Measurement System for Solar Cell Manufacturing

Manufacturer: Semilab	Model: WT-2000PVN
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Contact: Dr. Osama Tobail Osama.tobail@egnc.gov.eg

Description:

The WT-2000PVN system is a platform that equipped with a variety of measuring options. This allows characterization of silicon samples in diverse ways. It is a useful tool for incoming wafer inspection, quality control and process monitoring in wafer manufacturing as well as in solar cell manufacturing.

Features:

1. μ-PCD for determination of minority carrier lifetime
2. LBIC for diffusion length and internal quantum efficiency evaluation on solar cells
3. Eddy current for measurement of resistivity
4. SHR for determination of sheet resistance

The system is suitable for measuring R&D samples as well as industrial silicon wafers and solar cells up to 8 inch. This measurement can help in production line and process assessment in the field of silicon solar cell manufacturing and in characterizing solar cells developed in laboratories to evaluate either the material or the process quality.

Photo-conductance Lifetime Tester and Suns-Voc

Manufacturer: Sinton Instruments	Model: WCT-120 with Suns-Voc
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Contact: Dr. Osama Tobail Osama.tobail@egnc.gov.eg

Description:

The WCT-120 Lifetime Test Instrument employs Sinton Instruments' unique and powerful measurement and analysis techniques. The instrument uses an eddy-current conductance sensor and a filtered xenon flash lamp to measure carrier lifetime. Measurements can be taken using either Quasi-Steady-State-Photoconductance (QSSPC) method or Transient PhotoConductance Decay (Transient PCD).

This instrument is ideal for evaluation and optimization of material quality, dopant diffusion, and passivation quality in silicon photovoltaic wafers and cells. The Suns-Voc instrument is ideal for optimizing metallization and firing parameters in solar cells and solar cell precursors.

Features:

1. Measurement Results
   - Lifetime
   - Sheet Resistance (average resistivity)
   - Emitter saturation current density
   - Trap Density
   - One-Sun Implied Open Circuit Voltage
   - Implied I-V curve at open circuit
   - Pseudo-efficiency and pseudo-fill-factor
2. Lifetime Measurement Range from 100ns to greater than 10ms
3. QSSPC, Transient, and Generalized measurement and analysis modes
4. Resistivity measurement from 3 to 600 (undoped) ohms/square
5. Temperature controlled chuck (25°C) for the Suns-Voc measurement

Spectroscopic Variable Angle Ellipsometer

Manufacturer: Semilab	Model: GES5-E
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Contact: Dr. Osama Tobail Osama.tobail@egnc.gov.eg

Description:

GES5-E spectroscopic ellipsometer enables the determination of the thickness as well as the optical parameters (absorption and refraction) for one thin layer or a stack of nano-layers by means of analyzing the change in the polarization status of light. Layers with thickness down to 3 to 4 nm were analyzed by this equipment at Egypt Nanotechnology Center. The system is equipped with a powerful software for analyzing the data. In general, the course of ellipsometric data evaluation involves three main steps. Firstly, a structure model has to be assumed for the investigated sample as well as assignment of phase types (n&k file, dispersion laws, EMA, diffusion, alloy, periodic, anisotropy) for each defined layer is also necessary. In the second step the initial parameterization of selected optical functions should be made by interactive simulations. The third step invokes a curve fitting procedure to determine the fitted parameters.

Features:

1. Powerful software for data analysis and automatic mapping for samples up to 8 inch wafers
2. Vacuum chuck to fix the substrate during measurement
3. Determination of the absorption coefficient and refractive index of new material by assuming dispersion laws
4. Analysing nano layers of nanocomposites by the Effective Medium Theory

Solar Cell Quantum Efficiency Measurement System

Manufacturer: Protoflex	Model: QE1100
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Contact: Dr. Osama Tobail Osama.tobail@egnc.gov.eg

Description:

Quantum efficiency (QE) is used to determine the sensitivity of a photosensitive device, such as a solar cell. It is defined as the percentage of photons hitting the photoreactive surface which will product an electron-hole pair. When measured over a range of different wavelengths, it enables the characterization of a device's efficiency at each energy level. When summed across the entire solar electromagnetic spectrum, it can be used to calculate the current that a solar cell will generate when exposed to white light.

Features:

1. The ProtoFlex Quantum Efficiency Measurement System, Model QE-1100, provides capability for the accurate measurement of quantum efficiency of photosensitive devices and the transmission properties of thin films.
2. The system provides absolute accuracy of ±2% over a wavelength range of 300- 1100 nm over an area of 10 cm x 10 cm (4‖ x 4‖).
3. The analysis of the measured QE data gives information about the cell performance in terms of collection length, reflection and internal quantum efficiency which enables cell development.
4. Silicon certified reference cell is available for calibration.
5. Light and voltage biasing is available

Six-Source Thermal Co-Evaporator

Manufacturer: Protoflex	Model: Evap007
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Under Installation

Description:

Physical Vapor Deposition (PVD) technique based on evaporating the material from a solid source in vacuum and depositing it on a substrate with a controlled thickness.

