



INOR LABORATORY EQUIPMENT

BOOK

MOST ADVANCED
AND STATE OF THE ART
LABORATORY EQUIPMENT



MOCVD LAB | FABRICATION LAB | CHARACTERIZATION LAB



Institute of Nano Optoelectronics Research and Technology (INOR), Universiti Sains Malaysia (USM)
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11900 Bayan Lepas, Pulau Pinang



INSTITUTE OF NANO OPTOELECTRONICS RESEARCH AND TECHNOLOGY (INOR)



LABORATORY EQUIPMENT BOOK

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Institute of Nano Optoelectronics Research and Technology (INOR), Universiti Sains Malaysia (USM), SAINS@USM, No. 10, Persiaran Bukit Jambul, 11900 Bayan Lepas, Pulau Pinang.

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"It is my pleasure to welcome you to read our first Laboratory Equipment Book of Institute of Nano Optoelectronics Research and Technology (INOR), Universiti Sains Malaysia. INOR is previously known as Nano Optoelectronics Research and Technology (NOR) Laboratory which was officially launched in 2004. On May 29 2014, INOR was accredited to the status of Centre of Excellence (CoE). INOR is located at Block A at SAINS@USM. The SAINS@USM is a Research Campus of USM and is located about 3 km from the USM main campus.

As a CoE in Research, INOR offers research, services, and academic programs in the field of Optoelectronics and Nanotechnology. Services offered include processing, characterization, wafer products, training, and consultation related to nanotechnology, optoelectronic and electronic materials and devices. The facilities available in INOR are considered as state of the art for nano and advanced materials technology for optoelectronic and electronic applications especially in light emitting diode (LED)/laser, sensor, solar cell, and power device.

We look forward to having the opportunity to serve you. Please do not hesitate to contact us if you have any enquiries."

PROFESSOR DR. ZAINURIAH HASSAN, FASc
DIRECTOR



INSTITUTE OF NANO OPTOELECTRONICS RESEARCH AND TECHNOLOGY (INOR)



Institute of Nano Optoelectronics Research and Technology (INOR) focuses on research and development (R&D) from the areas of nanoscience, nanomaterials, nanofabrication and nanoengineering that are collectively building intellectual and technological bridges from nanoscale concepts to practical nano optoelectronic devices and systems.

This institute has been considered to be one of the most modern and innovative research laboratories on optoelectronic and nanotechnology in Universiti Sains Malaysia which has an

extensive range of equipment and facilities for growth, fabrication and characterization of optoelectronic and electronic devices at nanoscale. The physical structure and construction of the new laboratory are estimated to be worth RM 3 million (~USD 0.7 million), the equipment and facilities have cost another RM 15 million (~USD 3.5 million) and total floor area of approximately 300 m².

The growth and fabrication equipment such as Metalorganic Chemical Vapor Deposition (MOCVD), E-beam evaporator system, Maskless Lithography system, Inductive Couple Plasma Etching System (ICP), Rapid Thermal Processor (RTP), Single Zone Tube Furnace and High Temperature Furnace are capable to produce nanoscale thin films and devices. Meanwhile the nanoscale characterization tools such as Electroluminescence, High Resolution X-Ray Diffraction (HRXRD), Photoluminescence Spectroscopy System, Optical Microscope, Probe station for Quick test, Probe Station with Micro-Positioner, Capacitance-Voltage/Current-Voltage (CV/IV) measurement systems are properly equipped to give the best results of morphology, structural, optical, and electrical properties of the materials.

Currently, INOR offers PhD and MSc (Optoelectronics) Research Mode program for the following areas i.e Nano Materials Fabrication and Characterization, Nano Materials and Devices, Nano Device and Packaging, Modelling and Simulation of Nano Optoelectronic Devices, Nano Integrated Systems, Solid State Lighting System and Nano Optics field. In addition, MSc (Nano-Optoelectronics) Mixed Mode program is also offered.

INOR is also supported by strong collaborations with well-known national and international universities as well as industries, in particular with the 2014 Nobel Laureate in Physics, Prof. Dr. Shuji Nakamura from the University of California Santa Barbara, on the technology transfer program related to GaN on GaN based LED research. We are ambitiously looking for future collaborations with more universities as well as industries in our niche areas: Nano and Advanced Materials, LED/Laser, Sensors, Solar Cell and Power Devices.

LIST OF EQUIPMENT



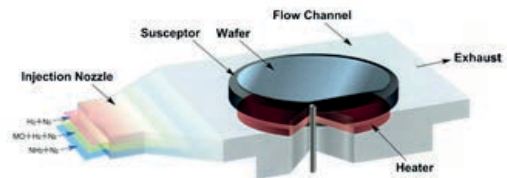
METAL ORGANIC CHEMICAL VAPOUR DEPOSITION (MOCVD) SYSTEM

GENERAL DESCRIPTION

The Taiyo Nippon Sanso Corporation (TNSC) MOCVD model SR4338KS-R(HT) is a high performance MOCVD equipment used for epitaxial growth of GaN-based materials (GaN, AlGaN & InGaN). The reactor is designed based on horizontal laminar flow reactor equipped with a glovebox and a high vacuum pass-box. This system can produce high quality and high uniformity of III-V nitride semiconductor epitaxial layers on 2" and 4" substrates suitable for various device applications. INOR has established the baseline recipes for the related high quality III-V epitaxial growth.

SYSTEM FEATURES

- 3-layer horizontal laminar flow reactor with 3 separate flow channels (upstream, middle and downstream) to maintain growth boundary condition.
- A resistance heating system (400 to 1200°C) with two SiC resistance heaters surrounded by a boron nitride reflector-suitable for GaN and AlN epitaxial growth.
- Growth pressure: 10kPa – 100kPa.
- Rotary susceptor: three pieces of 2 inch wafers or one piece of 4 inch wafer
- MOs source: 1-TMG, 2-TMA, 2-Cp₂Mg, 1-TEG, 2-TMI
- High purity gas supply including 2 gas carriers (99.999% N₂ and 99.999% H₂), 2 hydride lines (99.999% NH₃, 99.998% 10ppm Si₂H₆) and 1 standby hydride line.



- MOCVD system is featured to state of the art of incoming gas delivery system (GDS) for all gases which include high quality EP 316S/Steel line with orbital and VCR termination, purifier (regenerative + in-line) and in-situ O₂/H₂O impurity detector to ensure the purity level of all supplied gasses is in ppb level.
- The recipe setup uses excel-based software (MOCVD.xlsm) and the growth process is controlled automatically using PLC with in-situ monitoring (FA_Trend).
- The system comes with a complete set of gas detectors and interlock control for automatic safety monitoring as well as a hybrid burner to treat the residual gases.

