EOC
The Electro-Optics Center
A Manufacturing Center of Excellence

NewsFlash
FEBRUARY 2002
V3:N1

INSIDE:

FIBER OPTIC ARRAY ELECTRICAL SPLICE MANUFACTURING

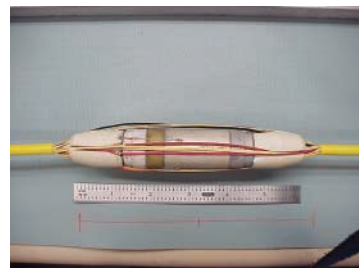
In just three years, the projects conducted by the EOC, and its EOA Partners, are being recognized by the Office of Naval Research, ManTech Program as "ManTech Success Stories". The below listed article is one of four that have approved by the ManTech Office for addition to the ManTech's Success Stories Website. Once the ManTech Office has posted this article, and similar Success Stories on the ADAM, EMM and Saphire Dome Projects, they will be available for viewing at:

https://mantech.pti.com/asp begin.asp?WhereTo=Tech&main=/techtrans/ successes/index.html&submenu=success

On behalf of the EOC, we want to say thank you to our partners for making the EOC a Success Story.

PROBLEM / OBJECTIVE

The current process for integrating the hydrophone to the undersea array cable requires systematically removing a one-inch section of the cable jacket, fishing out the three sets of twisted pair wires, cutting the wires, and soldering a "T" to tap into one pair of wires. The leads from the hydrophone are then soldered to the tap and packaged next to the cable followed by an epoxy potting procedure, which encapsulates the joint. Polyurethane overmold is applied to ensure water tightness and allow flexibility.



ACCOMPLISHMENTS / PAYOFF

This process is labor intensive and increases the risk of water intrusion that could render the entire array useless. In addition, there is risk of damage to the ruggedized optical fiber, which is bundled in with the twisted pairs. A more automated process would not only reduce the touch labor costs but also result in higher array fabrication yields, leading to a substantial reduction in the Unit Production Cost of the system.

Process Improvement:

The goals of this project are to develop a method or methods to streamline and automate the attachment of piezo-electric hydrophones to an undersea cable in such a way that reduces the array fabrication time and provides a reliable watertight assembly. The methods developed here should substantially reduce the unit production cost of the system and improve the yield of the fabrication process and the survivability of the array.

Implementation and Technology Transfer:

This project is designed to develop a low cost manufacturing process for making electrical splices and encapsulating sensors in watertight cables containing optical fibers and electrical conductors.

Expected Benefits:

The primary goal of this project is a 30% reduction in the touch labor cost associated with the attachment of the hydrophone electrical tap to the cable while meeting all performance and quality/ reliability specifications. This will result in a cost avoidance of over $850,000 per year for 5 years.

TIME LINE

Start Date: March 2001
End Date: February 2003

FUNDING

Navy ManTech
$1,847,362.00

PARTICIPANTS

Office of Naval Research
SPARWAR Advanced Deployable System Program Office PMW-183
Raytheon Naval & Maritime Integrated Systems
PSU Applied Research Laboratory (ARL)
Electro-Optics Center

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Message from the Director

This issue of the EOC Newsflash reflects a change that we will be incorporating in our publication. The number of projects underway has approached a level that makes it untenable to address them all in one issue. Therefore, starting with this issue, selected projects will be highlighted. A summary of all projects will be provided in the next issue. The issues after that will continue that pattern. The website (www.electro-optics.org) will contain information on all EOC projects and is available to all EOA members.

As we move this year forward we recognize there are many challenges ahead for our nation, our industry and the EOC.

It is time to start planning for FY03 ManTech projects. I encourage all EOA members to review Navy Stakeholder requirements and the ManTech process to support and develop issues, as appropriate through the ManTech database. It is through this process that determines project-funding allocations are determined. If you are not familiar with the Navy ManTech process, please contact the EOC for the booklet "How can my company work with Navy ManTech" or go online at https://mantech.pti.com.

NAVSEA is hosting "Center of Excellence" days for each of the Navy ManTech Centers of Excellence. Personnel from a variety of NAVSEA offices and programs will be able to interact directly with each of the COE's to stimulate the formation of new issues, discuss new technology and nurture partnerships. The EOC's day at NAVSEA will be at NAVSEA on is March 6, 2002.

We all are well aware of the September 11, 2001 attack on our Country. Several thousand lives were lost, many more families were forever affected, and a new kind of enemy to the US became clearly known. The US response includes new technology to begin what is most certainly to be a sustained campaign against terror. Developing and emerging technologies to support this campaign include electro-optics technology. I anticipate that the EOC will be fully entrenched over the next several years with the development and fielding of new equipment and with facilitating affordable space technology in service to our warfighters against new kinds of enemies..

As we move this year forward we recognize there are many challenges ahead for our nation, our industry and the EOC. We are confident that we will meet each of these challenges and that they will represent opportunities for growth. We look forward to continued cooperation with all Alliance members and interested parties.

