SAND2007-0579C

Microtechnology Cluster Development A Case Study

Franco-American Conference on "Competitive Clusters"

Session 7: Micro and Nano Technologies

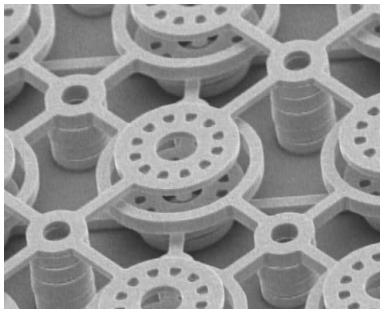
February 6, 2007

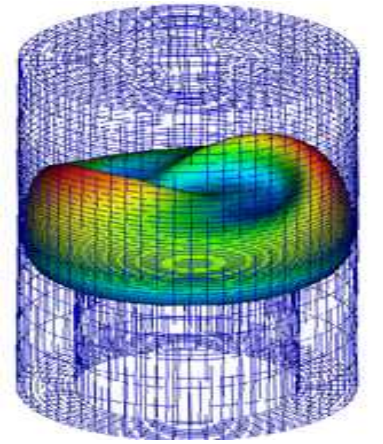
Gilbert V. Herrera
Director
Microsystems Science, Technology & Components Center
Sandia National Laboratories

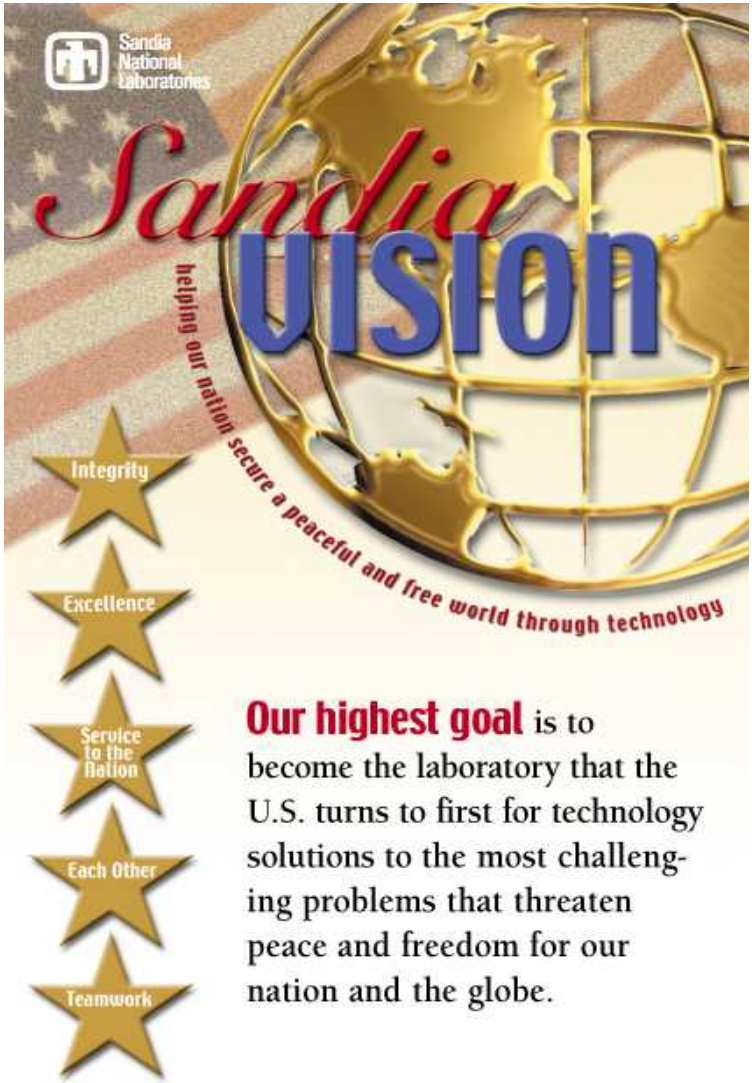
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

What is Sandia National Labs?

