KOKUSAI ELECTRIC Product Offering for 2018

Yoshio Joe Kitahara
President & Managing Director
Kokusai Semiconductor Europe GmbH
A bit of introduction on KOKUSAI ELECTRIC CORPORATION
## Company Overview

<table>
<thead>
<tr>
<th><strong>Company Name</strong></th>
<th>KOKUSAI ELECTRIC CORPORATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date of Establishment</strong></td>
<td>February 2, 2017</td>
</tr>
<tr>
<td><strong>Headquarters</strong></td>
<td>3-4, Kandakaji-cho, Chiyoda-ku, Tokyo 101-0045, Japan</td>
</tr>
<tr>
<td><strong>Representative</strong></td>
<td>Fumiyuki Kanai</td>
</tr>
<tr>
<td><strong>Paid-in Capital</strong></td>
<td>¥100 million</td>
</tr>
<tr>
<td><strong>Fiscal Year-end</strong></td>
<td>September 30</td>
</tr>
<tr>
<td><strong>Number of Employees</strong></td>
<td>979 (non-consolidated) 1,881 (consolidated)</td>
</tr>
</tbody>
</table>

### Executive Officers

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fumiyuki Kanai</td>
<td>President and Chief Executive Officer</td>
</tr>
<tr>
<td>Yuji Kamiya</td>
<td>Executive Vice President and Executive Officer Responsible for Corporate Management</td>
</tr>
<tr>
<td>Unryu Ogawa</td>
<td>Senior Vice President and Executive Officer Responsible for Technology Development and New Business Development</td>
</tr>
<tr>
<td>Hidehiro Yanagawa</td>
<td>Corporate Vice President and Executive Officer Responsible for Product Development, Production and Quality Assurance</td>
</tr>
</tbody>
</table>
Kokusai Europe – Training Center

- Newly developed Training Centre with a 300mm furnaces to cover the European market
- First course for FSE to commence in Oct.
- Open to Customers from Jan 1st 2019.

Provide KSE and Customer Training Courses:
- Auto Operations – Robotics Operations
- Phase 2 – Quartz Removal, Error recovery, Recipe Creation
- Phase 3 – Mechanical Training, PM training, Maintenance
- Customised machine training available upon request
VR300DEC

VR300D resistivity probe located at Training Centre

Advanced Technical Support capabilities for EU Customers
- Enhanced remote diagnostics
- Remote screen by screen error recovery
- Next day FSE dispatch capabilities

Training Capabilities:
In-house Operations training
Operations training for customers
European Market Status & its requirement
End Use Market Trend Analysis

IC Consumption by Mobile, Server, IoT & Auto Motive

(Gartner)

Real Growth Curve

Mobile Phone  Internet of Things

Transmissive Mirror Device
Devices required for IoT (Example)

KE/KSE tools brings solutions for all cores of IoT devices
0.13 μm has the most design starts; 65nm and 45nm have yet to peak.

"IoT Market: $19 Trillion by 2020!" (John Chambers/Cisco Systems CEO)

Sources: Gartner, IDC, Strategy Analytics, Machina Research, company filings, BII estimates.

Global internet device installed base forecast

Those equipment at aged/old Fabs (200/150/100mm) are still required to support IoT based chip set manufacturing.
Booming IoT Market

- # of Tool/Equipment connected through Internet has been forecasted by 2020 is 50B units per (Cisco revised to 500B/Yr)
- Once many goods starts connected, # of goods connected grow rapidly as follows
- # of IoT Modules x required # of chip sets

Prospective IoT connection

* source from Gartner Report in 2015

Cisco CEO said 50B units

if one IoT module require >10 set of chips require > 5
Trillion units of device required to ship beyond 2020
Many Capacitors/Resistors will be required in Analog/Mixed-Signal Devices:

✓ MIM Capacitor Films
✓ Poly-Si Resistor Films

* Source from: Tower Jazz Technical Seminar in 2015
Recent PZT Actuator by Trench Refilling as an example usage of Al2O3

1-1. New Vertical Furnace Overview

State-of-art 100/150/200mm Vertical Furnace on our proven platform

VERTRON® Revolution

**Features**
- Process
  - Diffusion/Anneal
  - CVD
- Features
  - Universal Wafers ready
    - 150mm, 200mm
  - <3m Height available
  - High throughput
  - Flexible batch size
    - 100 ~ 175 wafers per batch
  - Fully automated operation
  - FA host communication
  - Compact footprint
- Options
  - Internal SMIF Indexer
  - Thin wafer transfer
  - Translucent wafer transfer
  - Remote monitoring server

**Applications**
- LSI
- MEMS
- Wafer
- LED
- Power device
- Photovoltaic cell

* VERTRON is a registered trademark of KOKUSAI ELECTRIC CORPORATION.
1-2. Introduction
Advantages on VERTRON® Revolution

☑ Reliability proven as VERTRON® platform
Ready to transfer from existing VERTRON® process available

☑ Modern hardware/software
Upgraded new hardware utilizing latest 300mm tools designs

