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LIA TODAY

THE OFFICIAL NEWSLETTER OF LIA

On the Cover:

Innovations and Discussions: A Recap of LIA's Laser Additive Manufacturing Workshop

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- The Effects of Dental Lasers
- A Vision for Next-Gen Laser Safety Tech

LIA TODAY

THE OFFICIAL NEWSLETTER OF LIA

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

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INNOVATIONS AND DISCUSSIONS: A RECAP OF LIA'S LASER ADDITIVE MANUFACTURING WORKSHOP

The 2024 Laser Additive Manufacturing Workshop in Dayton, Ohio featured an educational symposium and technical presentations, exciting attendees with Dayton's photonics-centered curricula for students and high-quality papers on lasers, optics, and sensors in metals AM.

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Prof. Aravinda Kar
LIA 2024 President

As we navigate through a dynamic and ever-changing global landscape, I am proud to report that the Laser Institute (LIA) has not only weathered the storm but has emerged stronger than ever. Despite the ongoing global economic and geopolitical challenges, we have achieved exceptional performance, recording the highest margins in our history during the last fiscal year. This is a testament to the resilience and dedication of our community, and I extend my gratitude to each of you for your unwavering support.

Our commitment to supporting our partners from industries and other organizations worldwide remains steadfast. We continue to participate actively in key international events, such as the AKL Congress in Aachen, Germany, and support initiatives like UCF's CREOL Industrial Affiliates Symposium. Our collaborative efforts with organizations like SPIE, Optica, and AILU are driving innovative ways to bolster our growing industry, ensuring that we remain at the forefront of laser applications and safety.

I am excited to share that the recent Laser Additive Manufacturing (LAM) Workshop was exceptionally well-received, emphasizing the importance of fostering cutting-edge knowledge and collaboration within our field. The momentum and excitement surrounding this year's International Congress on Applications of Lasers & Electro-Optics (ICALEO) are palpable. Set to take place in Hollywood, CA, from November 4-7, 2024, ICALEO promises to be a landmark event, featuring groundbreaking research, insightful discussions, and unparalleled networking opportunities.

Inspired by the success of Laser Additive Manufacturing, the vision of creating efficient and waste-free production techniques is within our reach. The laser community is poised to take the lead in defect-free and cost-effective production by integrating artificial intelligence and machine learning to laser technology, reducing manufacturing and fabrication steps, reducing materials wastage, reducing electric power consumption and increasing throughput. As we look to the future, I am confident that LIA will continue to lead and inspire, driving innovation and excellence in laser technology and safety. Together, we are shaping a brighter and more technologically advanced tomorrow.

Thank you for your continued dedication and enthusiasm. I look forward to seeing many of you at our upcoming events.

United in purpose,

A. Kar

Gilbert Haas
Executive Director

Members and Friends of LIA,

We've been working hard behind the scenes to bring you the best of what LIA has to offer and I'm excited to share our progress.

First, we will soon announce some significant enhancements to our membership benefits. These improvements are designed to provide even greater value and support to our members, and we can't wait to share the details with you.

We are excited to announce the launch the next generation of the LIA website soon. Our new platform will be more user-friendly and packed with enhanced resources to make accessing our extensive library of information on laser applications and safety easier than ever.

The newly revised "ANSI Z136.3 - Safe Use of Lasers in Health Care" American National Standard has been sent to print and is expected to be available in August. This document is the definitive standard of medical laser safety and is a must-have for MLSO's.

Looking ahead, ICALEO 2024 is shaping up to be a truly incredible event. Registrations, hotel bookings, sponsors, and exhibitors are already exceeding expectations. This year's conference will feature exciting plenary talks from industry giants including Microsoft and Audi. We also have Gregory Niven, an Academy Award winner for his work in theatrical laser projection systems, lined up as one of our keynote speakers.

Stay tuned for more details on these exciting developments. Thank you for your continued support and commitment to advancing laser applications and safety.

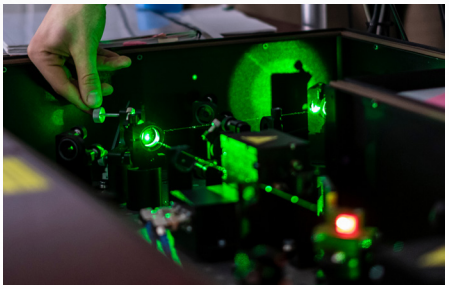
Sincerely,

A Look Ahead at Upcoming Laser Safety Training!

