LIA TODAY

VOLUME: 26 NO: 6 | NOV/DEC 2018

HEALING THE BODY WITH LIGHT: PHOTOBIOMODULATION (PBM)

PG 8

NANO- AND MICRO-SCALE 3D BIOPRINTING: A LIGHT-BASED TECHNOLOGY FOR REGENERATIVE MEDICINE

PG 12

ICALEO 2018: BACK TO BUSINESS

PG 14

Image of the NovoTHOR® Whole Body Light Pod [Image Credit: THOR Photomedicine Ltd]

LIA 50 YEARS 1968–2018

THE WORLD'S LEADING CONFERENCE ON LASER SAFETY

ILSC®

INTERNATIONAL LASER SAFETY CONFERENCE

March 18–21, 2019

Embassy Suites® • Kissimmee, FL USA

REGISTRATION NOW OPEN

WWW.LIA.ORG/ILSC

LIA MEMBER & STUDENT PRICING

SPONSORSHIP OPPORTUNITIES AVAILABLE

FEATURING:

- **Laser Safety Scientific Sessions**
- **Technical Practical Applications Seminar**
- **Medical Practical Applications Seminar**
  Earn contact hours while experiencing cutting-edge presentations

Presented by:

LIA™ 50 YEARS 1968–2018

www.lia.org/ilsc

ilsc@lia.org | +1.407.380.1553 | 1.800.34.LASER

WHAT'S IN THE VAN?

Play Video

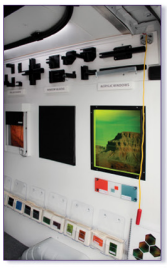
PHOTON 1

LASER SAFETY SOLUTIONS
PROVIDED DIRECTLY TO OUR CUSTOMERS!

PHOTON1 is Kentek's LaserSmart™ Mobile Safety Training and Product Demonstration Platform. We bring our LaserSmart™ products and specialists directly to your door! Come experience and learn in a unique "hands-on" environment consistent with our belief that laser safety knowledge is best demonstrated in person by qualified safety experts working with real products.

- LASER CURTAINS
- LASER WINDOWS
- LASER ENCLOSURES
- LASER ACCESSORIES
- LASER SAFETY EYEWEAR
- LASER INTERLOCK SYSTEMS

components accessories containment signs/labels education eyewear



Schedule a Customer Visit

1.800.432.2323

photon1.kentek.com

LEARN FROM THE BEST IN LASER SAFETY
WORK WITH THE BEST IN LASER SAFETY

KENTEK®
"Laser People Helping Laser People"®

Int'l: 1 603.223.4900 • Fax: 603.435.7441 • info@kenteklaserstore.com • kenteklaserstore.com

Inquire about our laser auditing, laser safety training, and laser consulting services presented by experienced laser experts.

LIA TODAY

THE OFFICIAL NEWSLETTER OF LIA

LIA TODAY is published bimonthly to educate and inform students and professionals of challenges and innovations in the field of photonic materials processing.

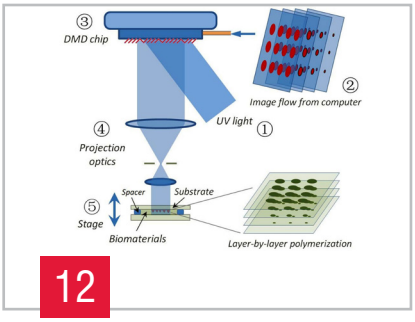
ON THE COVER:

8

Image of the NovoTHOR Full Body Light Pod, used for photobiomodulation treatment of the full body [Image Credit: THOR Laser]

HEALING THE BODY WITH LIGHT: PHOTOBIOMODULATION

Can light make us healthier? In part 3 of our series on lasers in cancer treatment, LIA spoke with James Carroll of THOR Photomedicine Ltd and Annette Quinn of Hillman Cancer Center to learn how Low Level Laser Therapy (LLLT), also known as Photobiomodulation (PBM), is being used in pain management and to improve the quality of life for patients undergoing radiation therapy.



12

DOPsL Printer for Biomimetic Tissues [Image Credit: UC San Diego]

NANO- AND MICRO-SCALE 3D BIOPRINTING: USING A LIGHT-BASED TECHNOLOGY FOR REGENERATIVE MEDICINE

With advances in technology, regenerative medicine is making great strides. ICALEO sub-plenary speaker Dr. Shaochen Chen of UC San Diego spoke with LIA about how a light-based 3D printing technology called dynamic optical projection stereolithography (DOPsL), is improving efforts at recreating the complexities of human liver and heart tissue in the lab, and what this could mean for the pharmaceutical industry.

14

ICALEO 2018 Opening Plenary Speakers

ICALEO 2018: GETTING BACK TO BUSINESS

ICALEO 2018 featured talks from influential players in the laser community. Opening-plenary speakers shared insights and experiences from their careers in the laser industry, business-panel speakers addressed trends in the global laser market, and this year's Schawlow award winner told the story of how a company worth $30 million later became worth billions. Dr. Ron Schaeffer recaps some of the key insights gained from these events in three back-to-back articles.

FOLLOW US!

Visit www.lia.org/subscriptions to sign up for our social media outlets.

IN THIS ISSUE:

20

IN LASER NEWS

25

A CUPPA WITH MILAN BRANDT

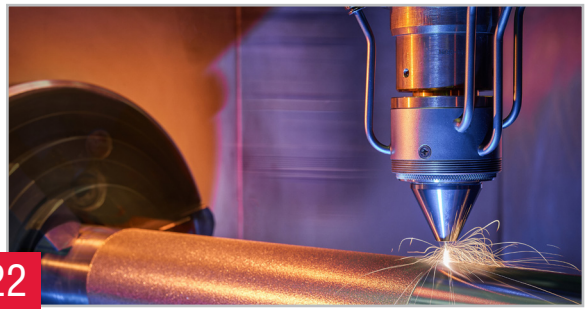
FEATURES

President & Exec. Dir. Messages	6, 7
Healing the Body with Light: Photobiomodulation	8
JLA Editor's Pick	11
Nano- & Micro-Scale Light-Based 3D Bioprinting	12
ICALEO 2018: Back to Business	14
In Laser News	20
Member Innovations	22
A Cuppa with Milan Brandt	25
2018 In Memoriam	26
LIA Calendar of Events	28

ADVERTISERS

Kentek Corporation	3
Board of Laser Safety	11
American Institute of Physics	17
Fraunhofer ILT	18
Photonics Media	21
Pennwell	21
Rockwell Laser Industries	29
TRUMPF, Inc.	31

LIA Corporate Member Innovations



22

THE JOURNEY FROM IDEA TO INNOVATION

THOMAS SCHOPPHOVEN, FRAUNHOFER ILT

24

WE NEED MORE POWER! HIGH POWER UV LASER SYSTEMS DEVELOPED TO MEET INDUSTRY NEED

JOYCE KILMER & NICK RYAN, PHOTONICS INDUSTRIES

President's Message

As I come to the end of my Presidency, I would like to reflect on what 2018 has been for the Association and for me personally. 2018 has been a very special year for LIA. The Executive Committee and Executive Director had to make some tough decisions in the interest of the Association and its long term growth and viability. These have been very difficult as they ultimately involved reducing staff and operating costs. Although the Association is not out of the "woods" yet I am happy to report that we are in a good shape with solid foundation on which we have started to build. Our budget for FY2019 has been completely rebuilt for each business unit and now better allows the Executive Committee and Executive Director to track revenues and expenses and provide alerts when modifications are required. We have developed a new marketing plan. It included launching a new social media and marketing campaign. This will rebuild our digital footprint and increase our social media critical to promotion of the Association's activities in the future. We are looking at our staff requirements and needs to assist with the various growing activities and initiatives. This "turn around" has in large part been due to Nat Quick and the Executive team who have guided us through some of these challenging times and I take this opportunity to thank them for all their efforts.

While we were managing some of these challenges, we were also planning to celebrate 50 years of LIA at ICALEO. We are one of the most experienced associations promoting and supporting lasers and applications globally. At ICALEO, we celebrated this and recognised our member researchers and corporations who have contributed to the huge impact laser technology has made globally to date in so many industry sectors, a trend which will only continue to grow into the future. Also, ICALEO '18 was one of our best conference in terms of attendance and "bottom line" for the last four years, thanks in part to the efforts of the General Chair Christoph Leyens and his co-chairs and organising committees. The Executive Committee and Executive Director are planning some new and exciting programs for ICALEO '19 which should see further growth in these areas.

Finally, it has been an honour and a pleasure to serve as your President for 2018. We have made some important changes this year and started new initiatives which will continue to move LIA in the right direction so we are ready to face 2019 and the future beyond with confidence.

I wish you all a happy, healthy and prosperous 2019 and hope you are all as excited as I am about our future ahead.

M. Brandt

Milan Brandt
President, LIA

2018 LIA OFFICERS

President – Milan Brandt
RMIT University

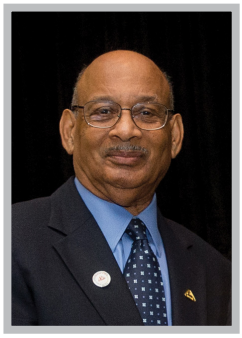
President-Elect – Minlin Zhong
Tsinghua University

Past President – Paul Denney
IPG Photonics

Secretary – Henrikki Pantsar
TRUMPF, Inc.

Treasurer – Gilbert Haas
Haas Laser Technologies, Inc.

Executive Director's Message



As the year comes to a close, I am contemplating our turn around and growth initiatives, challenges, and lessons learned that have had major impact in stabilizing our finances and defining feasible paths for growth. I would like to thank the Executive Committee and the Board of Directors for their support and active participation in addressing, analyzing, developing, and assisting in the execution of action plans. An important achievement has been overcoming obstacles to produce ICALEO 2018 and celebrate 50 years of LIA. This was accomplished economically, and also by introducing new concepts including focused panel discussions and a session focused on an industrial sector, semiconductor and IC technology.

An initiative I would like all to think about is redefining the role of LIA in supporting and developing Additive Manufacturing (AM). AM in general is considered by major companies as the next breakthrough in manufacturing, in particular for metal, alloy, and composite structures where the part is built layer by layer using powder and wire materials consolidated by thermal technologies, such as laser technology, and process controlled by computer technology. New design features are enabled including 1) combining the processing of several parts into the processing of a single part, 2) grading chemical composition in a part during processing, and 3) grading mechanical and other properties in a part during processing. Accelerating the acceptance of this technology into manufacturing requires coordination among 1) researchers 2) applications development engineers, 3) design engineers, and 4) manufacturing engineers. End users (manufacturers) must be involved during this process to quickly identify obstacles that require solutions.

A salient lesson learned from the introduction of panel discussions and sponsor presentations at ICALEO 2018 is that ICALEO can be the tool to achieve this coordination. LIA initiated the forum on laser additive manufacturing (LAM). A key component at this stage of LAM development, required for successful expansive introduction into manufacturing, is the identification and inclusion of end users (manufacturers) that are open to providing information on technology obstacles and direction on novel LAM applications, in an open forum. I welcome input from all on initiatives to build this alliance.

I wish all current and future members of the LIA community Happy Holidays and a prosperous 2019.

