

## MONTHLY ACCOMPLISHMENT REPORT

### PROPULSION DIRECTORATE

February 1999

#### GOTTSCHLICH WINS TECH TRANSFER AWARD:

Joseph M. Gottschlich of the Power Generation and Thermal Management Branch (AFRL/PRPG) has won the Federal Laboratory Consortium Award for Technology Transfer. Mr. Gottschlich recognized the commercial potential of a proposed research effort and initiated a SBIR contract to develop the proposed technology. External funding also supported the SBIR with Mainstream Engineering, entitled "Hybrid Cycle Heat Pump," arranged by Mr. Gottschlich. The transferred technology is a patented, low-cost refrigerant additive called "QwikBoost." QwikBoost increases the performance of air conditioners, heat pumps, refrigerators, and freezers that use the new non-ozone depleting, environmentally friendly, HFC refrigerants. Since the EPA's Clean Air Act banned the manufacture of ozone-damaging CFC refrigerants, the new HFC refrigerants will soon dominate in application. Performance enhancements of 10% using QwikBoost in HFC systems are common. QwikBoost became available for automotive air conditioners in early 1998 and is expected to debut in home appliances by 2000 and in residential air conditioners by 2003. This product will have a huge impact on the residential air conditioning and heat pump market because of its potential to cut consumer's heating and cooling bills. The projected savings to the nation's energy cost are billions of dollars per year. (J. Gottschlich, AFRL/PRPG, (937) 255-6241)



Joe Gottschlich



QwikBoost Being Added to Auto A/C

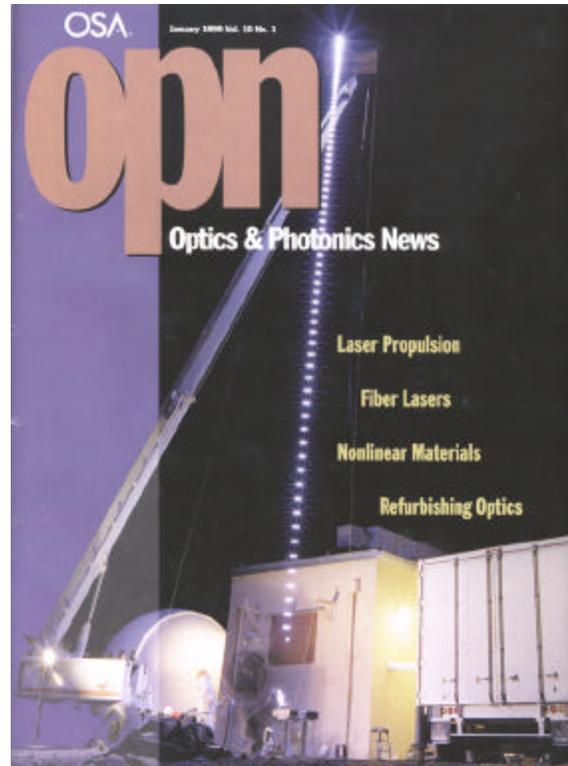


Dr. Won Chang

CHANG NAMED ASME FELLOW: Dr. Won S. Chang has been posthumously named a fellow of the American Society of Mechanical Engineers (ASME). Dr. Chang worked for many years in the Propulsion Directorate's Power Division (AFRL/PRP) and was a recognized expert in a wide range of heat and mass transfer phenomena. He demonstrated a keen ability to exploit fundamental research to impact design and performance of practical devices such as heat pipes and capillary-pumped two-phase loops. Dr. Chang possessed the talent to work well with others and often collaborated with government, industry, and academia. He skillfully managed several large research programs

involving graduate and undergraduate students and actively sponsored and coordinated with many professors on heat pipes and interfacial phenomena. (J. Pearce, AFRL/PRO, (937) 255-5451)

**LIGHTCRAFT GARNERS MORE POSITIVE PRESS:** The Laser Lightcraft Program is the cover story of the January 1999 issue of *OPN Optics & Photonics News*, a publication of the Optical Society of America (OSA). Patrick Carrick and Franklin Mead Jr. of the Propellants Branch (AFRL/PRSP) and Leik Myrabo of Rensselaer Polytechnic Institute (RPI) jointly authored the article, "Lightcraft Propulsion Technology for Low-Cost Access to Space." The article describes the Lightcraft concept of using laser propulsion to launch small payloads into space. An overview of the history and current status of the Lightcraft Program is also provided. The Lightcraft is envisioned as an inexpensive method for putting objects into low earth orbit (LEO). It is estimated that the cost of putting objects into LEO using laser propulsion could be as low as \$200/kg, which compares very favorably with the current cost of nearly \$10,000/kg to achieve LEO using the Space Shuttle. More information on the Lightcraft Program is available on the World Wide Web at <http://www.ple.af.mil/lcpublic.htm>. (F. Mead, AFRL/PRSP, (805) 275-5929)