Course Highlight

NEW!

LASER SAFETY OFFICER FOR RESEARCH & DEVELOPMENT TRAINING
SEPTEMBER 5-6, 2024 - BERKELEY, CA



This course is about providing the individual appointed as Laser Safety Officer with reasonable and adequate guidance for identifying laser hazards and implementing control measures for these hazards. The course is based on the American National Standard for Safe Use of Lasers in Research, Development, or Testing.

This course is tailored for individuals newly appointed as Laser Safety Officers and placed in charge of laser safety at corporate research laboratories, universities and colleges that are using lasers in graduate-level programs in physics, chemistry and electro-optics laboratories, as well as Department of Energy research laboratories. In addition, current LSOs at R & D laboratories and testing labs who would like a review or refresher course are encouraged to attend.

LASER SAFETY OFFICER	LASER SAFETY OFFICER WITH HAZARD ANALYSIS	MEDICAL LASER SAFETY OFFICER	INDUSTRIAL LASER SAFETY OFFICER	CALCULATING LASER SYSTEM HAZARDS
February 19-21 Orlando, FL	February 19-23 Orlando, FL	March 16-17 Virtual - Zoom	March 20-22 Novi, MI	May 13-15 Virtual - Zoom
April 8-10 Orlando, FL	April 8-12 Orlando, FL	May 18-19 Eden Prairie, MN	May 15-16 Novi, MI	August 12-14 Virtual - Zoom
September 16-19 Orlando, FL	September 16-20 Orlando, FL	July 13-14 Virtual - Zoom	August 14-15 Novi, MI	December 16-18 Virtual - Zoom
November 18-20 Orlando, FL	November 18-22 Orlando, FL	September 7-8 New York, NY	November 13-14 Novi, MI	
		December 7-8 Virtual - Zoom		

For a complete list of courses, both online and in-person, please visit lia.org/training.

LIA's Newest Corporate Members!

Welcome New Corporate Members

NEW LIA MEMBERS

Air Environmental Services, Inc.

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To find out more about becoming a corporate member, email membership@lia.org or visit lia.org/membership/corporate.

Already an LIA member? Ask about joining our Facebook group!

A Look Ahead at Upcoming Laser Industry Conferences!

1. Photonics West - Jan 30-Feb 1, 2024 (San Francisco, CA, USA)
2. AORN - Mar 9-12, 2024 (Nashville, TN, USA)
3. AKL - Apr 17-19, 2024 (Aachen, Germany)
4. DOE Workshop - Apr 30 - May 2, 2024 (Austin, TX, USA)
5. FABTECH Mexico - May 7-9, 2024 (Mexico City, Mexico)
6. RAPID + TCT - June 25-27, 2024 (Chicago, IL, USA)
7. **LAM - July 15-17, 2024 (Dayton, OH USA)**
8. ALAW - June 25-27, 2024 (Novi, MI, USA)
9. IMTS - Sept 9-14, 2024 (Chicago, IL, USA)
   - **ILC - Sept 11, 2024 (Chicago, IL USA)**
10. Directed Energy Symposium - Sept 11-12, 2024 (National Harbor, MD USA)
11. LANE - Sept 15-19, 2024 (Fürth, Germany)
12. FABTECH - Oct 15-17, 2024 (Chicago, IL, USA)
13. **ICALEO, Nov 4-7, 2024 (Hollywood, CA, USA)**

Cooperating Conference

LANE 2024

DIRECTED ENERGY SYMPOSIUM
SEPT. 11-12
NATIONAL HARBOR, MD

A Look Ahead at LIA's Industry Conferences!

INDUSTRIAL LASER CONFERENCE 2024

September 11, 2024 - Chicago, Illinois

ILC at IMTS Updates

The Industrial Laser Safety Conference will be hosted at IMTS in Chicago again this year!

Early Bird Registration is now available and a program for this 1-day event will be released soon, so be on the lookout!

Visit www.lia.org/industrial-laser-conference for more information.

Want your company to participate in this year's event? Sponsorships are still available. Email marketing@lia.org for more information.

