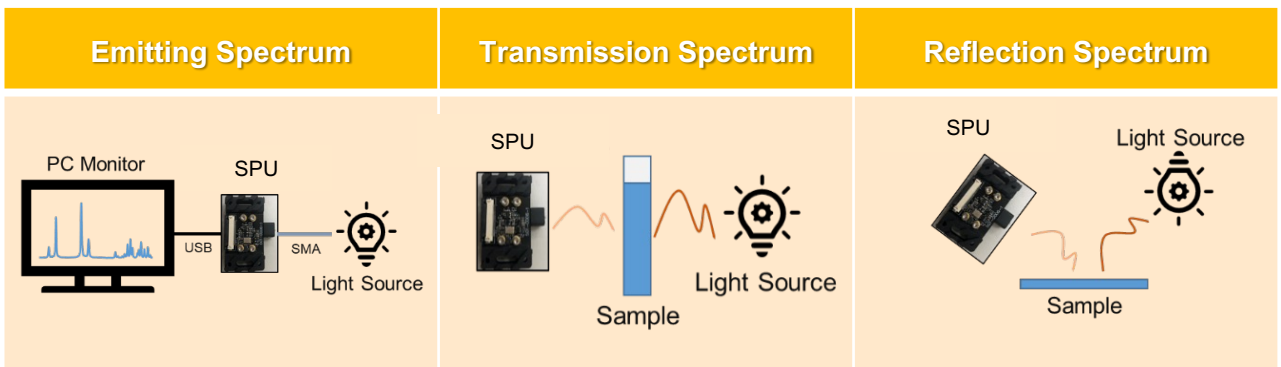# USB Micro VIS-NIR High-Resolution Spectrometer

MSU-100

Features

- USB connector to PC / Mac
- Plug and play
- Compact
- Open-source imaging software
- Compatible for all OS
- Broad wavelength range
- High spectral resolution
- Real time monitor
- Diverse applications (Optics, Medical…etc)

Application Examples

Emitting Spectrum	Transmission Spectrum	Reflection Spectrum

Model Number	MSU-100
Wavelength range	300 ~ 1000 nm
Spectral Resolution	5 nm
Spectral Accuracy	+/- 0.375 nm
Stray light	0.04 %
Image sensor	OV9281 Mono
A/D Conversion	8 bits
SNR_{max}	6000 (38 dB)
Dynamic range	6×10^6 (68 dB)
Optical connector[1]	SMA905
Measurement time	10 Hz[2]
Working temperature	5 ~ 35 ℃
Connector type	USB
Dimensions (WxDxH) / Weight (module only)	$44 \times 26.5 \times 11$ mm^3 / 12 g
Dimensions (WxDxH) / Weight (module + holder)	$44 \times 47.28 \times 26.25$ mm^3 / 50 g

Illustration

High sensitive detection of atomic spectrum from Hg-Ar light source
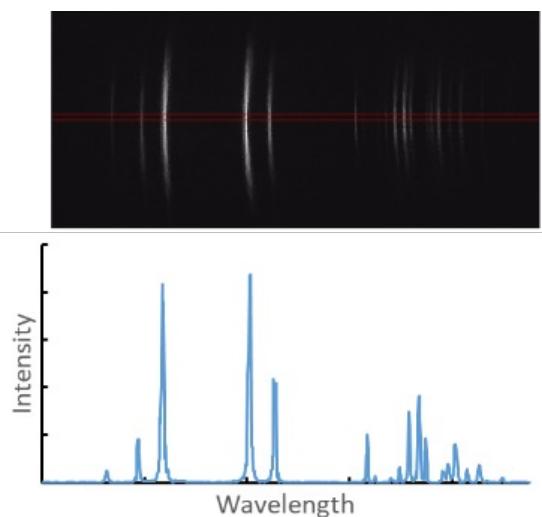
*1 Switchable to other types of optical connectors.
*2 Depending on system performance.

