UNITED STATES AIR FORCE MATERIALS TECHNOLOGY HIGHLIGHTS

Air Force Research Laboratory

Materials & Manufacturing Directorate

Wright-Patterson Air Force Base • Dayton, Ohio **Spring 2003**

Leaders Kick Off Work Force Initiative Program

By Katherine Gleason, Air Force Research Laboratory Public Affairs

WRIGHT-PATTERSON AIR FORCE BASE, Ohio (AFMCNS) - Advancing technology and boosting the Air Force's supply of scientists and engineers proved job one Feb. 20 as Air Force and academic officials from two leading universities joined forces.

Leaders from Air Force Research Laboratory's Materials and Manufacturing Directorate along with the Air Force Office of Scientific Research hosted a Science and Technology Workforce for the 21st Century Review in the ML Cafetorium. The event promoted current joint government and university programs with the Ohio State University and the University of Akron to provide opportunities for collaboration with world-class technical leaders.

Government and academic leaders attending the event included AFRL Commander Maj. Gen. Paul Nielsen; Dr. Charles Browning, Materials and Manufacturing Director; Dr. Lyle Schwartz, AFOSR Director; Dr. Brad Moore, OSU Vice President of Research; Dr. James Williams, OSU College of Engineering Dean; Dr. Frank Kelley, Akron College of Polymer Science and Engineering Dean (Dr. Kelley was ML Director from 1977 to 1978 and prior to that was Chief Scientist for the directorate); and Dr. George Newkome, Akron Vice President of Research.

"These joint programs will help address AFRL's need for workforce agility and flexibility," said General Nielsen. "We're reaching out to the universities in an effort to acquire expert technical assistance from faculty and students in fast-developing technical areas."

The Ohio State program is entitled, "Accelerated Metals Development by Computation," and focuses on accelerating materials development through improved modeling and simulation methods, and innovative experiments using advanced instrumentation. This partnership looks to take advantage of OSU's international reputation in metallurgical materials and processes, and its status as a corrosion center of excellence.

The University of Akron program, "Collaborative Center in Polymer Photonics," will expand the base of expertise and accelerate research in key photonic technology areas. Akron has an international reputation in polymer science and engineering and is the number two-ranked program in the United States.

"Both of these projects represent tremendous opportunities for AFRL," said General Nielsen. "By collaborating with world-class technology leaders, the teams are contributing to the advancement of technology with benefit to both the government and the universities. In addition, by working with these great universities, we are also helping to address a growing national problem by increasing the supply of scientists and engineers."

Dr. Browning agreed, saying, "These collaborations allow us to augment our staff, facilities and equipment by leveraging the resources of these world-class institutions. The quality and repute of all participants will be elevated to an even higher level."

The event included comments from General Nielsen on the STW-21 initiative, presentations by representatives from OSU and the University of Akron, a ceremonial ribbon cutting, and a technical poster session to facilitate interaction among program participants.

STW-21 was named after a study commissioned by the Secretary of the Air Force to assess personnel management and workforce composition in AFRL. The study recommended several strategic changes to increase AFRL's workforce agility and increase collaboration with non-government partners.

Sarath Menon, of UES Incorporated, explains a poster to Dr. Lyle Schwartz, AFOSR Director, during the poster session.

Researchers Develop System To Enable Force Protection, Active Range Clearance

The All-Purpose Remote Transport System above protects warfighters from hazardous situations, such as explosive ordance disposal.

Engineers at the Air Force Research Laboratory Materials and Manufacturing Directorate have developed a robotic platform that enables the Air Force community to accomplish its most harrowing munitions disposal and range maintenance missions.

AFRL's Airbase Technologies Division Robotics Research Group, part of the Office of the Secretary of Defense (OSD) Joint Robotics Program, developed the All-Purpose Remote Transport System (ARTS) in cooperation with Air Combat Command and the 99th Civil Engineering Group, Nevada Test Ranges. The robotic technology, which is multi-mission capable and unmanned, has established its value during range clearance operations, and demonstrates great potential in force protection, fire fighting, natural disaster clean-up, foul-weather operations, range remediation, and active range clearance.

"The purpose of ARTS is to reduce the risk to warfighters responding to real-world situations and accomplishing critical Air Force mission goals," Walter M. Waltz, the Robotics Group Leader said. "While there are specific tools used for active range clearance and force protection, the 'all-purpose' nature of ARTS allows for interoperability across multiple missions."

ARTS is a modified version of a construction tractor, the Posi-Track MD70. The platform has a diesel engine that delivers power to the 18-inch-wide, Kevlar-reinforced rubber tracks. The tracks have over 3,000 square inches of contact area, resulting in ground contact pressure of approximately two pounds per square inch. In addition, a remotely operated pintle hitch on the platform provides the capability to tow and release a payload.

