Y/AMT-487

Y-12

OAK RIDGE
Y-12
PLANT

LOCKHEED MARTIN

Project Accomplishment Summary
for
Project Number 93-Y12P-003-XX

SMALL BUSINESS INITIATIVE - SURFACE INSPECTION MACHINE INFRARED (SIMIR)

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PROJECT ACCOMPLISHMENT SUMMARY

Title: Small Business Initiative – Surface Inspection Machine Infrared (SIMIR)
DOE TTI Number: 93-Y12P-003-XX
CRADA Number: Y1295-0385
Partner: Surface Optics Corporation

BACKGROUND

The application of Fourier transform infrared spectroscopy (FTIRS) to the analysis of surfaces and gases has long been recognized as a key to the solution of many Department of Energy Defense Programs (DOE-DP) development, certification, and surveillance problems. With the establishment of an FTIRS capability at the Oak Ridge Y-12 Plant, a collaborative relationship with Harrick Scientific, Inc., Ossining, New York was established to development these technologies for DOE-DP purposes. This collaboration led to the development of evacuable cells for surface analysis by diffuse reflectance (IR-100 Award 1984) and remote sensing capabilities for surface inspection (R&D-100 Award 1989), primarily to measure the product of moisture corrosion LiOH on LiH. The diversification of this surface inspection method to areas such as the oxidation of uranium, coal and graphite-resin systems, as well as, stains on metals, woods, papers, and fabrics led to the development of a prototype portable system based on a MIDAC FTIR and a Harrick Barrel Ellipse diffuse reflectance accessory. The first of these systems was built for a NASA contractor for surface cleanliness measurements (1990) and the second was built for the Oak Ridge Y-12 Plant (1992) with the support of Lawrence Livermore National Laboratory (LLNL). This technology was used to demonstrate its applicability to inspecting LiH for LiOH in an assembly dry room at the Oak Ridge Y-12 Plant, field inspection of a military aircraft for heat damage to a graphite-resin component in a military aviation depot, and to inspecting certain weapons parts at Los Alamos National Laboratory (LANL) for corrosion and trace amounts of organic materials such as adhesives, plasticizers, and high explosives.

Collaborations with the Surface Contamination Analysis Technology Team (SCATT), a NASA/MFSC (Marshal Space Flight Center, AL) contractors' group, led to demonstrations that this technology, with certain realistically achievable performance improvements, would significantly improve their ability to certify the cleanliness of the sand-blasted steel inner surface of man-approved solid rocket motor casings prior to bonding the fuel insulator to the casing. The PI of this CRADA prepared for NASA a specification for the acquisition of such an inspection device to meet their requirements and NASA put this specification out for bids. Surface Optics Corporation (SOC, San Diego, CA) was chosen by NASA to build this instrument, and after consultation with the PI of this CRADA and evaluation of the Y-12 prototype committed to build this instrument for NASA early in calendar year 1995 for delivery in that year.

DESCRIPTION

This Cooperative Research and Development Agreement was a one year effort to make the surface inspection machine based on diffuse reflectance infrared spectroscopy (Surface Inspection Machine-Infrared, SIMIR), being developed by Surface Optics Corporation, perform to its highest potential as a practical, portable surface inspection machine. A secondary purpose was to evaluate applications that would serve both the private and the public sector. The design function of the SIMIR is to inspect sandblasted metal surfaces for cleanliness (stains). The system is also capable of evaluating graphite-resin systems for cure and heat damage, and for measuring the effects of moisture exposure on lithium hydride, corrosion on uranium metal, and the constituents of and contamination on wood, paper, and fabrics.