☑ Proven process experience as a market leader of Vertical Furnace Product
Most kinds of processes like diffusion, Anneal and CVD tool will be available at the least contamination environment

☑ Free from obsolete parts concerns for more than 20 years long onwards
Guaranteed spare parts supply since it’s newly developed tools

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## 2. Key Application

### Typical Process of 150/200mm wafer vertical furnace

<table>
<thead>
<tr>
<th>Power</th>
<th>Wafer</th>
<th>MEMS/Sensor</th>
<th>LSI</th>
</tr>
</thead>
</table>
| ● Hi-temp PYRO  
  - Dry/Wet-Ox, Well  
  ● Low/High temp Anneal  
  - N$_2$/H$_2$/Ar-Anneal, POCl$_3$  
  ● Thick Doped/Non-doped-Poly-Si | ● Hi-temp PYRO  
  - Dry/Wet-Ox, Well  
  ● High temp Anneal  
  - N$_2$/H$_2$/Ar-Anneal  
  ● Thick Doped/Non-doped-Poly-Si | ● Low temp Anneal  
  - N$_2$/H$_2$/Ar-Anneal, POCl$_3$  
  ● Si$_3$N$_4$, HTO, TEOS,  
  ● Thick Doped/Non-doped-Poly-Si | ● Hi-temp PYRO  
  - Dry/Wet-Ox, Well  
  ● High-temp Anneal  
  - N$_2$/H$_2$/Ar-Anneal, POCl$_3$  
  ● Si$_3$N$_4$,HTO,TEOS, CVD  
  ● Doped/Non-doped-Poly-Si |

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### Key applications for 150/200mm wafer

1. **Thick Polysilicon (≧ 5μm)**
2. **Hi-temp PYRO**  
   (= 1250°C)
2.2 Key Application
Poly Process for various applications

- High-temperature Annealing Furnace for Stress-Release & Dopant-Activation in Poly-Si Sensor Structure
- Annealing Furnace (H₂/Ar, ATM/LP) for Vacuum Cavity Formation in Pressure Sensor
- Thin-Si Seeding Technology for Bending-free poly-Si Diaphragm in MEMS Microphone
2.3 Key Process
Thick polysilicon – Example Data

Deposit thick poly-Si at one time

Free from boat mark

Trend of dry cleaning gas for Poly-Si

Free from frequent maintenance

**Cross section SEM**

- **thick poly-Si** at one time
- **Thickness** [μm]: 5.16
- **WiW.** [%]: 0.39
- **D/R** [nm/min]: 8.93

**Process Condition**
- Diameter: 200mm
- Thickness: 5μm/run
- # of Run: 1run
- Substrate: Si

**Boat mark**

**Equivalent etching rate**

**Gas A**

**Gas B**

- **Low initial cost**
- **Environment Friendly**
- **Clean gas to be used**
  - Gas A
  - Gas B
  - Etch rate: >400A/min

- **Poly-Si accumulation**
  - Before: 10 - 20μm
  - After: Gas B

- **Friendly Environment**
- **Initial cost**
- **Etching rate**
1.1 Flexible series of models per application specifics

4 point Probe systems

- **VR300DSE-2P**
  - (for 300mm line, 2 Load Type)

- **VR250**
  - (for less than 200mm, Table Type)

- **VR300DE**
  - (for less than 300mm Table Type)

### Key Features:

- **High-Precision Prove Control**
  - Enable High Precision and High Repeatability Measurement by Automatic Load Control.
  - (Repeatability: Less than 0.2%)  
  - 1 Probe enable to measure multiple films by Recipe Setting.

- **Enable to measure SiC, GaN**
  - Supply measurement system correspond to variety of wafers.

- **High Throughput Long Lifetime Probe**
  - High Throughput (30wfrs/h) by High Speed Transfer and Measurement.
  - Long Lifetime (~1 million time measurement) by Auto Probe Cleaning Function.
  - Running Cost Reduction (Long Lifetime Probe, Probe Type Reduction)

- **User Friendly GUI**
  - Efficient Operation by Original GUI Structure
2.1 VR250 Model Features

Probe Speed Control

In order to obtain the optimal Ohmic contact, the needle contact speed to wafer is very important. Our conventional tool can not make precise speed setting due to air drive and it is only adjustable by maker engineers. In VR250 series, probe speed enable to set by recipe and the measurement repeatability is significantly improved.

<table>
<thead>
<tr>
<th>Model</th>
<th>Conventional Model</th>
<th>VR250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Speed Control</td>
<td>Driving method: Air cylinder Requires Setting by engineer</td>
<td>Driving Method: Motor Control Enable to set Speed by Recipe</td>
</tr>
</tbody>
</table>
2.1 VR Probe Load Control

Probe Speed Control
By adjusting the speed, it enable to measure metal thin film wafers, low Dose and low energy implanted wafers, which were difficult to measure with the conventional method, with high repeatability. In VR250 series, probe speed enable to set by recipe and the measurement repeatability is significantly improved.