Spectro-Engine

Biochemical Analyzer

SE-100

Spectro-Engine is a compact, lightweight spectrophotometer with a wide spectral range and high resolution capabilities. It is versatile, suitable for analyzing transmission, absorbance, and fluorescence in chemical materials. It can also function as an embedded system for various industrial testing needs.
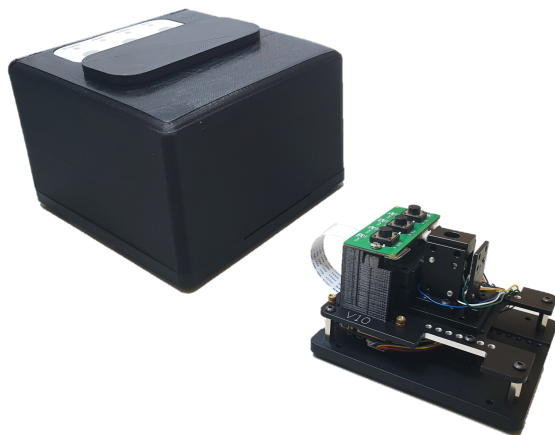
Features

- Spectral range: 300 ~ 1000 nm
- Easy operation with mobile phone App
- Reads absorbance and fluorescence
- Portable for any test site applications

Applications

- Chemical analysis
- Academic and pharmaceutical research
- Environmental monitoring
- Material characterization
- Food and beverage analysis
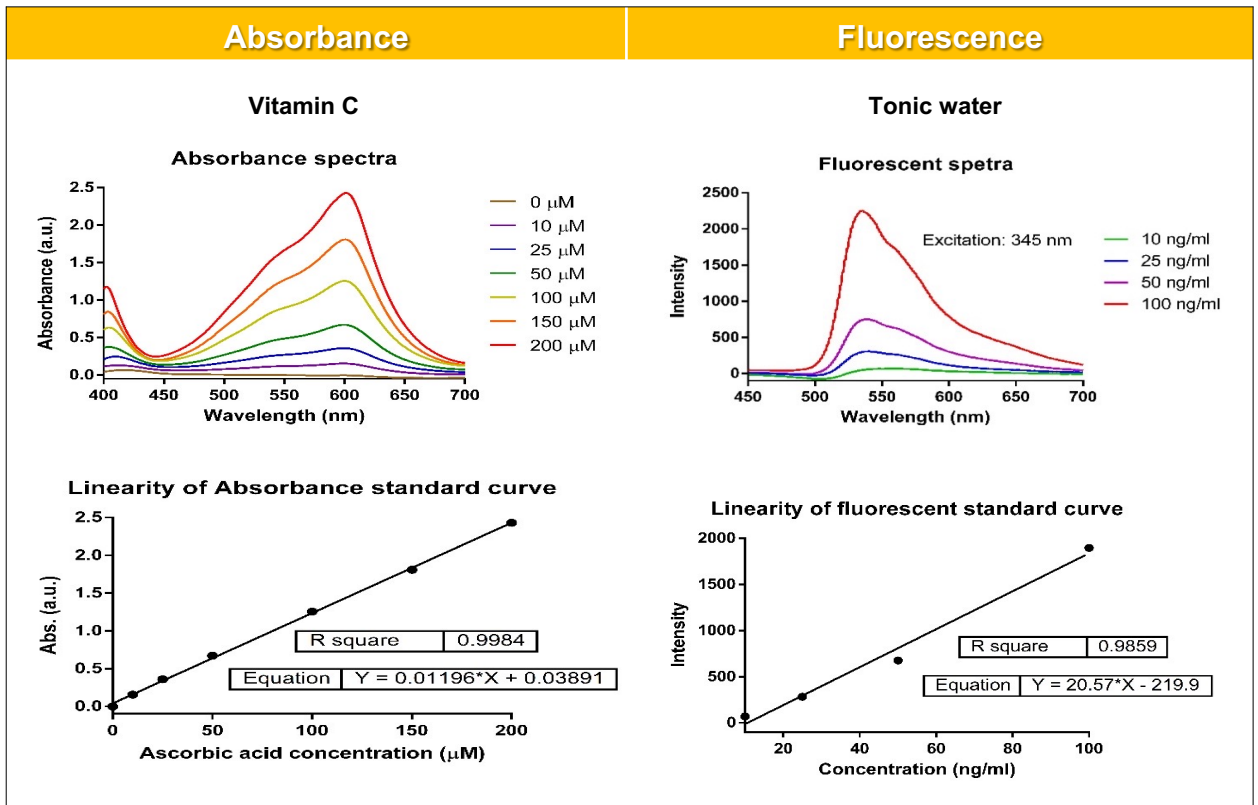
Configuration Example