Dr. Karl A. Harris,
EOC Director

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EOC

Graduate Work Recognized

Tara Plew, a Penn State Materials Science and Engineering graduate assistant, recently tied for first place in the student paper contest at the International Congress on Applications of Lasers and Electro-Optics (ICALEO) 2001 conference in Jacksonville, Florida that was held October 15th -18th.

Tara is supported by an assistantship through the Applied Research Laboratory's (ARL) Exploratory and Foundational Program at Penn State University. Her research is partially supported by the Office of Naval Research through the Navy MANTECH Electro-Optics Center.

Dr. Keng Leong from ARL's Electro-Optics Center and Dr. Joan Redwing from Penn State's Materials Science and Engineering Department are her co-advisors on this project.

Tara's presentation was entitled "Surface Modification of 6H SiC by Laser Direct-Write." The talk discussed the effects of the laser direct-write process on the microstructure of the 6H SiC surface, including Scanning Transmission Electron Microscopy (STEM) results illustrating a correlation between the porosity and electrical resistance of the laser processed regions.

The EOC and Brashear Hosts Area Students

As part of the Electro-Optic Center's on-going k-12 outreach, students, educators, and guidance counselors from four area high schools participated in the latest student forum held at Brashear LP on 31 January 2001. The EOC, with sponsorship by the Office of Naval Research, has partnered with the StrongLand Chamber of Commerce Education Committee to regularly sponsor these events that afford students the opportunity to visit local companies and learn about career opportunities from those working in the industry.

Brashear LP Chief Operating Officer Dawn Rucker greeted the group. During the visit Lloyd Harkless, Product Line Manager for the Directed Energy Systems, and Jim Arendt, Principal Engineer, provided a company overview along with information on their directed energy and airborne laser programs. In addition, a plant tour was conducted in which participants were able to see Brashear's products in various stages of production. As in the past, feedback from the Student Forum was positive. Future events are being planned.

Murtha Brings Funding

U.S. Rep. John Murtha visited the Electro-Optics Center on January 29, 2002 to announce $64.7 million for EOC-coordinated efforts that were included in the '02 defense appropriation that the Congress passed last fall.

"Electro optics is a rapidly growing industry, and we're positioning ourselves to be an international center in this industry," Murtha said. "As the Electro-Optics Center grows, I think it'll become even more of a magnet to attract more companies and jobs to Western Pennsylvania."

The EOC was created and is funded annually through Murtha's efforts as ranking member of the Defense Appropriations Subcommittee. "The center is leading a national effort to improve technology and reduce the costs of electro-optic manufacturing because our nation's defense depends increasingly on electro-optics components to give our military personnel the superior technical capabilities that provide a major advantage," Murtha said, noting that electro-optics is also experiencing enormous growth in commercial products.

Murtha also toured the EOC facility and newly created labs. Following the tour Murtha noted the progress that has been made in such a short time since his last visit and said he was impressed with the efforts.

FEATURED TECHNICAL ARTICLE: Femtosecond Lasers for Manufacturing

Keng H. Leong

The technology appears to be poised for transition to many industrial applications.

Building on the recent developments in femtosecond laser technology, EOC has initiated a laser micromachining project. EOC is collaborating with Extrude Hone, an EOA member, who will be supplying the laser workstations for the Clark-MXR CPA2010, an integrated 1W femtosecond laser system and Photonics Industries International DS10E-351, a 4W frequency tripled diode pumped solid state Nd:YLF laser. These two integrated industrial laser systems are capable of precision laser machining with insignificant or minimal heat effects to the substrate. The femtosecond laser will have a multi-axis workstation with trepanning capabilities and the diode pumped laser will have a galvo-controlled beam delivery. Initial applications will be on laser drilling of fuel injector nozzles, via hole drilling of infrared focal plane arrays, and drilling of inkjet printer nozzles.

The installation of these ultrafast lasers at the EOC in a proto-typing facility has become possible due to the evolution of this technology to the point where it is now a viable approach to a large number of micromaching and other industrial problems. The evolution of this technology is briefly described below in the following.

The development of ultrafast or femtosecond laser technology and the subsequent research on material interactions have resulted in many new and unique applications in diverse fields[1-4]. It has the unique capability of ablation of virtually any solid without significant heat effects. In addition, it can do multiphoton absorption for microscopy and diagnostics, terahertz generation, waveguide production for telecom components and provide a table top X-ray source.The improvement of ultrafast lasers from initial finicky and alignment sensitive instruments to turnkey tools has made industrial applications much more viable. The technology appears to be poised for transition to many industrial applications.