APPLICATION

MOCVD is used to grow complex semiconductor multilayers structure for electronic or optoelectronic devices such as light-emitting diodes (LEDs), lasers, transistors, solar cells, sensors, and etc. MOCVD system features high purity gas systems that ensure epitaxial films with excellent quality and uniformity of thickness, composition, and doping level can be produced.



ELECTRON BEAM (E-BEAM) EVAPORATOR FOR METALS

GENERAL DESCRIPTION

The ULTECH SEE-5S e-beam (metals) system is a cryo-pump thin films evaporator with a 6 kW power supply, 6 pockets of e-beam sources. The e-beam system has 270° beam deflection and a new magnetic field design. This provides a much straighter beam path through the melt material, thus can increase the usable portion of the melt inventory and produces a more uniform and predictable evaporant cloud. The SEE-5S (Metal) is used for evaporating high purity metals, such as Al, Au, Ni, Cr, Pt, Ti, Pt, etc. The system has a planetary substrate holder which suitable for any sample size up to 4-inch diameter. The system has 6 pockets for e-beam sources and also has a Telemark Model 861 controller that allows for fully automated programming of multiple layers deposition.

SYSTEM FEATURES

- Automatic pumping mode: Genesis Cryopump with water-cooled compressor which can reach $\sim 1e-7$ ultimate base pressure.
- Pumping speed: 40,000 l/sec for H₂O, 14,000 l/sec for air, 30,000 l/sec for H₂, 12,000 l/sec for Ar.
- Electron beam source: Six 15 cc e-beam source pockets with Telemark (Model 266-12) controller.
- Electron beam power supply: Telemark (Model TT-6) DC power supply with digital sweep. The voltage supply is from 6 to 8 kV and the max. beam current is 0.75 A.
- Deposition Control: Telemark model 861, 99 processes of up to 999 layers each for automatic or manual deposition control based on a resonating quartz crystal sensor, 0.03 Hz and 0.1 sec measurement interval.
- Automatic deposition of multiple layers stack.
- Planetary substrate holder: Up to five pieces of 4" wafers in one run with 1~30 rpm rotation speed.
- Substrate heating: Halogen lamp with max. temp. of 400°C and equipped with K-type TC.

APPLICATION

This system is used for depositing single or multiple layer of various metals on various substrates such as glass, polymer, semiconductors, etc. For electronic and optoelectronic applications, it is widely used for depositing Ohmic contacts, Schottky contacts, bond pads, and etc. For each run/deposition, the maximum thickness of deposition layers is limited to 1 micron.



ELECTRON BEAM (E-BEAM) EVAPORATOR FOR OXIDES

GENERAL DESCRIPTION

The ULTECH SEE-5S e-beam (oxides) system is a cryo-pump thin films evaporator with a 6 kW power supply, 6 pockets of e-beam sources. The e-beam system has 270° beam deflection and a new magnetic field design. This provides a much straighter beam path through the melt material, thus can increase the usable portion of the melt inventory and produces a more uniform and predictable evaporant cloud. This e-beam evaporation system is used to deposit single or multi layers of various oxides such as dielectrics, transparent conductive oxides (TCOs), etc. It is widely used to deposit SiO₂, TiO₂, ZnO, and ITO. During the deposition, oxygen gas can be flowed into the system to maintain the stoichiometry of the deposition layers. The system has a planetary substrate holder which suitable for any sample size up to 4-inch diameter. The system has 6 pockets for e-beam sources and also has a Telemark Model 861 controller that allows for fully automated programming of multiple layers deposition.

SYSTEM FEATURES

- Automatic pumping mode: Genesis Cryopump with water-cooled compressor which can reach ~ 1e-7 ultimate base pressure.
- Pumping speed: 40,000 l/sec for H₂O, 14,000 l/sec for air, 30,000 l/sec for H₂, 12,000 l/sec for Ar.
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- Automatic deposition of multiple layers stack.
- Planetary substrate holder: Up to five pieces of 4" wafers in one run with 1~30 rpm rotation speed.
- Substrate heating: Halogen lamp with max. temp. of 400°C and equipped with K-type TC.
- MFC for oxygen gas with max flowrate of 100 sccm.

APPLICATION

This system is widely used to deposit dielectrics/TCOs films that used for for current spreading layer, optical coatings (anti-reflective), dielectric coating, electrical insulators, and reactive ion etching masks. Typical deposition rates are several Angstroms/second and the maximum deposition thickness during each deposition is limited to 1 micron.



INDUCTIVE COUPLE PLASMA AND REACTIVE ION ETCHING (ICP-RIE) SYSTEM

GENERAL DESCRIPTION

ICP-RIE is a widely used technique for high etch rates, high selectivity, and low etching damage processes. The system is equipped with an ICP etching tool with 1000 W ICP power, 600 W RF substrate power, and RT operation with back-side helium cooling. The system has cooling and an electrostatic chuck to maintain controlled surface temperatures during etching. This system is configured with a wide range of gases, i.e., Cl₂, BCl₃, CF₄, CH₄, Ar, N₂, H₂ and O₂. Hence, it can be used to etch a variety of materials, i.e., metal oxides, metals, and semiconductor compounds.

SYSTEM FEATURES

- The system has Al₂O₃ cavity wall and equipped with loadlock chamber.
- The chamber is configured for 4" wafers size. The sample is handled using a silicone-based thermal heat sink compound.
- The ICP source uses uniform plasma density that suitable for 4" wafer processing.
- The system uses aluminium shower head type for source injection type.
- The chuck is cooled by chiller and the substrate is cooled by helium from the backside.
- Power supply: 13.56Hz 1000W RF ICP source, 600W RF sample bias source with automatic RF matching network.
- Automatic pumping mode using dry pump with 1,400 L/min and turbo molecular pump (magnetic type) with 1,400 L/sec The ultimate pressure is around 5.0×10^{-6} Torr.
- System equipment with 8 MFCs for different process gases: Cl₂, BCl₃, CF₄, CH₄, O₂, Ar, N₂, H₂ in process reactor.
- The recipe software is able to be edited, save, download and run automatically.
- The system comes with a complete set of gas detectors and interlock control for automatic safety monitoring.
- The system uses wet scrubber to treat the residual gases.

APPLICATION

The ICP-RIE reactor is configured for etching various materials such as III-nitride materials, metal oxide (ITO, SiO₂) etc. The ICP system features with high purity gases to ensure that the etching takes place with excellent etching rate and profile.



