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Lawrence Livermore National Laboratory Input to FY2004 Initiatives for Proliferation Prevention Annual Report

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Lawrence Livermore National Laboratory Input to FY2004 IPP Annual Report

Key Performance Measures (requested input)

For FY2004, the work of IPP projects resulted in the following impact on key performance measures.

- Publications in refereed scientific journals and other archival literature:
  - Anatolii A. Sinyanskii, Sergei P. Melnikov, Leonid E. Dovysh, and Gary L. Johnson, “Nuclear-Optical Converters for Nuclear Detection”, *Proceedings of the Fourth American Nuclear Society International Topical Meeting on Nuclear Plant Instrumentation, Controls and Human Machine Interface Technologies*, September 2004. (Sinyanskii, Melnikov and Dovsk are with VNIIEF, Johnson is with LLNL).
  - P. Rutberg, A. Safranov, A. Bratsev, V. Popov, A. Surov, V. Schegolev and M. Caplan, “Plasma Furnace for Treatment of Solid Waste”, *Progress in Plasma Processing of Materials*, Begall House, New York 2001. Contribution not previously reported. (Rutberg et al. are with the Institute of Electrophysics, Caplan is with LLNL).
  - P. Rutberg, A. Bratsev, A. Safranov, V. Popov, A. Surov, B. Laskin, V. Schegolev and M. Caplan, “Installation of Plasmachemical Disinfection of Hazardous Medical Waste”, *Progress in Plasma Processing of Materials*, Begall House, New York 2001. Contribution not previously reported. (Rutberg et al. are with the Institute of Electrophysics,Caplan is with LLNL).

- Presentations at refereed symposia:
  - Anatoly Vikharev and Malcolm Caplan, “Investigations of High Qualtiy Diamond Disk growth in High Pressure MPACVD Reactor”, *15th European Conference on Diamond, Diamond-like Materials and Carbon Nanotubes*, Trentino, Italy, September 2004. (Vikharev is with the Institute of Applied Physics and Caplan is with LLNL)
  - A. Rubenchik, “Management of Collaboration Between Small-Scale Enterprises of Russia and USA”, *International Symposium on Small-scale Enterprise Innovation Programs for Biophysics and Medicine*, Karlovy Vary, Czech Republic, 16-23 May 2004. (Rubnechik is with LLNL)
  - Gary Johnson, “Nuclear Optical Converters”, American Nuclear Society, Columbus OH, September 2004. (Johnson is with LLNL)
  - Valery Laptev, Valery Raevsky and Howard Lowdermilk, “Explosives Detection System”, Gordon Research Conference on Detection of illicit Substances: Explosives and Drugs, June 8-13, 2003. (Raevsky is with Lebedev Physical Institute, Laptev is with Center for Innovative Technologies and Lowdermilk is with LLNL).

- U.S. and foreign counterpart patent applications:
  - Russian patent application filed by researchers at VNIIEF for an optical nuclear detector under IPP project LLNL-T1-051-RU.

- US and foreign counterpart patents issued with claims or notice of claims:
  - Joint Russian LLNL patent # IL-10932 "Materials for Electrodes of Low Temperature Plasma Generators", filed May 23, 2003 with US Trade and Patent officer, Alexandria, VA (resulted from LLNL-T2-0199-RU)

- Prestigious awards and other recognition: None.

- Business created as a result of IPP projects: See Appendix I.

Featured IPP Project for FY04

Project Title: Advanced Welding and Fabrication of Lightweight Alloys

Russian/Ukrainian Institutes: Russian Federal Nuclear Center – Institute of Technical Physics, Snezhinsk, Russia
Mechanical Engineering Research Institute, Moscow, Russia
Institute for Light Alloys, Moscow, Russia
Paton Welding Institute, Kiev, Ukraine
Yuzhnoye Design Bureau, Dniepropetrovsk, Ukraine
Yuzhmash Production Plant, Dniepropetrovsk, Ukraine

U.S. Industrial Partner: The Boeing Company

Background.