Features:

1. Evaporation from up to three sources simultaneously
2. Sequential deposition of several layers up to 6 different material for any number of layers
3. Recipe based and manual deposition with thickness monitoring
4. Substrate heating from RT to 800C
5. Substrate size up to 8” wafer
6. Evaporating in a controlled oxygen flow for oxide deposition from metal sources

Six-Target Magnetron Co-Sputtering

Manufacturer: Protoflex	Model: Sputt007
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Under Installation

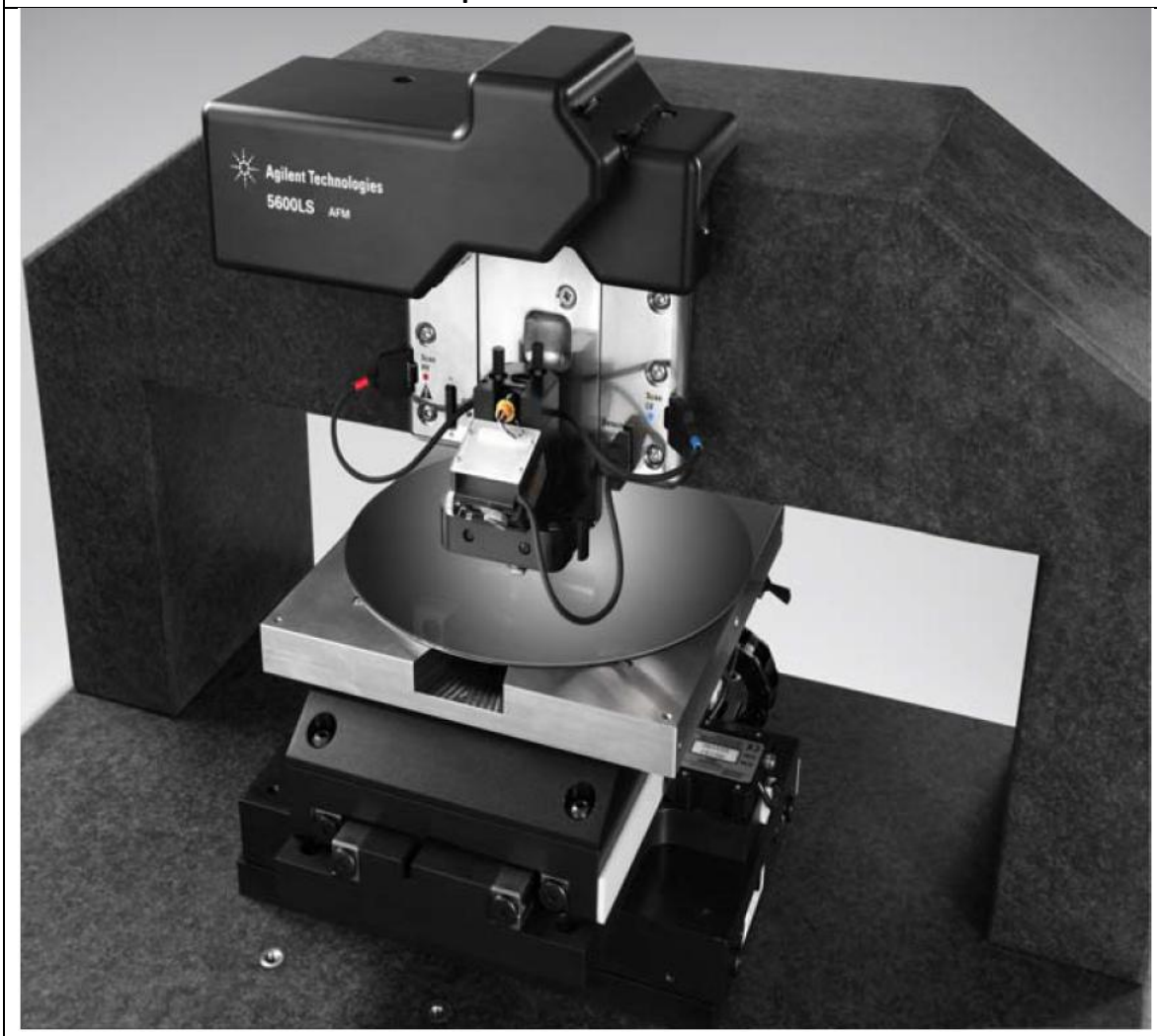
Description:

Physical Vapor Deposition (PVD) technique based on sputtering the material from a solid target in vacuum by plasma and depositing it on a substrate with a controlled thickness. The system uses Argon for sputtering and other gases for reactive sputtering.