- National security laboratory
- Primary mission in nuclear weapons
- Broader mission in science and technology to meet national needs

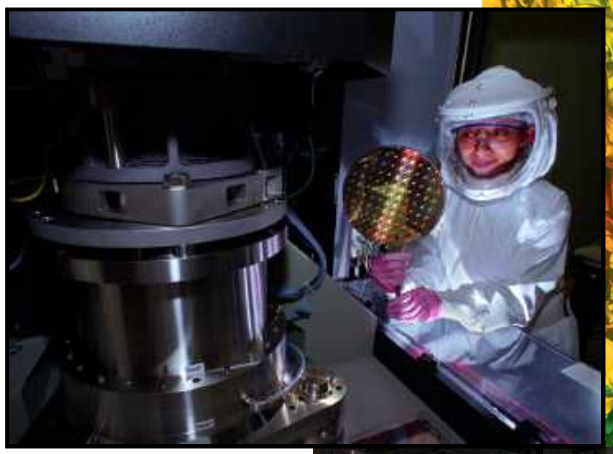


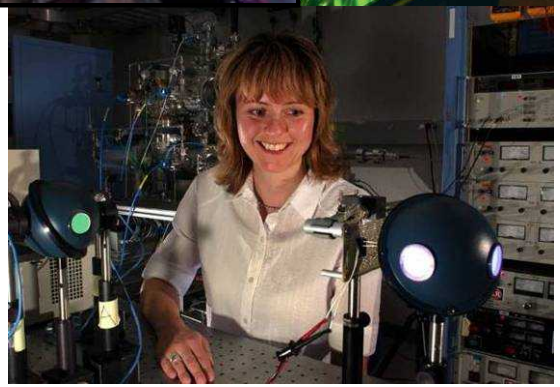


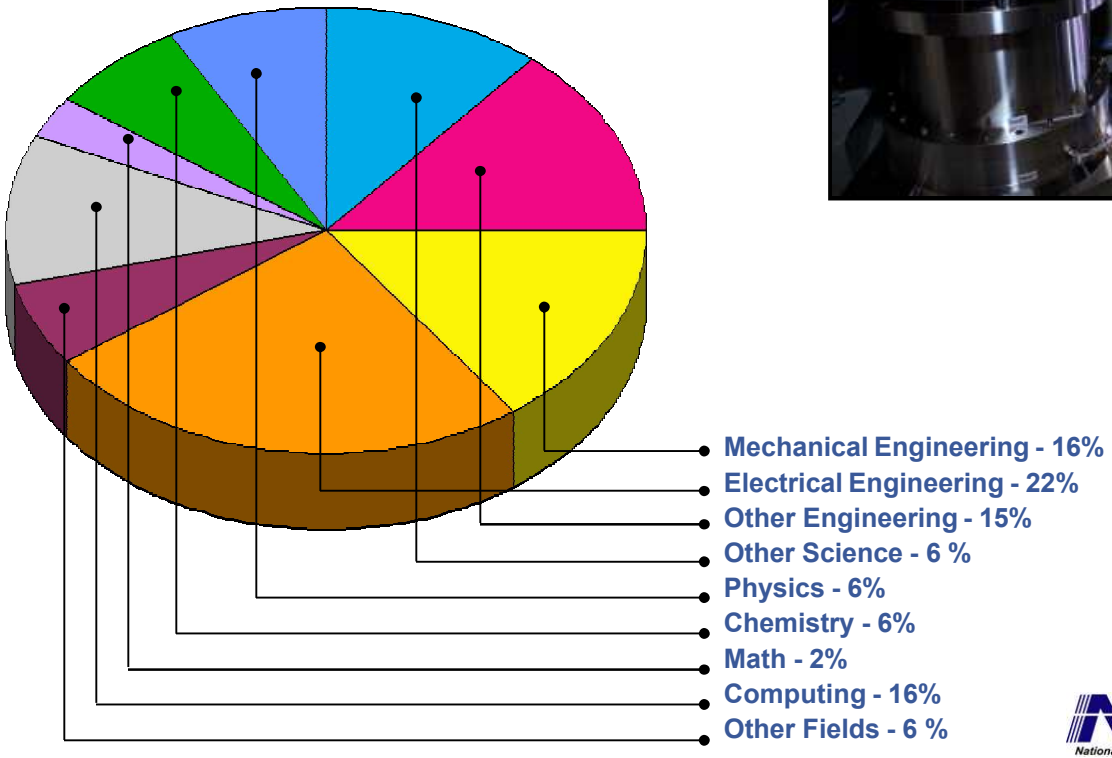


Highly Skilled Workforce

- More than 8,600 full-time employees
- More than 1,500 PhDs and 2,700 MS/MAs