Nat Quick, Executive Director
Laser Institute of America

Healing the Body with Light:
Photobiomodulation (PBM)

Part 1: LITT
Part 2: PDT
Part 3: PBM

WRITTEN BY ANDREW ALBRITTON
CONTRIBUTIONS BY JAMES CARROLL AND ANNETTE QUINN

[Image Credit: Thor Photomedicine Ltd]

In part 3 of our series on lasers in cancer treatment, LIA spoke with James Carroll of THOR Photomedicine Ltd and Annette Quinn of Hillman Cancer Center to learn how Low Level Laser Therapy (LLLT), also referred to as Photobiomodulation (PBM), is being used in pain management and to improve the quality of life for patients undergoing radiation therapy.

Picture a busy hospital. On one side of the hospital, a patient complains of chronic pain with no known cause and has returned for the third time this month seeking a resolution. This patient is one of the 100 million adults in the United States that are affected by chronic pain. Many doctors might prescribe opioids to a patient like this. With this solution, this patient may need to be prescribed more opioids over time as their body builds up a tolerance. It is a problematic form of pain management, as it puts this patient at risk of developing a physical dependency to the detriment of their health. In 2017, nearly 49,000 deaths were attributed to opioid related causes, and in 2016, around 19,000 deaths occurred from prescribed opioids. But, perhaps, at this hospital, a different treatment is proposed. Instead of opioids, a near infrared (IR) light is shined on the places where the patient experiences pain and inflammation, and after several treatments over a few weeks, the patient reports reduced pain.

Now, picture on the other side of the hospital a cancer patient receiving radiation therapy on the head and neck. Patients who need high dose chemotherapy or radiation therapy of the head and neck are at a high risk of developing a condition called oral mucositis (OM). OM is an oral inflammation that leads to ulceration, infection, and pain of the lining of the mouth and esophagus. This oral pain prevents patients from being able to swallow foods and often results in malnutrition and reliance on a feeding tube. This is a serious condition that reduces a patient's ability to recover from their treatment. In fact, there are 500,000 cases of OM every year in the United States. Now, with this imaginary hospital being on the cutting edge of technology, this patient never suffers the severe symptoms of OM because shining near IR laser light on the inside of their mouth was added to their treatment plan. This Low Level Laser Therapy (LLLT) is also known as Photobiomodulation (PBM), and it's taking modern medicine into the future.

PBM – A BRIEF INTRODUCTION

In 1967, while testing a hypothesis that exposure to a new invention called the 'laser ray' may cause cancer, Endre Mester found results that pointed to the opposite conclusion. By shaving the backs of two groups of rats and exposing one group to the low intensity laser light, Mester found that the hair on the exposed group grew back faster than the control group. This discovery is the foundation on which PBM Therapy was built. After thousands of laboratory experiments and hundreds of clinical trials, PBM Therapy has been shown to significantly increase the speed, quality and tensile strength of tissue repair; resolve inflammation and relieve pain. Today, researchers and supporters of LLLT/ PBM Therapy believe that the treatment method is up to the challenge of easing a patient's pain, improving the rate that they heal, and reducing the financial impact of some of the world's most serious illnesses.

Annette Quinn, the Program Manager of Radiation Oncology at the University of Pittsburgh Hillman Cancer Center, describes the PBM treatment for OM as a fairly simple procedure where "Patients relax

comfortably in a chair and wear specialized glasses. The laser does not get hot or cause any discomfort at all. It is aimed at each cheek, the tongue and the soft palate for one minute each. Treatment from start to finish only takes about 5-7minutes." According to THOR Photomedicine Ltd, one of the world's leading authorities on LLLT/ PBM, treatment devices often use red and near infrared light in the 600 nm to 1000 nm range emitted by laser or high-intensity LEDs that do not create any heat or discomfort to the patient. The process works similar to photosynthesis in plants, reducing oxidative stress and promoting ATP, resulting in decreased inflammation and cellular metabolism. In other words, decrease pain and increase healing efficiency.

James Carroll, founder and CEO of THOR Photomedicine Ltd., is quick to point out the numerous studies and the positive results of those studies with regard to PBM, "Evidence from 500 human clinical trials have shown that light, when applied to the body at the right wavelength, intensity and time, reverses the disease process of a growing number of medical conditions." There are some who attempt to discredit the effectiveness of PBM quoting research study results at given intensities not showing in any significant improvements. Through the multitudes of trials, researchers have identified specific intensity ranges that must be used to induce the desired results. Carroll gives a general overview of the Goldilocks effect of PBM; "Not enough light and there is no response, a bit more and we get the tissue regenerative and anti-inflammatory effects, too much light and those benefits go away, but a high dose treatment can induce an analgesic effect. Higher intensity/ higher dose PBM treatments suppress the speed and amplitude of pain signals, though they may be less effective at healing." Another factor to consider is penetration to the affected area may require a certain wavelength. James Carroll continues, "Near infrared in the 800 - 900 nm range will penetrate better than visible red 600 - 700 or [IR] 900 - 1000 nm". Luckily, there does not appear to be a need to adjust wavelength to treat various diseases, as most red and near Infrared wavelengths seem to initiate the desired response.

SO, HOW EXACTLY DOES PBM THERAPY WORK?

Nitric Oxide (NO) competes with Oxygen (O) and pushes it out of its place in the electron transport chain, which means there is less ATP (cell energy). "There are four different sources of Nitric Oxide (NO)," says Carroll. "We are interested in the NO that is made in mitochondria under stress. It binds to the terminal enzyme (cytochrome c oxidase) of the electron transport chain (ETC) and blocks consumption of oxygen. The ETC becomes dysfunctional, stops making cellular energy (ATP) and starts making lots of Reactive Oxygen Species (ROS) that trigger the processes of inflammation, cell death and initiates the diseases associated with ageing (cancer, Alzheimer's, osteoarthritis, etc). Light at the right wavelength and intensity can displace NO from cytochrome c oxidase, oxygen consumption is restored so disease and injuries heal more quickly." In other words, when a cell is put under stress, like during cancer treatments, there is a buildup of NO that prevents the cell from getting enough Oxygen, eventually leading to cell death. PBM Therapy helps to counteract the NO buildup, allowing the cells to access enough Oxygen to remain healthy and work properly.

For Annette Quinn the results experienced by her OM patients after PBM treatments are undeniable; she has produced many publications and given many presentations on the subject. Quinn believes that using PBM to decrease OM in oncology patients is critical to successful treatment. "Patients that are able to avoid significant OM and maintain adequate nutrition, avoid feeding tubes, avoid narcotic pain medication and most importantly these patients will not experience treatment delays due to OM which leads to better survival outcomes." Through these treatments, patients see a significant reduction in OM symptoms and are less likely to require a feeding tube or take a break from their cancer treatments. After PBM therapy became a common practice at the University of Pittsburgh Hillman Cancer Center, Quinn noticed a large increase in patient satisfaction with care. James Carroll adds, "Furthermore, a long term study on cancer patients shows that patients treated with PBM for their oral mucositis have better chance of survival than those who do not have PBM. Another study has shown that PBM reduces the costs of hospitalization by 30% in oral mucositis patients."

The most amazing aspect of PBM Therapy is that it is not decades away from changing lives; it is currently being put to use all over the world. In fact, the National Institute of Health and Care Excellence in the UK currently recommends PBM for preventing or treating OM caused by radiotherapy or chemotherapy, Blue Cross Blue Shield declares PBM "medically necessary for prevention of oral mucositis in select patients", and the Multinational Association for Supportive Care in Cancer now recommends low-level laser for the prevention of OM.

Far from being a "one-trick pony", PBM Therapy seems to have a multitude of applications. In fact, while preparing for this article we received a message through social media from George Yacoub, a recent graduate of Misr University for Science and Technology in Egypt, who completed a Fellowship in Laser Dentistry with Genoa University in Italy. He shared with us how PBM Therapy helped a patient with severe facial paralysis. Yacoub explains, "The 59-year-old uncontrolled diabetic patient suffered from Malignant Otitis which caused an inflammation of the 7th cranial nerve and severe facial paralysis. This was the second time the patient had suffered from Facial Palsy in the same side. The patient had been subjected to physical therapy and B12 medication to treat the facial paralysis for several months; but there was no improvement. Low Level Laser Therapy (LLLT) was suggested with the continuation of the physical therapy and B12. In only 9 sessions, the facial paralysis' state improved from severe to moderate." As impressive as helping to improve the patient's facial paralysis was, Yacoub continues, "[it was] not until the 9th session, when the patient's otolaryngologist discovered that the patient had been treated with the wrong antibiotic, not targeting the bacteria that was causing his ear infection. After a one year of follow-up, the patient is still maintaining the improvement results of his facial paralysis." Through this experience, Yacoub is a supporter of PBM Therapy and believes that this proves that LLLT/ PBM not only improves the symptoms of severe long-duration chronic facial paralysis caused by infection, it also can work as a barrier or a prophylactic to prevent the infection from spreading, causing more damage.

Continued on next page

There are still many other success stories to be had for PBM Therapy. As described by James Carroll, "Major Depressive Disorder (MDD) is the third leading cause of disability in the world. PBM is known to boost cerebral metabolism, promote neuroplasticity, and modulate endogenous opioids, while decreasing inflammation and oxidative stress. A small trial at Harvard demonstrated that PBM has antidepressant properties with a medium to large effect size in patients with MDD. Traumatic Brain Injury patients are showing signs of reduced PTSD, less emotional outbursts, fewer cognitive, behavioral and emotional difficulties. PBM to bone marrow in the patients with an Acute Myocardial Infarction study releases stem cells (MSCs) that are reducing the markers indicating damage to the heart (Troponin- T and Creatine Kinase). Dry Age related Macular Degeneration (AMD) is the leading cause of blindness in the developed world. A clinical trial in Canada has shown that PBM improves visual acuity and contrast sensitivity in dry AMD patients." Amazingly, PBM Therapy is not only being used to heal sick patients, but to also assist athletes at peak physical condition to train harder and longer. The NovoTHOR® whole body light pod by THOR Photomedicine Ltd has been utilized by world-class athletes and wellness centers to improve recovery time after intense physical activity.

WHAT'S NEXT FOR LLLT/ PBM?

So with all of these amazing trials and real world results, what is keeping PBM Therapy from being a standard practice, if not a requirement, in treatment for the multitude of conditions it improves? According to Annette Quinn and James Carroll, the biggest factor is insurance reimbursement. To some people in the insurance field PBM Therapy is seen as a luxury or an elective procedure. A study in 2009 determined that Medicare reimbursed over $40,000 per patient with ulcerative mucositis lesions. Couple that with the $600 Billion per year impact from healthcare costs and lost productivity as a result of pain, and it is clear that we need a more effective way to prevent and heal pain. While PBM Therapy has been shown to speed recovery and reduce complications, thus reducing costs, it has yet to be widely adopted by the industry. It is believed that with additional randomized studies in the United States that we may see more healthcare facilities and insurance carriers supporting PBM Therapy. Carroll confirms this thought "The first steps in PBM acceptance are high quality, multicenter clinical trials published in the high impact factor journals. That should lead to inclusion in clinical guidelines, insurance reimbursement, along with public & political awareness." Quinn believes PBM Therapy "should be standard of care for oral mucositis and you will continue to see so many more benefits of this wavelength of light therapy in the medical field."