Features:

1. Three DC and three RF magnetrons
2. Deposition from up to three sources simultaneously
3. Sequential deposition of several layers up to 6 different material for any number of layers
4. Recipe based and manual deposition
5. Substrate heating from RT to 800C
6. Substrate size up to 8” wafer
7. Reactive sputtering with O2 or N2 or both

Atomic Force Microscope:



Manufacturer: Agilent Technologies	Model: 5600LS
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Contact: Dr. Mostafa Elashry Mostafa.elashry@egnc.gov.eg

Description:

Atomic Force Microscopy (AFM) can resolve features as small as an atomic lattice, for either conductive or non-conductive samples. AFM provides high-resolution and three-dimensional information, with little sample preparation. The technique makes it possible to image *in-situ*, in fluid, under controlled temperature and in other controlled environments. The options of AFM extend to applications in life science, materials science, electrochemistry, polymer science, biophysics, nanotechnology, and biotechnology.

The equipment can be operated in the following modes:

- Contact Mode imaging
- AC mod (tapping)
- Scanning tunneling microscope
- Current sensing

Fourier Transform Infra-red spectroscopy: (FTIR)

Manufacturer: Thermo	Model: Nicolet 6700
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Contact: Dr. Mostafa Elashry Mostafa.elashry@egnc.gov.eg

Description:

Fourier transform infrared spectrometer (FT-IR) for the analysis of organic and inorganic compounds.

Features:

a. Spectral Range: 375 to mid IR

Optical resolution: 0.2 cm^{-1} or less

Detectors :

i. Deuterated Triglycine Sulfate (DTGS) Detectors (Temperature-stabilized)

ii. Mercury cadmium telluride (MCT) [liquid Nitrogen cooled]

Sources:

i. Near -Mid-IR source to cover the IR range

ii.White light source to cover the visible range

Beam splitter: KBr beam splitter

Precision: 0.01 cm^{-1} or better

Purgeable chamber

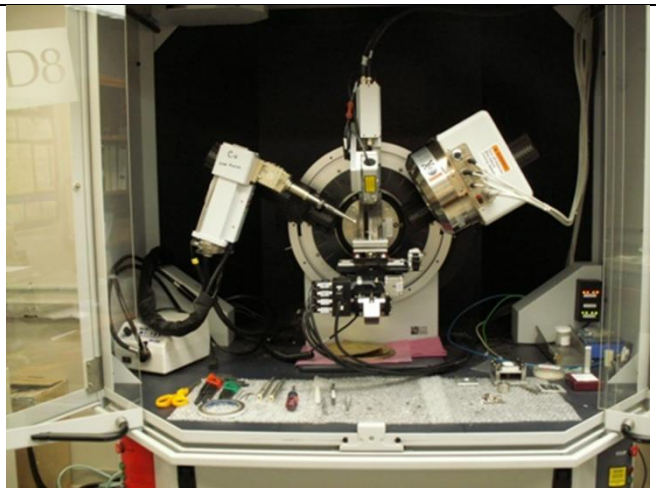
Auto validation facility as per NIST traceable validation kit, certified/ASTM protocol

Samples capability:

i. gaseous, liquid and solid,

ii. transmission and surface analysis

X-ray Diffraction (XRD)



Manufacturer: Bruker	Model: D8 Discover
Place: Egypt Nanotechnology Center, Cairo University, Shaikh Zayed Campus, B3	Contact: Dr. Ahmed Abou-Kandil Ahmed.akandil@egnc.gov.eg

Description:

Wide Angle X-ray Diffraction with Small Angle Capability

Features:

1. The D8 DISCOVER with DAVINCI design increases ease-of-use with real-time component detection, plug-and-play functionality and fully integrated 2-dimensional XRD capabilities.
2. X-ray diffraction applications, including reflectometry, high-resolution diffraction, in-plane grazing incidence diffraction (IP-GID), small angle X-ray scattering (SAXS), as well as residual stress and texture investigations.
3. For a 2-D detector, size is the most important feature. A large detector window not only enables increased data collection speed, it also provides information that is simply not accessible with 0-D, 1-D or smaller 2-D detectors. The VÅNTEC-500 detector features a huge 140 mm diameter window, covering up to about 80° (2θ) and a large γ-range.
4. The factory-aligned, SNAP-LOCK X-ray optics provide true 'plug-and-play' functionality, including automatic and tool-free switching of the diffraction geometry with minimal user intervention.
5. An X-ray optics module, a detector, or any accessory mounted onto the instrument registers itself in real-time with its relevant parameters and analytical capabilities, including powerful detection of possible component conflicts.