

# Research

## HIGHLIGHTS

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### Air Force Office of Scientific Research Logs Three Nobel Laureates for 2000 Awards

The Air Force Office of Scientific Research (AFOSR) identified, sponsored, and collaborated with other agencies to support over 35 Nobel Laureates before they won the Nobel Prize. On 10 December 2000, three additional AFOSR-funded researchers were awarded the Nobel Prize at the Stockholm Concert Hall in Sweden. This select group has earned worldwide recognition for their research contributions in physics, chemistry and medicine.

This is the second consecutive year that AFOSR's support, along with several other sources of funding, has helped a researcher to receive a Nobel Prize for work in Chemistry.

Three scientists, who created a plastic that conducts electricity like a metal, shared the Nobel Prize in Chemistry. **Dr. Alan J. Heeger**, University of California Santa Barbara (UCSB), the AFOSR-funded scientist sharing the **Nobel Prize in Chemistry** award, contributed to this innovative research, leading to one of the greatest chemical discoveries of our time.

In the late 1970s, Heeger, along with two associates, began fundamental research in conductive polymer plastics. Plastics are made up of polymers — molecules that form long chains — which repeat, like pearls in a necklace. The research team found that a thin film of polyacetylene, when oxidized with iodine vapor, exhibited an electrical conductivity increase of a billion times, turning an insulator to a conductor. This spectacular discovery opened up a new field of carbon-based electronics with wide applications and benefits for the Air Force.



Heeger's pioneering work pushes the field of polymer research from primarily addressing structural applications to other potential applications typically addressed by semiconducting materials. Scientists and engineers no longer just speculate about all "plastic airplanes" and "plastic engines." Today, "plastic electronics" and "plastic lasers" are targets of research opportunity supported by all services and agencies of the Department of Defense (DoD).

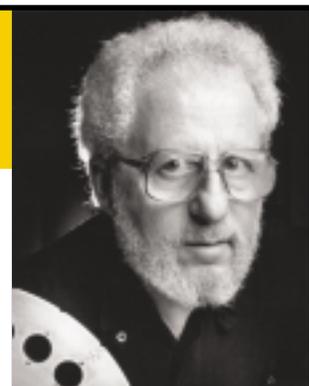
Since 1988, Dr. Charles Lee, Program Manager in Chemistry and Life Sciences at AFOSR, has continuously funded Heeger's research in conductive polymers for photonic applications. His current project reflects further development of the original work for which he received the Nobel distinction.

"The Air Force Office of Scientific Research funding played a critical role in the last decade in my research toward the development of conducting polymers, which resulted in the 2000 Nobel Prize in Chemistry. With that research over the last years we were able to move this field forward," Heeger stated in a voice communiqué with our writers.

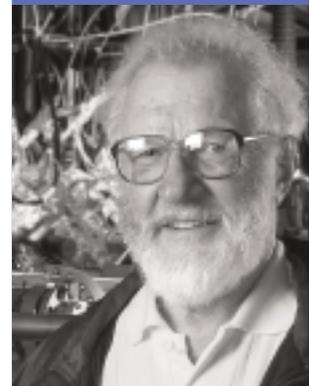
Heeger's research is a big boost to the polymer and Air Force research community. The AFOSR polymer program has been pushing hard in the last decade, and Heeger has been an important part of that effort. From his award winning research, plastic display panels — like those found in a variety of hand-held devices — will be an Air Force and commercial reality in the immediate future.

Heeger's current AFOSR research seeks development of techniques to conduct ultrafast spectroscopic

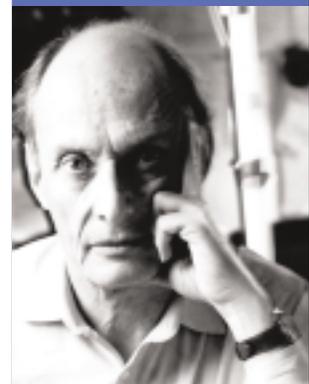
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Dr. Alan J. Heeger



Dr. Herbert Kroemer



Dr. Paul Greengard

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characterization of the charge-transfer response in conjugated polymers — to provide fundamental understanding that would lead to applications such as fast optical signal processing useful in target recognition. His ongoing funding includes a previous study funded by the AFOSR Physics and Electronics Directorate, centered on the orientation of polymer molecules in order to enhance their conductivity. Potential application of his research by the Air Force falls under general, potential uses in plastic lasers and plastic electronics for improved performance and lighter construction of aircraft and weapons systems.