- 2,200 on-site contractors
- $2.33 billion FY06 total budget



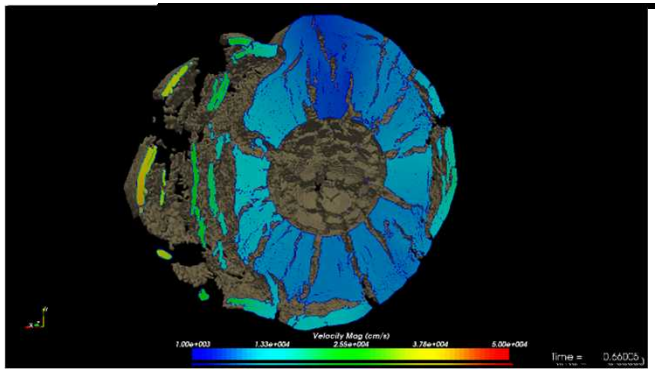




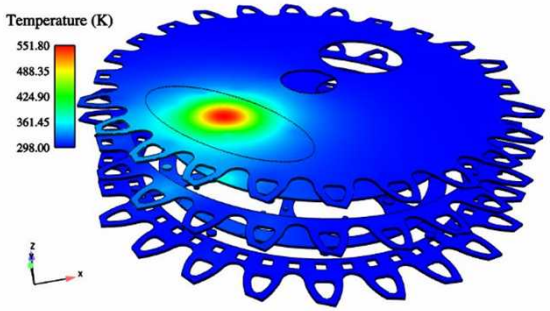
NNSA National Nuclear Security Administration

Sandia National Laboratories

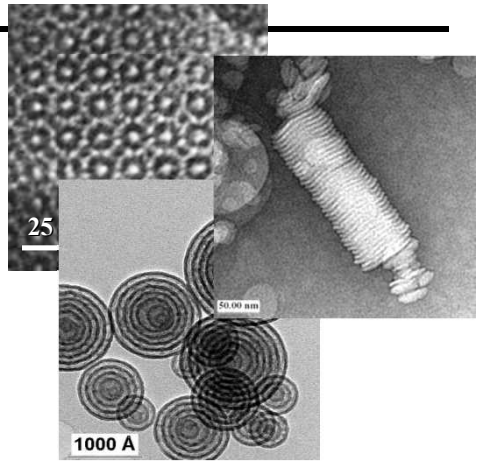
Our Mission Focus Relies on Strong Science and Engineering