These professionals are doing their best to fight for the speedy adoption of PBM Therapy. On October 11th 2018, James Carroll and Annette Quinn along with Praveen Arany, Assistant Professor at the University at Buffalo School of Dental Medicine, delivered a Congressional Briefing in Washington DC, hosted by the House Science, Space, and Technology Committee. During this briefing, they explained how and why PBM therapy works, presented evidence on the effectiveness for treating pain as an alternative to opioids, and spoke from first-hand experience in treating over 854 patients with OM. The trio expressed the following as the needs for the successful adoption of PBM Therapy; "Research grants to fund further basic science experiments, therapeutic dose, and large multicenter clinical trials. The FDA to create a PBM specific product code. Public and private health insurance reimbursement." It is the hope of James Carroll that "This should help the FDA, medical insurance, NIH, other influencers and gatekeepers to understand PBM and support further research funding."

REFERENCES

THOR CEO leads official US Congressional Briefing on Photobiomodulation (PBM). (n.d.). Retrieved from blog.thorlaser.com: https://blog.thorlaser.com/thor-ceo-leads-official-us-congressional-briefing-on-photobiomodulation-pbm/

THOR Photomedicine: The Making of an Icon. (n.d.). Retrieved from www.globalfounders.london: https://www.globalfounders.london/blog/thor-photomedicine-the-making-of-an-icon

U.S. Congressional Briefing "Ending Opioid Use" Highlights | Washington DC. (n.d.). Retrieved from vimeo.com: https://vimeo.com/298476546/29afcf20d4

What is LLLT / Photobiomodulation Therapy? (n.d.). Retrieved from www.thorlaser.com: https://www.thorlaser.com/LLLT/

About ANNETTE QUINN, RN, MSN

Annette Quinn RN MSN is the Program Manager of Radiation Oncology at the University of Pittsburgh Hillman Cancer Center. She has many publications and has given many lectures in the field of oral mucositis. She received her undergraduate degree in Nursing from Pennsylvania State University and a Master's Degree in Nursing Education from Duquesne University.

About JAMES CARROLL

Founder and CEO at THOR Photomedicine Ltd. James Carroll has been working on Photobiomodulation for 30 years (since 1987). He is a recognized authority on Photobiomodulation dose, dose rate effects and the measurement and reporting of parameters. He has written or co-authored 18 published academic papers and three books on Laser Photobiomodulation. His most recent appointments include: Biomedical Optics Society conference chair, Fellow of The Royal Society of Medicine, and Editorial Board of Photomedicine and Laser Surgery. He also served on the World Association for Laser Therapy and the North American Association for Laser Therapy. James recently presented a Congressional Briefing on PBM 11th October 2018 and presented at the United Nations Global Health Impact Forum 2014.

JLA Journal of Laser Applications

PRODUCTION OF OSSEOINTEGRATING (BONE BONDING) SURFACES ON TITANIUM SCREWS BY LASER MELT DISRUPTION EDITORS-PICK

G.-L. ROTH, C. ESEN, AND R. HELLMANN

Several techniques can be used to modify implant surfaces in order to accelerate bone growth around titanium implants. One method is to generate a surface structure which stimulates bone growth and remodeling. This paper describes and explains a nonablative method for producing osseointegrating (structural and functional bone bonding) surfaces on titanium implants using laser processing. The focus is especially on surface texturing of dental implant screws, where the ability of a Nd:YAG laser to generate "splashy" surfaces covered in resolidified microscale droplets coated with nanoscale surface oxides is assessed. The surfaces produced were analyzed by a scanning electron microscope and energy dispersive x-ray spectroscopy. It is concluded that laser processing using Q-pulsed Nd:YAG lasers can generate surfaces which match the demands set by clinical experience. One important characteristic of the surfaces discussed here is that they involve overhanging features which are suitable for trapping red blood cells and which cannot be created by mechanical or chemical roughening techniques.

Journal of Laser Applications 30, 042009 (2018)
https://doi.org/10.2351/1.5078502

Visit JLA Online: https://lia.scitation.org/journal/jla

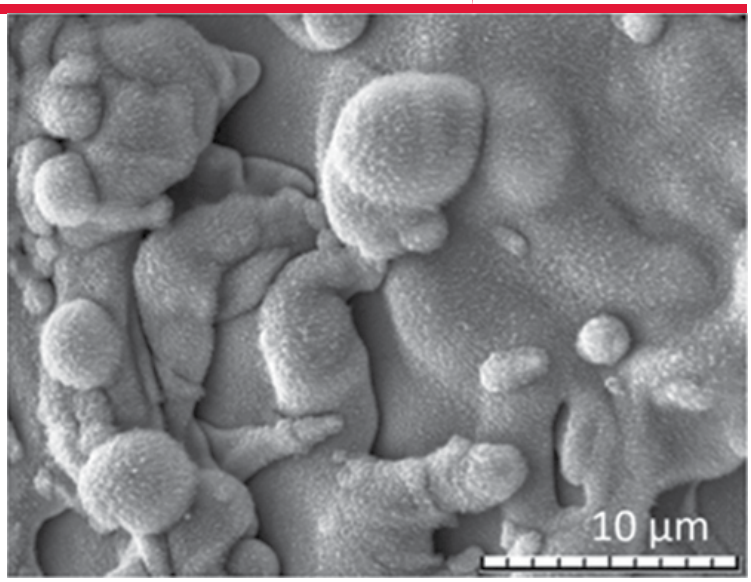


FIG. 1. "Splashy" laser melted surface covered in droplets in the diameter range 1–5 µm, coated with a nanoscale spongeous oxide layer.

Subscription Information

LIA MEMBERS	LIA members can view the digital JLA for FREE! Become an LIA Member: www.lia.org/membership
BY PHONE	For non-members of LIA, call the American Institute of Physics at 1.800.344.6902 for subscription information.
ONLINE	Sign up at **jla.aip.org/alerting_services/table_of_contents_alerts** to receive your *JLA* table of contents email alerts.

NANO- AND MICRO-SCALE 3D BIOPRINTING:
USING A LIGHT-BASED TECHNOLOGY FOR REGENERATIVE MEDICINE

By Liliana Caldero

As Dr. Chen begins his presentation in the standing room only session, eager attendees of ICALEO 2018 sit forward in their seats, taking notes as he explains how light is innovating our ability to print on the nano- and micro-scale. From 3D printed robotic microfish to 3D printed liver-like gel-nanoparticles, Dr. Shaochen Chen has been involved in headline-making research projects for many years. As a professor and vice chair of the Department of NanoEngineering and affiliated professor of the Department of Bioengineering at the University of California, San Diego, Chen leads a team of researchers in developing nano- and micro-scale 3D bioprinting techniques. When he looks out at the faces of the audience, he's reminded of himself early in his career. While working as a faculty member at the University of Texas at Austin in 2001, he took an interest in 3D printing applications. Specifically, he wondered how the highly customizable nature of 3D printing could be utilized to its greatest potential. He concluded that there is nothing quite as custom-made as a human, and so followed his expedition into nano/micro-manufacturing for regenerative medicine. Catching up with him after his presentation, I sat down with him to learn about part of his unique line of work - using light to print functional tissues.

So, What is 3D Bioprinting?

3D bioprinting refers to the use of three-dimensional printing methods that produce 3D tissues that are biomimetic, meaning they closely mimic the physiology and function of real organs. In essence, a scientist can print living tissue that looks just like a human liver or heart when placed under a microscope. Such tissues are printed using bio-inks derived from hydrogels, cells and growth factors, often utilizing adult human induced Pluripotent Stem Cells (iPSC). Thanks to the Nobel winning research of Shinya Yamanaka and Sir John Gurdon, skin cells can be taken from an adult human and 'reprogrammed' into iPSCs, which can then be used to make other types of cells that are harder to come by, such as liver cells or heart cells.

In order to mimic the complex structures of human tissue, working on the nano- and micro-scales is required; according to Chen, light-based printing methods have opened the door to faster printing of more complex biomimetic tissues, leading us closer to one day printing human organs for transplant using an individual's own skin cells. The key to this increased speed and nano-scale print resolution is light.

There are several types of 3D bioprinting methods that are used in tissue engineering. Extrusion-based bioprinting dispenses bio-ink through a nozzle in a continuous line onto a substrate, building layer-upon-layer as many traditional 3D printing methods also do. Inkjet-based bioprinting deposits bio-ink in picoliter droplets. Both of these methods have their uses; however, they are limited. These methods are considered slow and the print resolution relies on the diameter of the nozzle as well as the type of bio-ink being used. Although a topic of some debate, there are some who believe that these methods can also put the biomaterial at risk, because squeezing the bioink out of the tiny nozzle might break the membrane of the cells.

Light-assisted bioprinting improves upon these issues. Digital light processing, or DLP bioprinting utilizes light to polymerize a pre-polymer solution of cells and light-sensitive hydrogel. A specific type of DLP pioneered by Chen and his team is dynamic optical projection stereolithography, or DOPsL. In DOPsL, ultraviolet or visible light is directed at a digital micro-mirror device (DMD) chip consisting of around 4-million micro-mirrors; each micro-mirror can be switched on or off during printing to project detailed micro-scale patterns onto the reservoir filled with the pre-polymer solution. Within just a few seconds, the entire volume of a structure is polymerized and is ready to be placed in an incubator. Chen says this method is important for a few reasons.

First, the cell-viability is improved, since this method doesn't squeeze the cells. You may be wondering if there is a possibility of UV damage, but using far-UV light at 365 nm mitigates this. Chen adds, "We've also developed this visible light-based process, so we eliminate any UV damage, as long as the light intensity is not so high that it will thermally damage the [material]." Second, this technique offers speed that is unparalleled by extrusion and inkjet methods, and speed is important, as cells don't live very long without

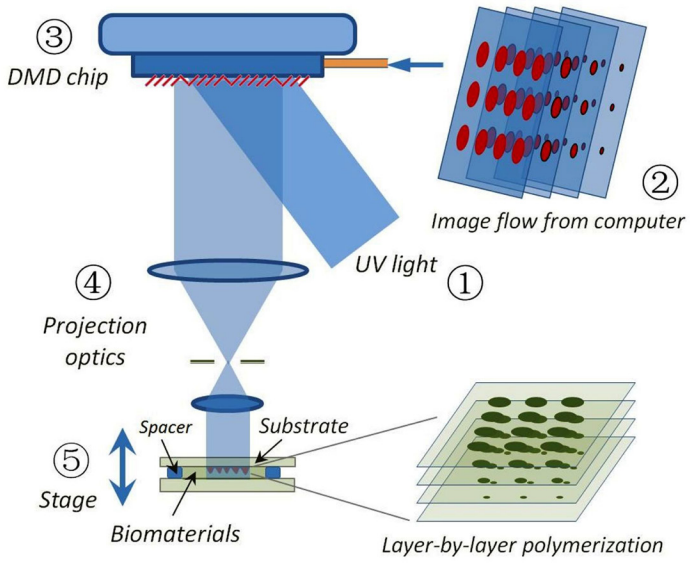


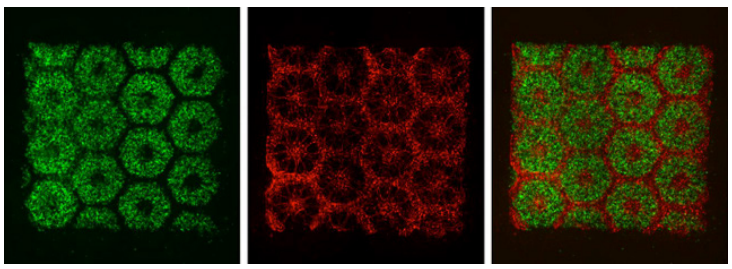
Illustration of a dynamic optical projection stereolithography printer (DOPsL) [Credit: Chen Laboratory, UC San Diego]

media support and the quality of the printed biomaterial declines over time. X. Ma, et al., cite that extrusion-based bioprinting ranges from 10 – 50 µm per second, with inkjet in the hundreds of mm per second, and DLP methods, on a volumetric scale, producing a few cubic mm per second [source]. Third, the resolution of DLP methods is ideal for micro- and nano-scale tissue engineering.