PC

Spectro-Engine

SPU

Light Source

Sample

or

Mobile Device
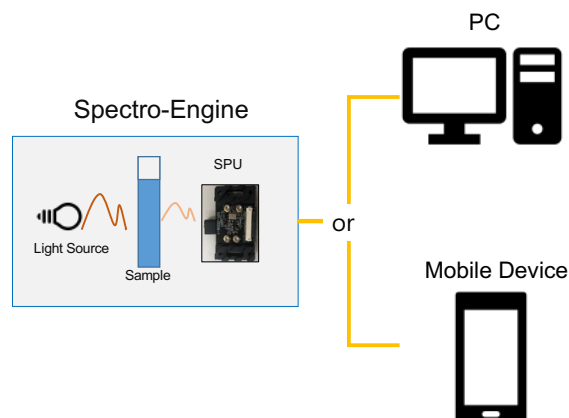
Specification

Optical	
Optical Module	SPU
Detection Type	Transmission, Absorbance, Fluorescence Spectrum
Spectral Range	300 ~ 1000 nm
Resolution	5.0 nm
Spectral Accuracy	0.5 nm
Light Source	UV LED (Peak~345nm)
	Cyan LED (Peak~500nm)
	White LED (400~700nm)
SNR	2400:1 (33.8 dB)
Dynamic Range	4096:1 (36.1 dB)
Stray light	0.04%

Biological	
Sample Vessel	200 µL, 600 µL 1cm cuvette, 3cm cuvette
Turn-around Time	4 seconds
Sensitivity: LOD	OD accuracy: <1% at 2.0 OD OD repeatability:<0.5% at 2.0 OD
Electrical / Dimension / Weight	
Power Interface	Micro USB (5V/2.4A)
Data Interface	Mini USB / Bluetooth
Power Supply	$\geq$ 12-Watt USB Power Adaptor
Dimension	11 cm x 10 cm x 7 cm
Weight	430 g

Spectral Performance

Absorbance	Fluorescence

Vitamin C

Absorbance spectra

- 0 μM
- 10 μM
- 25 μM
- 50 μM
- 100 μM
- 150 μM
- 200 μM

Linearity of Absorbance standard curve

R square	0.9984
Equation	Y = 0.01196*X + 0.03891

Tonic water

Fluorescent spetra

Excitation: 345 nm

- 10 ng/ml
- 25 ng/ml
- 50 ng/ml
- 100 ng/ml

Linearity of fluorescent standard curve

R square	0.9859
Equation	Y = 20.57*X - 219.9

Test Examples

Chemical Analysis

- Total antioxidant capacity assay
- Bicinchoninic acid (BCA) protein quantitation assay
- dsDNA broad range quantitative fluorescent assay
- Lactoferrin fluorescent assay

Environment Monitoring

- Copper ion level in liquid
- Silica (SiO_2) level in liquid

Point-of-Care Testing:
The ONE InstantCare Device

MA-100

The ONE InstantCare Device is a SPU-based LFIA[*1] analyzer for accurate quantification of rapid diagnostic test. It covers a wide spectral range from 300 to 1000 nm with a spectral resolution of 5 nm and an accuracy of 0.5 nm. It turns qualitative test into a quantitative measurement and enhance detection sensitivity.
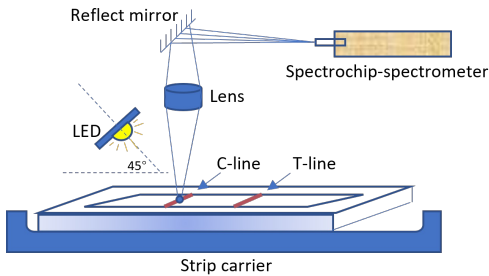
Features