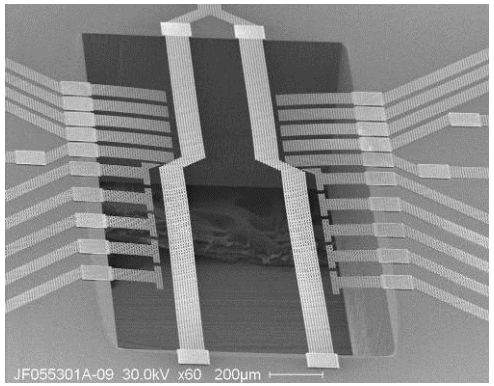
Computational and Information sciences



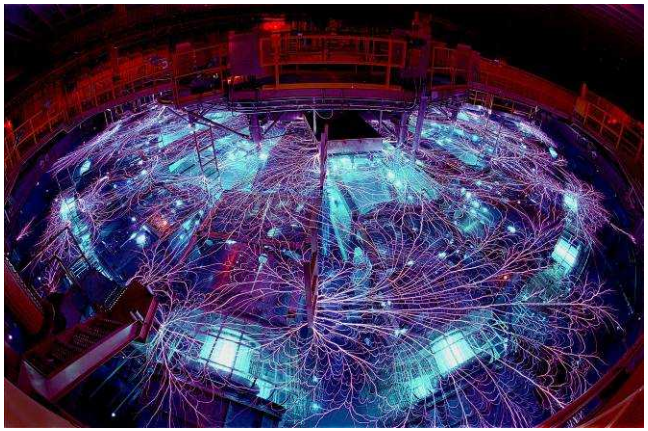
Engineering Sciences



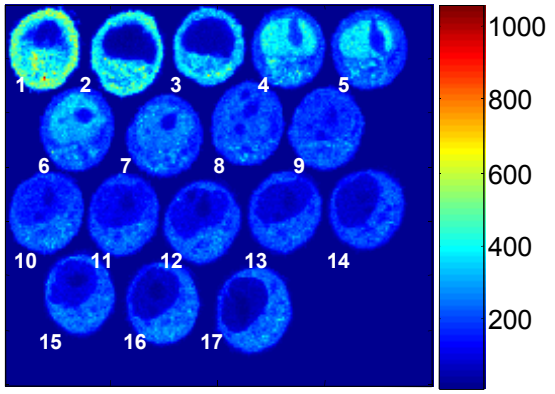
Materials Science and Technology



Microelectronics and Photonics



Pulsed Power



Bioscience

National Nuclear Security Administration

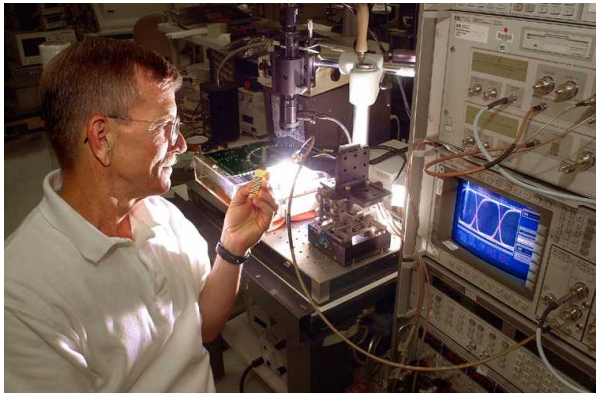
Sandia National Laboratories

Industrial and Government Partnerships

- **Provide access to state-of-the-art technologies, Intellectual Property, unique facilities, and talented scientists and engineers.**
- **Provide Sandia access to best commercial practices, relationships to mature technologies, and a means of placing state-of-the-art products in the hands of users — military, first responders, etc.**

Science and Technology park

EMCORE Partnership

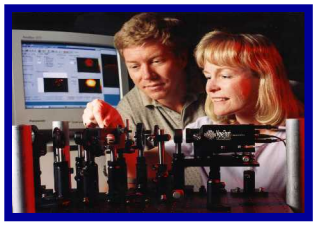


Extreme Ultraviolet Lithography Consortium

National Nuclear Security Administration

Sandia National Laboratories

Sandia Uses Many Mechanisms for Technology Partnerships



Novint Technologies

EMCORE

HARVARD UNIVERSITY

Stanford University

CRADAs enable collaboration.

Funds-In Agreements provide a choice of partnerships to meet industry needs.

Licenses promote commercialization and generate royalties.

Small-business technical Assistance includes five approaches.

University Collaborations are a way recruiting.

S & T Park aids regional development and building technology clusters.