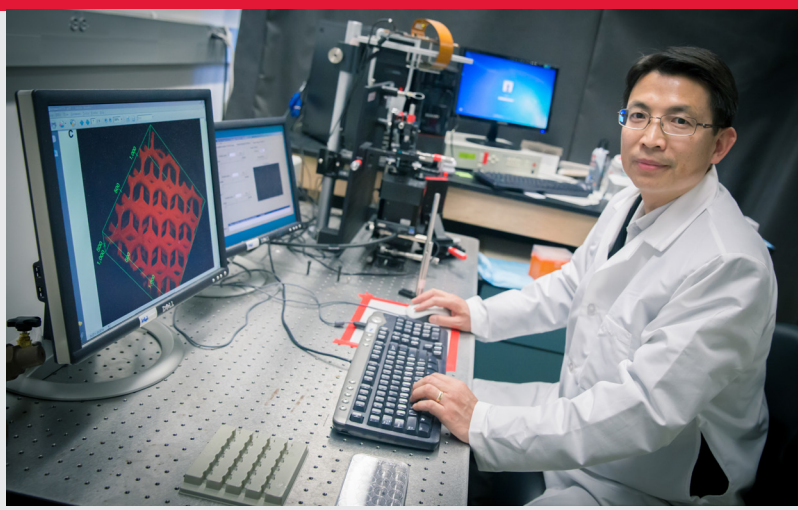
What's Next?

The goal is to one day be able to print entire organs for implantation using an individual's own cells; after all, people are living longer and with that will come quality of life concerns as their bodies age. Chen says that we are a long way away from printing an entire liver or heart; the structures are complex beyond our capabilities at this point. Still, the detail and speed provided by light-assisted bioprinting have opened the door to that future. According to Chen, there are more immediate uses for the technology. With further development, 3D bioprinted livers might help revolutionize the drug-screening process in the pharmaceutical industry.

"It typically takes about 12 years and $1.8 billion to produce one FDA-approved drug," says Chen. "That's because over 90 percent of drugs don't pass animal tests or human clinical trials." In the future, pharmaceutical companies may be able to test a drug's safety or efficacy by using 3D bioprinted livers, significantly cutting the time and cost of the drug-screening process. The way that a real liver metabolizes drugs and produces specific proteins helps determine whether a drug is safe. Still, current liver-models do not have the complex micro-architecture and diverse cell makeup of a real liver, so they will need to be further developed before being used to mimic how a real liver would metabolize a specific drug. Chen's lab has come very close, printing a 200-micrometer thick, 3 mm by 3 mm square of tissue that closely resembles real liver tissue under a microscope. With their light-based printing method, they print in seconds what other methods typically take hours to produce. Their model could potentially reproduce the complex relationship between circulation and metabolic functions of the liver in health and disease. Chen's team printed the tissue in two steps: first, a honeycomb pattern of 900-micrometer sized hexagons containing liver cells derived from human-induced pluripotent stem cells was printed; then a pattern of supportive endothelial and mesenchymal cells were printed in the negative space around and in the hexagons.



Images of the 3-D-printed parts of the biomimetic liver tissue include: liver cells derived from human induced pluripotent stem cells (left), endothelial and mesenchymal supporing cells (center), and the resulting organized combination of multiple cell types (right).[Credit: Chen Laboratory, UC San Diego]



Dr. Shaochen Chen in his lab at UC San Diego with a DOPsL printer [Credit: Chen Laboratory, UC San Diego]

By using biomimetic livers, Chen says pharmaceutical companies could identify which compounds are most promising; reducing the amount of compounds that need to go to animal tests and human clinical trials and essentially reducing the amount of time and resources needed to take a promising drug from research to market to the patient that would benefit from it.

An offshoot of Chen's Lab in California, Allegro 3D, is helping to encourage access to this technology by offering products such as DLP-based bioprinters, bioinks, and 3D printed microwells and vascular graft conduits. Chen's hope is that this kind of research will receive the funding it needs to transform healthcare as we know it. He says he's fortunate; he began with laser processing of non-biological materials and step-by-step moved into bioprinting, and was able to continue his research. The National Institute of Health (NIH) is also getting on board and giving more funding to this kind of research. "From our research point of view, we need more support, not just from the NIH, but also from the Department of Defense. I think other agencies should also provide more funding for this area because regenerative medicine is really important for this generation and the future."

Further Reading:

X. Ma, et al., 3D bioprinting of functional tissue models for personalized drug screening and in vitro disease modeling, Adv. Drug Deliv. Rev. (in press), https://doi.org/10.1016/j.addr.2018.06.011

Technology Prints 3D Blood Vessels in Mere Seconds: https://in.news.yahoo.com/technology-print-3d-blood-vessels-mere-seconds-093529913.html

Engineers 3-D-Print A New Lifelike Liver Tissue For Drug Screening https://www.eurekalert.org/pub_releases/2016-02/uoc--e3a020816.php

3D Gel Nanoparticle Device Detoxifies Blood: https://www.nih.gov/news-events/nih-research-matters/3-d-gel-nanoparticle-device-detoxifies-blood

Chen Laboratory: schen.ucsd.edu/lab/

Allegro 3D: https://allegro3d.com

ICALEO 2018: Getting Back to Business

ICALEO 2018 featured talks from some very influential players in the laser community. Opening-plenary speakers shared insights and experiences from their careers in the laser industry, business-panel speakers addressed trends in the global laser market, and this year's Schawlow award winner told the story of how a company worth $30 million later became worth billions. In this series of articles, Ronald D. Schaeffer recaps some of the key insights gained from these events.

ICALEO 2018 Opening Plenary: "Emerging Laser Technologies: A Path to Disruptive Business"

By: Ronald D. Schaeffer, Ph.D.

This year's three opening plenary speakers were all well known within the laser community and also outside of the laser community. Our first speaker and Keynote presenter was Dr. Islam Salama from Intel Corporation, speaking about "The Next Wave of Information and Computing Technology". Dr. Jason Eichenholz from Luminar Technologies gave a very fast paced and entertaining talk titled "Lighting the Path Toward Automated Mobility". Finally, Dr. Milton Chang from Incubic Management gave some sound advice for entrepreneurs based on his many years of experience in the laser industry – founding companies, running companies, growing companies, selling companies and now, funding the next generation of entrepreneurs through his capital management company.

Dr. Salama joined Intel over 14 years ago as a graduate of UCF's College of Optics and Photonics in Florida. He started as an engineer and worked his way up to his current position as a Global Business and Technology Executive specializing in strategic business leadership, technology development and generating revenue growth. As a senior leader at Intel he was instrumental in the expansion of Intel's manufacturing and technical capabilities, supply chain and talent acquisition.

Dr. Salama spoke about 'big data'. There is a saying attributed to Bill Gates (who vehemently denies he would ever have said anything so stupid…) that "640 KB of memory ought to be enough for anyone". With the expansive growth of the internet we are already orders of magnitude beyond 640 KB. Due to huge numbers of people joining the net (billions of people), the need for device interconnectivity (tens of billions of devices), and achieving this interconnectivity via the cloud, tremendous amounts of data will be generated and this will require a revolutionary change in the technology infrastructures used to transmit, store and analyze all of this data. One application that was specifically mentioned, and which is a great lead in to the next speaker, is autonomous driving which requires not only much larger computing capacity, but near instantaneous feedback, which are not available using currently deployed technology. All of this and more is driving the growth of future integrated circuit scaling. This scale up in technology will require the use of lasers – lots of lasers!

In 1958 Jack Kilby, Kurt Lehovec and Robert Noyce (1959) invented the integrated circuit (IC). It was also in this same year that Townes and Schawlow showed, in a paper published in Physical Review Letters, that MASERS could be made to operate in the visible and infrared regions and they even proposed how it could be accomplished. In many ways the growth of the IC market has paralleled the growth of the laser market. For instance, INTEL and LIA are both 50 years old this year! As the 4 'Waves' of computing have developed and are developing, lasers have played an increasingly important role – from PC's in the 1990's, to the web in the 2000's, to the cloud starting in 2010 and on to AI after 2015. Currently the lasers that are used in the manufacturing of IC's are doing things such as photolithography, marking, imaging for IC patterning, singulation, through hole vias and buried vias. While it is not expected that lasers will play a great role in the manufacture of the chip, it is in the packaging that lasers will have a great impact and the expected acceleration curve has a 'hockey stick' shape, meaning fast and large growth.

Dr. Salama made the point that packaging must scale as fast as or faster than Moore's Law for the market to expand. Also, optical interconnects (not Cu) are in the future and getting them onto the chips will be key – a great area for the growth of especially high precision lasers.

Dr. Jason Eichenholz is a serial entrepreneur and pioneer in lasers, optics, photonic product development and commercialization. Over 25 years in the industry he has led the development of hundreds of millions of dollars of new photonics products. Before joining Luminar as CTO and co-founder, Eichenholz worked as a senior level manager for companies such as Open Photonics, an open innovation company dedicated to the commercialization of optics and photonics technologies, Halma PLC, where he was responsible for supporting innovation, technology and strategic development for the Photonics and Health Optics Divisions, Ocean Optics Inc., and Newport/Spectra-Physics.

Dr. Eichenholz is a fellow of both SPIE and OSA. He has served as the principal investigator for Air Force and DARPA funded research and development programs and holds more than twenty U.S. patents on new types of LiDAR, solid-state lasers, displays and photonic devices. Like the first speaker he is also a graduate of CREOL.

"The auto industry will change more in the next 10 years than in the first 100 years" according to Peter Schwarzenbauer, Board Member of BMW. Electric vehicles, 3D printing and autonomous driving are all drivers in this change. Dr. Eichenholz's presentation showed the work done by his company, Luminar. First, he defined the 5 levels of autonomy:

1) Feet Off
2) Hands Off
3) Eyes Off
4) Mind Off
5) No Driver ….

Currently, judging by the number of vehicle accidents on the road every year, it can be accurately stated that, on average, humans are pretty bad drivers. However, Autonomy is worse! If we look at the above list, there is a big gap between levels 2 and 3 and that is where we are currently. Luminar is developing the LIDAR technology to sense things accurately in real

time out to hundreds of feet in all directions and without regard to possible interference. This process generates HUGE amounts of data and this data must be collected, processed and made actionable. Using the 1550 nm 'eye safe' wavelength, a set of lasers on the vehicle sends a signal which is then detected and analyzed. Even with the best current technology, Autonomous Driving is only good 99% of the time. To state his company's policy succinctly, they intend to solve the last 1% of the problem.