- High sensitivity: LOD[*2] down to sub ppb
- Spectral range: 300-1000 nm
- Easy operation with mobile Apps
- Rapid quantitative result in 10-15 mins
- Portable for any test site applications

Applications

- Healthcare management / POCT tests
- Component analysis in food, agriculture, veterinary industries, etc.
- An open-platform chromatogram reader that works with various LFIA tests under different commercial brands.

Principles

Reflect mirror
Spectrochip-spectrometer
Lens
LED
45°
C-line   T-line
Strip carrier

Operation Flow

IgG
IgM
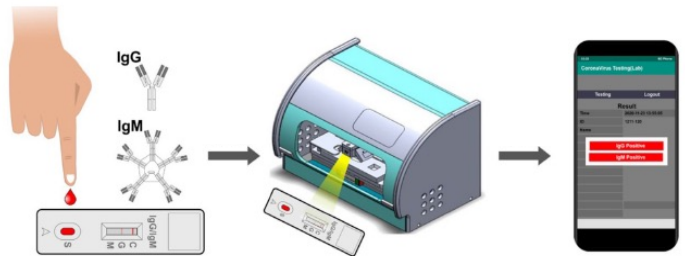
Specification

Optical	
Optical Module	SPU
Principle	Flat-field micro concave grating
Spectral Range	300 ~ 1000 nm
Spectral Resolution	5.0 nm
Spectral Accuracy	0.5 nm
SNR	2400:1 (33.8 dB)
Stray light	0.04%

Biological	
Platform	LFIA Rapid Diagnostic Test
Turn-around Time	10-15 mins
Specimen	Finger-tip Blood (10 μL)
Sensitivity: LOD	Antibody: 0.186 ng/mL (ppb)

| Electrical / Dimension / Weight	
Power Interface	USB Mini
Data Interface	Micro USB / Bluetooth
Power Supply	$\geq$ 12-Watt USB Power Adaptor
Dimension	16 cm x 10.5 cm x 12 cm
Weight	700 g

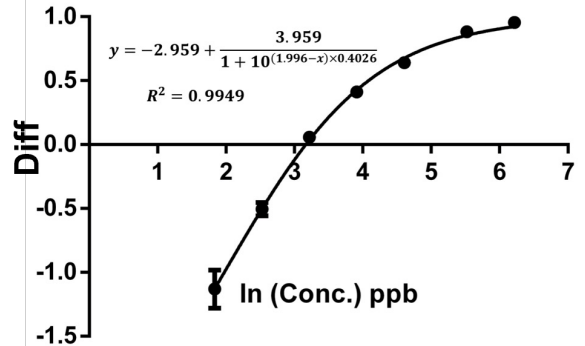*1. Lateral flow immunoassay
*2. Limit of detection

Spectral Performance

Absorbance spectrum performance of melamine test

Absorbance spectrum of melamine test strip (T line)

| 0 ppb |
| 2.5 ppb |
| 5 ppb |
| 10 ppb |
| 25 ppb |
| 50 ppb |
| 75 ppb |
| 100 ppb |
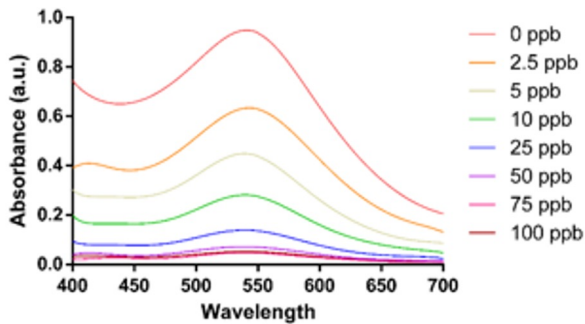
Concentration curve of the melamine

$$y = -2.959 + \frac{3.959}{1 + 10^{(1.996 - x) \times 0.4026}}$$

$$R^2 = 0.9949$$

Diff

ln (Conc.) ppb

POCT Assays Tested with ONE InstantCare Device

Routine Urinary Tests

- Urine protein
- Occult blood
- Nitrites
- Specific gravity
- pH
- White blood cells
- Urine sugar
- Ketone bodies
- Bilirubin
- Urobilinogen
- Microalbumin
- Creatinine

