PROPULSION DIRECTORATE

Monthly Accomplishment Report
November 2002

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PR TEAM MAKES MAJOR ADVANCE IN CAPACITOR TECHNOLOGY: A Propulsion Directorate team recently produced the biggest improvement in electrical and thermal properties of capacitor dielectrics in decades. The Diamond-Like Carbon (DLC) Capacitor Team successfully optimized DLC plasma deposition parameters to produce capacitors with energy density and temperature capabilities three times the current state of the art. These improvements are crucial for airborne applications of directed energy weapons (DEW) because they offer considerable savings in system weight. The team also achieved a new world record by manufacturing a 25 foot length of DLC capacitor film. As a result of this demonstration, the Army and Navy committed funding to develop capacitor films for DEW applications. Furthermore, there is an extensive collaborative effort with the Army and Navy to create an aggressive DLC tech transfer program with the goal of having a commercial product available by 2005. Scaling-up this technology will enable compact pulsed power systems for pulsed high power microwave applications. A paper entitled "Thin Film Diamond-Like Carbon Dielectrics" was presented at the 2002 International Power Modulator Conference and High Voltage Workshop. Both the aerospace and the DEW community identified this as a critical enabling technology. For their outstanding achievements, the DLC Capacitor Team was selected as PR's Team of the Month for October 2002. The team members are Sandra-Fries Carr and Jacob Diemer from the PR's Power Division (AFRL/PRP), Richard Wu and Kosai Hiroyuki from K Systems, and Vic McNier from the University of Dayton Research Institute. (J. Weimer, AFRL/PRPE, (937) 255-6236)

The DLC Capacitor Team (from L to R): Kosai Hiroyuki, Jacob Diemer, Sandra-Fries Carr, Vic McNier, and Richard Wu

GARSCADDEN WINS WILL ALLIS PRIZE: The Propulsion Directorate's Chief Scientist, Dr. Alan Garscadden, was named the 2002 winner of the Will Allis Prize for the Study of Ionized Gases. This prestigious award, established in 1989, is bestowed biennially by the American Physical Society (APS) in recognition of the outstanding contributions of Will Allis to the study of ionized gases for gaseous electronics phenomena. The citation for Dr. Garscadden's award reads:

> "In recognition of his distinguished career in gaseous electronics, marked by a sustained creativity in linking fundamental processes to the macroscopic properties of gas discharges and plasmas, and for his dedicated role as an advocate for the field of gaseous electronics."

In his role as PR Chief Scientist, Dr. Garscadden serves as technical adviser on a wide spectrum of aeronautical research, including many facets of propulsion, aerospace power, hypersonics, laser physics, combustion, and plasma phenomena and applications. He is known for his work in theoretical and experimental basic and applied research in nonequilibrium plasmas and energized gas flows, lasers, laser-based measurements, plasma-processing of thin films, optical and mass spectroscopic measurements, electron impact cross sections and their influence on electron transport, and the derivation of collision cross sections from transport data. He has authored more than 250 publications and presentations and served on many organizing committees for both national and international meetings and symposiums. Dr. Garscadden has served on various technical committees and several professional societies; reviewed more than 100 publications; authored several book chapters and conducted approximately 120 invited lectures and presentations to peer audiences, including plenary talks at international meetings. He has also served as thesis advisor and adjunct professor for several local and national universities. (Col A. Janiszewski, AFRL/PR, (937) 255-2520)


Dr. Alan Garscadden

Want more information?

- The American Physical Society's write-up on the Will Allis Prize can be found here.

NEW MICROTUBE PATENT ISSUED TO PR RESEARCHERS: Drs. Phillip G. Wapner[1] and Wesley P. Hoffman, researchers in the Propulsion Directorate's Propulsion Materials Applications Branch (AFRL/PRSM), were issued US Patent No. 6,458,231 on 1 October 2002. This patent, titled "Method of Making Microtubes with Axially Variable Geometries," describes a technique for manufacturing microtube devices which have peripheral geometries that are not uniform along the microtube or micro-device axis. The preferred process for manufacturing these microtubes involves forming a complex mandrel and giving it one or more metallic and/or nonmetallic coatings by a variety of techniques. The complex mandrel can then be removed by appropriate chemical or physical means leaving a microtube structure with an axial profile duplicating that of the mandrel from which it was formed. This technique overcomes some limitations associated with conventional lithographic techniques that use planar silicon to manufacturing microtubes. For instance, this technique can be used to make microtubes with a circular cross section, which is essential for many applications. Microtubes manufactured by this process have numerous applications, including heat exchangers, bellows, and actuators, and there is particular interest in this technology for the manufacture of microelectromechanical (MEMS), micro-fluidic, and micro-optical systems. (W. Hoffman, AFRL/PRSM, (661) 275-5768)

[1] Dr. Wapner is an on-site contractor with AFRL/PRSM.