Their technology is designed to take the guesswork out of autonomy by measuring millions of points per second and to put that resolution where it matters most. This allows their sensors to see not just where objects are but what they are, even at a distance. Compared to most advanced LIDAR deployed in vehicles today, their system has 10x the range and 50x the resolution. It can 'see' further than 200 meters at less than 10% reflectivity while current technology can only see 30-40 meters out at 10% reflectivity. Further site means more time to react safely, especially at highway speeds. While this technology is very promising, there is a lot of work to be done and, as Dr. Eichenholz stated, "I will put Technology into a Product, I will NOT put Science into a Product". His motivations are both professional and personal. He has two teenage children and aging parents. In the case of his children he is hoping the technology will make their lives safer and even help to enrich the life of his son, who has autism and may otherwise never have the ability to be mobile. He also reminded all of us who have been in that position how painful it is to have to tell your Father, the man who taught you to drive, that he can no longer drive because of age and the poor eye sight and slow reaction times that come with it.

Dr. Milton Chang is the co-founder, managing partner and managing director at Incubic Management LLC. Dr. Chang served as the President and Chief Executive Officer of New Focus, Inc., which he founded in 1990 and took public in 2000 and the companies he incubated resulted in six IPOs and seven acquisitions; none failed. He was appointed as Chief Executive Officer and President of Newport Corporation in 1971. He provided original seed capital to Uniphase (later JDS-Uniphase). Some of the high level positions he holds or has held include: Medical Director of BioTheranostics, Inc., President of IEEE LEOS Photonics Society and the Laser Institute of America, Director of Precision Photonics Corporation, Director of Aurrion, Inc., Director of MBio Diagnostics, Chairman of Arcturus Engineering and Oepic. Director of Arcturus Bioscience Inc., Lightwave Electronics, Vello Systems, Inc. (also known as OpVista), Teledyne Scientific & Imaging, LLC (also known as Rockwell Scientific), IRIDEX Corporation, Agility Communications, Inc., LightConnect, Inc., Member of Advisory Board at OCG Ventures, LLC, Member of the Board of Trustees of the California Institute of Technology, Investor/Advisor at Photonic Materials Ltd., Director of BioTheranostics, Inc. (also known as AviaraDx), Director of YesVideo, Inc., Uniphase and Gadzoox Networks, Inc.

Pictured from left to right: Dr. Nathaniel Quick (Executive Director of LIA), Dr. Islam Salama (Intel Corp.), Dr. Milton Chang (Incubic Management, LLC), Dr. Jason Eichenholz (Luminar), Dr. Milan Brandt (RMIT University; President of LIA), Prof. Dr. Christoph Leyens (Fraunhofer ILT; ICALEO 2018 General Chair).

He has received a number of prestigious awards from professional societies. He writes monthly business columns for Laser Focus World, Photonics Spectra, (and in fact is the only person I know who has, or could, write columns for both of these highly competitive magazines at the same time!) and for the quarterly journal of the IEEE Technology and Engineering Management Society. He is the author of Toward Entrepreneurship. He has received the Distinguished Alumni Award from both the University of Illinois and Caltech and elected an Overseer of the Huntington Library. He is a Fellow of the IEEE, Optical Society of America, and the Laser Institute of America. He attended the Harvard Owner President Management program. Dr. Chang received a Ph.D. and M.S. degree, both in Electrical Engineering from the California Institute of Technology and a B.S. in Electrical Engineering, with highest honors, from the University of Illinois.

In the early days the Laser was a solution looking for a problem. Now, the problems are looking for laser solutions. The wave of innovation and changes in manufacturing technology brought on by the 4th industrial revolution (Industry 4.0) will bring huge opportunities to the laser industry for decades to come. A growth strategy for any successful company should include:

- Strengthening of competitive advantages
- Pursuing an ambitious vision, but one milestone at a time
- Identifying 'customers' with specificity to become their go-to for all their needs
- Garnering adequate resources and expertise to achieve excellence
- Remembering – resources come with reciprocity – give to get, fair exchange

For Technical Professionals, the following pointers were given:

- Develop and ambitious long term goal and define specific steps to get to that goal
- Gain recognition on the job
- Build reputation and build relationships in the community
- Gain a reputation for leadership!

As a closing, a list of beneficial reminders were given to help on the success path. Challenge your own ideas, assumptions and beliefs. Have enough humility to listen to advice, but make your own decisions based on logic. Verify your assumptions – if something is unlikely to happen based on sound logical reasoning, it probably won't happen! And finally, remember to take calculated risks – a modest success is better than a spectacular failure! Great words to end the Opening Plenary Session.

The 2018 Business Forum and Panel Discussion: "The Global Laser Market and Its Future Development"

By: Ronald D. Schaeffer, Ph.D.

The year 2018 has been one of the best, if not the best year in the laser industry! The traditional machine tool industry is having probably its best year ever, with venues such as IMTS (September in Chicago, and also where LIA held a very successful laser forum) and Fabtech (November in Atlanta) showing both record attendance and vendor participation. Major laser companies' valuations are on the rise pretty much across the board. Some of the larger companies (Coherent and IPG come to mind) have gone through pretty sever market 'corrections', but these may also provide opportunities to the shrewd investor as long term these stocks are sure to rise as the market keeps growing at a double digit pace. On one hand a case could be made that there is no end in sight short term to this fantastic growth. On the other hand, the reality is that outside forces – such as the US mid-term election results and trade sanctions - may have a significant impact on the market. As Industrial Laser Solutions Senior Editor, Past President and Schawlow Award winner (1995) David Belforte pointed out, it has been many years since we have had a recession and one is – on a historical basis – long overdue. Will we see this in 2019?

Klaus Loeffler from Trumpf Laser- und Systemtechnik and Dr. Bo Gu from BOS Photonics organized the business forum which took place on Tuesday afternoon of the conference – the same day as the vendor reception. These approximately 3 hour sessions usually draw a few dozen people that are frequently business leaders in the industry or who are new to entrepreneurship and are attending to gain valuable knowledge. Probably the most important thing is the personal interaction and networking opportunities as the Business Forum, much like the ICALEO conference in general, is a GREAT place to meet others in the industry from new comers to old veterans.

After introductions and call to order by Klaus, Dr. Gu started things off with an overview of the laser market in China. As usual, his presentation was informative and entertaining and his many graphs clearly showed the important role in which the Chinese government in particular views the Photonics Industry. Dr. Gu was born in China, is a long time US citizen, has held important positions in a number of laser companies (Lumonics/GSI and IPG come to mind) and understands both the technology and international aspect of doing business, particularly in the US and China. I should also mention that I was honored to receive an LIA Fellowship this year along with Bo, a long time industry colleague and dear friend.

This year's forum was intentionally oriented toward the Chinese market since it is the biggest in the world. Last year, China installed more than 60,000 laser systems with most of the lasers made in China, but not so many being exported. That may all change very rapidly and the question was posed as to whether this was a threat or an opportunity for other non-Chinese laser businesses.

Pictured from left to right: Flame Yan Chen (Han's Laser), Hongqiang Chen (GE Global Research), Bo Gu (BOS Photonics).

As an example, one of the featured speakers, Dr. Hongquiang Chen from GE Global Research Center talked about the Additive Manufacturing business at GE, where they are investing a lot of money and resources into this new manufacturing technology. As an example, he showed a part that – made using traditional manufacturing technology – had 855 components or pieces to it. When redesigned for 3D additive manufacturing, the number of pieces was reduced to just 12!

I was surprised to see that Chinese companies like Beijing JCZ Technology and YSL Photonics were not only attending ICALEO, but were high-level sponsors as well! Dr. Weija Yang from YSL gave a talk on the development of Ultrafast Fiber lasers and some of the applications they have addressed. Their business is strong in China and they are now trying to expand to the export market.

The final talk was given by Flame Chen from the Hans Laser Smart Technology Group. Hans laser is one of the biggest laser companies in the world, currently second in both market value and revenue. With their aggressive growth strategy, it would be no surprise if they were #1 in both categories very soon. They build very advanced, laser-based manufacturing systems, and have even started providing their own laser in some cases.

As usual, all of the speakers were asked to come up after the last talk for a question and answer session. Questions ranged from technical to business related and the answers were kicked about by the various people on stage. Finally, we adjourned to the Vendor reception to put good business practices in play!

Journal of Laser Applications
in partnership with AIP Publishing

ICALEO, ILSC AND PICALO PROCEEDINGS

Now Available Free of Charge until December 31, 2018

As a benefit of membership, the Proceedings will be exclusively available to LIA members only beginning January 1, 2019.

ICALEO PROCEEDINGS
The International Congress on Applications of Lasers & Electro-Optics (ICALEO®), organized annually by the Laser Institute of America, is viewed as the premier source of technical information in the field.

This Special Collection of ICALEO Proceedings dates back to the first ICALEO in 1982. Since 2015, peer-reviewed papers from the ICALEO have been published separately in the Journal of Laser Applications.

ILSC PROCEEDINGS
The International Laser Safety Conference (ILSC®) covers all aspects of laser safety practice and hazard control.

This Special Collection of ILSC Proceedings starts with the first-ever ILSC in 1990.

PICALO PROCEEDINGS
The Pacific International Conference on Applications of Lasers and Optics (PICALO) focused on the growth of industrial lasers and applications in the pacific region.

This Special Collection of PICALO Proceedings includes all four biennial conferences from 2004-2010.

All special collections can be found under the collections tab at jla.aip.org.

The 2018 Arthur L. Schawlow Award Winner: Dr. Don Scifres

By: Ronald D. Schaeffer, Ph.D.

This year the prestigious "Schawlow Award" was given to a true pioneer in the laser industry in many respects, Dr. Don Scifres. Dr. Scifres is the 37th recipient and in very good company with past industry giants including, like the award's namesake, a number of Nobel Prize Winners. His address was an interesting history of the laser industry.

My first job in the laser industry was with Spectra Physics in their lead salt diode laser division. Spectra Physics also owned Spectra Diode labs at the time and I remember thinking then that I was probably working in the wrong division as lead salt diodes had pretty much already run their course and were giving way to other technologies. Don was gracious enough to have a chat with me after his address and we discussed the old days at Spectra Physics and some of the people involved, including Herb Dwight (then President of SP and 1990 Schawlow Award recipient). He mentioned that he actually did not start out in the direction of diode lasers, but was actually in the 'right place at the right time' when he received a Fellowship from the University of Illinois in solid state and semiconductor devices. As he was sitting in one of his professors office waiting for an interview he picked up a brochure that was lying around on the topic of semiconductor lasers and decided that it would be a good field to go into. The rest, as they say, is history.

Pictured: Dr. Don Scifres (left) shaking hands with LIA Executive Director Dr. Nathaniel Quick (right).

Except that there was a lot more along the way. Don joined the Xerox Palo Alto Research Center and became a Fellow. Along the way Spectra Physics acquired an interest in the technology that Don was working with and thus SDL (Spectra Diode Labs) was born. Unlike Herb, who was more of a business man and marketer, Don actually worked in the lab and he told of the many breakthroughs he personally worked on – many having to do with that scourge of making working things smaller and more powerful – thermal management. He helped refine new semiconductor processing technologies, particularly metal organic chemical vapor deposition. After some time, SDL was involved in government funded programs of a 'black' nature and when Spectra Physics was in the process of being sold to a foreign owned entity, this became a problem. So, Don led an employee buy-out from Spectra Physics. Don tells that the first few years were tough and things were tight, but in the end after about 7 years the company they paid just over $30 million for was worth billions. One of the greatest success stories in the history of the laser industry occurred when JDSU purchased SDL and made not only Don wealthy, but a large number of his employees as well. Many of these lucky folks are still in the industry and are in very influential positions, some even used their new found wealth to start laser ventures. As such, Don's influence on the industry cannot be overestimated.