"This vehicle profile allows for a low center of gravity and light footprint, which makes it rugged, reliable, and the perfect candidate for range operations because it minimizes forces that could detonate sensitive munitions," Waltz said.

Directorate researchers also developed the robotics control package. The package enables remote operation of all tractor functions. The standard configuration includes provisions for four fixed video cameras. A pair of digital radios transmit command signals from the operator control unit (OCU), which resides a safe distance from dangerous operations, to the vehicle. An independent transmitter/receiver pair communicates audio and video from the vehicle to the OCU.

To meet urgent and compelling requirements in Southwest Asia and in Europe, Waltz said the directorate transitioned an ARTS "build to print" technical documentation package to Vertek Inc. for production and support. Vertek engineers built 18 units that were distributed worldwide.

The directorate also distributed the technical transition package to the Air Armament Center's Engineering Manufacturing and Development System Program Office, the office responsible for final configuration and maintenance of the system. Currently, 41 ARTS units are fielded throughout the Air Force and an additional 22 units are scheduled for production.

The Air Force operates several bombing ranges where pilots train by dropping lethal anti-armor/anti-personnel weapons. Periodically, EOD teams must clear debris, such as bomb fragments, from the range. Past methods required the teams to walk the area, manually cleaning the range. Air Force explosive ordnance disposal (EOD) personnel now use the system to perform a variety of range clearance and unexploded ordnance (UXO) tasks such as clearing sub-munitions using a surface clearance blade, and towing a trailer and remotely disconnecting it.

When the United States transferred ownership of the Panama Canal back to the Panamanian government, the Air Force had to clear UXOs from ranges at Howard Air Base, which pilots used during the 1960s and 1970s. Ten-foot-tall jungle grass had over grown the target area, and any surface UXO presented EOD personnel with a tremendous challenge. Clearing such ranges required personnel to burn the foliage, but jungle grass has the tendency to fold over and not burn thoroughly. In order to properly clear Howard AB using this method, personnel would have to saturate the area with a burning agent, and burn the foliage to an acceptable level to where EOD personnel could clear the UXOs.

Because the ARTS comes with a variety of tools, including a brush cutter mower and a two-bottom plow to turn the soil, EOD personnel used it to mow the jungle grass and remove surface UXOs. They then turned the soil to expose any UXOs that were hiding under the

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Tough, Lightweight, Transparent Ceramic ALON™ Material Scaled Up For Military and Commercial Applications

Engineers at the Air Force Research Laboratory Materials and Manufacturing Directorate (ML) have completed an advanced development effort to evaluate forming techniques and optimize fabrication processes for a tough, lightweight, transparent ceramic material that offers outstanding potential for both military systems and commercial products.

Polycrystalline aluminum oxynitride, known commercially as ALON™, addresses a wide range of technological interests throughout the Department of Defense and other federal agencies, as well as private industry.

As part of the advanced development effort, the engineers fabricated a 14-inch by 20-inch ALON™ plate for possible flight-testing on reconnaissance aircraft. They also developed plates for ballistics testing and transparent armor applications. Their efforts demonstrate that ALON™ has excellent mechanical and optical properties and provides a number of advantages when compared to conventional transparent armor, including dramatic life cycle cost savings.

ALON™ was developed through engineering research efforts at ML, and by Raytheon Electronic Systems, Lexington Laboratories, Lexington, Mass., which owns the patent. ALON™ is a polycrystalline ceramic material comprised primarily of aluminum oxynitride (Al_2O_3 with a small amount of nitrogen) and is a very durable optical material with a high degree of transparency from the ultraviolet (UV) through the mid-infrared (IR) wavelengths.

ALON™ has a number of significant advantages over conventional materials currently used to make windows for reconnaissance aircraft, missile domes, protection shields and lenses, and other products supporting the warfighter. There is already a potential market for its use in supermarket scanner windows, which are manufactured in quantities of tens of thousands of units per year. Field-testing is under way for this technology transfer.