Over the past three or four years, AFOSR's support, along with several other sources of funding, has helped researchers to receive the Nobel Prize for work in Physics.

**Dr. Herbert Kroemer**, a Physics professor, also at UCSB, and an AFOSR-funded scientist, shared half of the **Nobel Prize in Physics** with Dr. Zhores I. Alferoz, A.F. Ioffe Physio-Technical Institute, St. Petersburg, Russia — the other half going to Professor Jack Kilby, a retired Texas Instrument research engineer (*see sidebar inset at right for USAF connection*). Kroemer's significant research, spanning several years, laid the foundation for modern information technology.

In 1957, Dr. Kroemer was the first to propose the use of thin layers of semiconducting materials, known as heterostructures — novel composites of two or more materials — to develop the heterostructure transistor. The new transistor, relying on these composites, made significant improvements over conventional transistors in current amplification and high-frequency applications. In 1963, Drs. Kroemer and Alferoz, working independently of each other, proposed the further use of heterostructures. As a result, the heterostructure laser was created — an innovation crucial in the development of fiber optic communications. Today, the Air Force and civilian communities use heterostructure technology in radio link satellites, the Internet, mobile phones, and CD Players.

AFOSR supported Kroemer's continuing work in semiconductors from 1995 to 2000. His research team at UCSB was supported by the AFOSR Physics and Electronics Directorate. Kroemer's AFOSR research centered on applications of gallium arsenide, a composite

semiconductor, and on the newly emerging field of oxides and oxide electronics, a technology that has found widespread applications in the area of opto-electronics.



AFOSR continues support of his investigations into development/discovery of unique materials, because for any given need that the Air Force has, it's rare that a material uniquely fits all requirements. If we had only the materials that nature gives us — the simple listing of materials in the periodic table — we would be stuck. But, through research we discover ways to put together new materials, and then tailor to individual needs — sort of "designer" materials.

Kroemer's work has and will continue to tailor materials to the Air Force's needs. His revolutionary discoveries affect the way the Air Force communicates, and opens the door to endless research possibilities for the future.

**Dr. Paul Greengard** of Rockefeller University, supported by Dr. Bill Berry, a former Program Manager in the Chemistry and Life Sciences Directorate at AFOSR, shared this year's **Nobel distinction in Medicine** with two other neuroscientists. Greengard received his award for discoveries of synaptic transmission mechanisms between human nerve cells. Greengard's research, begun over thirty years ago, demonstrated the means by which chemicals known as neurotransmitters carry signals between nerve cells. These findings have resulted in the understanding of how brain processes function and in the development of new drugs.

AFOSR Life Sciences supported Greengard's research in neurotransmission from 1984 to 1987. Under AFOSR sponsorship, Greengard experimented with large nerve cells to understand the molecular activity of synapse transmission. Such knowledge has led to a better understanding of the brain's function in perception, cognition and action. In turn, this provides a solid scientific basis for designing equipment and jobs to match human capabilities and limitations.

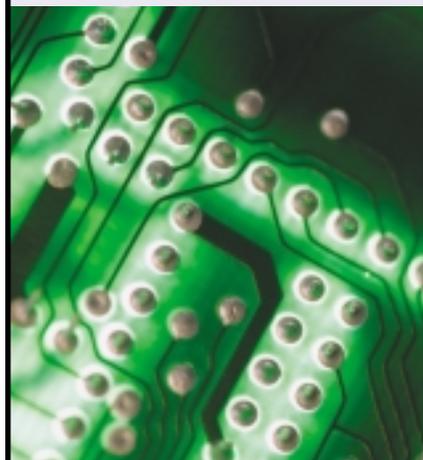
For more information on AFOSR's support of Nobel Prize recipients, please send an e-mail with your name and address to [laura.coens@afosr.af.mil](mailto:laura.coens@afosr.af.mil) for our free Nobel Laureate brochure.

