FULLY AUTOMATED First-of-a-kind 200mm SiC FAB
The Path of Manufacturing Innovation
**WOLFSPEED AT A GLANCE**

**Company Overview**

- $6.5 billion in planned capacity investments for materials & fab
- Announced plans to build largest 200mm silicon carbide fab in Saarland, Germany
- $1.25 billion secured note financing with Apollo
- ZF and Wolfspeed announce strategic partnership
- BorgWarner invests $500 million in capacity
- Renesas commits to 10-year silicon carbide wafer supply agreement

**Wolfspeed Annual Revenue (M)**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>2021</th>
<th>2022</th>
</tr>
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<tbody>
<tr>
<td>Revenue ($M)</td>
<td>$525M</td>
<td>$746M</td>
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**By the Numbers**

- #1: Producer of silicon carbide substrates
- >60%: Wolfspeed makes more than 60% of the world’s silicon carbide today
- >90%: Wolfspeed manufactured >90% of the silicon carbide ever produced
- 1st: First commercially available fully qualified silicon carbide MOSFET
- 35+ years: Wolfspeed has been vertically integrated making silicon carbide semiconductors
- 10+ trillion: Silicon carbide device field hours
WHAT IS SILICON CARBIDE?

- Combination of silicon and carbon in a crystalline structure
- Crystalizes at very high temperature and can take many (>200) crystalline structures
- Can be electrical insulator or conductor
- Superior mechanical, chemical and thermal properties, all combined
- Variety of applications including abrasive, ceramics, electronics and medical
- Ultimate material to design and build power, RF and optical devices

¹Source: Wolfspeed website
OUR SILICON CARBIDE EVOLUTION

- Tairov and Tsvetkov – 1978
- Cree Inc founded – 1987
- First Commercial SiC Substrate – 1992
- Zero Micropipe (ZMP) 100 mm Substrate – 2006
- High quality 150 mm substrate – 2010
- 200 mm Demonstrated – 2015

Wolfspeed produces over 60% of the Silicon Carbide in the world today.

Over the past 35+ years, Wolfspeed has produced 90% of the Silicon Carbide in the world.

Delivering substrate and epitaxy options up to 200mm diameter

Stability, volume, quality

Wafer Shape improvement

Dislocations reduction

Micropipes - major defect

WOLFSPEED POWERS THE FUTURE
How we lead the pack in vertical integration

HOW IT WORKS

From Product Design → To Silicon Carbide Crystal → To Wafers and Epitaxy → To Device Processing → To Test Packaging Final Test
KEEPING A SUSTAINABLE FUTURE AT THE FOREFRONT

**In Our Facilities**

**Water Savings**
1,892,705 liters
Of annual water savings are built into the design of the Mohawk Valley Fab

**Reducing Landfill Waste**
75%
Diverted construction waste during building The JP in Siler City, NC

**Building Efficiency**
**LEED certification**
New Wolfspeed facilities are designed to meet LEED requirements

**Our Products in the Wild**

**Energy Savings**
113 million MWh
Will be saved by the power and RF devices we sold in 2021 over their estimated lifetimes

**Electric Vehicles**
690 kg CO\textsubscript{2},eq
Lifetime GHG emissions reduced per EV using Silicon Carbide, equal to the CO\textsubscript{2} in 77 gallons of gasoline

**Solar Inverters**
10MW
Saved for each GW when using Silicon Carbide components
MOHAWK VALLEY FAB: FIRST, LARGEST AND ONLY 200 MM SILICON CARBIDE WAFER FABRICATION FACILITY

The fab’s 200mm Silicon Carbide wafers are revolutionizing the semiconductor industry, allowing for greater power and efficiency and leading the way to a more sustainable future.
INVESTING TO ENABLE CONVERSION

Mohawk Valley: Going into Production Now
- ~$2B annual Power Device revenue targeted
- 200mm wafers
- Highly automated