The initial development of ultrafast or femtosecond lasers in the early 1980s provided new tools for diagnostics and research. These early lasers had limited pulse energies (~nJ). Nevertheless the ultrashort pulses provided several orders of magnitude higher intensities than conventional nanosecond pulses and enabled multiphoton excitation of molecules for improved diagnostics. Ablation of materials was limited by the available pulse energy. Chirped pulse amplification was subsequently applied in the mid-1980s to circumvent the deleterious effect of extremely high intensities on the laser cavity[5]. Low energy femtosecond pulses from an oscillator were stretched to approximately a nanosecond. These long pulses (~nJ) can then be amplified without damage to the optics as the intensities are substantially lower. The

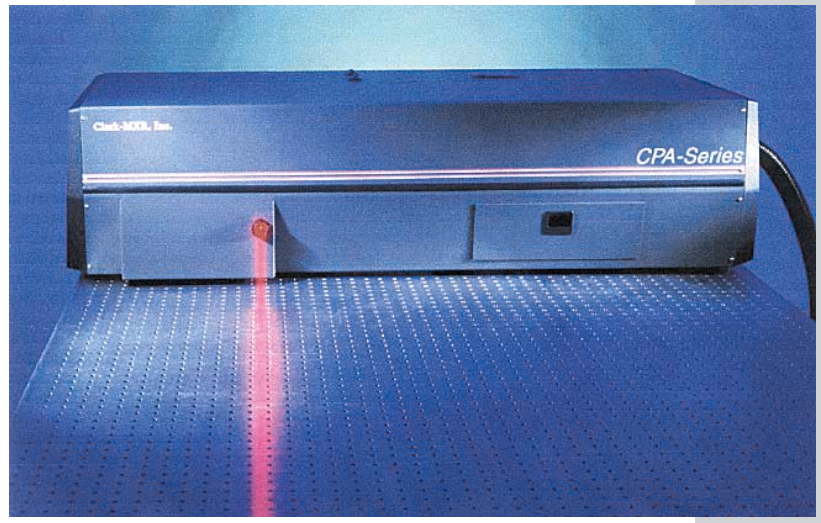
Clark-MXR CPA2010 integrated femtosecond laser
Photonics Industries DS10E-351

amplified long pulses (~mJ) are then recompressed to femtosecond pulses. Consequently, pulse energies of tens of μJ to Joules can be produced[2]. The available pulse energies enable precise laser micromachining of virtually any solid.

Femtosecond laser ablation of materials has initially been carried out in vacuum[6]. Recent efforts have shown that with the appropriate choice of parameters, ablation in ambient air can be achieved with similar results[4]; hence removing another hurdle to the acceptance of the technology. With the proliferation of applications and the uniqueness of ultrafast laser effects on materials, one would expect a rapid transition to industrial applications. However, several factors have hampered the ready acceptance of ultrafast lasers.

There is the common barrier of inertia in current production. New technology often requires capital, effort and time to implement and hence has associated risks. Another factor is that femtosecond lasers have been perceived as expensive, complex and difficult to operate. The first commercially available amplified femtosecond lasers were scientific instruments that consisted of several components (oscillator, pump source and amplifier) that required frequent alignment. They were sensitive to changes in ambient temperature and humidity. In the mid 1990s, integrated amplified femtosecond lasers were introduced by Clark-MXR that were more conducive to unattended long term use as in a production environment. Spectra-Physics followed shortly with their integrated model and more recently, Quantronix and Femtolasers. There are over 100 installations of integrated amplified femtosecond laser systems in the world today, mostly at research and development facilities.

The availability of a turnkey amplified system resulted in the first (published) industrial application as a dielectric mask repair tool used in photolithography replacing the pulsed (ns) Nd:YAG laser[7]. The ultrashort pulses enabled removal of selected chromium layers on the mask



Frequency tripled Nd:YLF laser

without any significant effect on the optical transmission of the dielectric substrate unlike the old technique. This was a niche application where the new tool provided a much improved process and a higher return on investment. It is also worth mentioning that turnkey oscillators have found acceptance in semiconductor manufacturing. Rudolph Technologies (www.rudolphtech.com) uses the Coherent Vitesse femtosecond oscillator as part of their picosecond ultrasonic laser sonar system for opaque film thickness determination. Over 200 installations are in operation in semiconductor plants.

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2002 Industry Events

Navy League Sea-Air-Space Expo
Washington DC, 26-28 March

SPIE Aero Sense
Orlando, FL, 2-4 April 2002

TECH Trends
Baltimore, MD, 3-4 April 2002

CLEO/QELS
Long Beach, CA, 21-23 May 2002

JARI
29-31 May 2002, Johnstown, PA

OSA Optical Fabrication & Testing Workshop, Tucson, AZ, 3-5 June 2002

SPIE Annual Meeting
Seattle, WA, 7-12 July 2002

ARMTech
Kittanning, PA, 31 July - 1 August 2002

EO Alliance Meeting
Kittanning, PA, 1 August 2002

ONR Naval-Industry R&D Conference
Washington DC, August TBA

EOA Meeting Date Changed

The Armstrong County Planning Department has changed the date of the ARMTech Showcase for 2002. ARMTech has been held in October since its inception but this year the Showcase will take place July 31 – August 2. The Showcase will also have a change of venue by moving to the Belmont Sports Complex in West Kittanning.

The Electro Optics Alliance fall board meeting will also be changed to run concurrent with the ARMTech Showcase. The EOA meeting is tentatively scheduled for Thursday, August 1 at the Electro-Optics Center in Kittanning. More information will be sent to members in the next few months and also will be available on our website www.electro-optics.org

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