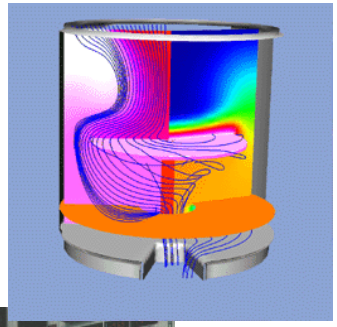
Sandia National Laboratories

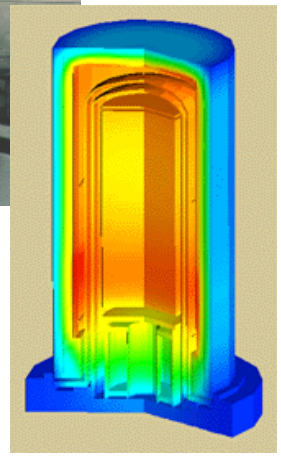
The Sandia-EMCORE Partnership

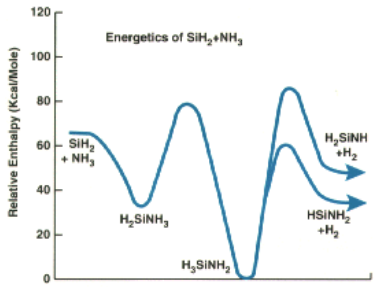
Sandia National Laboratories

Government Investment in Basic R&D

- By the early 1990's, Sandia had built up considerable expertise in metal-organic chemical vapor deposition technology based on advances and capabilities developed over the previous decade under US government funded Chemical Vapor Deposition Sciences project.
- These long-running BES programs supported basic R&D in:
  - Fundamental materials physics
  - Growth chemistry and reactor physics
  - In-situ monitoring and stress-engineering



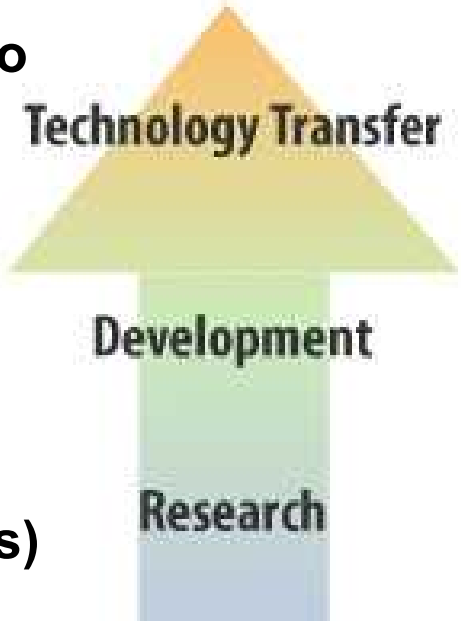




Sandia National Laboratories

Technology Transfer as a Mission

- Stevenson-Wydler Technology Innovation Act (1980).
  - Required Federal laboratories to facilitate the transfer of Federally owned and originated technology to state and local governments and to the private sector.
  - Established technology transfer as a mission of the government.
- National Competitiveness Technology Transfer Act (1989).
  - Amended the Stevenson-Wydler Act to allow government-owned, contractor-operated (GOCOs) laboratories to enter into Cooperative R&D Agreements (CRADAs).
  - Established technology transfer as a laboratory mission for GOCOs and their employees.