RAPID THERMAL PROCESSOR SYSTEM (RTP)

GENERAL DESCRIPTION

The UTR-100 is a manual loading RTP system manufactured by Ultech Korea. The UTR-100 can process up to 4-inch wafer substrate. The system can hold one 4-inch wafer or smaller substrates placed on top of a silicon carrier wafer. The recipe software is able to be edited, save, download and run automatically.

SYSTEM FEATURES

- Substrate size and load capacity: Up to 4 inch.
- Max. temperature: 1,200°C.
- Ramp rate: 50~120°C/sec for Silicon wafer, 10~50°C/sec for GaN substrate.
- Temperature uniformity: $\leq \pm 1.5\%$ (@800°C, Silicon wafer), $\leq \pm 1.0\%$ (@800°C, GaN substrate on SiC coated Graphite plate).
- Temperature accuracy and repeatability: $< \pm 3^\circ\text{C}$.
- Ultimate pressure: 5.0×10^{-3} Torr.
- Process gas: N_2 .
- Minimum anneal hold time: 30 min (@1,000°C).
- Heating source: Tungsten Halogen Lamp in series connection.
- Substrate holder: SiC coated graphite or Si as substrate holder for different wafer size up to 6" in diameter.

APPLICATION

The UTR-100 is designed for ohmic contact formation to semiconductors, film densification, implant activation, damage annealing and dopant activation. Several materials can be annealed in the stainless steel and aluminium chamber including Si, SiO_2 , Si_3N_4 , GaAs, InP, GaSb, GaN, and metals. For materials that will decompose at the elevated temperatures, a dielectric anneal cap must be deposited on the wafer or an enclosed wafer holder must be used to prevent contamination of the chamber walls.



HIGH TEMPERATURE FURNACE

GENERAL DESCRIPTION

MTI Corporation high temperature furnace, Model OTF-1500X is a split three-zone tube furnace with mullite tube and conventional flange which can work up to 1500°C. The temperature controllers have an accuracy of +/- 5°C accuracy. It is an excellent furnace for multi-purpose heat treatment experiments.

SYSTEM FEATURES

- Tube furnace with 3 heating zone.
- The system consists of inlet/outlet seal/flanges, working tube, temperature controller and mass flow controller.
- The length of 3 heating zone is about 500 mm.
- Max temperature 1500°C
- Working tube:
 - Tube size 75 mm (ID) X 1300 mm (length).
 - Tube materials:
 - i) Quartz for 1200°C, (ii) alumina for 1800°C.
- Temperature controller
 - Programmable controller to set heating rate and dwell time.
 - Able to ramp followed by dwell using the temperature controller for more than 20 segments.
 - Temperature controller comes with RS485 to connect direct to a data logger or a computer.
- Mass flow controller
 - Max flow rate 500 sccm.
 - Mass flow controller: nitrogen, hydrogen, oxygen, and argon gases.

APPLICATION

High temperature furnaces are used to for annealing, brazing, calcination, degassing, sintering, soldering, sublimation, synthesis, and tempering. Besides that, it can be used for thermocouple calibration, testing of fuel cells, or in catalyst research.



SINGLE ZONE TUBE FURNACE

GENERAL DESCRIPTION

MTI Corporation single zone tube furnace, model GSL-1100X-S is a high temperature vacuum tube furnace with a compact design for heating samples up to 1100°C. The system comes with stainless steel vacuum flanges with valves, vacuum pressure gauge, and quartz tube. Besides that, the built-in precision temperature controller can program up to 30 segments of heating, dwelling, and cooling steps. The furnace can be set up in both vertical and horizontal positions to meet various applications such as sample heating, VLS, CVD, and quenching tests.

SYSTEM FEATURES

- With energy saving high purity Al₂O₃ fibrous insulation liner
- Equipped with stainless steel shells with adjustable height.
- The furnace's vertical position is adjustable.
- Multiple configurations for various thermal processing needs.
- Max. temperature: 1100°C (< 1 hr).
 - Continuous working temperature: 1000°C.
 - Max. heating rate: 10°C /min.
- Mechanical vacuum gauge: For pressure range of 0.1 to 0.15 Mpa.
- PID automatic control and auto-tune function.
- 30 programmable segments for precise thermal processing.
- Temperature accuracy: +/- 1 °C.
- K type thermocouple.

APPLICATION

A tube furnace can be used for annealing, brazing, calcination, degassing, sintering, soldering, sublimation, synthesis, and tempering. Besides that, it can be used for thermocouple calibration, testing of fuel cells, or in catalyst research.



DIP COATER

GENERAL DESCRIPTION

EQ-PTL-OV5P programmable dip coater is designed for fabricating samples by coating multi-layers with maximum 5 different kinds of solutions (coating materials). The whole process is conducted under an enclosed heating chamber. The chamber is with controllable temperature.

SYSTEM FEATURES

- Pulling and dipping speed are controlled by touch screen digital controller. It can be programmed dipping/pulling rate, dwell times for both in liquid and temperature chamber to achieve automatically coating from one solution to another by rotating liquid holder disk up to five different solutions.
- Precision controlled pulling and dipping rates from 1 mm/minute to 40 mm/minute.
- Digital display speed with +/-0.02% accuracy.
- Dipping cycle travel distance is 80 mm or 3.14".
- Rotary dipping stage with five slots to place coating solution containers. It can rotated automatically as programmed.
- Five 150 ml glass containers (60 mm diameter x 60 mm height) are included for immediate use.
- One sample holder which can hang up to four substrates/samples.
- Pulling-dipping-rotation mechanism is built in a controlled temperature chamber which can be heated up to 100°C with +/-1°C accuracy.
- Inner temperature chamber made by stainless steel with the dimension: 280 mm L x 280 mm W x 280 mm H.
- Compact desktop design with dimension: 500 mm x 500 mm x 1180 mm.

APPLICATION

Multilayer coating of optical and epitaxial films from a liquid solutions such as OLED and Polymer films.



UV-OZONE CLEANER

GENERAL DESCRIPTION

Ossila UV Ozone Cleaner has proven to be a simple, an inexpensive and efficient tool for non-acidic, dry, non-destructive atomic cleaning and removal of organic contaminants using intense 185 nm and 254 nm ultraviolet light. The presence of ozone and UV light allows the removal of organics and sterilizes the surface. The UV Ozone Cleaner System can clean a wide range of substrates, such as quartz, silicon, gold, nickel, aluminium, gallium arsenide, alumina, and glass slides, etc. The cleaning procedure is based on a photo-sensitized oxidation process, where the contaminant organic molecules are excited and/or dissociated by the absorption of short wavelength UV radiation.

