High-end solutions for high-tech industries

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Focus on technology

Meyer Burger is a leading global technology company specializing in innovative systems and processes based on semiconductor technologies.

The company’s focus is on photovoltaics while its competencies and technologies also cover important areas of the semiconductor and the optoelectronic industries as well as other selected high-end markets based on semiconductor materials.
Global infrastructure at a glance

Meyer Burger Group – 1,300 employees – Leading global technology group
Serving high-tech industries

- Semiconductor
- Optical Optoelectronic
- Displays Touch Panels
- Printed Electronics & PCB
- Batteries
- Smart Glass
- Automotive
- Photovoltaics

High-end solutions for high-tech industries
Meyer Burger’s Specialized Technologies portfolio

Cutting
Slicing

Ion Beam
processing

Plasma
processing

Inkjet
Printing

Extensive experience in cutting of high quality hard and brittle materials

Advanced plasma and ion beam technologies for high-precision coating, structuring and processing of surfaces

Innovative, multi-functional inkjet printing for today's and future applications

Covering a broad range of applications available in high-end markets
Meyer Burger enables the future of wireless communication and IoT

- Thickness correction
  - MEMS MOEMS

- Frequency trimming
  - BAW SAW

- Pole trimming
  - TFH

IonScan
- Uptime > 95% at customer side
- > 50 installed base
- Reduction of standard deviation $\sigma$ factor >10

Leading technology to trim surfaces in the 0.1nm range
IonScan Technology roadmap

**PRODUCT RELEASE**
14.11.2017

**PRODUCT RELEASE**
Q1 2018

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### Electrostatic clamping
- Replacing mechanical by electrostatic clamping
  - No edge exclusion
  - No mechanical stress
  - More efficient cooling
  - Increased process area (100%)
  - Less breakage rate (> 99%)
  - Higher uptime
  - Reduced CoO by - 10%

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### New Ionbeam source
- Redesign of standard source
  - Adjustability of the grid potentials
  - Precise positioning of the grids
  - Robust components
  - Improved long-term stability (+150%)
  - No arcing
  - Less wear of grids
  - Enhanced control and monitoring during process
  - Reduced CoO by - 20%
PECVD coating and etching systems

- Industrially proven tray based Inline PECVD equipment SiNA® / MAiA® / HELiA®
- Installed base > 800
- Substrate widths up to 1000 mm

Plasma sources:
- Linear Microwave
- Pulsed DC
- RF
- ECR
- ICP
- Ion beam

Medium scale production and R&D
- Widespread modular batch or inline system
- Substrate widths up to 500 mm

Scalability
- Processes, components, and technologies

Large area, High throughput

Plasma experience for more than 30 years
Microwave-PECVD hard coatings (transparent Si$_3$N$_4$ layers)

- Hardness (GPa)
  - 10: high rate intermediate RF bias 1.6
  - 12: high rate no bias 1.9 - 2.2
  - 14: high rate no bias doped < 1.9
  - 16: high rate high RF bias 1.8
  - 18: low rate high RF bias 1.9

- Temperature (°C)
  - 100: high rate high RF bias
  - 200: high rate no bias
  - 300: high rate intermediate RF bias
  - 400: high rate no bias
Microwave-PECVD hard coatings (transparent Si$_3$N$_4$ layers)

RF-biased enhanced PECVD at T < 100 °C

- Deposition rate > 1.2 nm/s
- Hardness ~ 15 GPa
- Low absorption $\varepsilon < 0.002$ @ 400 nm
- Low film stress +100 to -250 MPa for 2 µm
- Good grafting with peel strengths > 1 N
  - On plastics, organics, epoxide resins, copper and tin alloys
- High breakdown voltage in salty water 20 V/µm
- Application
  - Hard and scratch-resistant coatings for displays, windows, watches, lenses
  - Insulating barrier layers in electronic devices (e.g. PCBs, panels) under humid condition
Microwave-PECVD hard coatings (transparent Si₃N₄ layers)

- High variability of refractive index of SiNₓ films (up to 2.2)
- Low absorption ε < 0.001 @ 400 nm
- Hardness of up to 16 GPa for doped SiNₓ
- Low film stress +100 to -250 MPa
- Reduction of reflectivity

<table>
<thead>
<tr>
<th>Reflectivity</th>
<th>Uncoated</th>
<th>Coated</th>
</tr>
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<tbody>
<tr>
<td>Glass</td>
<td>8 %</td>
<td>3 %</td>
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<tr>
<td>Sapphire</td>
<td>15 %</td>
<td>3 %</td>
</tr>
<tr>
<td>Multi Si</td>
<td>27 %</td>
<td>9 %</td>
</tr>
<tr>
<td>Mono Si</td>
<td>11 %</td>
<td>2 %</td>
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</table>
Microwave Plasma Etch
Thin Film and Bulk material

### Key benefits
- Well-defined etch depth for typical layer thicknesses 50nm – 1000nm
- Minimizing stress on sample

### Materials
- **Nitrides** $\text{Si}_3\text{N}_4$
- **Oxides**: $\text{SiO}_2$, $\text{ZnO}$, $\text{Ta}_2\text{O}_5$, ITO, Phosphorus glass, Boron glass
- **Silicon** a-$\text{Si}$, Si cryst., doped $\text{Si}$, et al.
- **Carbon-based** Graphit, diamant, organics, et al.