Figure 2: Repeatability of each point
Multi 121 Point Measurement x5 times. (Impla As+ 130Ω/sq)

- Probe Down Speed: 1.1mm/s
  - Repeatability: 0.30% Ave. Each Point

- Probe Down Speed: 0.66mm/s
  - Repeatability: 0.09% Each Point
3.1 Output Display / variety of Samples
4.1 VR250 New Model

Auto Load Type (for 200mm)

VR250 New Model
- Release December, 2018
- VR250 Auto Load Type

- Added Wafer Transfer System to VR250
- 8 inch wafer Transfer (Option: 6 inch)
- Less Foot Print
- Enable to implement SMIF
- Possible to implement the customer already have VR250 desktop system.

Auto Load Type (for 300mm)

VR300DSE-2P
2 Load port type

VR300DSE
1 Load port type

Semi-Auto type (for 200 & 300mm)

VR300DE
75mm(3") – 300(12")mm

VR250
75mm(3") – 200(8")mm
Miyatsushin/KSE Solutions proposals / Batch type Ashers
1.1 Newly renovated Ashing platforms

New 100/150/200mm batch ashing tool built on a proven platform

**MG-8500/6500R**

- Proven reliability
  - Designed based on proven RAM platform
  - Modern computing Architecture
- Proven process
  - Low damage ashing
  - Low temp process
  - Big batch volume (50 wafers/batch)
- Worry-free on maintenance parts readiness
  - Long-term parts supply

(Φ200mm case)
## 2.1 Hardware Specifications

<table>
<thead>
<tr>
<th></th>
<th>Specification (8500R/8inch)</th>
<th>Specification (8500ZS/8inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plasma Method</strong></td>
<td>Co-axial Electrode Type (Vertical type)</td>
<td>Co-axial Electrode Type (Vertical type)</td>
</tr>
<tr>
<td><strong>Ashing Chamber</strong></td>
<td>1 Chamber</td>
<td>2 Chamber</td>
</tr>
<tr>
<td><strong>RF Generator</strong></td>
<td>2kW, 13.56MHz, Auto Tuning</td>
<td>2kW, 13.56MHz, Auto Tuning</td>
</tr>
<tr>
<td><strong>Process Gas</strong></td>
<td>O₂</td>
<td>O₂</td>
</tr>
<tr>
<td><strong>Purge Gas</strong></td>
<td>N₂</td>
<td>N₂</td>
</tr>
<tr>
<td><strong>Process Step</strong></td>
<td>3 Steps, 128 recipes</td>
<td>3 Steps, 20 recipes</td>
</tr>
<tr>
<td><strong>Wafer Size</strong></td>
<td>8 inch (φ200mm)</td>
<td>8 inch (φ200mm)</td>
</tr>
<tr>
<td><strong>Wafer Transfer Method</strong></td>
<td>Vertical movement, Cassette elevator system</td>
<td>Vertical movement, Cassette elevator system</td>
</tr>
<tr>
<td></td>
<td>Direct movement single arm robot (2 fingers)</td>
<td>Scara arm robot (single arm, 2 fingers)</td>
</tr>
<tr>
<td><strong>Utility</strong></td>
<td>Power: Φ3 AC 200V</td>
<td>Power: Φ3 AC 200V</td>
</tr>
<tr>
<td></td>
<td>Vacuum pump: 10000L/min</td>
<td>Vacuum pump: 10000L/min</td>
</tr>
<tr>
<td></td>
<td>O₂: 0.2MPa</td>
<td>O₂: 0.1MPa</td>
</tr>
<tr>
<td></td>
<td>N₂: 0.3MPa</td>
<td>N₂: 0.5MPa</td>
</tr>
<tr>
<td></td>
<td>CDA: 0.5MPa</td>
<td>CDA: 0.5MPa</td>
</tr>
<tr>
<td></td>
<td>Finger adsorption: —80~—60KPa(OPTION)</td>
<td>Finger adsorption: Unconfirmed</td>
</tr>
<tr>
<td></td>
<td>Cooling water: 6L/min minimum 0.5MPa Max.</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Loader</strong></td>
<td>SMIF treated as option</td>
<td>SMIF Compatible</td>
</tr>
<tr>
<td><strong>Clean Module</strong></td>
<td>Option</td>
<td>ULPA Clean module</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>500 (Main System unit), 120 (Control rack)</td>
<td>1500 (Main System unit), Unconfirmed (RF rack)</td>
</tr>
</tbody>
</table>

«Changes required as a option for SMIF equipped model»
1. Change Frame
2. Wafer transfer system development
3. Need to add ULPA (Ultra Low Penetration Air Filter) Clean module
5.1 Outstanding Advantages due to wafer batch type:

a) Possible to even ash down side of the wafer bevel
b) Possible to ash the back side of wafer besides small contacts (good for post wet ashing on the back side of wafer when necessary to do so)
c) Smallest foot print requirement (including sub-units) even among batch type ashers, nevertheless it is volume production worthy models
End of my talks.
Thanks for your hearing & attention