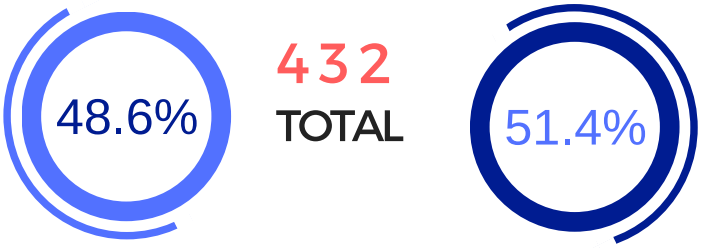
Some of the employees lovingly tell of Don's 'thriftiness', especially in the early days. One such story is that Don used to always insist that, if one of his employees offered to pick up Chinese food for him at the strip mall around the corner from SDL, they use his 'eat 5 meals get one free' card. I was wrestling with whether to use this story and the response I got was, "I think he would be proud! I truly really think so!" Congratulations to Dr. Don Scifres for his pioneering work in the laser industry and for his mentoring of a whole host of people that are now dong pioneering work in our industry as well.

ICALEO®
INTERNATIONAL CONGRESS ON APPLICATIONS OF LASERS & ELECTRO-OPTICS

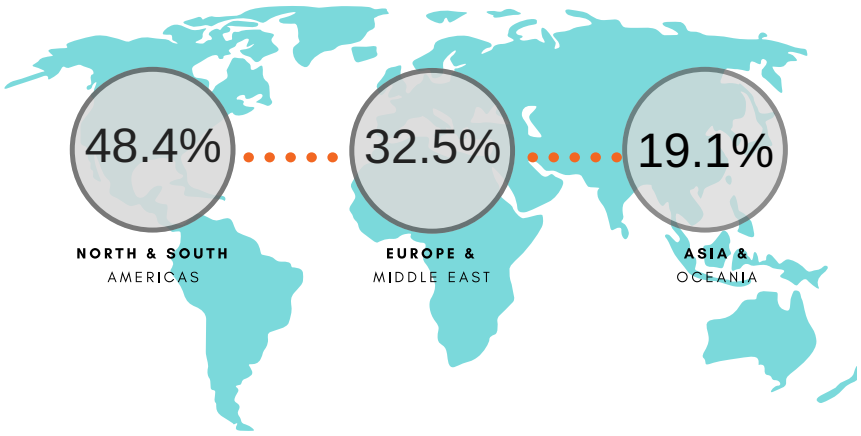
ICALEO 2018 was quite an event! With more attendees and more companies than years previous, we are excited to see ICALEO continue to grow as a place where the laser community can come together to exchange ideas.

As Told By Infographic

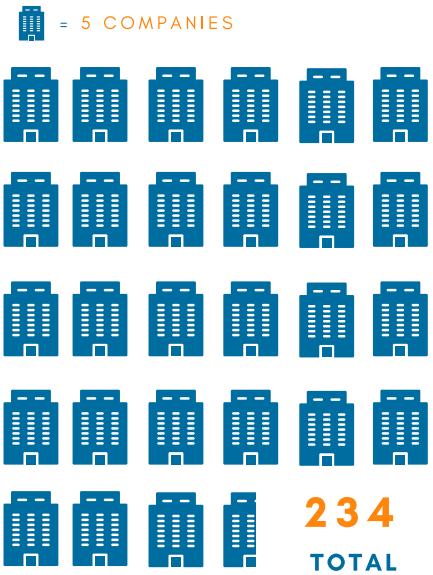
TOTAL ATTENDEES



ATTENDEES BY REGION



COMPANIES REPRESENTED



2018 AWARDS

Student Paper Awards

1st Place	Dennis Arntz
2nd Place	Dennis Haasler
3rd Place	Yanzhe Chen

Poster Presenter Awards

1st Place	Qiying Chen
2nd Place	Jan Bernd Habedank
3rd Place	David Waugh

Journal of Laser Applications Best Paper Award

Dr. Jannis Kranz

Arthur L. Schawlow Award

Dr. Don Scifres

LIA Fellows

Dr. Bo Gu
Dr. Ron Schaeffer

2019 BOARD MEMBERS

Amber Black
Flame Chen
Paul Denney
Stefan Kajerle
Yongfeng Lu
Eric Mottay
Robert Mueller
Andreas Ostendorf
Rajesh Patel
Karl Schulmeister
Brian Victor

LASERS IN THE NEWS

1 LIA CELEBRATES 50TH IN TIME SQUARE

Just ahead of the 37th International Congress on Applications of Lasers and Electro-Optics (ICALEO), LIA celebrated its 50th anniversary in New York's Time Square on October 12, 2018. In celebration of its 50 years, LIA showed thanks to the support received from industry giants IPG Photonics, Coherent, Han's Laser, and TRUMPF, at the world-famous Thomson Reuters building. Complimenting this message was a bold statement below, previewing the future of LIA and its strategy to shape the future of the photonics industry: "Defining the next 50 years of photonics – LIA."

2 2018 NOBEL PRIZE FOR GROUNDBREAKING INVENTIONS IN LASER PHYSICS

The Nobel Prize in Physics 2018 has been awarded "for groundbreaking inventions in the field of laser physics" to Arthur Ashkin (Bell Labs), Gérard Mourou (École Polytechnique & Univ. of Michigan), and Donna Strickland (Univ. of Waterloo). Half of the 9 million Swedish kronor (4.5 million kronor or about 500,000 US dollars) prize goes to Ashkin for the invention of optical tweezers - laser light which can be used for grabbing particles, atoms, viruses, and other living cells. The second half of the prize is being split between Mourou and Strickland "for their method of generating high-intensity, ultra-short optical pulses," without destroying the amplifying material. The technique is called chirped pulse amplification (CPA) and has paved the way for increased speed and precision of laser systems.

Read more here:
https://www.nobelprize.org/prizes/physics/2018/press-release/

3 U.S. DEPARTMENT OF ENERGY FUNDS NETWORK OF INSTITUTIONS OPERATING HIGH-INTENSITY LASERS

"LaserNetUS includes the most powerful lasers in the United States, some of which have powers approaching or exceeding a petawatt."

Read more here:
https://news.utexas.edu/2018/10/29/ut-austin-selected-for-new-high-intensity-laser-network/

4 INFRARED LIGHT-SOURCE MARKET EXPECTED TO INCREASE TO US $6.5 BILLION BY 2023

"The development of new and smart functionalities in smartphone, medical, and automotive applications, as well as the development of breakthrough devices and functions such as wearables and virtual reality (VR), are pushing the growth of the IR LEDs and laser diodes industry."

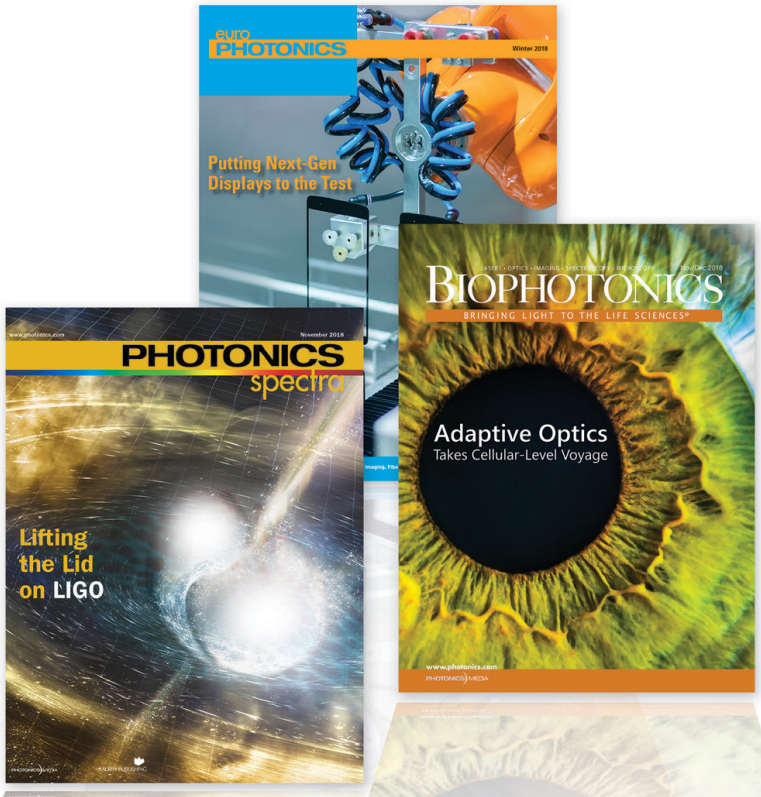
Read more here:
https://www.laserfocusworld.com/articles/2018/10/ir-lighting-applications-drive-growth-of-ir-light-sources-market.html

5 RAMAN SPECTROSCOPY MAY PROVIDE A VIABLE TEST FOR BLOOD GLUCOSE LEVELS FOR DIABETICS

"The new procedure employs a technological development from MIT that uses a process known as Raman spectroscopy to evaluate blood glucose levels via the skin. A person with diabetes would need to wear a wristband connected to a fiberoptic cable that uses laser light to measure fat tissue, protein, collagen and glucose molecules in the skin. The device then produces a "molecular fingerprint" based on changes in wavelengths which indicate different glucose levels."

Read more here:
https://www.healio.com/endocrinology/diabetes/news/online/%7B17bc3dc0-1505-4d56-ad42-c9c8751c489c%7D/laser-technique-may-become-alternative-to-finger-stick-for-blood-glucose-testing

Stay Connected.



Stay informed with the industry's leading magazines. Photonics news from your industry and your part of the world.

To subscribe, visit: photonics.com/subscribe.

PHOTONICS MEDIA photonics.com

Available in print and digital formats.

To contribute to Photonics Media publications submit a 100-word abstract to editorial@photonics.com for consideration.

LASERS&PHOTONICS MARKETPLACE SEMINAR®

Presented by LaserFocusWorld

MONDAY AT SPIE PHOTONICS WEST

FEBRUARY 4, 2019

MARRIOTT MARQUIS, SAN FRANCISCO, CA

WWW.MARKETPLACESEMINAR.COM/2019

ANALYZING THE BUSINESS OF PHOTONICS

REGISTER TODAY! VISIT MARKETPLACESEMINAR.COM/2019

OWNED & PRODUCED BY: PennWell® PRESENTED BY: LaserFocusWorld SUPPORTED BY: Strategies Unlimited. INDUSTRIAL LASER SOLUTIONS BioOptics WORLD

THE JOURNEY FROM IDEA TO INNOVATION

BERTHOLD LEIBINGER INNOVATIONSPREIS AWARDED TO RESEARCH TEAM FROM FRAUNHOFER AND RWTH AACHEN UNIVERSITY

Having received a Joseph von Fraunhofer Prize in 2017, a research team from Aachen has now also won the prestigious Berthold Leibinger Innovationspreis. Their award-winning process "Extreme High-Speed Laser Material Deposition" is known by its German abbreviation, EHLA. The technology allows protective metal coatings to be applied at extremely high speeds in a cost-effective and environmentally friendly manner. EHLA is also a model of successful cooperation based on partnership and of how to solve practical, application-oriented problems. In addition, it exemplifies how the Fraunhofer-Gesellschaft works.

