Company Introduction and History

Semilab Semiconductor Physics Laboratory Co. Ltd.
Outline

• Basic Facts about Semilab
• Semilab Worldwide
• History
• Company acquisitions
• Technology purchases
• Semilab Staff
• Current portfolio
Basic Facts about Semilab

Main activity: Development, manufacturing and marketing of metrology equipment for the semiconductor and photovoltaic industries.

- Laboratory, office and manufacturing space: 11,000 m², about 3,000 m² in the US
- Over 400 employees worldwide
- 51 physicists employed worldwide
- 18 employees holding a Ph. D. in physics (7 in Hungary)
- Patents: wholly owned – 90, applications – 8, licensed – 41
- ~400 tools with automated wafer handling installed in semiconductor production
  - 130 tools in 300mm fabs
- 34 different product lines, 110 products with various configurable options
History of the Semilab Group

1990: Founded by researchers as a spin-off from the Research Institute for Technical Physics of the Hungarian Academy of Sciences

2004-2010: Photovoltaic area
- 90% annual growth (industry growth ~40%)
- Dominant player in front-end electrical metrology

2004-2014: Semiconductor area
- Growth by company and technology acquisitions
- 5th biggest pure-play metrology company
- Building significant customer base in FPD industry
Semilab around the World

- Headquarters: Budapest (HQ)
- R&D and product Center: USA, Boston, Denmark, Copenhagen, Germany, Braunschweig, France, Grenoble
- Sales & Service: USA, San Jose, USA, Tampa, Korea, Seoul, Japan, Tokyo, China, Shanghai, Wuxi, Taiwan, Hsinchu, Singapore
Global Corporate Organization

- Semilab HQ Budapest
  - Semilab USA Billerica, MA
    - Semilab AMS Billerica, MA
    - Semilab SDI Tampa, FL
  - Semilab Korea Seoul
  - Semilab China Shanghai
    - Semilab China Wuxi
  - Semilab Taiwan Hsinchu
  - Semilab South-East Asia
    - Semilab Germany
    - Semilab Denmark
  - Semilab Japan Shin-Yokohama

Semilab Europe Customer support
Semilab Staff

Semilab Employees Worldwide

- Hungary: 63%
- Germany: 1%
- China: 10%
- Japan: 6%
- Singapore: 1%
- France: 1%
- Korea: 4%
- Taiwan: 2%
- USA: 12%

Semilab Worldwide

- Hungary: 63%
- Other: 28.5%
- PhD: 5.8%
- PhD students: 2.6%
- University/College without PhD (s): 63.1%
- Other: 28.5%

Qualifications

Semilab Employees Worldwide

- 1998: 18
- 2000: 22
- 2002: 23
- 2004: 28
- 2006: 37
- 2008: 61
- 2010: 170
- 2012: 392
- 2014: 443
- 2016: 408

2/2/2016
History of the Semilab Group

- **Established:** 1990
- **Acquired:**
  - 2004
  - 2008
  - 2008
  - 2008
  - 2015

- **USA, formerly:**
  - **Ams**
  - **SDI**
Technology Acquisitions in the Semiconductor Sector

IBM

Junction Photo-Voltage measurement for ion implant characterization from IBM

APPLIED MATERIALS®

Photo-Modulated Reflectivity measurement for ion implant characterization from Applied Materials
Technology Acquisitions in the PV Sector

- Microcrack inspection technology from Basler AG
- Visual wafer inspection technology from Tordivel Solar
Applications for the Semiconductor Industry: Wafer Makers

**Ingot**
- Resistivity testing
- Contamination monitoring

**Wafer**
- Contamination and defect monitoring by non-destructive methods
- High-sensitivity contamination analysis
- Bulk microdefect characterization

**Epi layer**
- Contamination monitoring
- Resistivity monitoring
- Resistivity profiling
Applications for the Semiconductor Industry: Device Makers

- **Incoming wafer**
  - Electrical quality control by carrier lifetime and carrier diffusion length