SYSTEM FEATURES

- UV Lamp: Synthetic quartz 4 x 4 grid UV lamp.
- UV lamp key wavelengths: 185 nm and 254 nm.
- Power supply: 230V \pm 10 %; 50/60Hz, 50 VA.
- Class of protection: Class I.
- Degree of protection: IP20.
- Maximum run time: 59 minutes and 59 seconds.
- Safety features: Interlock, thermal cut-out.
- Unit dimensions:
 - Width: 193 mm.
 - Height: 230 mm.
- Depth: 300 mm.
- Tray dimensions: 100 mm x 100 mm.
- Weight: 5 kg.

APPLICATION

Surface cleaning, improvement of surface hydrophilicity, preparation for thin film deposition and surface treatment, ultraviolet curing, surface sterilization, removal of surface monolayers and surface oxidation.



MASKLESS LITHOGRAPHY

GENERAL DESCRIPTION

μPG 101 Maskless lithography manufactured by Heidelberg-Instruments utilizes methods that directly transfer the information onto the substrate, without utilizing an intermediate static mask, i.e. photomask that is directly replicated. In lithography process, UV radiation will be used to transfer an image of a time constant mask onto a photosensitive resist.

SYSTEM FEATURES

- Substrates size: up to 6" x 6"
- Maximum thickness of substrate: 6 mm thickness
- Flatness/ parallelism: $\pm 20 \mu\text{m}$
- Structures down to $1 \mu\text{m}$
- UV diode laser source: 375 nm, 70 mW, laser class 3B
- Maximum design size: 100 x 100 mm
- Write focal length: 4 mm
- Write Speed: $5 \text{ mm}^2/\text{minute}$
- Write Edge Roughness: 120 nm
- Write CD Uniformity: 200 nm
- Write Alignment Measurement Accuracy: 200 nm
- Basic grayscale exposure mode
- Exposure Optimization: Energy Series, Focus Series, Evaluation of Exposure Series
- Real-time autofocus system (pneumatic, optional optical)
- Camera system for alignment
- Multiple design input formats: GDSII, DXF, CIF, Gerber, BMP
- As an option, system come with LayoutEditor and SchematicEditor for pattern design.
- The μPG 101 is equipped with rubber feet for coarse vibration isolation.

Recommended Photoresist Coatings:

For binary exposures (2D) on thin resists (~5000 Å):	
S18XX	A standard Shipley resist. S1805 is a resist of this family that is well tested on Heidelberg Instruments lithography systems. It can be spin for $0.5 \mu\text{m}$ thickness.
AZ15XX	Clariant resists which are comparable to the S18XX Shipley family. Recommended type is AZ1505 for $0.5 \mu\text{m}$ resist thickness.

Please contact respective PIC for further details.

APPLICATION

The μPG 101 Maskless Lithography is used for direct-write lithography process. Subsequently, it helps to skip the entire time-consuming and expensive photomask process. Besides that, the user can redesign CAD-drawing (again and again, if necessary) and immediately re-expose the pattern. This Maskless Lithography widely used for semiconductor fabrication process i.e. LED, PV, sensors, power devices & photomask production.

General Chemicals Recommendations:

Developer	TMAH series (metal-ion free), or 351B, for most resists*
Rinsing	All rinsing during processing should be done with DI water
Stripper	Commercial stripper, or concentrated NaOH solution (e.g., undiluted developer) after exposure of the remaining with an UV lamp
Cleaning	After the processing, chrome substrates can be cleaned using DI water and a mild detergent



OPTICAL MICROSCOPE

GENERAL DESCRIPTION

The Olympus BX53M-S is a well-designed and easy-to-use simplified complex microscope. The easy, comfortable operation of the BX53MRF-S also improves reproducibility by minimizing human error. The observation method, illumination intensity, and magnification are automatically recorded by the software and stored with the associated images.

SYSTEM FEATURES

- Motorized filter turrets for fluorescent illumination are available. No tools are needed to add or remove filter cubes.
- Large selection of custom cubes for single, dual, and triple stained specimens are available.
- A 100 W halogen light source for brightfield and contrast observations; 100 W mercury light; 75W xenon, LED, and metal halide illumination systems for fluorescence microscopy.
- Coaxial coarse and fine focus with stage up and down mechanism.
- Microscope frame:
 - Stroke: 25 mm
 - Fine stroke per rotation: 100
 - Illumination: Reflected
 - With upper limit stopper, stage torque adjustment for coarse handle.
- Observation methods: fluorescence, brightfield, darkfield, MIX, polarized, differential interference contrast.
- Flexibility stage height for various samples.

APPLICATION

Used in microelectronics and materials science applications, include, metal parts, fiberglass, industrial manufacturing failures in materials, carbon fiber, plastics and concrete.



X-RAY DIFFRACTION SYSTEM (XRD)

GENERAL DESCRIPTION

The Bruker D8 DISCOVER features with DAVINCI design is an ease of use XRD system with plug-and-play functionality and real-time component detection. Plug-and-play concept allows real-time component detection functionally and fully integrated XRD system. These unique features allow the user to easily switch between the X-ray diffraction applications, including qualitative and quantitative phase analysis, structure analysis, reflectometry, high-resolution X-ray diffraction, reciprocal space mapping, grazing incidence diffraction (in-plane GID), etc.

SYSTEM FEATURES

- Extremely easy switch of all beam path components from the X-ray tube, optics, sample stages to detectors.
- Alignment- and tool-free change of optics (SNAP-LOCK).
- Fully automatic component recognition with conflict detection and fully automatic instrument configuration.
- Highly-accurate, high-precision, two-circle goniometer with independent stepper motors and optical encoders for the Theta and 2Theta circles.
- Vertical goniometer with Centric Eulerian Cradle.
- Horizontal specimen holder with vacuum chucks.
- Motorized switch between Bragg-Brentano and parallel beam geometries for primary and secondary beam path.
- Easy switch between line and point focus applications without disconnecting cables or unscrewing the X-ray tube.
- Triple beam path analyzer, motorized and software-controlled switch between channel-cut monochromator and TWIN optics
- Fully integrated rotating anode generator for point, line and micro focus applications with unique source alignment by means of a highly sophisticated 5 degrees of freedom stage.