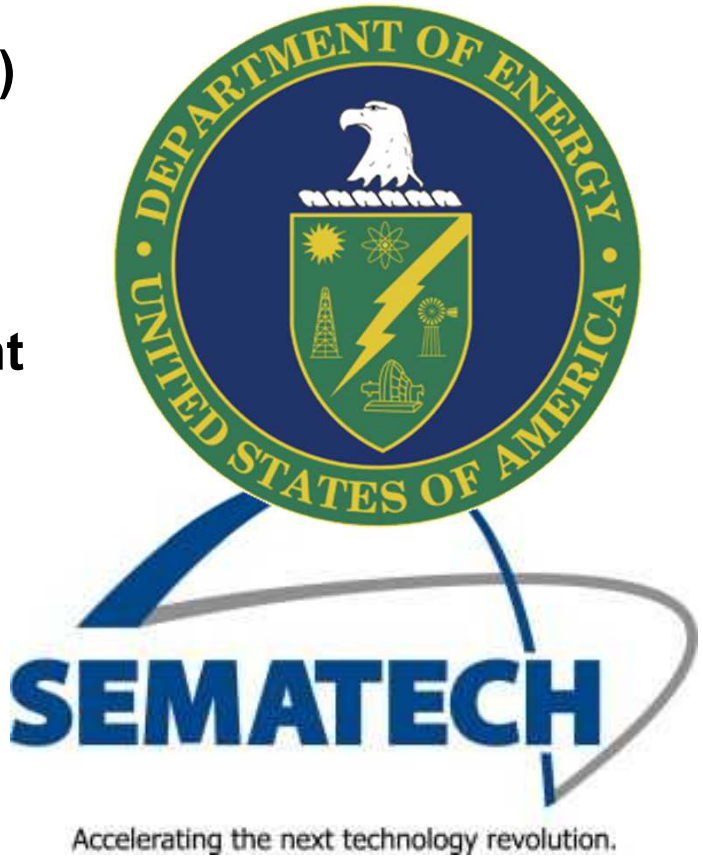


Sandia National Laboratories

SEMATECH CRADA

- In the fall of 1989 the Semiconductor Equipment Technology Center (SETEC) program was established at Sandia to support SEMATECH

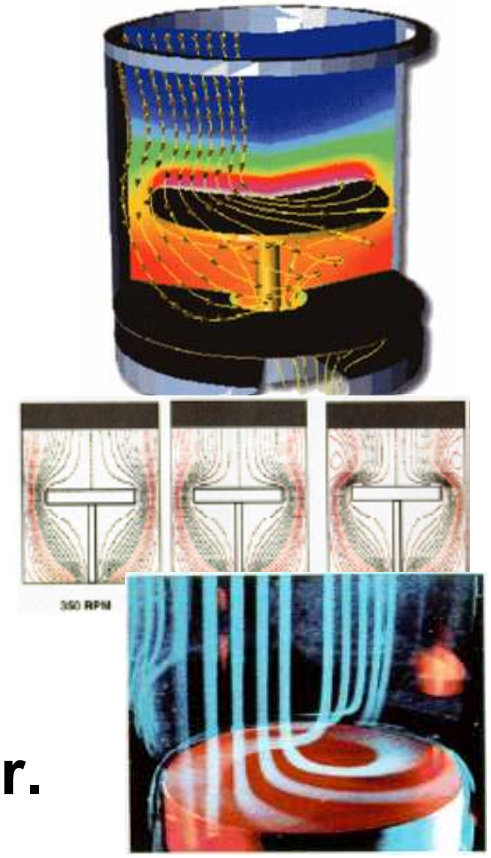
- In 1993 SEMATECH and the Department of Energy sign a 5 year CRADA in the areas of
  - equipment benchmarking and engineering
  - contamination free manufacturing research
  - equipment and software reliability
  - equipment modeling and design
  - materials and process analysis
  - semiconductor process analysis



Sandia National Laboratories

First CRADA with EMCORE

- In the fall of 1993, EMCORE signs $3.9M CRADA with Sandia.
- EMCORE's goal is to apply Sandia's expertise in rotating-disk reactor technology to improve EMCORE's commercial high-speed rotating disk MOCVD reactor and help design a next generation, high-volume production scale rotating-disk reactor.
- CRADA spans six years.