Surface Optics Corporation supplied LMES-Y12 with a prototype SOC-400 that was evaluated by LMES-Y12 and rebuilt by Surface Optics to achieve the desired performance. LMES-Y12 subsequently evaluated the instrument against numerous applications including determining part cleanliness at the Corpus Christi Army Depot, demonstrating the ability to detect plasticizers and other organic contaminants on metals to Pantex and LANL personnel, analyzed sandblasted metal contamination standards supplied by NASA-MSFC, and demonstrated to Lockheed Martin Tactical Aircraft, Marietta, GA, for analyzing the paint applied to the F-22 Fighter. The instrument also demonstrated the analysis of yarn, fabric, and finish on these textiles to the AMTEX CRADA participants at Amoco Development Center, Atlanta, GA, Hoescht-Celanese Research Laboratories, Charlotte, NC, and Cookson, Bristol, VA. The SIMIR was demonstrated at exhibitions including PITTCON'96 in Chicago, IL, the Tri-Services Environmental Conference at Hershey, PA, and HET Instruments, Utrecht, the Netherlands. Papers describing applications and performance of the SIMIR at the AIRSII Advanced Infrared Spectroscopy symposium at Duke University, Durham, NC, the Aerospace Environmental Conference, Huntsville, AL, and the SAMPE conference, Seattle, WA. Over the life of the CRADA, the SIMIR supplied to LMES-Y12 was exercised, evaluated, and refined interactively between Surface Optics, LMES, and the market place.

BENEFITS TO DOE

The SIMIR, marketed as the SOC-400, has filled an important new technology need in the DOE-DP Enhanced Surveillance Program with instruments delivered to or on order by LMES, LANL, LLNL, and Pantex, where extensive collaborations are underway to implement and improve this technology. LMES and LLNL are focused on glove-box applications related to measuring the moisture corrosion of LiH. Pantex is applying their SOC-400 SIMIR to the detection of plasticizers, adhesives, explosives, and other organic residues on the metal exteriors of certain assemblies. LANL has undertaken to develop a variation of the SIMIR for plutonium applications that involve optical feedthroughs into glove boxes and the capability of inspecting the inside surfaces of shells. The SCO-400 supplied to LMES by SOC as part of this CRADA played a vital role in decisions concerning the practicality and applicability of this technology to Enhanced Surveillance since available and demonstrable capability was required. This CRADA SOC-400 SIMIR played a vital role in the AMTEX CRADA for Finish on Yarn by demonstrating unique at-line capability to characterize thread and textiles for the finishes applied to them. This instrument formed the foundation for the establishment of the OIT Forest Products CRADA in collaboration with Sandia National Laboratory by making similar measurements on wood and paper as was done with the textiles.

ECONOMIC IMPACT

The SOC-400 is now a commercial device in the international market place. At least six SOC-400 units were sold in CY 1996 for approximately $50,000 each. The annual market potential should be greater than that in the future, but depends primarily on the ability to tailor the SOC-400 to a particular application such that the customer sees the instrument as a turnkey device.

The SIMIR has potential in characterizing paint, fabrics and fibers, ceramics, metal cleanliness, surface films, corrosion products, and forensics. Coupled with positioning technology developed on Research and Development and Enhanced Surveillance activities, the SIMIR produces spatial images based on pixels deduced from spectrometric data that are the highest quality available. The AMTEX CRADA applications introduced the textile industries to "at-line" analysis capabilities of which they were unaware. At least one major textile manufacturer acquired and SOC-400 SIMIR. Similar applications are there for forest products and paper, as well as the paint and surface finish industries.

PROJECT STATUS

The project is complete.

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PROJECT EXAMPLES

See attached.

TECHNOLOGY COMMERCIALIZATION

This CRADA has been successful at establishing the SOC-400 Surface Inspection Machine-Infrared (SIMIR) as a viable product in the international market place and as an essential tool in DOE-DP Enhanced Surveillance activities. This CRADA also has provided that critical element of having an SOC-400 available to evaluate real capability for immediate decision making in the light of the needs of the DOE-DP Enhanced Surveillance Program (moisture corrosion of LiH and detection of organic chemical residues on metals), the textile industry (identification and characterization of textiles and of finish on textiles), the forest products industry (identification and characterization of wood and paper and of coatings on paper), the aerospace industry (cleanliness determinations, coatings characterization, resin on graphite characterization, paint characterization), and the private sector (rapid chemical identification of powders and oils, forensics) in general. Coupled with positioning devices, the SIMIR defines the state-of-the-art of spectrometric imaging of surfaces with respect to the quality of the spectrometric data that constitutes the pixels. Thus, it has a place in both the research laboratory the ultimate potential of spectrometric imaging as an analytical chemical tool and in the factory inspecting parts.

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