### Process gases
- **Fluorine-based**: $\text{NF}_3$, $\text{SF}_6$, $\text{CF}_4$, ...
- **Chlorine-based**: $\text{N}_2\text{O}$, $\text{Cl}_2$, $\text{BCl}_3$, ...
- **Others**: $\text{H}_2$, $\text{O}_2$, $\text{N}_2$, ...

![etch gas ratio](image)

- RIE of quartz
- RIE of Si
- RIE of GaSb$_2$
Functional Inkjet printing

PiXDRO

Semiconductors
Printed Electronics
Displays
PCB
Photovoltaics

LP50
R&D

IP410
Engineering & Pilot line

JETx
Mass production
Focus applications for Inkjet printing

Printed Circuit Boards

- Soldermask
- Versatile Pilot Production
- Flexible Mass Production

Semiconductor

- Photoresist
- Dams
- Adhesive
- rQFN

Printed Electronics

- Flexible Hybrid PE
- PV
- Barriers
Integrated System Solutions

Device Encapsulation

- Complete encapsulation solution
  - Includes plasma and inkjet tools
  - Inert product handling

Barrier for Foil

- Complete barrier film solution
  - Based on innovative atomic layer deposition
  - Includes foil pre-treatment and organic coating modules

CONx Microfab

- Integrated pilot manufacturing line for novel electronics
  - Includes plasma and inkjet tools
  - Integrated product handling and controlled environment
# Advanced Plasma Coating

## Application and Key Figures

<table>
<thead>
<tr>
<th>Application</th>
<th>Key Figures</th>
<th>Process</th>
<th>Process Material</th>
<th>PV</th>
<th>OLED</th>
<th>Battery</th>
<th>Electronics</th>
<th>Glass</th>
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<tbody>
<tr>
<td>Encapsulation</td>
<td>WVTR &lt;1*10^{-6} g/m²/day</td>
<td>in/organic coating</td>
<td>SiH₄, NH₃, N₂O, TMA</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>High capacity anode</td>
<td>&gt;40% higher capacity</td>
<td>amorphous silicon</td>
<td>SiH₄, H₂</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Etching/Stripping</td>
<td></td>
<td>material removal</td>
<td>CF₄, NF₃, O₂</td>
<td></td>
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<tr>
<td>Hardening on plastics</td>
<td>&gt; 15GPa, with T&lt;100°C</td>
<td>inorganic coating</td>
<td>SiH₄, NH₃, H₂</td>
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<tr>
<td>AR coating</td>
<td>Reflectivity 2%</td>
<td>inorganic coating</td>
<td>SiH₄, NH₃, H₂, N₂O ...</td>
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*WVTR = Water Vapour Transmissibility Rate*
Many thanks for your attention. Visit us at: B1-1815 and B3-178
## Properties of selected PECVD-layer