In this project The Boeing Company and Lawrence Livermore National Laboratory have teamed with six institutes in Ukraine and Russia to demonstrate and evaluate light alloy manufacturing technologies for application to Boeing products. The technologies are expected to see numerous applications in commercial aircraft as well as launch vehicles. The Russians and Ukrainians are well known for their expertise in metal forming and welding, alloy development and the application of these technologies to lightweight structures, including missiles. The institutes involved in this project, their previous technical background and their contributions to this project are shown in Table 1. During Soviet times, a number of these institutes worked closely together either in the design, development and manufacturing of WMD hardware or the development and implementation of critical enabling technologies, such as welding, material forming and light alloy development.

Table 1
Background and contributions of the institutes

Institute	Previous technical background	Contributions to IPP project
Russian Federal Nuclear Center – Institute of Technical Physics	Nuclear weapons development	Engineering support services
Mechanical Engineering Research Institute	Engineering support, primarily in delivery systems	Testing and characterization
Institute for Light Alloys	Light alloy development	Extruded panels
Paton Welding Institute	Welding	Precision welding technology
Yuzhnoye Design Bureau	Missile design and development	Manufacturing process development for welded structures
Yuzhmash Production Plant	Missile production	Manufacturing of welded structures

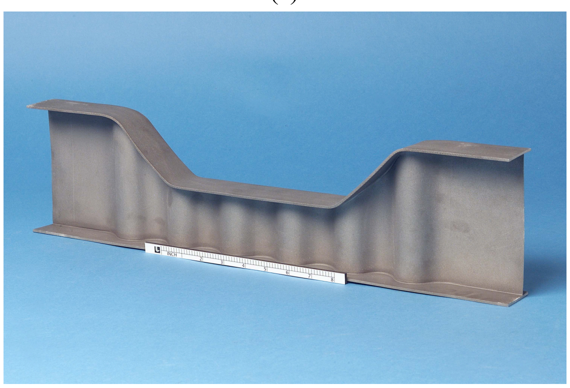
Three important manufacturing technologies were demonstrated and evaluated as a result of the work completed on this project – 1. forming and welding of extruded Al-Li alloy panels, 2. precision electron beam welding of titanium alloys and 3. flash butt welding of aluminum alloys. The extruded panel technology involves a one-step extrusion process for forming panels with reinforcing ribs. This process was developed in the Former Soviet Union and has been used to manufacturer large, thin-walled sections for missiles. The technology potentially simplifies manufacturing and reduces costs, since the reinforcing ribs are introduced during the forming process. Competitive processes for producing reinforced panels require machining ribs into the structure, which can produce enormous amounts of waste, or require adding ribs using welding or riveting. The precision electron beam technology was derived from work at the Paton Welding Institute. This technology images the region to be welded and allows precise control of the electron beam during welding. As a result, complex contoured shapes can be welded with minimum heat input. The flash butt welding technology makes possible the butt welding of thick sections. A high current density is passed across the interface of the sections to be joined, which results in heating of the interface. Subsequent forging across this interface results in a remarkably strong weld.

Current status.

As a result of this project, a number of demonstration components have been manufactured. Figure one shows three demonstration components that were received and evaluated in the USA during the past year. Figure 1(a) and 1(b) show components that were manufactured using the extruded panel technology. The two components in Figure 1(a) are fuselage sections that were derived from the MD-11 aircraft. Each section is approximately 1.2 m by 1.2 m. Figure 1(b) shows a prototype cryogenic tank for a Delta-series launch vehicle. Two tanks were manufactured and each tank is 3m high and has a diameter of approximately 1m. For both the fuselage sections and the cryogenic tanks, the components were manufactured by welding individual reinforced panel sections together. Figure 1(c) shows a sub-scale, prototype floor beam for a commercial aircraft that was made possible by the precision electron beam welding technology. The web of the floor beam was formed into a sine wave shape. Successful manufacturing of the floor beam required precise control of the electron beam for minimal energy deposition at the interface between the web and the flange during welding. As a critical part of the project, LLNL and Boeing evaluated the hardware and manufacturing practices and validated test data obtained by our Russian and Ukrainian colleagues relative to Western standards.

(a)

(b)



(c)

Figure 1. Demonstration hardware manufactured using unique Russian and Ukrainian forming and welding technologies. (a) fuselage sections manufactured from an Al-Li alloy using extrusion technology, (b) cryogenic tank manufactured from an Al-Li alloy using extrusion technology, (c) sine wave floor beam manufactured from a Ti alloy.