## Air Force Basic Research Supported Development of the Integrated Circuit

**A**ir Force basic research contributed significant support to Jack Kilby, who received half of this year's Nobel Prize in Physics, during his early development of the integrated circuit in the late 1950s. The integrated circuit has led to the development of computers that process data in everything from washing machines to medical diagnostic equipment to space probes and military weapons and command and control systems.

In the 1950s, two Air Force scientists working at Wright Field, Richard Alberts and Harold Noble, secured Air Force funding for Kilby at a critical stage in his integrated circuit research. From the Electronics Components Laboratory, Alberts and Noble became strong advocates and supporters of Kilby's notion that semiconductors could be developed for potential use in Air Force weapon systems.

"As a direct result of their [Alberts and Noble] efforts," Kilby noted, "The first Minuteman II missile computer was successfully flight tested in May 1964." Kilby added that early ballistic missile tests with integrated circuits largely assured the acceptance of semiconductor technology for other military and commercial uses.



# Early Career Researchers Win Presidential Award

**T**wo researchers, funded by the Air Force Office of Scientific Research (AFOSR), have received the prestigious Presidential Early Career Awards for Scientists and Engineers (PECASE) for the Year 2000.

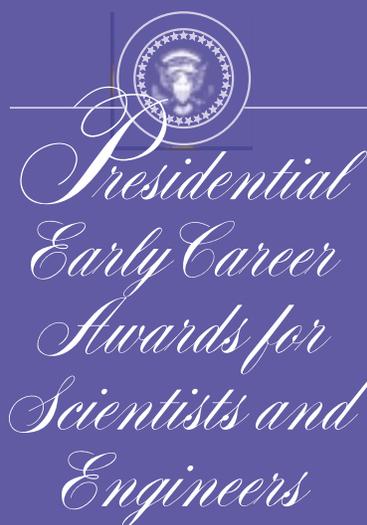
This award recognizes the finest scientists and engineers who, early in their research careers, show exceptional potential for leadership at the frontiers of scientific knowledge. The award includes a five-year, \$500,000 research grant.

Both researchers, **Dr. John G. Morrisett** of Cornell University and **Dr. SonBinh T. Nguyen** of Northwestern University were recognized by AFOSR for their outstanding research and interest in areas ranked high-priority by the Department of Defense (DoD) and which show great relevance for the U.S. Air Force.

Dr. Morrisett conducted his research at Cornell University in the field of software engineering on an AFOSR project managed by Dr. Robert Herklotz, Program Manager, Software and Systems, Directorate of Mathematics and Space Sciences. Dr. Morrisett's research focused on the design and implementation of compilers for programming languages with richly expressive type systems. His work provides the foundation for software that will one day support very high levels

of formally provable security for mobile and transportable code.

Additionally, his proof-carrying code permits embedding of code fragments and checks executable code thus allowing host systems to formally verify correct implementation of any arbitrary security policy desired. This supports the principle of



“least privilege” which constrains any program to the absolute minimum privileges required to get a particular job done. This new approach provides a much higher level of security and code-protection than presently available, which supports a wide variety of future military and civilian applications with mobile code. This capability should enable safe deployment of network and computer infrastructures required for a modern battlefield.

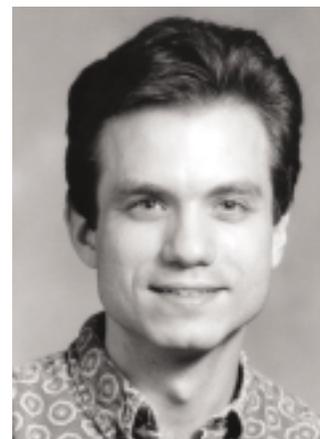
The second PECASE winner, **Dr. SonBinh T. Nguyen**, conducted his research at Northwestern University in the field of nano-material synthesis on an AFOSR project managed by Lt. Col. Paul C. Trulove, Program Manager, Directorate of Chemistry and Life Sciences.

