RTCC SMART Series
Innovating the Next Wave of Manufacturing
October 5, 2017
Mission
Accelerate the cleantech economy through collaboration and partnerships which promote innovation and sector growth
Leadership Members & Project Partner

Leadership Members

- ELECTRICITIES of North Carolina, Inc.
- NC Electric Cooperatives
- Hoffman Building Technologies, Inc.
- KILPATRICK TOWNSEND
- United States Environmental Protection Agency

Project Partner

- CHATHAM PARK
Event Partner/Host

PowerAmerica
General Nick Justice
Executive Director
Panelists

John Nicholson
NC DEQ

Raoul Farer
Freudenberg Performance Materials

Jason Massey
Industrial.io

Dave Grider
Wolfspeed
John Nicholson
Chief Deputy Secretary
Smart Series:
Innovating the Next Wave of Manufacturing

October 5, 2017
John Nicholson, Chief Deputy Secretary

Department of Environmental Quality
DEQ Mission

To protect North Carolina’s natural resources and safeguard our air, water, and climate to enhance the quality of life and economic growth opportunities for all North Carolina citizens.
Goals

• Work effectively with state and local governments, and when appropriate, the federal government, to provide leadership and implement laws and regulations that protect public health, the environment, and the vitality of manufacturing industries in NC.

• Inform and educate the public, legislators, government agency officials, and others about environmental health, safety, and energy issues.

• Promote the use of science, engineering, and economics in legislative recommendations and regulatory programs.
State Energy Program

- Provide expertise and knowledge on all aspects of energy including but not limited to: fossil fuel resources, renewable energy resources, and emerging energy technologies and their impact on the state’s environment and the economy.
- Examine methods to increase and promote energy efficiency.
- Develop and adopt energy security, resiliency, and emergency preparedness plans.
- Explore and identify opportunities for economic growth that also yield environmental quality co-benefits.
- Leverage and understand the role of the electric NC co-ops.
Division of Environmental Assistance and Customer Services (DEACS)

- DEACS’ focus is on providing permit assistance and solid waste reduction guidance to industry and local governments.
- DEACS works with industrial partners, e.g., Manufacturer's Alliance and the Economic Development Partnership of NC to identify permitting requirements, waste reuse or reduction, energy and water consumption opportunities, and emissions reductions opportunities.
Environmental Stewardship Initiative (ESI)

- An internal DEACS program that recognizes NC agencies and businesses that have an outstanding commitment to environmental performance.
- Voluntary program - available at no cost to membership.
- Provides technical assistance and networking opportunities to stimulate the development and implementation of programs that employ pollution prevention, energy efficiency, and innovative approaches to meet and exceed regulatory requirements.
- Goal: to reduce environmental impact beyond those measures required by any permit or rule, producing a healthier environment, conserving natural resources, and resulting in long-term economic benefits.
Permitting Transformation Initiative

- Streamline agency processes to facilitate the application process for both the applicant and the agency.
- Improved on-line functionality through an on-line application process with the ability to track the progress of permit applications.
- Expedited application process for projects that will create new jobs, save energy, and/or reduce waste.
- Create a SINGLE POC for industry – a TEAM of DEQ staff who will stick with you throughout every stage of the permitting process.
- Facilitate permittees that are in good standing to modify permits under certain conditions.
Commissions

- Environmental Management Commission GS § 143B-28213B-1
- Sedimentation Control Commission GS § 143B-298
- Coastal Resources Commission GS § 113A-104
- Marine Fisheries Commission GS § 143B-289.50
- State Water Infrastructure Board
- Energy Policy Council GS § 113B-1
- Mining Commission GS § 143B-290
- Oil and Gas Commission GS § 143B-293.1
There is still too much waste in the pursuit of efficiency
The Industrial Awakening will generate $14.2 Trillion of global output by 2030...

...but the value of this digital transformation is at jeopardy of being squandered.
Successful digital implementations can result in...

5X More Revenue Growth
8X More Profits
2X More Shareholder Value

McKinsey & Company
M2M/IoT Value Chain
2018 Worldwide Projected Revenue

$4B Hardware
$25B Connectivity
$120B Value-added Services
Predicts $60 trillion in IIoT investments over the next 15 years

...now imagine a company dedicated to reducing that number yet achieving the same output value...
Perfect Storm

**Data** is everywhere but nowhere with system data locked in silos

**Cost** of entry for existing industrial companies is high with consultants and customization

**Waste** is still unknown in industry and comes in many forms

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99% of factory data is discarded

$10B spent in customized application development

30%-40% in wasted overall equipment effectiveness

*Industrial Internet Consortium, IoT Analytics, Boston Consulting Group*
Yet...