<u>Impact on commercialization.</u>

The technologies demonstrated have the potential for commercialization and could result in long-term sustainable employment via two distinctly different business models – 1. component supplier to Boeing or 2. manufacturing process/technology development. The component supply business model is usually implemented as part of a team and the individual responsibilities and work flow used in the IPP project (e.g. material casting, forming, welding and testing) are representative of the teaming operations that would be necessary in component supply. To date, no component supply partnerships with Boeing have resulted from IPP work. However, we are making significant progress toward this goal and success in this area would probably result in a significant number of sustaining jobs. The manufacturing process/technology development model is easier to implement and has produced tangible results. Last year Boeing spent approximately $2 million dollars in Russia and Ukraine for technology development in support of Boeing products. The IPP project has been instrumental in developing the partnerships and demonstrating the technical capabilities of the Russian/Ukrainian institutes that result in this investment by Boeing. This work resulted in the creation of 20 full time jobs.

Appendix I

Business Created as a Result of IPP Projects

IPP project: LLNL-T2-152-RU ("TENS Device") and LLNL-T2-242-RU (Breast Cancer Diagnostic System: Data Analysis and Algorithm Development)

US partner: Cyclotech Medical Industries (152) and BioLuminate (242)

NIS business entity: Biofil

Business area: R&D on biomedical devices, business has resulted from contracts with US businesses

Revenue to NIS from non-US government sources: pre-FY04 = >$350K
FY04 = $120K cash, $35K equipment

Details:

Pre-FY04:

Pearl Technology Holdings, Tampa, FL, BioFil Funding $214K
Burn debridement device, laser surgical device and ultrasound tissue characterization

DermaHealth Systems, Livermore, CA, BioFil Funding $120K
Ice microdermabrasion device and novel RF surgical devices.

ProSpine, La Jolla, California, BioFil Funding $20K
Supported BioFil development of novel thermal device for spinal surgery.

FY04:

BioTelligent, Livermore, CA, $120K for a contract with Biofil. In addition, a prototype system worth $35K was sent to Biofil. Please see letter from BioTelligent.

IPP project: LLNL-T2-199-RU ("Hazardous and Medical Waste Destruction")

US partner: Scientific Utilization Inc.

NIS business entity: Soliton-NTT (spin-off company from Kurchatov)

Business area: Plasma torches

Revenue to NIS from non-US government sources: $460K

Details:

Two 500kW plasma torches and a power supply were sold to the National University of Taiwan (NCKU) in Tainan City by Soliton (working with the Institute of Electrophysics) for a medical waste and incinerator ashdestruction system. The torches were successfully operated in Taiwan, Aug. 2004 by Russian engineers where they passed extensive acceptance tests. The amount of the sale was about $400K. In addition, toprch electrodes were sold to Taiwan for $60K.

IPP project: LLNL-T2-234-RU ("Medical Isotope Program: 018, C13, and Xe129")

US partner: Spektr Gases

NIS business entity: Cryocarbon (spin-off company from the Kurchatov Institute)

Business area: Medical isotopes

Revenue to NIS from non-US government sources: $140K (expected by Dec. 2004)

Details:

FY04

$140K to Kurchatov from Spektr gases as per USIC survey June 2004

FY05 expected revenue

- Total revenue stream for production of both isotopes is $5 million per year, with $2.5 million from sales in Russia
- Full production capacity for ^{18}O and ^{13}C is expected December 2004

IPP project: LLNL-T2-189-RU ("Thin Section Al-Li Superplastic Extrusions") and LLNL-T2-226-RU ("Advanced Welding and Fabrication of Al-Li Alloys")

US partner: The Boeing Company

NIS business entity: miscellaneous institutes including Paton Welding Institute, National Institute of Aviation Technologies, Yuzhmash and Yuzhnoye

Business area: Research and development of manufacturing technologies for lightweight structures

Revenue to NIS from non-US government sources: $2M

Details:

As per USIC survey of June 17, 2004, total revenue to Russian and Ukrainian institutes is $2M.

IPP project: LLNL-T2-216-RU (“Rarefaction Shock Wave Cutter”)

US partner: Halliburton Energy Services Inc. (Jet Research Center (JRC))

NIS business entity: VNIIEF

Business area: shock wave cutter

Revenue to NIS from non-US government sources: revenue unclear

Details: JRC has entered into a commercialization option agreement with VNIIEF for manufacturing of the shock wave cutter in the USA.