APPLICATION

- High-resolution X-ray Diffraction (HRXRD), X-ray Reflectometry (XRR), Reciprocal Space Mapping (RSM), In-Plane Grazing Incidence Diffraction (in-plane GID), Grazing Incidence Small Angle X-ray Scattering (GISAXS), Stress and Texture, and Phase Identification (Phase ID).
- Thickness, composition, mismatch, relaxation, and defects of epitaxial layers.
- Thickness, roughness, and density of crystalline or amorphous layers.
- Orientation identification and quantification of crystalline, textured layers or bulky samples.
- Residual stress in crystalline layers or bulky samples.
- Qualitative and quantitative phase composition, d-spacings and strains of crystalline powders and bulky samples.



PROBE STATION WITH STABLE MICROPOSITIONER

GENERAL DESCRIPTION

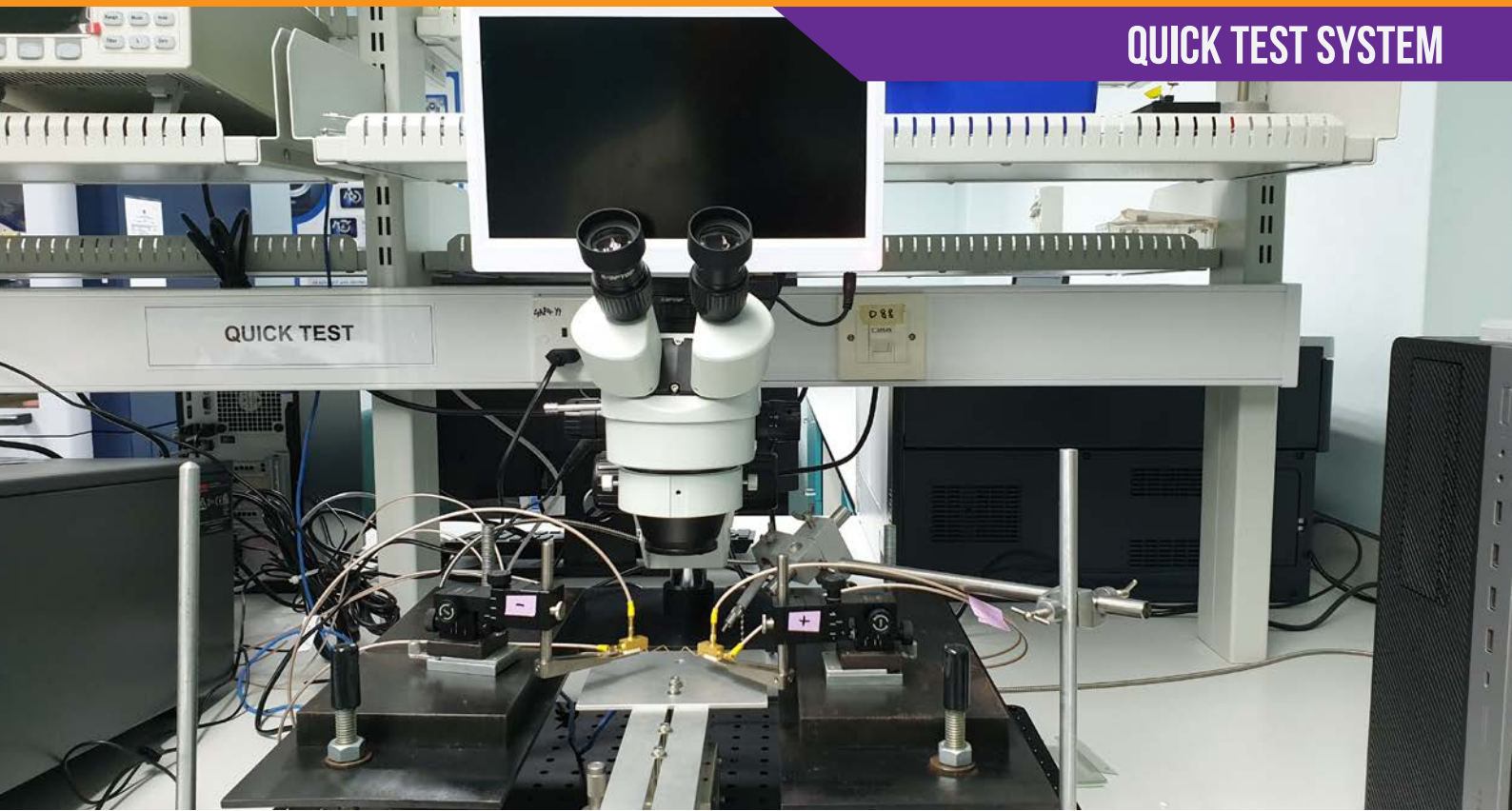
MPI Corporation Probe Stations with Micro Positioner are versatile and flexible research platforms that can be used in dedicated applications. MPI TS150 probe system also is an effective and highly accurate manual probe system designed for precise analytical probing of substrates with diameter up to 150 mm. It also designated to support a wide variety of applications and enable physical scientists and researchers to conduct fundamental research through convenient and repeatable measurements producing consistent results.

SYSTEM FEATURES

- Microscope and movement
 - Stable bridge for high quality optics
 - Linear Z lift for easy reconfiguration
 - 25 x 25 mm air bearing or 50 x 50 mm linear XY movement.
- Probe Platen
 - Stable and rigid design
 - Supports DC/CV and RF measurements
 - Rectangular adjustments for RF positioners
 - Designed for maximum thermal stability
- RF Calibration
 - 2 auxiliary chucks for calibration substrates
 - Built-in ceramic for accurate calibration
 - 1 μm flatness for consistent contact quality
- Modular Chucks
 - Various non-thermal or thermal chucks
 - Choice of triaxial or coaxial connection
 - Wide range of temperature up to 300 °C
 - Easy switch between center and small wafer size control
- Chuck XY-Theta Stage Movement
 - Unique puck-controlled air bearing stage for quick single-handed operation
 - 180 x 230 mm XY total stage movement
 - Including 25 x 25 mm fine micrometer control
 - Resolution < 1.0 μm (0.04 mils) @ 500 $\mu\text{m}/\text{rev}$
 - Extra wide Y-range for easy loading
 - $\pm 5^\circ$ Theta fine adjustment
- Adjustable Platen Height
 - Micrometer control for precise adjustment
 - 20 mm range for various applications

APPLICATION

Often used in R&D, product development and failure analysis applications, where engineers need a flexible, precise tool to conduct tests on different areas on a device. This systems address a wide variety of applications such as Failure-Analysis Testing, Design Validation/IC Engineering, Wafer Level Reliability, MEMS, High Power and Device Characterization and Modeling.