- **Ion implant**
  - Dose monitoring before anneal
  - Sheet resistance measurement after anneal
  - Junction depth measurement

- **Gate dielectric**
  - Optical thickness measurement
  - Qualification of electrical properties (by contact and non-contact methods)

- **Porous dielectric**
  - Optical thickness measurement
  - Porosity measurement
  - Qualification of electrical properties (by contact and non-contact methods)

- **Metal layer, 3D structures**
  - Non-contact thickness measurement
  - Non-contact determination of mechanical properties
  - Bonded wafer inspection (for voids and alignment)
Products for the Semiconductor Industry

- Most metrologies available in different platforms for different customer needs
  - Lab-scale R&D and small-scale production control
  - Automated up to 200mm for Tier 2 fabs
  - Automated up to 300mm without OHT for mid-range fabs
  - Full 300mm automation with OHT and factory integration for Tier 1 customers
  - 450mm tools already shipped: Wafer Tester for bulk Si qualification by carrier lifetime and diffusion length, Laser Ellipsometer
- High-end tools are meeting all advanced fab cleanliness standards, including integrated minienvironments.
- Key applications to control critical parameters in production:
  - Contamination and damage monitoring
  - Monitoring key steps: implants, dielectric layers, metallization layers, etched structures
For wafer makers, we offer 12 product lines, 43 products.
For semiconductor device makers, we offer an additional 11 product lines with 44 products.

Available from manually loaded lab platform to 300mm automated platform

Available from ≤200mm automated to 300mm automated platform
Products for the Photovoltaic Industry

- Handheld tools for quick testing
- Table-top tools for high resolution wafer mapping
- In-line tools for integration with a fully automated product line
- Key applications to control critical parameters:
  - Contamination monitoring
  - Resistivity and sheet resistance measurements
  - Visual inspection
    - Geometry
    - Surface
    - Microcracks
  - Photoluminescence imaging
  - Efficiency measurements
For the photovoltaic industry, we offer 7 product lines with 23 products and a large number of metrology options.
Applications for the Photovoltaic Industry

Feedstock
- p/n type bulk resistivity
  - Off-line inspection

CZ Growing Casting Ribbon pulling
- carrier lifetime bulk resistivity, defect detection
  - Off-line inspection

Ingot, Block, Ribbon
- carrier lifetime bulk resistivity
  - In-line inspection

Sawing, Etching, Polishing
- carrier lifetime, thickness, TTV, bulk resistivity, wafer sorting
  - In-line inspection

Wafer

Incoming wafer inspection
- carrier lifetime thickness, TTV bulk resistivity
  - Off-line inspection

Chemical saw damage etching
- In-line inspection

P diffusion, P glass removal
- emitter sheet resistance carrier lifetime
  - Off-line inspection

Silicon nitride ARC
- carrier lifetime Interface recomb. velocity, coating thickness
  - Off-line inspection

Back side printing, Front side printing

Testing
- LBIC+reflectance IQE
  - Off-line inspection

Comprehensive, fully in-line process control for the c-Si PV manufacturing process.
Fully Automated In-line Metrology Systems for PV Production

Wafer loading from stack or cassette

Wafer unloading to stacks

Testing and classification:
- Electrical testing (carrier lifetime, resistivity)
- Visual inspection (geometry, edge, surface, microcracks)
- Photoluminescence imaging
Products for the Flat Panel Industry

- Optical and electrical characterization of state-of-the-art thin layers
- From table-top R&D tools to fully automated systems capable of automatic operation up to Gen. 8. glass panels
Products for Flat Panel Industry

- Electrical and optical characterization can be combined
- Various options available
  - Line mura detection (ELA process characterization)
  - Spectral reflectometry
  - Imaging spectroscopic reflectometry for halftone process monitoring
  - Sheet resistance measurement
  - Contact angle measurement
  - Full sheet stress measurement
Thank you!

For All Your Metrology Needs