

NEWS in Science and Technology

from the



CONNECTICUT ACADEMY OF SCIENCE AND ENGINEERING

Vol. 9, No. 3 / Fall 2010

The following is an Executive Summary of the Academy's quarterly Bulletin (Vol. 25,3) that includes topics and issues in science and technology deemed by the Academy to be both timely and relevant to Connecticut's interests. Each item is briefly summarized from press releases and reports of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. Hyperlinks are included to the original online source, where more detailed information is available.

NOTE: Online versions of this newsletter and the Bulletin are available on the Academy website at www.ctcase.org.

FEATURE ARTICLE

➤ Connecticut's Laser Industry: A Proud Past, A Brilliant Future

In a high-bay facility of the Laser Applications Laboratory (LAL), a division of the CT Center for Advanced Technology in East Hartford, Laser researcher Bobby Wright drills a hole into a section of engine turbine blade made of nickel. He isn't using a drill bit, but pulses of high energy light produced by a Nd:YAG laser. The pulses last less than a millisecond but reach a peak power of 25 kW; the hole, one of more than 1.5 million per engine, is drilled in a matter of seconds. Connecticut's reputation for precision manufacturing is now focused on lasers.

Early History of the Laser

- **1958**—Many agree that the laser began with the submission of a manuscript by Charles Townes and Arthur Schawlow, then at Bell Labs, to the journal *Physical Review* describing theoretical calculations of a concept originally termed an optical "maser."
- **1958**—Columbia University graduate student Gordon Gould developed a doctoral thesis involving measurement of the energy levels of thallium atoms excited to higher energy states by "pumping" with suitable light. His notebook contained the phrase, "rough calculations on the feasibility of laser light amplification by stimulated emission of radiation," the first known use of the acronym "LASER."
- **1959**—Gould filed for and was denied a patent.
- **1960**—The patent went to Bell Labs, sparking a twenty eight year lawsuit on the part of Gould.
- **1960**—Theodore H. Maiman constructed the first functioning laser at Hughes Research Laboratories in California. Maiman used a pulsed light source lasting only a few milliseconds as the "pump," so only a short pulse of emitted light was generated rather than a continuous wave.
- **1961**—First continuous operation of a laser was achieved at Bell Labs
- **1987**—Gould was finally awarded a patent for an optically pumped laser.

**The controversy over who actually invented the laser continues to this day. It should be noted that Bell Labs made significant contributions to laser technology throughout its early history.*

Properties of a laser

Light emitted from a laser has the following properties:

- **Monochromatic:** Light of a single wavelength or a very narrow spectral range.

- **Coherent:** Individual waves of light that move together through space with coinciding peaks and valleys.
- **Collimated:** Individual beams are parallel, able to travel long distances with little divergence.

How Lasers Are Produced

- Electrons in an atom or molecule are "pumped" from their ground state to an excited state.
- When an energetic electron spontaneously returns to the ground state, a photon of light is produced.
- When the pumping rate is sufficiently high, the number of excited electrons exceeds the number of ground-state electrons and a so called "population inversion" occurs.
- Also, an excited atom may be induced by an emitted photon to produce a photon of light of equal frequency and phase to the first, and the two resulting photons are termed coherent in the phenomenon of stimulated radiation first described by Albert Einstein in 1917.
- Some of the coherent photons produced by pumping the lasing medium will move in a direction parallel to the axis of the lasing container, and will bounce back and forth between a reflective and a partially reflective surface, stimulating other atoms to produce photons with each trip in a process described as optical amplification. What eventually escapes through the partially reflective mirror is coherent, monochromatic, collimated laser light now used in hundreds of applications.

The Connecticut Laser Story

If Einstein is the grandfather and Townes, Schawlow, Gould and Maiman the fathers of the laser revolution, then Anthony DeMaria is the great uncle of the Connecticut branch of the family. About DeMaria:

- A former CASE president and currently Chief Scientist with Coherent in Bloomfield.
- Conducted groundbreaking research in picosecond [10^{-12} second] laser pulse physics, at United Technologies Research Center (1958-1994), which profoundly influenced the study of molecular and atomic dynamics, non-linear optics, and plasma physics.
- A member of LaserFest, an international commemoration of the 50th anniversary of the demonstration of laser technology.

There are literally dozens of companies in Connecticut devoted to lasers, including

- JDS-Uniphase—leading provider of high speed optical modulators used with laser diodes for the fiber optic telecommunications industry
- TRUMPF, Inc.—major international player in various laser applications and laser-based production processes
- Lasercut Technologies—laser applications specialist
- Evergreen Laser Corp.—instrument repair provider

- Nufern—designer and manufacturer of fiber laser systems, among other things
- RSL Fiber Systems—remote source lighting technology

Lasers Today and Tomorrow

Fred Leonberger, Senior VP and CTO (ret.) JDS Uniphase: “State-of-the-art laser encoding of information and transmission by fiber optics is currently at a speed of 40 gigabits per second. That is like transmitting the Encyclopedia Britannica in less than 100 milliseconds. The next breakthrough will be in speeds of more than 100 Gbits per second,” says Leonberger.

Elliot Ginsberg, president & CEO of CCAT: “Connecticut was traditionally a machine tool state. Lasers and optics are the next generation of machine tools, which will manufacture the next generation of products. Lasers will become even more ubiquitous and every company that works in materials processing should have lasers in their toolbox.”