Covid-19

- Antigens
- Antibodies
- Neutralizing antibodies

Dengue virus

- Type I
- Type II
- Type III
- Type IV

Cardiac Tests

- Troponin-T
- Troponin-I
- CK-MB
- D-Dimer
- NT-proBNP

Controlled Substances

- Drug
- Paraquat
- Heavy metal
- Food safety test (melamine/ractopamine)

Chronic diseases

- HbA1C
- Total cholesterol
- HDL
- LDL
- Triglycerides,
- Blood glucose
- Creatinine

Optical Thin Film Thickness Measurement

MST-100

In this application, SPU module is used for optical thin film thickness measurement. It can measure film thicknesses above 1 µm. Open-source software for this system is readily available on the Raspberry Pi platform, allowing easy integration into inspection systems for various applications.
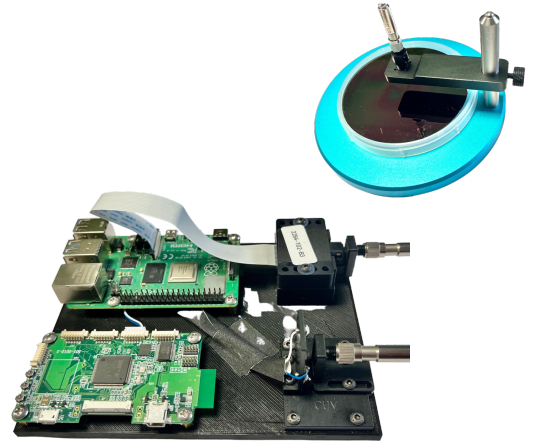
Features

- Simplified measurement
- Python source code available
- Compact
- Compatible for Linux platform (Raspberry Pi)
- Real time monitor for interference pattern

Configuration Example

Raspberry Pi

Sample

Sample stage

Monitor (Data analysis)

Film thickness measurement software (open source)
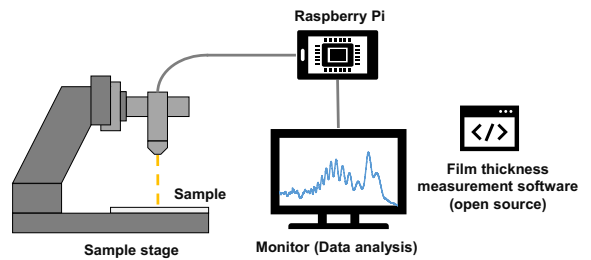
Specification

Model Number	MST-100
Measurement film thickness range	> 1 um
Light source	LED
Measurement wavelength range	300 ~ 1000 nm
Measurement reproducibility	0.5 nm
Working distance*1	10 mm
Spot size*1	Approx. Φ1 mm
Measurement time*2	10 Hz
Power supply voltage*3	AC100-240V, 50-60Hz
Light guide connector	SMA905 / FC-PC

*1: Depending on optical system or objective lens magnification to be used
*2: Depending on user's performing environment
*3: Depending on model of used Raspberry Pi

Principles

Interference spectrum is used to determine film thickness.

White light is directed onto the sample, producing a characteristic spectrum influenced by the film's thickness. Through analyzing the interference spectra, the film thickness can be determined.
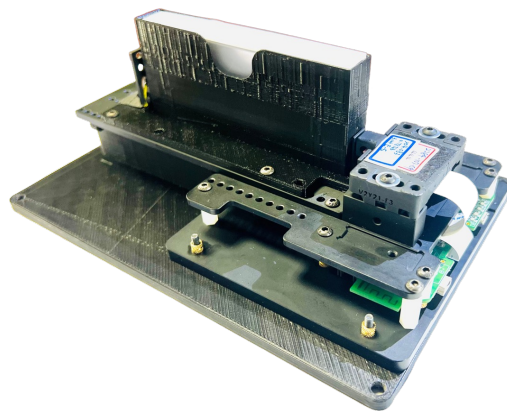

Number of signal interval increased.