Cover of January 1999 Issue of *OPN Optics & Photonics News*

**ADVANCED ROLLER BEARING SETS NEW STANDARD:** A Lubrication Branch (AFRL/PRSL) designed hybrid (steel & ceramic) roller bearing and lubrication concept was successfully demonstrated at Integrated High Performance Turbine Engine Technology (IHPTET) Joint Expendable Turbine Engine Concept (JETEC) Phase II conditions. This demonstration was performed in rig testing at Allison Advanced Development Company (AADC) in early January. PRSL personnel worked closely with General Electric (GE) and AADC personnel to assure the success of the test. The bearing was vapor lubricated and contained patented PRSL technology including the vapor lubricant, method for lubricant delivery, carbon-carbon cage, and heat transfer concepts based on models developed in-house by PRSL. The bearing operated at 1.8 million DN (bearing diameter in millimeters x speed in rpm) and was run at temperatures of 600 to 800°F for almost six hours. These conditions are by far the most severe ever withstood by a rolling element bearing for sustained operation. This bearing and lubrication concept is now being incorporated into the GE/AADC IHPTET Phase II demonstrator engine. The use of this technology meets IHPTET goals and allows the production of expendable or reusable engines with lubrication systems that run 400°F hotter while weighing and costing 70% less than current lubrication systems. (L. Rosado, AFRL/PRSL, (937) 255-6519)



A Hillsborough County Sheriff's Office Bell Jet Ranger

#### POLICE HELICOPTERS SUCCESSFULLY FLOWN WITH +100 ADDITIVE:

The Fuels Branch (AFRL/PRSF) recently completed a field demonstration program on the use of a thermal stability enhancing additive in commercial Jet A fuel. The Tampa Florida Police Department Aviation Unit and the Hillsborough County Sheriff's Office hosted the helicopter field demonstration that began in December 1997 and was completed in September 1998. Data from the study showed that the +100 additive, which was developed as

an additive for JP-8 fuel, reduced coking and sooting when added to Jet A. The additive was tested in the Allison T63-A-720 (military) and 250-C20B (commercial) helicopter engines, and the use of the additive extended the time between required nozzle cleanings ten-fold. Previously, nozzle cleanings were required every 15 to 20 hours, but using the +100 additive, the time between cleanings was increased to more than 200 hours. A report on this program is currently being prepared. (W. Harrison, AFRL/PRSF, (937) 255-6601)

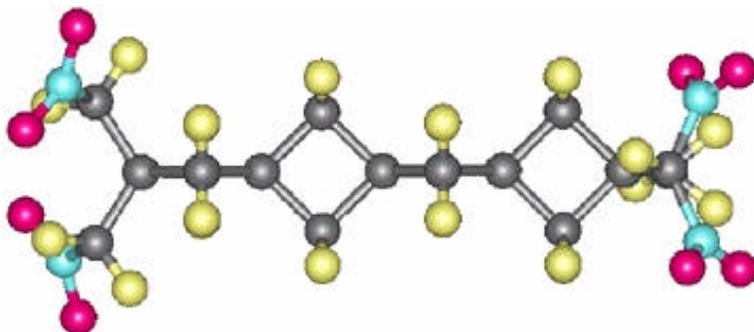
#### PATENT AWARDED FOR NEW CAPACITOR SUBSTRATE DEPOSITION PROCESS:

A patent, titled "Capacitor Structures with Dielectric Coated Conductive Substrates," was awarded on 1 December 1998 to Sandra J. Fries-Carr of AFRL/PRPE, Richard L. C. Wu of K Systems Corp, and Peter Kosel of the University of Cincinnati. The patent describes a method for depositing a dielectric material onto a conductive substrate. This method is essentially the reverse of the industry standard process for fabricating capacitors. The patent further describes a feasible process to produce unlimited lengths of a conductive substrate with the deposited dielectric. The resultant material is used to fabricate new capacitors with greatly improved electrical and thermal performance as well as reduced size and weight. The deposition of diamond-like carbon (DLC) onto capacitor-grade aluminum foil has greatly enhanced volumetric efficiency, and capacitor size and weight can be reduced by at least fifty percent over those that use current state-of-the-art polymers. This can be significant for pulse-power capacitors that presently weigh as much as 200 pounds. These capacitors will find numerous applications in both aircraft and spacecraft power systems, as well as pulse-power systems for directed energy weapons, space based lasers, railguns, and high power microwaves. Commercial applications include well drilling, high temperature power supplies, domestic utilities and appliances, and medical equipment. This technology will have a significant impact, as the new deposition techniques become more economically feasible, thereby making deposition onto metal electrode systems more compelling in application. AFRL/PRPE is actively working through Wright Technology Network (WTN) to transfer this technology to industry. (S. Fries-Carr, AFRL/PRPE, (937) 255-6016)