Dr. Nguyen has built a world-class materials and catalysis research effort, producing cutting edge research in the areas of polymers and nano-materials.

His plans include expanding his nano-material synthetic processes to the production of nano-building blocks with unique functionalities. These new materials will then be utilized for the construction of novel nano- and meso-scale devices. His proposed PECASE research project has important implications to the DoD efforts in the self-assembly of nano-building blocks into three-dimensional functional architectures.

Additionally, Dr. Nguyen's exceptional performance at Northwestern has garnered recognition through awards from the Dreyfus Foundation, Dupont Company, Beckman Foundation, Packard Foundation, and Union Carbide.

The Presidential Award embodies the high priority placed by the government on maintaining the leadership position of the United States in science by producing



**Dr. John G. Morrisett**



**Dr. SonBinh T. Nguyen**

outstanding scientists and engineers and nurturing their continued development. Eight Federal departments join together annually to nominate the most meritorious young scientists and engineers who will advance science and technology that will be of the greatest benefit to the participating government agencies.

## AFOSR Research Engineer Receives National Jaycee Award

The U.S. Junior Chamber of Commerce recently announced Major Tim Lawrence as one of the Ten Outstanding Young Americans for 2000. Lawrence and nine others will be honored during a ceremony on 27 January 2001 at the Renaissance Hotel in Washington, D.C.

Lawrence shares this honor with the 600 previous young people selected by the Junior Chamber of Commerce as the best, brightest, and most inspirational leaders America has to offer. Former notables include: President John Kennedy, Howard Hughes, Orson Wells, Elvis Presley, and Christopher Reeve.

Lawrence has led a life of leadership which began in the Boy Scouts and flowed into his decision for career military service. In 1988, he graduated from the United States Air Force Academy (USafa) in the top of his class with a degree in mathematical sciences. He earned his master's degree in nuclear engineering at MIT in 1993. As a follow-on, he won an award from the Department of

Energy's Brookhaven National Laboratory to conduct research critical in developing propulsion systems for future NASA interplanetary missions. Later, he served as an instructor at the USAF Academy in the Department of Astronautical Engineering.

In 1998, Lawrence completed his Ph.D. from the University of Surrey, UK. Then, in December 2000, he received the Thomas Hawksley Gold Medal from the University of Surrey for the best-published research paper. The paper, entitled "Research into Resistojet Rockets for Small Satellite Application," led to a new rocket engine being flown in space.

Today, at the European Office of Aerospace Research and Development, the London detachment of AFOSR, Maj. Lawrence's responsibilities include surveying the achievements in space technology across Europe, the former Soviet Union, the Middle East, and Africa. He has started more than 40 cooperative space research projects between the U.S. and European space nations.

To his further credit, he was selected as the sole Department of Defense member on the NASA Nuclear Thermal Propulsion Technical committee and recognized by the International Astronautics Federation for an outstanding propulsion paper in 1998. Also, during his assignment in Europe, Lawrence took advantage of his location, and became the first active-duty Air Force member to swim the English Channel on 4 September 1999.

AFOSR and the Air Force Research Laboratory proudly feature this outstanding engineer's accomplishments.



ABOVE: Maj. Tim Lawrence (right) receives the Thomas Hawksley Gold Medal from Denis Liler, President, University of Surrey, UK.

### Research Highlights

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*Research Highlights* is published every two months by the Air Force Office of Scientific Research. This newsletter provides brief descriptions of AFOSR basic research activities including topics such as research accomplishments, examples of technology transitions and technology transfer, notable peer recognition awards and honors, and other research program achievements. The purpose is to provide Air Force, DoD, government, industry and university communities with brief accounts to illustrate AFOSR support of the Air Force mission. *Research Highlights* is available on-line at:

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