Anthony DeMaria: “Lasers have not reached their full potential in the computing sector. Telecommunications, lighting industries, and advances in materials processing will all be major fields of advancement for the laser.”

[http://www.ctcase.org/bulletin/25_3/25_3.pdf]

NEWS FROM THE NATIONAL ACADEMIES

The following is excerpted from press releases and other news reports from the National Academies (www.national-academies.org).

➤ Strong Evidence on Climate Change Underscores Need for National Strategy, Action Now

Informed by Reliable Data'

A comprehensive national response to climate change should be informed by reliable data coordinated through climate services and a greenhouse gas monitoring and management system to provide timely information tailored to decision makers at all levels, says a report by the National Research Council. The report recommends several mechanisms for improving communication about climate science and responses and calls for a systematic framework for making and evaluating decisions about how to effectively manage the risks posed by climate change. Although the report does not specify a particular agency to lead federal efforts, it emphasizes the importance of coordination across the federal government and with state, local and private sector decision makers. The report is part of a congressionally requested suite of studies known as *America's Climate Choices*, which also includes three other recently released reports. A report to be released later this year will build on all four reports and other materials to offer a scientific framework for shaping the policy choices underlying the nation's efforts to confront climate change.

[<http://americasclimatechoices.org>]

Today's CO₂ Emissions Choices Will Impact Climate for Centuries

Choices made now about carbon dioxide emissions reductions will affect climate change impacts experienced not just over the next few decades but also in coming centuries and millennia, says a new report from the National Research Council. Because CO₂ in the atmosphere is long lived, it can effectively lock the Earth and future generations into a range of impacts, some of which could become very severe.

Policy choices about emissions can be informed by recent advances in climate research that quantify the relationships between atmospheric CO₂ and warming levels, and between warming levels and future impacts. Drawing upon this research, the report estimates changes in precipitation, streamflow, wildfires, crop yields, and sea level rise that can be expected with different degrees of warming. It also estimates the average temperature increases that would be likely if CO₂ were stabilized in the atmosphere at various target levels. However, the report does not recommend any particular stabilization target, noting that choosing among different targets is a policy choice rather than strictly a

scientific one because of questions of values regarding how much risk or damage to people or to nature might be considered too much.

[http://www.nap.edu/catalog.php?record_id=12877]

➤ New Rule Simplifies PTSD Disability Claims

A new rule announced by the government in July makes it easier for veterans with post-traumatic stress disorder to receive disability benefits. This change could affect hundreds of thousands of veterans who served in Iraq, Afghanistan, and Vietnam. Under the new regulation, the VA will grant disability benefits to all veterans who can prove they served in a war zone, performing a job consistent with the traumatic events that allegedly triggered the PTSD. Veterans are no longer required to corroborate traumatic events related to hostile military activity, such as coming under fire or watching a friend die. According to the US Department of Veterans Affairs, the new regulations on PTSD claims will apply to claims received by the VA on or after July 13, 2010, as well as to claims received or appealed before this date, which have not yet been resolved by the Board or by VA regional offices. The rule applies to veterans who served in any US war.

[<http://www.nationalacademies.org/headlines/20100714.html>]

◆ Role of Language in School Learning Examined

A new book, *Language Diversity, School Learning, and Closing Achievement Gaps: A Workshop Summary*, from the National Academies Press, summarizes and synthesizes two days of workshop presentations and discussion from the Workshop on the Role of Language in School Learning: Implications for Closing the Achievement Gap. Participants in the workshop, which was sponsored by the William and Flora Hewlett Foundation, included members of the National Research Council (NRC) planning committee and other invited content experts and guests. It was held to explore three questions: What is known about the conditions that affect language development? What are the effects of early language development on school achievement? What instructional approaches help students meet school demands for language and reading comprehension? The aim of the meeting was not to reach consensus or provide recommendations, but rather to offer expert insight into the issues that surround the study of language, academic learning, and achievement gaps, and to gather varied viewpoints on what available research findings might imply for future research and practice. workshop presentations and discussion.

[http://www.nap.edu/catalog.php?record_id=12907]

◆ Continued Focus on Hydrogen Technologies Urged

The public-private partnership to develop vehicles that require less petroleum-based fuel and emit fewer greenhouse gases should continue to include fuel cells and other hydrogen technologies in its research and development portfolio, according to a new report by the National Research Council. The third volume in the FreedomCAR series states that, although the partnership's recent shift of focus toward technologies that could be ready for use in the nearer term—such as advanced combustion engines and plug-in electric vehicles—is warranted, R&D on hydrogen and fuel cells is also needed given the high costs and challenges that many of the technologies must overcome before widespread use. The FreedomCAR (Cooperative Automotive Research) and Fuel Partnership is a research collaboration among the US Department of Energy, the United States Council for Automotive Research, five major energy companies, and two electric utility companies.

[http://www.nap.edu/catalog.php?record_id=12939]

Our Thanks to Academy Sponsors

The Academy wishes to express its sincere thanks to its sponsors, whose support makes the important work of the Academy, including this publication, possible.

◆ Leading Patrons ◆

The Connecticut Light and Power Company