THERMOMECHANICAL ANALYSIS OF ELECTROMACHINE ROTORS: A joint Power Division/Turbine Engine Division (PRP/PRT) funded delivery order contract has been awarded through the University of Dayton Research Institute (UDRI) to the Virginia Polytechnic Institute (VPI) in Blacksburg, Virginia. The objective of this task, "Thermomechanical Analysis of a Rotor and Microstructural Investigations of Candidate Rotor Materials," is to develop a modeling technique to predict the time-dependent nonlinear stresses and deformations associated with the thermal and mechanical loading of an electromachine rotor. VPI plans to develop finite element models to analyze thermomechanical deformations of a uniformly rotating rotor, and they also plan to conduct a variety of heat treatments on the rotor material. Material investigations will be done in order to develop an understanding of the microstructural evolution of the rotor laminate materials ("soft" magnetic iron-cobalt alloys) as a function of the heat treatment process. The candidate rotor materials are planned for use in main engine starters and generators, aircraft integrated power units, and magnetic bearings. These components in turn support directed energy weapons, space power systems, and the More Electric Aircraft. Knowledge gained during this research will directly support the need of the electromachine design community for better microstructural processing maps and analytical tools pertaining to structural integrity and life assessments of rotors. Endorsements for this research have come from DoD, academia, and industrial partners. (R. Fingers, AFRL/PRPG, (937) 255-6241)

NAVY AND JSF INTERESTED IN OIL CONDITION MONITOR: The Navy is considering purchase of advanced sensors developed by Foster-Miller, Inc under Lubrication Branch (AFRL/PRSL) sponsorship. Under a Phase II SBIR, Foster-Miller developed an on-line instrument to monitor the condition of aircraft lubricating oil. The on-line oil condition monitor (OCM) addressed an Air Force need for a low-cost, reliable sensor to provide indications of the condition of the engine lubricating oil without grounding the aircraft for time consuming laboratory testing. When PRSL personnel briefed Air Force oil system monitoring technologies to the Navy's Maintenance Engineering Technology Team (METT) in December 1998, the Navy expressed interest in using the OCM for shipboard use. The Navy wants to test the device later this year, probably in the September time frame, on an advanced version of an Allison shipboard turbine engine. In addition, the Joint Strike Fighter (JSF) office is interested in installing the OCM on their next seeded-fault engine test at Pratt & Whitney, Florida. This JSF seeded fault test is scheduled for late February, and PRSL is working with JSF and Pratt & Whitney to meet this approaching test date and exploit this opportunity for OCM testing. (R. Wright, AFRL/PRSL, (937) 255-5568)

PRSP COMPUTATIONAL CHEMISTRY EFFORTS RECOGNIZED: Research in computational chemistry performed by Drs. Jeff Mills and Jerry Boatz of the Propellants Branch (AFRL/PRSP) is being featured on the web by the Maui High Performance Computing Center (MHPCC). The highlighted work, entitled “Heats of Formation of Prospective Rocket Fuels Calculated on the IBM SP,” was performed as part of the DoD High Performance Computing Challenge Project Initiative. This research effort is focused on a computational determination of the heat of formation of a chemical substance. The heat of formation is an essential property of prospective high-energy rocket fuel candidates, and the ability to computationally determine the heat of formation provides a tool to efficiently screen prospective molecules. In turn, the time and expense required to develop and deploy high performance propellants are reduced. For more information, see the featured web page (address given below). (J. Boatz, AFRL/PRSP, (805) 275-5364)



One of the Molecules Analyzed (C<sub>17</sub>H<sub>24</sub>N<sub>4</sub>O<sub>8</sub>)

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[see image, BOATZ.jpg]

[see web page, <http://www.hpcmo.hpc.mil/Htdocs/DC/index.html>]

GM INTERESTED IN AFRL TECHNOLOGIES: Personnel from General Motors' (GM) Innovation Zone visited the Wright Research Site (WRS) on 3 February 1999 to discuss potential collaborations on technologies of interest to both the automotive and aerospace industries. The Innovation Zone is a GM initiative to have industry and government laboratories display their technologies to GM design engineers. The goal is to bring these new technologies into automotive design. The GM engineers toured facilities in the Human Effectiveness, Materials & Manufacturing, and Propulsion Directorates. They liked what they saw and expressed interest in returning to see more of AFRL's technologies. (K. Schario, AFRL/PROP, (937) 255-2131 and S. Hall, AFRL/HEOX, (937) 255-4649)