By: Thomas Schopphoven
Head of the Productivity and Systems Engineering Team
Fraunhofer ILT

Back in 2010, Gerhard Maria Backes from the Chair of Digital Additive Production DAP at RWTH Aachen University was already wondering how to make the technique of laser material deposition faster. The classic method involves creating a melt pool on the surface of the material with a laser and then fusing a metal powder there. Although well established, this technology is relatively slow when it comes to processing large areas. What if we could melt the powder while it is still in the air and then deposit the liquid metal?

However, the fundamental science for implementing this idea had not yet been researched. Dr. Andres Gasser from the Fraunhofer Institute for Laser Technology ILT applied for research funds from the Fraunhofer-Gesellschaft and hired Thomas Schopphoven. The latter was able to devote himself fully to the problem in the internal Fraunhofer funding program for SME focused, applied research. Schopphoven carried out basic research in interdisciplinary teams, developed the systems technology together with partners from industry and brought the technique to industrial application over the following years.

BRINGING RESEARCH AND INDUSTRY TOGETHER

A company from the Netherlands with an interest in the technology, Hornet Laser Cladding BV, was brought into the project at a very early stage. Together, the partners integrated the laser into a conventional lathe. With this first machine, the research team and Hornet were able to convince first customers. In close coordination, they built a machine for coating 10-meter-long hydraulic cylinders. As well as being highly efficient, the solution also offered an alternative to the use of hexavalent chromium, which is damaging to human health and the environment and which is now subject to strict regulations. In this way, lasers can be used to apply highly robust and durable coatings to hydraulic cylinders and to applications in shipbuilding and the oil industry.

In recent months, the technology was not only officially recognized with a prize – the Steel Innovation Award 2018 shows the major importance of the technique for the steel industry – but industrial partners in the Netherlands and China also booked the first five orders. Others have followed since. The developer team is already working on the next innovation – adapting the method for additive manufacturing.

INNOVATION IS NO COINCIDENCE

"Success is not something you can plan out with certainty, but you can create the ideal conditions for it," explains Prof. Reimund Neugebauer, President of the Fraunhofer-Gesellschaft. "An organization's success depends in large part on the expert knowledge, experience and commitment of its people, especially in a research organization. We're constantly striving to create an environment for our scientists that facilitates creative, forward-looking and solution-oriented research. After all, innovation always begins with an idea. Our principal role is to translate these ideas into industrial applications and thereby support the innovative capacity of the German economy. Awards like the prestigious Berthold Leibinger Innovationspreis are proof that we're on the right track."

Picture 1: From left to right: Thomas Schopphoven, Dr. Andres Gasser (Fraunhofer Institute for Laser Technology ILT) and Gerhard Maria Backes (Chair of Digital Additive Production DAP at RWTH Aachen University) with Prof. Michael Zäh (Technical University of Munich), who delivered the prize-giving speech, at the award ceremony on September 21 in Ditzingen.

Picture 2: Award-winning protective coating: First prize of the Berthold Leibinger Innovationspreis 2018 was awarded to a joint research team from Fraunhofer ILT and the Chair of Digital Additive Production DAP at RWTH Aachen University for development of the EHLA process.

AWARD-WINNING RESEARCH

The Fraunhofer-Gesellschaft focuses on needs- and problem-oriented research. In domains such as climate change, health and environmental protection, the results of research by the organization's scientists provide solutions that address various social challenges. The employees of the Fraunhofer-Gesellschaft produce research of outstanding quality. They help Fraunhofer maintain its position at the pinnacle of research in Europe. For their excellent achievements, they are honored with top national and international prizes every year, such as the Franco-German Business Awards, the European EARTO Innovation Awards and the Engineering Emmy Awards.

Fraunhofer ILT

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 72 institutes and research units at locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of more than 25,000, who work with an annual research budget totaling 2.3 billion euros. Of this sum, almost 2 billion euros is generated through contract research. Around 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

WE NEED MORE POWER!

HIGH POWER UV LASER SYSTEMS DEVELOPED TO MEET INDUSTRY NEED

According to Globe Newswire, the current market for industrial lasers was $4.31 billion USD in 2017 with a projected 7% annual growth between 2018 and 2022.[1] Lasers that have a low cost of ownership and high processing capabilities will be crucial to manufacturers.

As technology moves more into augmented reality, flexible displays, and smaller wearable devices, the production requirements are growing dramatically. A critical component to staying competitive in the market is going to be the ability to maintain cost efficiency while being able to meet the increased production requirements.

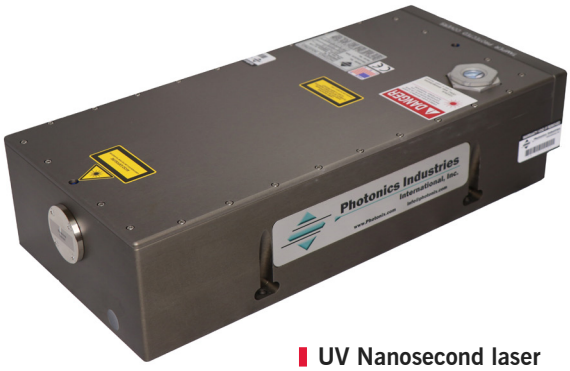
Conventional laser sources required manual adjustment for a wide variety of parameters depending on the application. The key to maintaining or improving efficiency while increasing output lies in increasing laser output capabilities and enabling computer-controlled parameter adjustment. Some materials require specific parameters to be adjusted while processing for the material to be processed effectively. The application could call for the adjustment of wavelength, pulse energy, pulse width, and repetition rate to process at higher speeds.

To address this industry need, Photonics Industries has released all-in-one, high-power UV lasers utilizing Total Pulse Control features. These features include individually triggered pulses on demand, burst mode, pulse energy control, and duty control covered by US Patent # 9,531,147 among others. Photonics Industries' lasers were recognized for these capabilities and awarded the Laser Focus World's 2018 Innovators Award for high-power output and Total Pulse Control with our nanosecond laser. For example, our UV (355 nm) nanosecond laser can reach >1 mJ pulse energy at 40 kHz.

Total Pulse Control is a highly valuable capability for glass cutting and other material processing. This feature allows the user to change repetition rates if the laser is going in a straight or curved line or going around tight corners. This leads to increased quality of the glass cutting and quicker processing time by not having to manually adjust the parameters.

Photonics Industries is dedicated to providing lasers with a low cost of ownership for high-power UV picosecond and nanosecond output. With our high-power capabilities, the laser output beam can be split numerous times to simultaneously feed multiple work stations. This allows improved processing time and a greater return on investment on the system.

Another key goal in the development these lasers for low cost of ownership is the implementation of an all-in-one design which eliminates a separate umbilical and controller, reduced overall footprint, low power consumption and rugged design to handle a variety of environments.



UV Nanosecond laser

UV Picosecond laser

Photonics Industries
International, Inc.

Sources:

1.https://globenewswire.com/news-release/2018/09/19/1572902/0/en/Global-Industrial-Laser-Industry-Report-2018-2022-Focus-on-the-Chinese-Industry-Featuring-10-Foreign-and-13-Chinese-Manufacturers.html

Authors:

Joyce Kilmer, PHD – Director of Marketing

Nick Ryan – Sales and Marketing

URL: https://photonix.com/

A Cuppa with Milan Brandt

In celebration of LIA's 50th Anniversary, we took our tea and questions to ask LIA President, Milan Brandt, on his thoughts on laser materials processing – the global trends, research, developments and unique advantages over other technologies.

LIA: Welcome Milan and thank you for joining us today. There have been strong projections made for the global laser materials processing market; can you tell us about some of the unique global trends that you see in laser materials processing applications?

Milan: Laser materials processing globally is focused on and driven by additive manufacturing. In the "powder fed" or laser metal deposition area the trend is more industrial applications, such as repair and refurbishment of high value components in the aerospace, defense, and mining sectors. The research in this area is focused on the printing of large structures and hybrid manufacturing involving both subtractive and additive processes in one machine. In the "powder bed" area, the focus from industrial perspective is on standards, process reliability, process qualification while from the research perspective the focus is on new materials for printing, process monitoring, software tools for design for manufacture and new cheaper and faster printing systems.

LIA: As a professor at RMIT, can you tell us about some of the significant laser technology developments that were fostered at RMIT under your leadership?

Milan: The RMIT Centre for Additive Manufacturing researches and develops additive manufacturing technology for design of parts, materials, and processing to improve the mechanical properties of aircraft structures under fatigue loading conditions, in particular for repair of those aircraft structures. Some of this research has now been transferred to local industry.

LIA: Do you have any laser design concepts that you would like researchers to pursue in the future?

Milan: A limitation of current "powder-bed" systems is the use of multi-materials in a build. Development of such systems would allow new structures to be designed and manufactured with properties not possible with current technologies. In the "powder-bed" systems, the ability to manipulate and control the microstructure as the part is being manufactured would open up a range of new applications.

LIA: Laser processing market is expected to reach $23 billion by 2025, tell us about some areas where laser materials processing has a unique advantage over other technologies?

Milan: The main benefits lasers offer to manufacturers compared to other technologies include:

- The ability to produce a wide range of wavelengths.
- The ability to produce a wide range of irradiance (power per unit area) levels at the surface of a workpiece, thereby changing the physical state of that surface from solid to melting through a non-contact interaction;
- The ability to easily manipulate the beam through computer numerical control techniques because it has no weight or mechanical contact with the workpiece; and,
- The ability to shape the laser beam on the workpiece both spatially and temporally, thus enabling processing of a wide range of materials and component shapes

These translate into, for example, relatively rapid and low heat input process compared to other metal melting technologies, resulting in microstructures with superior mechanical properties and parts with low residual stresses and distortion. Also, the small laser focus allows for finer structures and features to be manufactured in the "powder bed" systems compared to e-beam technology.

LIA: Do you think the existing laser/photonics research through commercialization infrastructure is adequate?

Milan: Different countries and regions have different approaches and support for technology commercialization so the question is somewhat broad, but in general, I believe that more encouragement, focus, and support should be given to new ideas and start-ups in the area.

LIA: How would you describe LIA's role in laser/photonics technology acceptance and growth?

Milan: LIA, in my view, has played a central role in the promotion, education, and growth of laser technology and applications globally. It has been the focus for this since its inception. I have been a member of LIA for some 32 years and this has enabled me to not only stay abreast of the latest developments in technology and applications but also develop global connections and networks in the area.

LIA: Thank you Milan, it has been our pleasure to have a cuppa with you!

Three Active Leaders in Laser Safety Were Lost in 2018

Three active members of the non-ionizing radiation safety community who contributed greatly to laser safety standards were lost in 2018. Both Prof. Myron Wolbarsht (retired from Duke University) and Ron Petersen (formerly of Bell Laboratories, later Lucent) passed away within a week of each other last July and Captain Handren (formerly CDRH) passed away last April.