QUICK TEST SYSTEM

GENERAL DESCRIPTION

The quick test measurement can be taken with various electronic test equipment, including a custom probe station with Optika microscope, Newport linear stage and MPI micropositioner, Keithley parameter analyzer for synchronizing current-voltage (I-V), capacitance-voltage (C-V) and ultra-fast pulsed I-V measurements, Newport power meter for optical power and energy near-monochromatic or monochromatic sources measurements and Ocean Insight spectrometer for UV-Visible (200-850 nm) measurements.

SYSTEM FEATURES

- OPTIKA SZM Series Microscope.
- Newport M-562-XYZ Linear Stage.
- MPI MP25 Micropositioner.
 - Feature resolution: $<5 \mu\text{m}$.
 - Travel range (X/Y/Z): $10/10/10 \mu\text{m}$.
 - Screw resolution (X/Y/Z): $500/500/500 \mu\text{m}$.
 - Mounting: Magnetic.
 - Base stage size: 25 mm.
- Keithley 4200A-SCS Parameter Analyzer.
 - DC current-voltage (I-V) range: 10 nA-1A; $0.2 \mu\text{V}$ -210 μV .
 - Capacitance-voltage (C-V) range: 1kHz-10 MHz; $\pm 30 \text{ V}$ DC bias.
 - Pulsed I-V range: $\pm 40 \text{ V}$ (80 V p-p), $\pm 800 \text{ mA}$; 200 MSa/sec, 5 ns sampling rate.
- Newport 1936-R Power Meter
(refer to Newport folio page)
- Ocean Insight Flame S-UV-VIS Spectrometer
 - Detector collection lens: No
 - Detector: Linear silicon CCD array
 - Entrance slit: 25 μm
 - Pixels: 2048
 - Optical resolution: 1.33 nm FWHM (typical)
 - Wave length range: 200 nm - 850 nm

APPLICATION

I-V/CV coaxial and ultra-low current triaxial measurements, Femtofarad capacitance measurements, Semiconductor and NVM reliability, C-V measurement for high impedance applications, Nanoscale device characterization, Resistivity of materials, MOSFET characterization, CW measurements, Peak-to-peak power measurements, Power ratio and power reference measurements, Pulse energy measurements, Signal integration measurements, Measuring laser pulse energy with an 818P thermopile detector (single shot), Frequency measurements, RMS measurements, Laser characterization, LED measurement and light metrology measurement.



ELECTROLUMINESCENCE SYSTEM

GENERAL DESCRIPTION

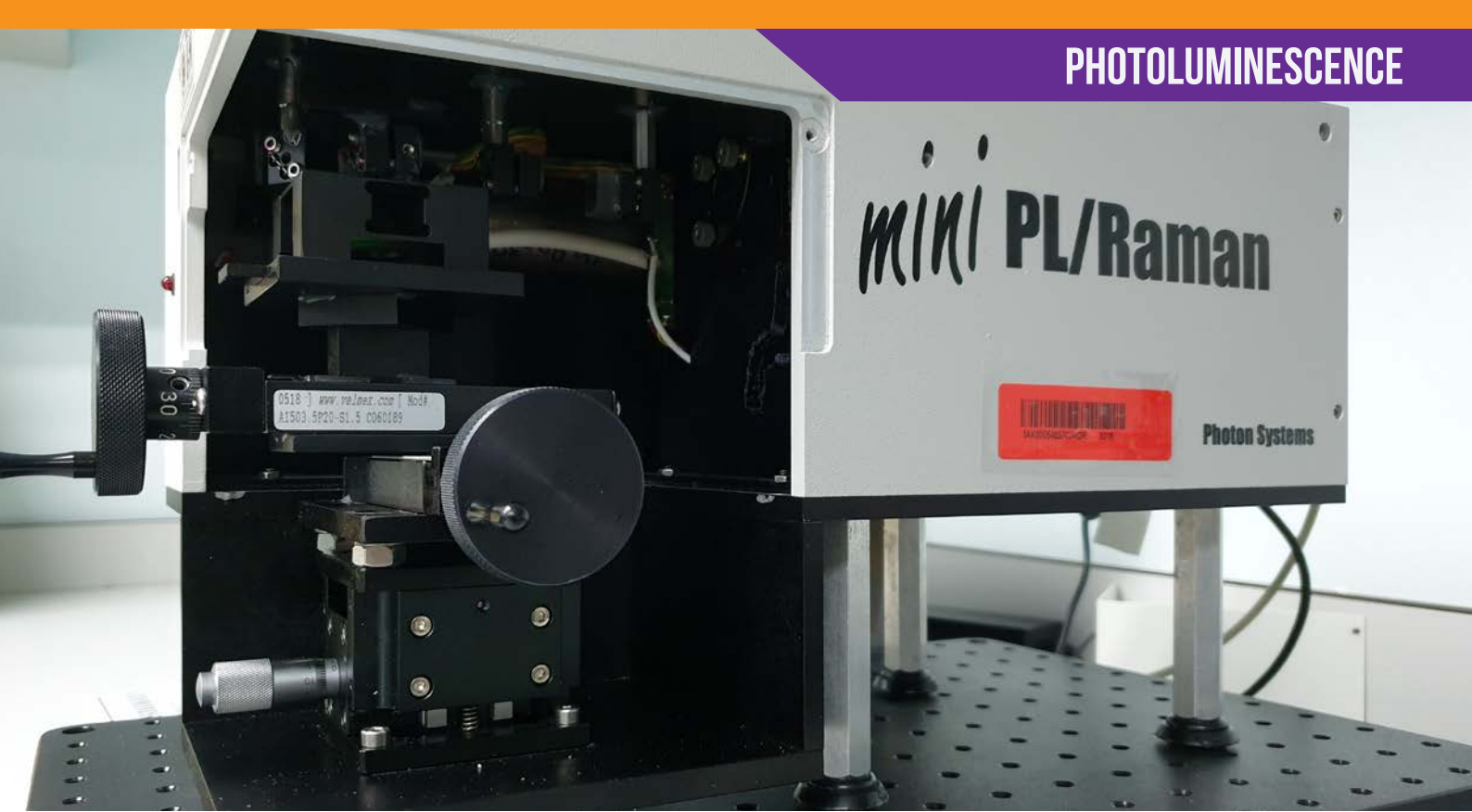
Electroluminescence is a phenomenon of certain materials such as semiconductors that causes the material to emit light due to the passage of an electric current. Electroluminescence leads a direct conversion of electric energy to light. The Avasphere integrating sphere has a diameter of 108 mm and a SMA port at 90 degrees for both irradiance and reflection measurements. The reflection sphere has an additional SMA-connector port at 8 degrees.