75% of IoT projects fail

60% don’t advance beyond PoC

There are over 300 IoT platform startups, but most will fail

Applications focused on business outcomes insure platform success
Sequencing matters...

- **Start small** - *What is the smallest yet all inclusive experiment you can run? is the sample set significant?*

- **Leverage internal field experts and data scientists** to help scope projects and follow the data - *Have they built batch processed models with optimized outputs?*

- **Run experiments** with data sets before trying to ingest too much data - *Do you really need that new sensor or do you really need that data every second?*

- Always **start with outputs** to track back to required inputs - *Are the improvements worth the ROI? Is the technology sufficient to achieve the output?*

- **Be realistic on** what it takes to **scale**... *scaling before ready can lead to false positives and costly rebuilds - don’t squander budget just to appear innovative*
We hate waste...

industrial.io is focused on eliminating waste in manufacturing and industrial operations, whether it be waste of raw resources and energy, waste of products, wasteful processes, waste of software code and waste of time, by harnessing the power of real-time data.
Raoul Farer
Head of Technology
Innovative materials that are optimally suited for use in automotive headliners as well as trunk linings and rear seat coverings.

Sound absorption
Innovative microfilament materials based on Evolon® technology for high levels of sound absorption.

Carpet backings
Easy to mold and dimensionally stable tuft backing for automotive carpets.

Battery separators
Optimum safety in battery cells by using pioneering nonwoven solutions as battery separators.

AUTOMOTIVE
Fuel cell components
High-tech nonwovens used as gas diffusion layers for fuel cells. Excellent quality standards and exceptional functional flexibility.

Molded carpets
Nonwovens based on Lutraflor® technology for molded automotive carpets

Molded underbody panels
Nonwoven composite based on spunlaid technology for molded underbody panels and wheel liners
Roofing
Nonwovens used to reinforce bituminous membranes for waterproofing roofs

Building interiors
Nonwovens and microfilament textiles for outfitting buildings

SoundTex
Acoustic nonwoven materials optimize speech intelligibility and minimize noise levels in modern buildings

Construction industry
Nonwovens for the construction industry and the protection of buildings
**Anti-mite encasings**
A revolutionary microfilament textile for anti-mite encasings - Evolon®

**Advanced wound care**
Innovative nonwovens and polyurethane foams for advanced wound care

**Traditional wound care**
Effective and versatile nonwovens for traditional wound care

**Transdermal solutions**
Very soft, flexible and conformable backing materials and release liners for transdermal solutions

**Stoma care**
More quality of life: ultramodern components for stoma care

**MEDICAL**
Our History

1849
Foundation of Freudenberg

1938
Start of nonwoven production

1948
Introduction of Vlieseline interlinings

1957
Filter production started; technical nonwovens established

1970
Introduction of spun-bonded polyamide nonwovens

1997
Expansion into building materials Texbond/Terbond

1998
Introduction of acoustic nonwovens (SoundTex)

1999
Start of Evolon: hydro-entangled microfilament nonwoven

2001
Entry into fuel cell technology sector

2015
Acquisition of PHT foams

2017
Freudenberg Performance Materials

TECHNOLOGY
Facts & Figures for the Freudenberg Group

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales (in million US$)</th>
<th>Workforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>8,900</td>
<td>40,474</td>
</tr>
<tr>
<td>2016</td>
<td>10,100</td>
<td>48,010</td>
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Freudenberg Performance Materials RBU NA
Durham, NC

- 3 spunbond production lines = Lutradur® Technology:
  - Continuous Filament 100% PET
  - Coarse Denier
- Workforce: ~ 150
- Sales: ~ $110M
- Markets & applications:
  1. Automotive:
     - Carpet backings, acoustics, underbody panels, etc…
  2. Building Products:
     - Carpet backings, furniture & bedding, landscape (weed block), other niche applications.
  3. Medical:
     - Advanced wound care, PUR foam, transdermal patch backings
  4. Technical Specialties:
     - Battery separators, cable & electro application, building acoustics (SoundTex®), FR mattress, fiber reinforced plastic (FRP) surface veils, packaging & wipes (Evolon), filtration media and shoe components.
Durham, NC - Freudenberg Performance Materials Plant
**ECONOMIC RESPONSIBILITY**
- Long-term business orientation
- Healthy growth through “buy and build”
- Solid financial base
- Responsible financial management
- Continuous innovation