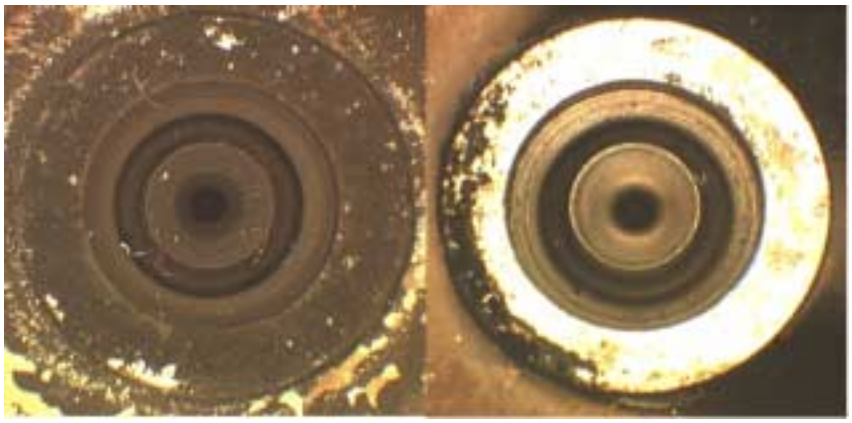
Want more information?

- The full text of this patent is available here.

Dr. Phillip G. Wapner

Dr. Wesley P. Hoffman

PR HOSTS SUCCESSFUL INTERNATIONAL FUELS WORKSHOP: On 4-5 December 2002, the Propulsion Directorate's Fuels Branch (AFRL/PRTG) and the University of Dayton Research Institute co-hosted a Jet Fuel Thermal Stability Workshop at the National Composites Center in Kettering, Ohio. This highly successful workshop was attended by over 50 individuals from Government, the refining and aerospace industries, and academia, including representatives from the UK and France. The goals of the workshop were to: (1) assess the current heat sink capacity of jet fuels (JP-8, JP-5, Jet-A, and Jet A-1), (2) summarize the current understanding of fuel stability chemistry, and (3) plan for anticipated increases in thermal stability requirements in the future. As part of the Versatile Affordable Advanced Turbine Engines (VAATE) Program, the US military services and NASA are planning future R&D projects to improve the thermal stability of jet fuels for military aircraft. These fuels are also expected to make up an increasing share of military ground vehicle fuels. The need for improved thermal stability is being driven by the increasing use of fuel as an aircraft heat sink. It is expected that the current



The juxtaposition of fouled (left) and clean (right) fuel nozzles illustrates the need for thermally stable fuels

trend toward commercial/military fuel interchangeability will continue, so this increase in thermal stability is not expected to come about by increased processing (and resulting cost) of military fuel relative to commercial fuel. It follows that the use of expensive specialty fuels such as JP-7 will be minimized. Rather, it is expected that increased thermal stability in military jet fuels will result from: (1) improved thermal stability additives (e.g., the JP-8+100 additive), possibly injected on-board the aircraft, (2) on-board fuel processing, such as deoxygenation of the fuel, and (3) "coke-tolerant" designs and procedures, such as "coke-resistant" materials/coatings and on-wing cleaning of heat exchangers. This workshop focused on fuel/additive chemistry related to thermal stability, rather than test methods or instrumentation. (T. Edwards, AFRL/PRTG, (937) 255-3524 and P. Pearce, AFRL/PRTG, (937) 255-6918)

YBCO DUAL USE PROGRAM MAKES GREAT STRIDES: The Dual Use Science & Technology Program entitled "High Temperature Superconducting (HTS) Coated Conductors for Power Generation and Magnets" has made remarkable progress in obtaining long lengths of YBCO (Yttrium Barium Copper Oxide) coated conductor in preparation for a Title III manufacturing program. American Superconductor Corp (AMSC) started the program with their technology only proven on static short lengths (within 2 cm). They have rapidly extended the development to a moving reel-to-reel system over several meters. A 29 October 2002 press release by AMSC provided the news that AMSC "… has achieved reproducible results in electrical performance over 10-meter lengths of its second generation, coated conductor composite, high temperature superconductor (HTS) wires that are significantly ahead of the goals set." Mr. Greg Yurek, chief executive officer of AMSC, added:


Coated conductor wire

> "The exciting and important aspect of these goal-breaking results is that the wires are being made using a high volume, low-cost manufacturing method. This means we can expect to scale up this process to make long lengths of second generation, coated conductor wires with excellent electrical performance, and we can expect to achieve this performance in wires with a price-performance ratio below that of copper. On the basis of these and related results we have in hand, we intend to accelerate our second generation product development efforts."

