SEMICONDUCTOR CHARACTERIZATION SYSTEMS

Wafer Mapping Tools for high speed, high resolution whole wafer mapping of defects and/or contaminants

Bulk Microdefect Analyzer for imaging of extended defects (from 20nm to several micron)

Deep Level Spectrometer for identification of electrically active point defects
WT-2000 Wafer Tester
monitoring defects and contamination both in the bulk and in the surface region of silicon wafers

Applied measurement techniques:

- $\mu$-PCD for bulk Si
- Charge-PCD for bare wafers
- EpiTest for epi wafers
- Temperature dependent $\mu$-PCD for Si and compound materials
- SPV for bulk Si
- Kelvin Probe for oxide characterization
- Eddy current for resistivity mapping
- LBIC for solar cell characterization
μ-PCD (microwave photoconductive decay) technique for mapping crystal growth and process induced defects and heavy metal contamination in bulk silicon wafers.

APPLICATIONS

CRYSTAL GROWTH DEFECTS

PROCESS INDUCED DEFECTS/Fe MAPPING

\[ I = I_0 e^{-t/\tau} \]
Surface Photovoltage (SPV) technique for mapping heavy metal contamination and crystal defects in the bulk silicon wafer.

IRON CONCENTRATION MAPPING

\[
N_{Fe} = C \left( \frac{1}{L_{after}^{2}} - \frac{1}{L_{before}^{2}} \right)
\]

Fe AND O₂ MONITORING BY COMBINED \(\mu\)-PCD AND SPV TECHNIQUES
Semilab’s patented new surface passivation method applying controlled charge deposition on to the wafer surface during lifetime mapping provides a highly efficient, reproducible and homogeneous surface recombination elimination on bare wafers.

\[
\frac{1}{\tau_{\text{meas}}} = \frac{1}{\tau_{\text{bulk}}} + \frac{1}{\tau_{\text{diff}} + \tau_{\text{surf}}}
\]

Lifetime map measured without charging

\[\tau_{\text{average}} = 15.7 \, \mu\text{s}\]

Lifetime map measured with charging

\[\tau_{\text{average}} = 268 \, \mu\text{s}\]

Surface/interface characterization

Interface recombination velocity map of an oxidized wafer calculated from the lifetime map measured with and without charging on the same wafer.
Monitoring minority carrier lifetime as a function of temperature in narrow band gap semiconductors (InSb, HgCdTe, etc.)

Two measurement strategies:
- whole wafer mapping at a preselected stabilized temperature between 85K and 300K
- single point lifetime plot as a function of temperature between 85K and 300K
**Improved μ-PCD** (microwave photoconductive decay) technique for the characterization of recombination processes in epi structures.

**Diagram:**
- **Light excitation:** Green laser 532nm
- **Microwave**
- **Oxide or passivation**
- **Epi layer**
  - $S_{\text{surface}}$
  - $S_{\text{interface}}$
  - $\tau_{\text{epi}}$
- **p+ or n+ substrate**
  - $\tau_{\text{substrate}}$

**Lifetime map**
- Fe concentration map
Plasma damage monitoring and oxide/interface characterization by non-contact V-Q curve measurement using Kelvin Probe with additional high intensity illumination and controlled corona charging

Plasma damage monitoring by oxide charge map

Non-contact V-Q

- $T_{ox}$: Electrical oxide thickness
- $Q_{eff}$: Effective charge
- $V_{fb}$: Flatband voltage
- $V_t$: Threshold voltage
- $V_{ox}$: Oxide voltage
- $D_{it}$: Density of interface traps
Non-contact whole wafer resistivity mapping based on the eddy current technique for the determination of bulk resistivity distribution in silicon wafers.
Non-contact, non-destructive method based on reflection mode confocal microscopy for detection and analysis of bulk microdefects.
Detection and identification of trace level of impurities in concentrations down to $10^9$ atoms/cm$^3$

**CRYOSTATS IN DIFFERENT TEMPERATURE RANGES**
- Closed Cycle He-cryostat from 20K to 300K
- LN$_2$ cryostats from 77K to 450K:
  - simple bath type LN$_2$ cryostat
  - automatic LN$_2$ cryostat with controlled LN$_2$ flow

**SAMPLE HOLDER**
with motor driven positioning

**Radiation defects**
in n-type FZ silicon

**Radiation defects**
in p-type FZ silicon

**Influence of annealing on Fe-B pairs**
LBIC=Light Beam Induced Current

Very high, 1µm resolution mapping capability to measure at low temperatures
Major application: HgCdTe devices