<table>
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<tr>
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<tbody>
<tr>
<td>SiOx</td>
<td>SiH₄ + N₂O or silicon organics + N₂O</td>
<td>150 – 500</td>
<td>1.46 – 1.52</td>
<td>5 - 12</td>
<td>2 – 2.6</td>
<td>5 -12</td>
<td>3.8 - 4</td>
<td>1 - 10</td>
<td>Optics, Electronics, PV Semiconductor, food, hard coating, protection</td>
<td>µW, CCP, ETP, ICP</td>
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<tr>
<td>SiOxNy</td>
<td>SiH₄ + N₂O + NH₃ or Si org. + N₂O + NH₃</td>
<td>150 - 400</td>
<td>1.6 – 1.8</td>
<td>5 - 6</td>
<td>2.2 – 2.8</td>
<td>8 - 15</td>
<td>4 - 5.2</td>
<td>2 - 8.4</td>
<td>PV, glass industry, moisture barrier,</td>
<td>µW, CCP, ETP, ICP</td>
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<tr>
<td>SiNx</td>
<td>SiH₄ + NH₃</td>
<td>&lt; 150°C</td>
<td>1.6 – 2.2</td>
<td>3.5 - 6</td>
<td>2.0 – 3</td>
<td>10 - 16</td>
<td>7.5 – 7.8</td>
<td>3 - 8</td>
<td>Optics, plastics, semiconductor, barrier,</td>
<td>µW</td>
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<tr>
<td>SiNx</td>
<td>SiH₄ + NH₃</td>
<td>150 - 500</td>
<td>1.9 – 2.3</td>
<td>3.5 - 6</td>
<td>2.2 – 3</td>
<td>15 - 20</td>
<td>7.5 – 7.8</td>
<td>3 - 8</td>
<td>PV, Optics, semiconductor, barrier, architecture glass</td>
<td>µW, CCP, ETP</td>
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<tr>
<td>SiCxNy</td>
<td>(SiH₄) + TMS + NH₃</td>
<td>250 - 500</td>
<td>1.9 – 2.3</td>
<td>3.3 – 5.3</td>
<td>2 – 3 ?</td>
<td>19 - 24</td>
<td>3 - 7</td>
<td>1.8 – 8.3</td>
<td>PV, ARC, mech. and chemical protection,</td>
<td>CCP, ICP,</td>
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<tr>
<td>SiCx</td>
<td>SiH₄ + CH₄</td>
<td>250 - 600</td>
<td>2.2 – 3.4</td>
<td>1.8 – 2.4</td>
<td>3.2 ?</td>
<td>11 - 30</td>
<td>7 – 9.7</td>
<td>2.3 – 3.7</td>
<td>PV, LED, sensors, protection, high temperature stable,</td>
<td>CCP, ICP</td>
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<tr>
<td>a-Si:H</td>
<td>SiH₄ + H₂</td>
<td>150 - 250</td>
<td>3.5 – 4.5</td>
<td>1.7 – 1.8</td>
<td>2 - 2.3 ?</td>
<td>&lt; 14</td>
<td>11 - 12 ?</td>
<td>0.1 - 0.3 ?</td>
<td>PV, electronics, TFT, semiconductor.</td>
<td>µW, CCP, ETP, ICP</td>
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<td>µc-Si:H</td>
<td>SiH₄ + H₂</td>
<td>150 - 250</td>
<td>3.5 – 4.5</td>
<td>1.1 – 1.6</td>
<td>2 - 2.3 ?</td>
<td>5 - 13</td>
<td>11 - 12 ?</td>
<td>0.1 - 0.3 ?</td>
<td>PV, semiconductor,</td>
<td>CCP</td>
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<tr>
<td>AlOx</td>
<td>TMA + N₂O</td>
<td>250 - 500</td>
<td>1.6 – 1.7</td>
<td>8.8 ?</td>
<td>2.7 – 3.7</td>
<td>&lt; 16</td>
<td>7 - 8 ?</td>
<td>2 - 5</td>
<td>PV, Optics, semiconductor,</td>
<td>µW, CCP, ETP, ICP</td>
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<tr>
<td>a-C:H (DLC)</td>
<td>C₂H₂ + Ar</td>
<td>&lt; 150</td>
<td>1.9 – 2.05</td>
<td>1.2 - 4</td>
<td>1.2 – 2.2</td>
<td>&lt; 40</td>
<td>2.7 – 3.8</td>
<td>1 – 7</td>
<td>Optics, hardcoating, electronics,</td>
<td>CCP</td>
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<tr>
<td>Diamond</td>
<td>CH₄ + H₂</td>
<td>400 – 1000</td>
<td>2.4</td>
<td>5.4</td>
<td>3.5</td>
<td>60 - 70</td>
<td>5.5</td>
<td>10</td>
<td>Electronics, hardcoating,</td>
<td>µW</td>
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</table>
Vacuum processes for surface modification

**Coating**
- PECVD
- MOCVD, ALD
- IAD, PICVD
- IBD, DIBD
- MSD
- evaporation (thermal, e-Beam)

**Etching**
- Reactive and non-reactive
- RIE, MERIE, ALE
- Chemical etching
- IBE, RIBE, CAIBE

**Functionalisation**
- Change of binding properties of the surfaces
- Oxidation
- Nitriding
- Carbonating
- Hydrogen-diffusion
- Radiation (IR, UV)

**Implantation**
- Ionen Implantation
- PBII
- PIII
- Doping

**Treatment**
- Particle interaction with the substrate surface,
- Physical and/or chemical,
- Radiation

**Applications**
- Antireflection, Reflection, Filter
- Protective coatings
- Electr. isolation
- Dielectrics
- semiconductors
- Contact-layer
- Barriere coating

- Structuring of surfaces of metals, dielectrics, semiconductor
  - e.g. MEMS,

- Hydrophobic or hydrophilic
- printing
- Coloration
- water absorption
- hardening

- Hardening
- Change of conductivity
- Buried functional layers
- semiconductor-functions (e.g. pn-junctions)

- Surface activation
- Improve of adhesion
- Inerting
- Germ and bacteria killing
- Cleaning