Mr. Yurek also commented that having demonstrated the ability to manufacture multiple 10-meter lengths of second generation wires, AMSC is on a path to achieve price/performance goals that are expected to accelerate the broader market adoption for HTS-based applications. (P. Barnes, AFRL/PRPG, (937) 255-4410)

Want more information?

- A press release from American Superconductor Corp on this topic is available here.

PRESIDENTIAL DETERMINATION SIGNED FOR TITLE III PROGRAM: Mr. Pete Aldridge, the Under Secretary of Defense (AT&L), has given final approval of a Title III manufacturing program for YBCO (Yttrium Barium Copper Oxide) coated conductor. In this program, the Department of Energy (DoE) and the Department of Defense (DoD) are joining forces on a combined manufacturing program for the YBCO coated conductor. The need for YBCO coated conductor is being driven by Air Force directed energy weapons programs and the Navy's electric ship drive programs. The DoE Office of Power Technologies and the DoD Defense Production Act—Title III Office are currently setting aside $12 million in federal funds to combine with $12 million in industrial funding to ensure availability of YBCO coated conductor in long-length sections. The Propulsion Directorate's Dr. Barnes, technical advisor for the program, and Mr. Petonito of the OSD Title III Office in Washington, briefed the Director of Defense Research & Engineering (Dr. Ronald Sega) last month on the importance of the program for defense requirements. Previously, the US President signed the final approval, until Executive Order 12919 delegated this authority. Mr. Aldridge certified that: (1) the industrial resource or critical technology item is essential to national defense, (2) without action under DPA authority, US industry cannot reasonably be expected to provide the capability for the needed critical technology item in a timely manner, (3) DPA instruments represent a cost-effective, expedient, and practical alternative method for meeting the need, and 4) the combination of the US national defense demand and foreseeable non-defense demand for the industrial resource or critical technology items is not less than the output of the domestic industrial capability, including the output to be established through this project. (P. Barnes, AFRL/PRPG, (937) 255-4410)

PLASMA GROUP ATTENDS GASEOUS ELECTRONICS CONFERENCE: The 55th Gaseous Electronics Conference (GEC) was held in Minneapolis, Minnesota, from 15-18 October 2002. About 300 researchers attended the conference, with overseas research organizations representing about one-third of this figure. The number of papers presented was comparable to the number of attendees, with the Propulsion Directorate's Plasma Physics group presenting one oral paper and two poster papers at the conference. The group's research topics mirrored the growth areas of research opportunities, which included low pressure plasma processing of wide band gap semiconductors and microelectromechanical systems (MEMS) devices, and high-nonequilibrium high pressure gas discharges including pulsed dielectric barrier discharges. As an added topic, nonthermal discharges at atmospheric and near-atmospheric pressure are finding many industrial applications for material surface property modifications, from the automotive industry to consumer staples like baby diapers. Proctor & Gamble is funding recent research in this area as one example. Another potential application is biomedical research, including chemical-biological materials processing. At the conference, the American Physical Society (APS) Will Allis Prize winner for 2002, PR's Dr. Alan Garscadden, gave an invited talk summarizing the highlights of nearly 40 years of gas discharge physics research at the Propulsion Directorate (and also the Aerospace Research Laboratory). In the conference business meeting, the executive committee members presented a new conference Constitution and Bylaws for adoption by the members. The members voted to adopt the new constitution, which will now designate this conference as a special conference of the APS Division of Atomic, Molecular, and Optical Physics. In one of the

executive committee meetings, the preliminary program and the invited papers selection were finalized for the 2003 GEC, planned to be held in San Francisco, California, and hosted by NASA Ames Research Center. The committee also accepted the proposal from Queen's University to hold the 2004 GEC in Shannon, Ireland. No bids for the 2005 and 2006 GECs were accepted, but a bid from AFRL to host the 2005 conference in Dayton could be considered favorably. (B. Ganguly, AFRL/PRPE, (937) 255-2923)

Want more information?

- The general homepage for the Gaseous Electronics Conference can be found here.
- The homepage for the 55th Gaseous Electronics Conference can be found here.