Thin film

Thick film
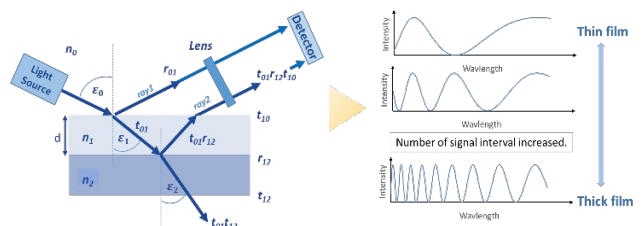
Measuring Silica Contamination in Ultra Pure Recycling Water

MSW-100

Features

- Simplified measurement
- Compact
- Real-time monitoring
- Broad wavelength range
- High spectral resolution
- Diverse applications in water quality measurement

Applications

- Semiconductor manufacturing
- Power plant operation
- Water purification
- Environmental monitoring
- Laboratory and research settings

Configuration Example

Specification

Model Number	MSW-100
Wavelength range	300 ~ 1000 nm
Spectral resolution	5 nm
Spectral accuracy	0.5 nm
Stray light	0.04 %
Image sensor	CMOS (AR0130) A/D 12 bits
Light source	LED: 810 nm
Optical path	100 mm
Measurement precision	+/- 0.07 ~ +/- 0.25 ppb
Detection principle	Molybdenum blue method
Measuring range	ppb ~ ppm range
Measuring time	10 seconds
Dimensions (W×D×H)	200 × 140 × 95 mm^3
Weight	750 g

Spectral Performance
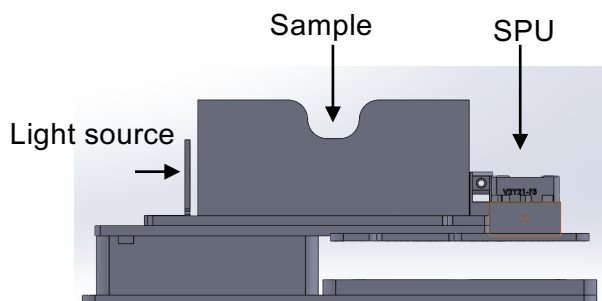
SiO_2 standard curve
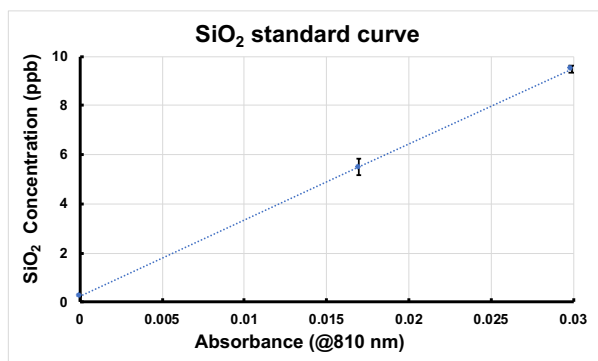
Precision:
5 ppb +/- 0.18 ppb
10 ppb +/- 0.07 ppb

Bringing Changes in Full Spectrum

Empowering Industries with SpectroChip Technology

- **45 Related Patents in USA & Taiwan**
- **FDA 510(k) Registration / TFDA Certification of Modules/Devices**
- **Awards and Recognitions:**
  - **Innovation / Special / Gold Awards, Malaysia Technology Expo 2023**
  - **Top 3 Best Startup, World Cup Taiwan 2022**
  - **2021 International Innovation Awards, Enterprise Asia**
  - **2020 Taiwan National Innovation Award**
  - **2018 & 2019 Taiwan National Scientific Breakthrough Award**
  - **2018 & 2019 Taiwan National Most Popular Science Award**