**SOCIAL RESPONSIBILITY**
- Globally responsible corporate citizenship
- Global initiatives
- Safety at work: “We all take care” initiative
- Health protection
- Youth encouragement programs
- Member of United Nations Global Compact

**ENVIRONMENTAL RESPONSIBILITY**
- High safety standards, exceeding legal requirements
- Certification: Oeko-Tex, ISO, REACH, etc…
- Optimization of processes and minimizing resource consumption
- Production and integration of recycled fibers and materials
- Development of products that contribute to environmental protection

**ECONOMIC, SOCIAL AND ENVIRONMENTAL SUSTAINABILITY**
**THREE PILLARS OF SUSTAINABILITY**
Thank You!

For further information:
www.freudenberg-pm.com
David Grider
Power Program Manager
Cree’s leadership begins with innovative technology that delivers high-efficiency performance for three businesses including Lighting, LED Products and Wolfspeed (Power and Radio Frequency (RF) products).

**Our Business**

**Lighting**
- Annual Revenue [FY17]: $701 Million
- [48% of Total Revenue]

**LED Products**
- Annual Revenue [FY17]: $550 Million
- [37% of Total Revenue]

**Wolfspeed**
- Annual Revenue [FY17]: $221 Million
- [15% of Total Revenue]
What’s the Wolfspeed Difference?

Equal parts ingenuity and hard work.

- Wolfspeed is a technology company constantly driving our product roadmap to forge change, challenge the status quo and unlock new possibilities.
- We invest significant in R&D to create the highest-performing solutions.
Wolfspeed is an established, growth business

Headquartered in Research Triangle Park, North Carolina, USA, with approximately 550 employees across nine locations on three continents

2,245 patents worldwide (April 2017)

46,000 square foot fabrication facility on 55 acres

Class 10, 100, and 1000 Clean Rooms

Growth fueled organically and via acquisition.
How does Wolfspeed lead? By being first.

- **1987**: Cree Founded
- **1991**: Released world’s first commercial SiC wafers
- **1997**: Created industry’s first GaN HEMT on SiC, with record power density
- **1999**: Demonstrated 4-inch SiC wafer
- **2000**: Demonstrated industry’s first GaN HEMT MMIC, grown on semi-insulating SiC substrate
- **2002**: Released our first 600V commercial SiC JBS Schottky diode
- **2006**: Released industry’s first 1200V SiC MOSFET
- **2007**: Commercial release of 100-mm, zero-micropipe SiC substrates
- **2009**: Demonstrated record-efficiency GaN HEMT Doherty amplifier with digital pre-distortion
- **2010**: Developed high-quality 150-mm SiC substrates
- **2011**: Released industry’s first SiC MOSFET
- **2012**: Released new-generation 50V GaN HEMT technology
- **2014**: Introduced industry’s first 1200V SiC half-bridge module
- **2015**: Exceeded two trillion field hours power
- **2016**: Introduced the Industry’s 1st 1000V SiC MOSFET
- **2017**: Introduced a SiC 900V, 10mΩ MOSFET for EV Drive Trains enabling reduction of EV drive train inverter losses by 78%

- **1991-2017**
  - **1991**: Introduced industry’s first 1200V SiC 25mΩ MOSFET
  - **1998**: Introduced industry’s first 1700V SiC half-bridge module
  - **1999**: Became Department of Defense Trusted GaN Foundry
  - **2000**: Acquired APEI
  - **2002**: Introduced our first 1200V SiC half-bridge module
  - **2007**: Released market’s highest power, single-ended GaN RF transistor for L-Band Radar
  - **2008**: Announced sample release of 90W GaN HEMT
  - **2009**: Introduced industry’s first 900V SiC MOSFET for EV Drive Trains enabling reduction of EV drive train inverter losses by 78%
  - **2010**: Released industry’s first 1700V SiC Schottky diode
  - **2011**: Developed high-quality 150-mm SiC substrates
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  - **2017**: Released world’s first commercial SiC wafers
  - **2017**: Introduced a SiC 900V, 10mΩ MOSFET for EV Drive Trains enabling reduction of EV drive train inverter losses by 78%
POWER

RF

MATERIALS

Global technology leadership in wide bandgap materials including SiC Substrates for GaN RF and SiC Power devices

Market’s broadest, most field-tested portfolio

Leading innovator and manufacturer of SiC semiconductor devices for efficient power conversion and GaN-on-SiC RF power devices for wireless communications

> Performance
> Power Density
Size <
Energy Costs <
The Future is Electric, and it starts now with Wolfspeed SiC
Smaller, Cooler, Better Systems with Wolfspeed SiC Inside

- Released our first 600V commercial SiC JBS Schottky diode
  - **WHAT IT MEANS FOR OUR CUSTOMERS**
  - Enables the creation of ENERGY STAR® 80-Plus Gold, Platinum, and Titanium power supplies.