Sandia National Laboratories

EMCORE and Sandia Jointly Publish

Journal of Electronic Materials
Volume 25, Number 9, September 1996

The Scaling of CVD Rotating Disk Reactors to Large Sizes and Comparison With Theory

ALAN G. THOMPSON,[1] R.A. STALL,[1] P. ZAWADZKI,[1] and G.H. EVANS[2]
1--EMCORE Corporation, 394 Elizabeth Avenue, Somerset, NJ 08873. 2--Sandia National Laboratories, Livermore, CA 94550

"We believe that this is the first report of a truly scalable CVD reactor geometry with both theoretical and experimental justification. Using the RDR technique therefore enables the grower to develop a process on a small system and transfer it to a larger system for manufacturing, without having to reinvent the process. It also enables the CVD system manufacturer to design and build new systems that will perform in a predictable manner, or to adapt new process conditions to an existing system, without requiring extensive re-engineering efforts."

Sandia National Laboratories

Sandia and EMCORE Partnership Expands

- As a result of the significant success of Sandia's and EMCORE's first CRADA, a number of subsequent agreements followed.
- Collaborations expanded into VCSEL technology, photovoltaic materials, and optical switching.

JOURNAL ARTICLES BY FLUENT SOFTWARE USERS

JA090

Emcore Saves Hundreds of Thousands of Dollars in Testing Costs by Using CFD to Scale Up Patented Semiconductor Production Process

By Robert Walker, Director of Marketing
Pete Zawadzki, Laboratory Director
EMCORE Corp., Somerset, New Jersey

Computer Generated Flow Patterns in Rotating Disk System (THEORY).
(Gift courtesy of Sandia National Laboratories)

EMCORE Corp. has used computational fluid dynamics (CFD) analysis software to cut hundreds of thousands of dollars off the cost of scaling up its patented semiconductor production process. Critical to translating its TurboDisc® deposition process from small, R & D-size systems to production-size models is ensuring that material growth conditions within the system remain the same as the size of the chamber increases. Without the ability to simulate operational characteristics such as gas flow, the company would have to build and test many prototype machines. Testing one prototype costs hundreds of thousands of dollars and takes several months.

These costs are avoided by simulating the performance of larger equipment and using the results to determine the best operating conditions before the first prototype is built. EMCORE Corp. makes metal organic chemical vapor deposition (MOCVD) systems used in the manufacture of compound semiconductors. The company's proprietary TurboDisc deposition technology uses a unique high-speed rotating disc in a stainless steel chamber. Reactive gases decompose and deposit ultra-thin layers of compound semiconductor or advanced oxide materials on a substrate wafer.

Wafers grown by TurboDisc deposition allow for circuits and devices that are faster, have optoelectronic capabilities and possess properties superior to those manufactured using traditional deposition techniques. For example, EMCORE customers have used its systems to produce the highest-brightness InGaAlP LEDs, the lowest-

FLUENT

Sandia National Laboratories

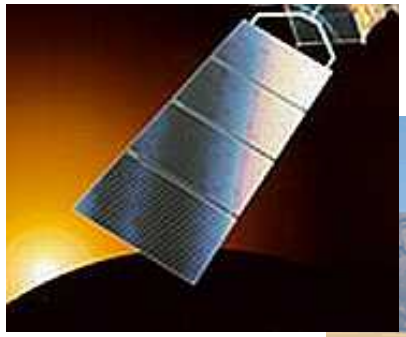
EMCORE First Tenant in Sandia Science & Technology Park

- May 28, 1998 formal groundbreaking ceremony for the new EMCOREwest building in the Sandia Science & Technology Park (SS&TP).
- "Much of the technology we'll be using at the site is the technology EMCORE developed in partnership with Sandia," EMCOREwest Chief Business Officer Karen Schneider said in a recent interview. "Now, we'll be right there at the front gate."

Sandia National Laboratories

EMCORE Expands Partnership with Sandia and Presence in SS&TP

- July 28, 2006 – EMCORE Corporation and Sandia enter into agreement involving EMCORE's terrestrial solar systems products.
- October 2006 – EMCORE announces it is moving its headquarters to the Sandia Science & Technology Park.



Sandia National Laboratories

Technology Partnerships are a Contact Sport

- All parties must have technical and business competence, but the foundation is technical respect and synergy
- Frequent interactions are necessary to make progress
- Trust is essential
- You must build upon success to achieve larger successes

Sandia National Laboratories