PROFESSOR MYRON LEE WOLBARSHT (1924 – 2018) – In memoriam

Dr. Wolbarsht, a Fellow of the LIA (known to most as "Mike") studied classics at St Johns College, Annapolis, MD for his B.A., and attained his Ph.D. in biophysics, studying under the famous vision scientist and Nobel laureate in Medicine and Physiology, Prof. Hartlein. He then worked for a dozen years at the Naval Medical Research Institute before accepting an appointment as Director of Research in the Dept. of Ophthalmology at Duke University. He was a pioneer in studying retinal thermal injury from lasers and was the first to publish a study with a Neodymium laser and developing a retinal melanin-granule model for pulsed laser injury. He co-chaired the Gordon Conference on Lasers in Medicine and Biology at least three times. He was the leader of the ASC Z136 Sub-Committee on Biological Effects on the Eye during the first decades of that Committee and led the very spirited discussions that established the first Z136 MPEs – developed in 1970-72 and published in 1973. At that time, the setting of limits was highly contentious and there was a stalemate amongst the biological researchers on the process for deriving the MPEs – with two high divergent views. Finally after several long meetings held at ANSI in New York City – generally lasting into midnight hours, Prof. Wolbarsht achieved a breakthrough. He abandoned all mention of the derivation process and circulated a set of MPEs from 1 ns to many seconds for direct-beam, intrabeam viewing of a collimated beam for the retinal hazard region (400 – 1400 nm), and achieved unanimous agreement! Those limits remained unchanged – at least from 1 ns to 0.25 s – for more than four decades. He served as President of LIA from 1982-1983.

Prof. Wolbarsht received many awards and recognitions too numerous to list, but of some note was the Wilkening Award of LIA and the Mark Award of the American Society for Lasers in Medicine and Surgery. He co-authored (with David Sliney) a 1,000-page handbook, *Safety with Lasers and Other Optical Sources* in 1980, and edited a series of four books on Lasers in Medicine and Biology (1971, 1973, 1977, 1989).

Many saw Mike as a bit of a curmudgeon who always appeared to have an opposing view, but this was just his nature of academic debate to tease out potential inconsistencies in an argument. He was always recognized in his traditional blue-jean suit. Once asked how he kept that familiar suit clean, he explained that he had 3 or 4 identical outfits and more than one pair of his traditional black boots. There are many amusing stories about Mike. David Sliney tells the story of one time dining with Mike, who always designed his meal around his favorite course, the dessert. One evening at dinner, Dave asked if Mike would like to split a dessert and suggested the type of dessert and Mike agreed. When the waiter approached, Dave ordered the dessert, only to be surprised when Mike ordered another dessert, so puzzled Dave asked if Mike had forgotten. "No," was the reply, "I shall have half of yours as well!"

RONALD C. PETERSEN (1937 – 2018) – In memoriam

Barbara Sams, LIA Director of Standards Development (Left), with Ron Petersen (Right) at an awards ceremony.

Ron Petersen, a Fellow of the LIA, received his BS (EE) and MS in Electrophysics from the Polytechnic Institute of Brooklyn. He joined the Bell Labs Solid-State Device Development Laboratory in 1960 where he worked on device development including low-noise travelling-wave maser amplifiers. After a decade in R&D, he joined the Bell Labs Environmental Health and Safety Center under George Wilkening in1970. He then became manager of the Wireless and Optical Technologies Safety Department (WOTS), which was the AT&T and later Lucent Technologies resource for non-ionizing radiation safety issues (and standards work).

Ron served many roles on the ANSI Accredited Standards Committee (ASC) Z136, including as its Secretary and later Chair. For many years he chaired its standard subcommittee that developed the Z136.2 Safety of Optical Fiber and Free Space Optical Telecommunications Systems.

His retirement in 2001 from Lucent, did not slow down his activities in standards work. Activity only intensified. While spearheading the rewrite of ANSI Z136.2 (released in 2012), he took on the added responsibility of chairing ASC Z136's Editorial Working Group, forwarding the work of the standards subcommittees through editorial review of each document at maturity.

In addition to his expertise in laser safety and laser diodes, Ron always remained very active in radiofrequency (RF) safety. He chaired IEEE Standards Coordinating Committee 34 (SCC-34) on the Safe use of Electromagnetic Energy, SCC-28 Safety Standards with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields. He served two six-year terms on the National Council on Radiation Protection and Measurements (NCRP) where he chaired Scientific Committee 89 Non-Ionizing Radiation. Ron received a number of awards including the prestigious ANSI Finegan Standards Medal, the IEC Edison Award and the LIA Wilkening Award.

CAPTAIN ROBERT (BOB) HANDREN (1935 – 2018) – In memoriam

Remembered by Jerry Dennis

"About the time that I had been at the FDA Bureau of Radiological Health (now the CDRH), Robert (Bob) Handren was hired from the Army Medical Service, joining the Commissioned Corps of the Public Health Service to work in our compliance group for the laser radiation standards program. It turned out that Bob, who hailed from Westchester County was also a graduate of the Fordham University College of Arts and Sciences in the Bronx. Because Bob was five years behind me at Fordham, I never knew him there. He had been a biology major. We also had in common that we were both in Army ROTC. Upon graduation and commissioning, Bob spent his service time between Aberdeen Proving Ground in Maryland and in San Antonio, Texas while I was "fighting the cold war" in the Army Fort Monmouth Signal Corps Laboratories. Having so much in common, we became fast friends once he joined the FDA. With his leadership qualities, it was not long before he became our section chief running the laser and sunlamp programs. During this time he became very active in the ASC Z136 and the LIA. He served as LIA president in 1993 and for a time served on the Board of Commissioners for the Board of Laser Safety. Some years after the enactment of the Medical Device Amendments to the Food, Drug and Cosmetic Act, Bob transferred into the Office of Training andMedical Assistance where he saw better long term opportunities.

"Bob's hobby was automotive; he was a long time member of the Oldsmobile Club of America, For some years, he would do any repair that were needed on my own cars. He very much enjoyed doing auto repairs. It was hard to tell whether he was doing me favors by repairing my cars or if I was doing him favors by letting him repair them. He later bought a mobile home with which he vacationed and saw the country. After retirement from the FDA, Captain Handren moved to Florida and became a consultant to manufacturers of medical devices, assisting and guiding them in the preparation of premarket notifications and applications for premarket approval. I am sure we all will miss Bob's good humor and helpfulness that we have enjoyed for so many years."

Conference Highlight

ILSC®
INTERNATIONAL LASER SAFETY CONFERENCE

MARCH 18-21, 2019
KISSIMMEE, FL

The International Laser Safety Conference (ILSC®) is a comprehensive four-day conference covering all aspects of laser safety practice and hazard control. Scientific sessions will address developments in regulatory, mandatory and voluntary safety standards for laser products and for laser use. The Practical Applications Seminars (PAS) complement the Scientific Sessions by exploring everyday scenarios that the LSO and MLSO may encounter. Professionals in all fields and applications will find ILSC a tremendous source for information and networking opportunities.

REGISTRATION NOW OPEN!

LIA Laser Safety Trainings

LASER SAFETY OFFICER TRAINING	
Orlando, FL	Feb. 20 - 22, 2019
LASER SAFETY OFFICER WITH HAZARD ANALYSIS*	
Orlando, FL	Feb. 25 - Mar. 1, 2019
Orlando, FL	Jun. 3 - 7, 2019

** BLS Certified Laser Safety Officer Exam offered after the course.*

INDUSTRIAL LASER SAFETY OFFICER TRAINING	
Novi, MI	Feb. 13 - 14, 2019
MEDICAL LASER SAFETY OFFICER TRAINING*	
Orlando, FL	Feb. 23 - 24, 2019
Orlando, FL	Jun. 1 - 2, 2019

** BLS Certified Medical Laser Safety Officer Exam offered after the course.*

Visit www.lia.org for all course and event listings

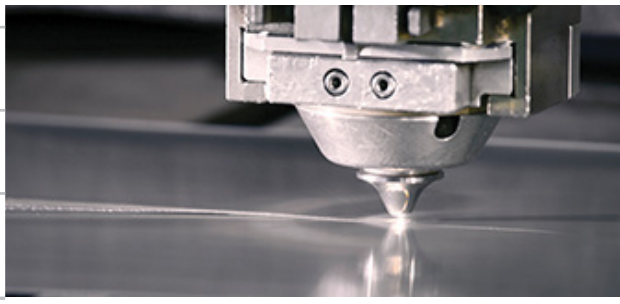
Course Highlight

LSO WITH HAZARD ANALYSIS TRAINING

This course takes a mathematical approach to laser safety, designed to teach LSOs administrative duties and hazard analysis calculations that will help them develop, implement and maintain laser safety programs while meeting the training requirements as outlined by the ANSI Z136.1 Safe Use of Lasers standard and OSHA.

All attendees will receive a course manual including a resource CD with useful LSO documentation forms, ANSI Z136.1 Safe Use of Lasers, LIA's Laser Safety Guide, and a certificate of completion. This course meets the training requirement to apply to sit for the official Certified Laser Safety Officer exam offered by the Board of Laser Safety.

FEBRURARY 25 - MARCH 1, 2019



What's New?

In this conversation B C E S

Message
Today 10:11 AM

B
Board of Laser Safety

If you are a BLS CLSO or CMLSO and your cycle ends December 31, 2018, don't forget to submit your CM Worksheet! Download a copy at **www.lasersafety.org** and email to **bls@lasersafety.org**

C
Conferences

Registration for the International Laser Safety Conference is open! LIA members and students can check out speical pricing here: https://www.lia.org/conferences/ilsc

Our complete listing of training courses for 2019 is now available on www.lia.org/training. Our courses will all be held in sunny Florida this year on a quarterly basis; Orlando is a great destination at any time of the year!

E
Education

S
Standards Dev.

Accredited Standards Committee (ASC) Z136 will hold its annual meeting on March 17, 2019 just preceding ILSC! Observers are welcome to attend; please contact bsams@lia.org for more information.

Join the discussion! Send

Laser Safety Solutions for over 40 Years

Training / Consulting / Products / Testing / Enclosures

Laser Sentry™ Entryway Control System With LED Warning Sign

- Controls Laser Emission
- 50,000 + Hr LED Lifetime/ Low Voltage
- Complies with "Entryway Controls" as specified by ANSI Z136.1-2014, Section 4.4.2.10.3

The Laser Sentry™ door and laser control system manages entry, egress and laser emission to areas in which there is accessible and/or exposed laser energy. The Laser Sentry™ can be utilized as part of a system to meet the specifications of ANSI Z136.1-2014, 4.4.2.10.3, Entryway Controls.

LAZ-R-BARRIER™ / LAZ-R-SHROUD™

RLI carries a complete line of laser curtains that can withstand laser exposures, up to 300 W/cm^2.

- Can be manufactured to accordion fold.
- Interlocking system is available for added safety.
- Suspended from a track system, or portable frame options.
- Design / Installation services are available.
- Window covers available for medical facilities.

An assortment of specialty fabrics designed to provide protection from reflected laser beams can be fabricated into most curtain sizes and design shapes.

Rockwell Laser Industries

(800) 94-LASER
www.rli.com

RLI 40 1978 - 2018

For all applications

Put Your Confidence in TRUMPF

With advancements that can't be topped: control, diodes, and cooling equipment - everything in the disk laser is brand new. Its intelligent inner workings include optimal hardware conditions for controlling the laser power in real time. Whether it's for welding, cutting, or surface processing of metals, the TruDisk excels in all applications that demand high power with brilliant beam quality. Put your confidence in TRUMPF – Together we can build your success.

www.trumpf.com