SYSTEM FEATURES

- AVASPEC-ULS4096CL-EVO.
 - Optical Bench: ULS Symmetrical Czerny-Turner, 75 mm focal length.
 - Wavelength range: 200-1100 nm.
 - Resolution: 0.05-20 nm, depending on configuration.
 - Stray-light: 0.19-1.0%, depending on the grating.
 - Sensitivity: 218,000 counts/ μ W per ms integration time.
- Detector: CMOS linear Image Sensor.
- The AvaSphere integrating sphere.
 - Internal diameter 108 mm.
 - Sample port diameter 12 mm.
- Interface1010E
 - It is a full-featured potentiostat capable of performing all techniques, including electrochemical impedance spectroscopy.
 - i. Max Applied Current - ± 1 A
 - ii. Maximum Applied Potential - ± 12 V
 - iii. EIS 10 μ Hz - 2 MHz
- Others
 - Power Supply PS-12 VDC/2.08 A
 - PS-12 VDC/5.0 A for HSC NIRLine and SensLine TEC-EVO
 - Interface Cables
 - AVASPEC Product CD-ROM

APPLICATION

Irradiance measurements such as Colorimetric, Photometric and Radiometric, measuring reflective surfaces as well as for colour measurements, fluorescence spectroscopy and forward I-V LED measurement.



PHOTOLUMINESCENCE SYSTEM

GENERAL DESCRIPTION

Photon System Deep UV (DUV) Mini PL/RAMAN Spectrometer provides the most compact and inexpensive instrument with deep UV (224 nm) excitation light source. This system allows the PL measurements of semiconductor materials with bandgap up to about 5.5 eV corresponding to AlGaN with Al concentrations up over 80%.

SYSTEM FEATURES

- Room temperature PL measurement.
- 5.5 eV (224 nm) excitation laser source with output power of 25 mW.
- Excitation and emission energy measurements for direct QE measurements.
- Highly portable 15 x 18 x 36 cm, <8kg.
- High-resolution 0.2 nm (multi slits included).
- Computer controlled grating selection and calibration.
- 1200 g/mm grating std (300 nm peak).
- 3600 g/mm grating for High Res PL optional (250 nm peak).
- Digital PMT controller with gated box car Integrator & Averager for low noise digital PMT output measurement.
- <20 Watts (90-240 VAC) input.
- Fully integrated, self-contained, system.
- Lab View interface and control of laser, spectrograph, PMT, spectral data.
- Analysis software includes, FWHM, peak, side lobe identification, spectral subtract, normalize, etc.
- Up to 50 mm diameter sample size
- X-Y-Z stage manual control 50 mm dimension.
- 50 mm X-Y motorized stage including mapping software.

APPLICATION

Photoluminescence (PL) is used to characterize the optical properties of semiconductor materials. It provides information about the carrier doping levels, alloy composition, energy bandgap, etc. These measurements are important both for materials research and process monitoring.



KEITHLEY SYSTEM SOURCE METER

GENERAL DESCRIPTION

The Model 2450 is Keithley's next-generation source measure unit (SMU) that truly brings Ohm's law (current, voltage, and resistance) testing right to your fingertips. Its innovative graphical user interface (GUI) and advanced, capacitive touchscreen technology allow intuitive usage and minimize the learning curve to enable engineers and scientists to learn faster, work smarter, and invent easier.

SYSTEM FEATURES

- V-Ranges: 20 mV – 200 V
- I-Ranges: 10 nA – 1 A
- 0.012% Basic Accuracy
- Wideband Noise: 2 mVrms Typ
- Sweep Types: Linear, Log, Dual Linear, Dual Log, Custom, Source-Memory (SCPI 2400 Mode)
- >250,000 Point Reading Buffer
- >3000 Readings/Sec.
- SCPI (2400 + 2450) + TSP Programming
- GPIB, USB, Ethernet (LXI)
- Front: Banana Jacks, Rear: Triax
- Temperature Coefficient (0°–18°C and 28°–50°C): $\pm(0.15 \times \text{accuracy specification})/^\circ\text{C}$.
- Maximum Output Power:
 - 20 W, four-quadrant source or sink operation.
- Source Limits:
 - V-source: $\pm 21 \text{ V}$ ($\leq 1 \text{ A}$ range), $\pm 210 \text{ V}$ ($\leq 100 \text{ mA}$ range)
 - I-source: $\pm 1.05 \text{ A}$ ($\leq 20 \text{ V}$ range), $\pm 105 \text{ mA}$ ($\leq 200 \text{ V}$ range)
- Overrange: 105% of range, source and measure.
- Load Impedance:
 - 20 nF typical (standard). Stable into 50 μF typical (High-C mode).
 - High-C mode valid for $\geq 100 \mu\text{A}$ ranges, $\geq 200 \text{ mV}$ ranges.
- Maximum voltage drop between force and sense terminals: -5 V .

APPLICATION

Ideal for current/voltage characterization and functional test of a wide range of today's modern electronics and devices, including: Nanomaterials and Devices, Semiconductor Structures, Organic Materials and Devices, Energy Efficiency and Lighting, Discrete and Passive Components, and Material Characterization.



NEWPORT POWER METER

GENERAL DESCRIPTION

The Newport 1936-R, RoHS compliant Single Channel High Performance Optical Power and Energy Meter is one of the most sophisticated optical meters available in the market. These instruments combine the superb femtowatt level sensitivity reached by the 1931-C and the extreme versatility of 1935-C, resulting in a truly revolutionized instrument. All compatible detectors will work with the instrument.