Planned Saarland Fab
- ~$2.6B annual Power Device revenue targeted
- 200mm wafers
- Highly automated

Unparalleled Global Market Leader in Silicon Carbide Capacity Investment
FULLY AUTOMATED First-of-a-kind 200mm SiC FAB
The Path of Manufacturing Innovation

MISSY STIGALL | SVP, GLOBAL FAB OPERATIONS
PRIYA ALMELKAR | SVP, CHIEF INFORMATION OFFICER
WOLFSPEED MANUFACTURING IT LANDSCAPE

Semiconductor manufacturers are faced with substantial external challenges, placing increased pressure on systems and solutions.

### Semi Industry Headwinds
- Increasing technical complexity of manufacturing processes
- Need for AI/ML driven automation of production processes
- Fragmented, legacy infrastructure with limited scalability
- Volatile, cyclical demand for products
- Geopolitical challenges and delinking of the supply chain
- Semi Talent Shortage and competition with tangential industries

### Internal Wolfspeed Challenges
- Expanding manufacturing footprint 30x by 2024
- Need for faster NTPI cycle times
- Need for increased qualification testing success rates
- New facilities, new locations, and new process technologies
- High yield and fast ramp targets
- Fragmented Manufacturing IT application landscape
- Diverse applications, processes, and maturities

### Transforming Manufacturing IT for Tomorrow

#### Connected Plants
Run more efficiently and better manage inventory while reducing unscheduled downtime

#### Accelerated Time to Market
Empower planning and remove roadblocks when developing & delivering new products to the market

#### Resilient Operating Model
Agile and efficient Op Model connected through Front-office and Back-office; designed to withstand disruption

#### Connected Digital Worker
Embracing automation drives higher productivity and lowers OPEX
3-PHASED APPROACH TO DIGITIZATION

Employing an adaptable but thorough approach to digitization creating a repeatable blueprint which can be applied to effectively transform Manufacturing IT capabilities across the enterprise

**Phase 0: Pre-Design**

**Activities**
- Identify and validate gaps between applications, capabilities, and target state aspirations
- Defined technology vendor landscape and select vendor by capability
- Define ‘North Star’ technology architecture with target state application landscape design
- Develop business case defining benefits, costs, and estimated resourcing at a high-level

**Functional**
- Develop list of specific activities by capability, business unit, and site to reach target state as defined by the ‘North Star’
- Define high-level functional design on future systems, processes, tools and resource usage (including operating model, security, digital twin)

**Technical**
- Draft Target State technology architecture detailing integration of selected vendor solution into current state architecture
- Develop detailed source to target mapping capturing data flow of impacted current state systems across in scope sites

**Phase 1: Planning and Design**

**Activities**
- Future State Blueprinting
- Execution Planning

**Functional**
- Drive enterprise portfolio management across in-scope systems and capabilities planned for deployment,
- Develop communications, organizational change management, and training strategy

**Technical**
- Finalize implementation approach & sequencing based and define data migration strategy
- Develop UAT and SIT Testing strategy

**Phase 2: Implementation**

**Activities**
- Detailed Design
- Build
- Test & Release

**Functional**
- Build detailed sprint planning with planned releases, user stories, and epics
- Define detailed future state operating model for in scope capabilities

**Technical**
- Develop detailed technical design for custom technical objects (e.g., integration, enhancements, conversions for all in-scope capabilities)
- Configure applications per the design blueprints for each in-scope system and capability
- Shape the strategy and plan for system, performance and integration hypercare
DEPENDENCIES ACROSS THE DIGITAL MANUFACTURING LANDSCAPE

Converging digital capabilities with manufacturing operations creates dependencies between processes and systems in the Digital Manufacturing Landscape which must be considered throughout the broader transformation.

