

# Capital Efficient Systems for SiC Manufacturing Expansion and R&D

### Corporate Overview

- Founded in 1989; Privately Held
- 60+ Employees
  - Corporate HQ San Jose, CA
    - Manufacturing, Design & Software Engineering, Customer
    - Support, Applications, Sales
  - Engineering Center Vietnam
    - Customer Support (Asia), Design & Software Engineering
- Over 1200 systems installed globally
- All systems manufacture in San Jose, CA
- Low Cost-Of Ownership Products & Services
- Systems individually optimized to meet specific customer specifications
  - Footprint, layout, software functions, new processes, special
  - hardware....
- In-House R&D, Machine Shop, Software System Development for Fast-Turn Service & Enhancements



### Process Systems Platforms

- Global customer base
  - R&D − Low Volume Production → HVM
  - Si, GaAs, InP, GaN, Glass, SiC, LiNbO<sub>3</sub> ....
  - IC, Discretes, RF, MEMS, LED, PIC ...
- Customer focus
  - Optimize systems based on customer need
  - Optimized HW & SW
  - Continually developing new applications and
  - technologies & functionality

2 inch wafers to 300 mm wafers Wafer on Tape Frame and HOOP Wafer Fab and Packaging











<u>P8000 Linear</u> <u>Platform</u>



## C&D Applications



<ul> <li>PR Coat &amp; Develop</li> <li>Positive PR</li> <li>Negative PR</li> <li>DUV</li> <li>PMMA</li> <li>25 nm Node</li> </ul>	<ul> <li>Planarization (SynchroSpin<sup>™</sup>)</li> <li>Positive PR</li> <li>Polyimide</li> <li>BCB</li> <li>SOG</li> <li>Thick Films, 150 µm</li> </ul>	Metal Lift-Off • Positive PR / Negative PR • DUV • 25 nm Node • HVM Configurations • PR Stripping Post Etch	Multilayer Application Single or Process Spectrum Applications
<ul> <li>• Thick PR, 150 μm</li> <li>• Optical Edge Bead Removal</li> <li>• HVM Configurations</li> </ul>	<ul> <li>Packaging - Wafer</li> <li>Interposer Fabrication <ul> <li>Si, 100 μm Glass</li> </ul> </li> <li>Molded wafer</li> </ul>	<ul> <li>Spray Coating</li> <li>4:1 Aspect Ratios</li> <li>Combine with planarization</li> <li>Combine with std coating</li> </ul>	
<ul> <li>and Pillar</li> <li>Thick Resist Develop</li> <li>Dry Film Develop</li> </ul> Thermal Process <ul> <li>Alloy for Compound Semi</li> </ul>	<ul> <li>KDL</li> <li>Temporary Bonding Coater</li> <li>Multiple HPOs &amp; Coaters</li> <li>Coating &amp; Cleaning</li> <li>Life Science – Sensor Manufacturing</li> </ul>	Frame Track • HOOP Process • Frame Processing • Dice Protect Layer Coat • Saw, Laser, Plasma	

- Low temp RTP w/o lamps
- LiNbO<sub>3</sub>, GaAs Compounds

- Peptide Synthesis
- DNA Synthesis

- Post Dice Clean/Strip
- HVM Configurations

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### Investments Sampling



- Green Field
  - Infineon Kulim \$5.5B
  - ST Microelectronics & Sanan \$3.2B
  - STM Catania €5B
  - STM GF €7.5B
  - University of Arkansas \$18M
- Brown Field
  - Bosch & TSI \$1.5B
  - X-Fab \$200M
  - Vishay Newport \$177M
  - Clas-SiC £24M
  - Microchip \$880M
  - Rohm \$1.9B
  - OnSemi \$300M
  - SK Powertech \$111M

### Capital Efficiency



- Low Cost of Ownership
  - Pricing
  - Availability
  - Reliability
- Enhancement of Spending, enabling additional purchases
- Extendibility, Future Proofing Equipment Selection
  - Enhance-ability
- Multiple Applications on a single platform
- Different system platforms for different needs
- Legacy support

- Capital Budget
  - Extending Budget Application
  - Short lead times
- Operating Budget
  - Low schedule downtime, < 5 hrs. per month
  - Low unscheduled downtime, < 5 hrs. per month
  - Low MTTR, < 4 hrs.'.
  - Low consumable and PM parts cost, < \$10,000 per year

### Example 1 – Budget ~ \$6M



### RFQ

- 1 Department
- 2x Coater/Developer Production
- 1x Coater/Developer R&D

### Final

- 3 Departments
- 2x Coater/Developer Production
- 1x Coater/Developer R&D
- 1x Coater Special Application
- 1x Scrubber
- 5x Microscope Loader

#### Benefits

- Price
- Short lead time, less than 6 months
- Process Performance
- Low COO
- Multiple applications with single platform
- One stop shopping

# Example 2 – R&D to Light production

C & D Semiconductor

- Fleet of 5 P9000 (3x Coat & Develop, 1x Lift-off, 1x Special Apps)
- Advantage Multiple applications in single system
- Advantage Reliability, repeatability, cost, common platform (spares & operations simplification)
- Substrates: SiC, Quartz, GaAs, GaSb
  - Transparent & Opaque
  - 100 mm, 150 mm, 200 mm simultaneously Size scale up
- Two coaters with 8 resist for each system
  - Different photoresist/coating materials on each system
- Two developers positive and negative

### Example 3 – Wafer Thinning: Temporary Bonding, Grinding

Fleet Installation – 3+

- HVM environment
  - SiC and GaAs
- Optical and thermal debonding processes
- 10+ Years
- Proven reliability
  - MTBF > 400 hrs.
  - Scheduled down time < 5 hrs per month
  - Unscheduled downtime < 5 hrs per month
- Proven Repeatability
  - High stress wafers stringent testing
  - Coating performance
- Transition from Linear to P9000
  - Increase capacity with smaller foot print
  - Retire older equipment





### **Configuration**

- 2 Coating Modules
  - 4 Dispense Nozzles
    - 9.5 mm, 6.3 mm, 4.75 mm, 3.2 mm
  - EBR Nozzle, 3.2 mm
- 12 Hot Plate Ovens (HPO)
- 3 Chill Plates
- 2 Indexers
- 1 Centering Device
- 1 Chemical Cabinet

## Example 4 - Legacy



- Adding new high viscosity dispense
  - Requirement: new pump, new dispense line new dispense fixtures
  - Original supplier: >\$10,000 and 6 month lead time for new dispense line & fixtures
  - C&D: \$1,500 with 3 week lead time
- Expanding foundry
  - Upgrade from legacy linear systems
  - 5x legacy linear systems replaced with 2x P9000
    - Increased productivity
    - Reduced floor space, reduced operating cost

### Summary



- Capital Efficiency
  - Extending Capital Budget
    - More capability for the same budget
    - Equal or better performance
    - Optimized systems
  - Future proofing
    - Reduced expense cost for future operation
    - Extendibility of equipment lifetime
      - Upgrades
      - Expansion purchases
- Operational Efficiency
  - High availability
    - Low scheduled downtime
    - Low unscheduled downtime, high MTBF and MTBA
  - Low consumable and spare parts requirements