SYSTEM FEATURES

- Sampling Rate: 250 kHz (10 kHz accessible by user)
- Compatible Detectors: 818-xx/DB, 918D (photodiode), 818P, 919P (thermopile), 818E (pyroelectric), 819C.
- Data Storage: 250,000 Point Internal Storage
- Analog Output: 0-1 V, 0-2 V, 0-5 V or 0-10 V (user selectable output impedance)
- Bandwidth: Up to 500 kHz (Photodiode), Up to 1.9 MHz (Thermopile or Pyroelectric) depending on Range
- Accuracy: $\pm 0.2\%$ for CW, $\pm 1\%$ for Peak to Peak, Pulse to Pulse, and Integration Mode
- Detector Input: Up to 25 mA for photodiode, 130 V for thermopile and pyroelectric detectors
- Display Mode: 20 mm Numeric, Bar Chart, Min/Max Bar, Statistics, Analog Needle
- Display Type: 5.7 in. Graphical TFT LCD, $\frac{1}{4}$ VGA
- Display Refresh Rate: 20 Hz
- Photodiode Measurement: Average Power, Peak-to-Peak Power, Frequency
- Thermopile Measurement: Average Power, Single Shot Energy
- Frequency Measurement Range: 1 Hz - 250 kHz
- Measurement Rate: Up to 10 kHz pulses for pyroelectric, Up to 20 kHz for photodiode (peak to peak measurement)
- Resolution: 0.0004% of Range Full Scale
- Power Requirements: 90-240 VAC
- Operating Temperature: 5 to 40°C, <70% RH

APPLICATION

Measurement of the optical power in a light beam, for example a laser beam. Power measurements with a relatively low bandwidth and average power, when receiving a pulse train with a high pulse repetition rate, e.g. from a Q-switched or mode-locked laser.



GLOVE BOX

GENERAL DESCRIPTION

Custom made universal glove box for samples handling in isolated and controlled environment to prevent oxidation, moisture and dust from the sample. This glove box can be used with or without vacuum.

SYSTEM FEATURES

- A fully sealed transparent (see through) acrylic chamber. The thickness of the acrylic is 5 mm.
- The chamber containment size is 900 x 500 x 500 mm (LXWXH).
- N₂ gas feedthrough to maintain N₂ ambient during the process and exhaust port to the vacuum pump.
 - Single stage vacuum pump up to 2.5×10^{-2} mbar.
- Equipped with one pair of latex gloves.

APPLICATION

A glove box (or glove box) is a sealed container that is designed to allow one to manipulate objects where a specific atmosphere is desired. It allows a person to work with hazardous substances, such as infectious disease agents that must be contained within a very high purity inert atmosphere, such as argon or nitrogen.



SPIN COATER

GENERAL DESCRIPTION

The POLOS SPIN150i spin coater is a versatile and high-quality substrate spin coater, made out of PTFE or NPP. It is specifically designed for R&D and low volume production. Users may program the spin coater with custom programs of the system for the deposition of uniform thin layer especially for photoresist process.

SYSTEM FEATURES

- Substrates size: up to 6" wafer or up to 4" x 4"
- Maximum speed: 1000 rpm.
- Central dispensing syringe holder consists of a maximum of 3 syringe holder.
- Vacuum chuck adapter for small substrate for various dimension from 0.5 inch (1 cm) up to 6 inch (15 cm) diameter sample size.
- USB Port.
- Weight: 14 kg.

APPLICATION

The Polos Spin Coater is a process tool for typical spin process applications. The range of applications depends on components and options installed including coating, cleaning, drying, developing and etching.



DEGAS VACUUM SYSTEM

GENERAL DESCRIPTION

Vacuum pump for removing trapped gases from compounds. With the appropriate vacuum pump, the degas chamber is used to reduce the pressure above the surface of the material and permit escape and subsequent removal of entrapped air and other gases that could induce failure of the final product.

SYSTEM FEATURES

CHAMBER

- Anti-back flow to prevent the oil from flowing back.
- Forced oil cycling system lubricated by oil inlet system
- Integrated body structure by integral cylinder block, to achieve limiting vacuum

VACUUM PUMP

- Integral handle is firm and comfortable with high pressure rubber and metal insert.
- Big sight glass oil level to monitor clearly and preventing lack of oil.
- Large starting torque and can be started under the circumstance of low temperature ($\geq -5^{\circ}\text{C}$) and low voltage ($\geq 180\text{V}$) in winter.

APPLICATION

Degas Vacuum pump is used in the process to remove gases entrapped in the mixture compounds.



MICROWAVE CHAMBER

GENERAL DESCRIPTION

The BP-125 from Microwave Research and Applications, Inc. is an economical and compact laboratory microwave ideal for tissue staining, antigen retrieval, chemical processing, sample ashing, and other general laboratory heating tasks. The user can program the process controller for a temperature profile for the sample. The process controller then monitors the sample temperature and will increase the temperature of the sample at the programmed rate and then hold the sample at a desired temperature for any length of time.

SYSTEM FEATURES

- 230 volt 50 Hertz operation.
- Temperature probe configurations are available.
- Microwave safe gas feed through ports.
- Corrosion resistance package.
- Ashing package with muffle to 1,000 °C.
- Vacuum chamber.
- Air driven magnetic stirrer system.
- Upgraded process controller with RS-232 or USB PC interface with 126 process steps into 31 programs.
- Time and temperature data collection with graphing.
- Fully safety tested for microwave leakage, electrical safety and operation.

APPLICATION

Tissue staining, antigen retrieval, chemical processing, sample ashing, and other general laboratory heating tasks.

HANDY SPECTROMETER



HANDY SPECTROMETER

GENERAL DESCRIPTION

UPRtek MK350N Plus Handheld Spectrometer is a Spectrum Analyzer, LED Meter and Flicker Meter for LED measurement. It includes more than 40 light measurement units such as CCT, CRI, CIE1931/1976, LUX, TLCI and others.

SYSTEM FEATURES

- Capture Function – One-time / Continuous.
- Operation Modes – Standalone / WiFi, USB + PC connection.
- Integration Modes – Auto / Manual.
- Measuring Modes – Basic Value, Spectrum Graph, CIE 1931 / 1976 Chromaticity Diagram, Color Rendering Index (CRI), LUX Image Distribution, Measurement Log, Correlated Color Temperature (CCT) BIN Chart, Quality Control Checker, Measurement Comparison, Data Browser.
- Measuring Capabilities – CCT, LUX / Foot Candle, CRI Ra / R1~R15, Spectral Irradiance, CIE Chromaticity Coordinates (1931 x, y coordinates, 1976 u', v' coordinates, 1931 XYZ value), Peak Wavelength / Dominant Wavelength, Δx , Δy , $\Delta u'$, $\Delta v'$, Delta un (Duv), Color Quality Scale (CQS), TM-30-15 (Rf, Rg, Color Vector Graphic), LB/CC Filter, Spectral Power Distribution (SPD) mW/m², Integration Time (I-Time), Scotopic and Photopic Ratio (S/P), Excitation Purity, PPF (400 nm - 700 nm) and BIN.

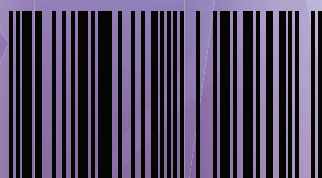
APPLICATION

Characterization of the light emission from emitting devices, such as LEDs.



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