Core Digital Manufacturing Capabilities... ...optimized with AI/Advanced Analytics

**PLM**
- New Technology & Product Intro
- Product/Engineering Data Mgmt.
- Ideas & Requirements Mgmt.

**ERP**
- Work Order / Plant Order
- PIC / SIOP / MRP
- Equipment sheet

**MES**
- Plan
  - Detailed routing
  - Current Program
- Execute
  - Production execution management
  - Production dispatching
- Monitor
  - Tracking & Work done
  - Data collection / Traceability
  - Production performance analysis

**YMS**
- Advanced Processs Control
- SPC (Statistical Process Control)
- Defect & Reliability Analysis
- Quality Management
- Data Integration & Query
- Chart/Statistics
- Wafer Map Analysis
- Advanced Correlation Analysis
- (Device, Material, EPI, Module, Assemble, Package, Final Test)

**Automation, Machines, Devices**
- Preparation
  - Detailed routing
- Capacity Planning
  - Detailed scheduling
- Core Digital Manufacturing Capabilities... optimized with AI/Advanced Analytics

Wolfspeed Insights
Advanced Analytics Platform
SECURITY IN DIGITAL MANUFACTURING

Security in the digital manufacturing space crosses the cyber and physical boundary, providing for the safety, security, integrity, and efficacy of the manufacturing operation.

Digital Manufacturing is fully connected
Connectivity supercharges the effectiveness of a manufacturer allowing for remote access, real-time monitoring, and cloud storage. However, if not addressed, these connected devices can introduce risk to the environment.

Why it matters...new security challenges
Digitally-enabled operations mean that manufactures must now contend with both physical and cybersecurity threats.

Social Engineering
Supply Chain Attacks
Tailgating
Edge Device Hijacking
Dumpster Diving
Ransomware

The risk can be substantial
Predicted financial impact of cyber-physical attacks will reach $50B by 2023.

By 2025, Gartner predicts that cyber attackers will have weaponized OT environments with the ability to cause fatalities to humans and grave damage to companies.

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Growing Silicon Carbide crystals requires a controlled environment of 2500 °C, half the temperature of the sun.

Silicon Carbide doesn’t melt, unlike silicon, it evaporates requiring precision to create a quality crystal.

Automate using Industry 4.0 based MES system and SEMI Standards for tool and transport system connectivity.

Once a process module is fully automated, it can be duplicated during tool installation allowing for faster ramp.

Silicon Carbide can form 200+ crystal structures - only ONE polytype is usable for power applications.

Wolfspeed has refined SiC production over 35+ years and now is running fully automated Fab.

**WOLFSPEED SILICON CARBIDE IS THE FUTURE OF SEMICONDUCTORS**

Silicon Carbide is superior to silicon

- Higher efficiency
- Faster switching
- Improved thermal performance
- Higher reliability
- Lower system costs

**Powering more, consuming less.™**
WOLFSPEED’S 200MM PROCESS IS STATE-OF-THE-ART

BIG DATA and ANALYTICS
Use of big data and analytics to drive throughput, cost, and yield.

FACTORY AUTOMATION
Wolfspeed is the first to adopt the overhead transport system and automated load ports in 200mm Silicon Carbide manufacturing.

"Lights Out Fab": Operates 24/7, even in the event of severe weather. There are few operators in the clean room; the 600 employees at MVF are tool technicians or engineers.

REDUNDANCY

Statistical Process Control
Advanced Process Control
Fault Detection and Defect Classification

Intelligent Dispatching

Artificial Intelligence, Machine Learning, and Predictive Maintenance

Fully-Automated means:
- Reduces production touches from 10,000 to zero mitigating yield losses.
- Includes custom tools created specifically for Silicon Carbide production.
SILICON CARBIDE FIVE YEARS OUT: CULTURE WE BUILD

1. Wolfspeed is investing substantially more than competitors in Silicon Carbide capacity.

2. Demand will likely outstrip supply for years to come.

3. Strong partnerships will be tremendously important for the next decade.
We harness the power of Silicon Carbide to change the world for the better