- Released industry's first 1200V SiC Schottky diode
  - **WHAT IT MEANS FOR OUR CUSTOMERS**
  - Instrumental in the creation of the world’s most energy-efficient solar inverters.

- Released industry's first SiC MOSFET
  - **WHAT IT MEANS FOR OUR CUSTOMERS**
  - Is the key building block for new power conversion systems, achieving smallest size, weight, and BoM.

- Introduced industry's first 1700V SiC half-bridge module
  - **WHAT IT MEANS FOR OUR CUSTOMERS**
  - Delivers SiC switching speed and energy-efficiency to solar, EV, and industrial power supplies that require kilowatts of power.

- Exceeded three trillion field hours with power products
  - **WHAT IT MEANS FOR OUR CUSTOMERS**
  - Demonstrates the reliability of our SiC devices in high-volume commercial systems.

- Introduced SiC 900V, 10mΩ MOSFET
  - **WHAT IT MEANS FOR OUR CUSTOMERS**
  - Enables the reduction of EV drive train inverter losses by 78%. Also ideal for increasing power density in EV chargers and solar inverters.
Optimum Performance with Wolfspeed GaN RF

Leading innovator and manufacturer of GaN-on-SiC RF power devices for wireless communications
Leaders in GaN-on-SiC RF Technology

We were the first. And we’re still the leader after 15 years of producing GaN-on-SiC devices.

In August, 2000, we fabricated the industry’s first successful GaN-on-SiC MMIC amplifier that generated 20W at 9GHz.

We led the RF industry to better alternatives to expensive GaAs devices and bulky TWTs delivering better efficiency and higher power densities for radar and satellite communications.

In civilian markets, commercial industry, military infrastructure and everywhere in-between, Wolfspeed GaN semiconductors are liberating engineers and designers to think dream bigger and deliver unprecedented power and efficiency.
Wolfspeed Materials

Three decades of global technology leadership in wide bandgap materials

• SiC substrates and epiwafers for GaN RF and SiC power devices
• Highest volume producer globally
• Leading IP portfolio
• Proven track record of delivering fully qualified, commercially viable, highly reliable products
Outperforms Si and GaAs with superior quality and reliability

<table>
<thead>
<tr>
<th>SiC Power</th>
<th>GaN RF</th>
</tr>
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<tbody>
<tr>
<td>4+ TRILLION FIELD HOURS for Wolfspeed SiC power products (650V – 1700V)</td>
<td>170+ BILLION FIELD HOURS for Wolfspeed RF products</td>
</tr>
<tr>
<td>MORE THAN 6 YEARS of commercial SiC MOSFET products</td>
<td>MORE THAN 8 YEARS of commercial GaN HEMT production experience</td>
</tr>
<tr>
<td>THOUSANDS OF CUSTOMERS in industrial markets</td>
<td>OVER 15 MILLION devices successfully fielded to date</td>
</tr>
<tr>
<td>MILLIONS OF FIELDED SiC MOSFETS</td>
<td>ACCREDITED AS A CATEGORY 1A TRUSTED FOUNDRY BY THE U.S. DEPARTMENT OF DEFENSE</td>
</tr>
<tr>
<td>FIT RATE MUCH LESS THAN SI</td>
<td>FIT RATE MUCH LESS THAN SI AND GaAs</td>
</tr>
</tbody>
</table>
Wolfspeed recognizes that easily accessible energy is finite; how we use it matters.

Market-leading innovator in SiC and GaN technologies

Most experienced team of scientists and engineers in the industry

30-year history of innovation, delivering fully qualified, commercially viable, highly reliable products

Portfolio addresses the broadest set of commercial and government applications

Best value at the systems level

Strong financial foundation that fuels growth and innovation

Entrepreneurial business with the ability to leverage the global scale and resources of Cree
Wolfspeed


www.wolfspeed.com
Upcoming Events

November 2 – Marketplace: The Role of Data Analytics in Revolutionizing the Energy Market
THANK YOU