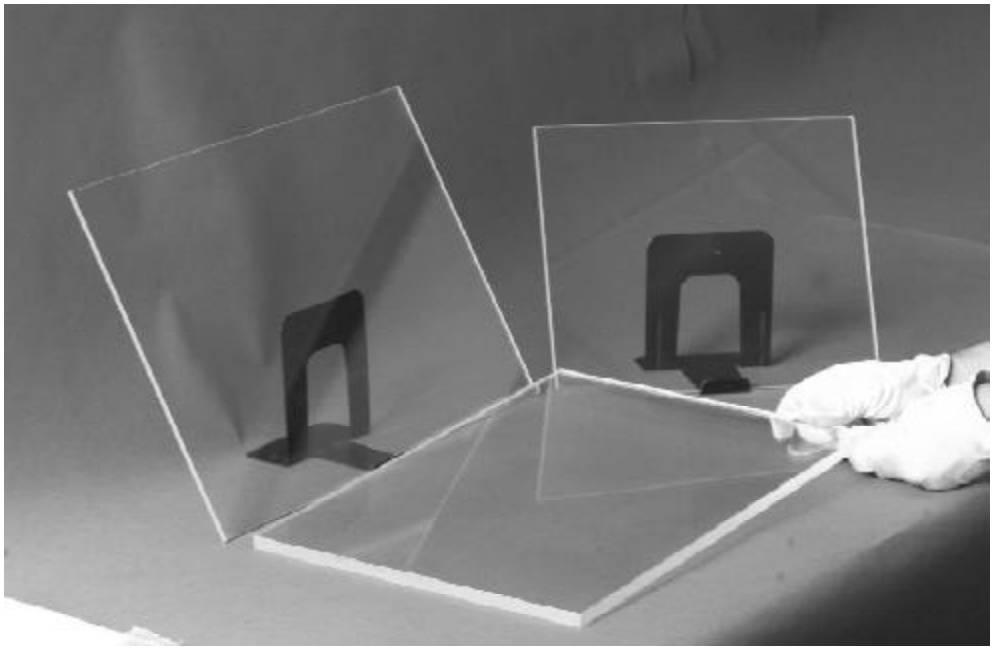
ALON™ is equivalent to sapphire in terms of optical quality, low density, high strength and high durability but it is also an isotropic ceramic, making it scaleable by conventional powder processing methods. ALON™ has demonstrated outstanding ballistic impact resistance, making it an excellent candidate for motor vehicle windows designed to safeguard occupants. Since most threat weapons are automatic or semiautomatic, one critical requirement is the ability to withstand multiple hits. Previous ballistic tests of ALON™ material have demonstrated superior performance in single hit impact testing. Multi-hit ballistic tests conducted since then revealed that ALON™ laminate withstands multiple impacts with no resulting penetration. Subsequently, it is under evaluation for insertion into ground-based transparent armor applications.

The advanced development effort demonstrated conclusively that ALON™ has excellent mechanical and optical properties and that it provides several advantages when compared to conventional glass/polycarbonate transparent armor. The material is also IR transparent, whereas glass, polycarbonate and other conventional materials are not. With regard to applications, tens of thousands of window panels have been identified throughout the Department of Defense as potential applications for this new technology.

Significant weight and life cycle cost savings have been predicted when using ALON™ technology for principal applications such as large IR windows and windows for ground vehicles. As part of the advanced development effort, the engineering team succeeded in producing plates as large as 14-inches by 20-inches using conventional ceramic forming techniques. The production processes themselves are now being scaled to produce even larger pieces and large quantities of ALON™. Looking to the future, ALON™ is a promising material with both military and commercial applications. It has already been inserted into a number of Raytheon applications and is under evaluation for possible use in several other programs.

ALON™ is extremely versatile since it offers performance and scaling not otherwise possible for large, lightweight, IR transparencies. This new technology could play a significant role in the development of affordable, transparent armor, including windows for military reconnaissance aircraft, where trimming life cycle costs could save up to $25 million, while providing greater protection for flight crews. Other primary military applications include forward-looking infrared windows and domes, such as missile domes and towed underwater sensors, riot shields and protective headgear for bomb disposal operations.

For more information, contact the Materials and Manufacturing Directorate's Technology Information Center at techinfo@afrl.af.mil or (937) 255-6469. Refer to item 02-542.



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ground's surface. They cleared the range, meeting the closure treaty requirements, and the Panamanian government accepted the land.

"Based on feedback from users in the field, the directorate is continually developing and integrating new attachments for the ARTS to meet mission requirements where normal, conventional procedures could have been used, but would have put the technician in harm's way," Waltz said.

"The ARTS' largest success has been in the acquisition strategy," Waltz said. Initially developed in late 1995, the directorate transitioned ARTS to support worldwide missions in less than five years. At the beginning of development, no requirement documents, transition plans, or procurement money existed. Through constant input from the field, and compelling mission needs, ARTS has evolved into an adaptable, multi-purpose tool.

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COMPLETED CONTRACTS

- Virtual Nondestructive Evaluation (NDE): Computational - F33615-02-M-5215
- Lightweight Titanium Heat Exchangers - F33615-02-M-5323
- Electrochemical Machining Process For Hard Passive Alloys - F33615-97-C-5275
- Hybrid Semi-Insulating Silicon Carbide Wafers - F33615-02-M-5409

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