ICALEO®
43RD INTERNATIONAL CONGRESS ON APPLICATIONS OF LASERS & ELECTRO-OPTICS

November 4-7, 2024 - Hollywood, California

ICALEO Updates

Join us in sunny Hollywood for this year's International Congress on Applications of Lasers and Electro-Optics!

Early Bird Registration is now available. so make sure to sign up before prices increase! Group and Student Registrations are also available.

Early Bird 1: $1099 (*$999 Member*) - Early Bird 2: $1199 (*$1099 Member*)
Standard: $1349 (*$1249 Member*) - On-Site: $ 1375 (*$1275 LIA Member*)
One Day Only: $475 (*$425 Member*) - Field Trip Add-On: $50 (*Limited Availablity*)

Our Advance Program is coming out soon! Join our subscriber list to not miss it's release.

Want your company to participate in this year's event? Sponsorships and exhibit space are still available. Email marketing@lia.org for more information.

ILSC®
INTERNATIONAL LASER SAFETY CONFERENCE

March 2-5, 2025 - Orlando, Florida

ILSC Updates

SAVE THE DATE: We are excited to announce our next ILSC conference will be in Orlando, Florida from March 2-5, 2025!

The Call for Papers will be opening soon! Subscribe on our website at ilsc.ngo to stay in the loop as updates become available.

STUDENT SPOTLIGHT

Name: Dmitrii Konnov
Hometown/State: Orlando, FL
Year in School: 6th Year
Area of Study/Major: Optics and Photonics

When were you first introduced to photonics/electro-optics?

"My acquaintance with photonics started during my last year of the middle school when my father bought me a DIY electronic kit with multiple components including an LED and a photodiode. Then at the Physics class in the high-school, I was introduced to fundamental concepts of Optics and Photonics such as Diffraction, Interference, Wave-Particle Duality, etc. This inspired me to apply for the undergraduate school in electrical engineering with the primary focus on lasers."

What or who inspired you to choose your line of study?

"The overall decision to pursue the PhD in Optics and Photonics was motivated by my curiosity and passion about this filed. Talking about the specific research area that I am involved in, I was inspired by my current advisor Dr. Konstantin Vodopyanov, who introduced me to truly amazing applications of the technology that he was working on before I have joined his research group."

Describe your favorite course you have taken so far.

"My favorite course at CREOL is "Light Matter Interaction" which I took in my very first semester during the graduate school. The course was taught by Dr. Pieter Kik who made each lecture extremely clear and informative while keeping it very friendly and engaging."

Are you researching anything at the moment? Can you tell us about it?

"I am actively involved in the research process aimed at high-precision high-resolution dual-frequency-comb molecular absorption spectroscopy across an unprecedented spectral range from 1.5 to 45 THz (6.6–200 μm). We use a pair of mutually-coherent combs from mode-locked Cr:ZnS (λ≈2.35 μm) lasers. One of the combs is frequency downconverted via intrapulse difference frequency generation to produce a longwave 'sensing' comb, while the second comb is frequency doubled to produce a near-IR 'probe' comb for electro-optic sampling."

What would you like to do in the future with your studies?

"In the context of my professional future, my greatest dream is to participate in the creation of a laser-based human exhaled breath analysis device, which represents a new frontier in medical testing allowing non-invasive diagnosis of diseases and monitoring of metabolic status. This will not only improve early diagnosis and patient care, but also improve overall healthcare outcomes through effective treatment and monitoring of diseases."

ICALEO®

INTERNATIONAL CONGRESS ON APPLICATIONS OF LASERS & ELECTRO-OPTICS

SEE YOU IN HOLLYWOOD!

November 4–7, 2024

The 43rd annual ICALEO is in Hollywood, California for 2024. We hope to see you at this year's event at the beautiful Loews Hollywood Hotel.

ICALEO is designed for professionals, researchers, academics, and enthusiasts who are passionate about lasers and electro-optics and want to learn about the latest trends.

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SENIOR RESEARCH SCIENTIST FOR DE, TECHNICAL CENTER,
U.S. ARMY SPACE & MISSILE DEFENSE COMMAND

INNOVATIONS AND DISCUSSIONS: A RECAP OF LIA'S LASER ADDITIVE MANUFACTURING WORKSHOP

The Laser Institute (LIA) held the 2024 Laser Additive Manufacturing Workshop (LAM) on 15-17 July in Dayton, Ohio. This event consisted of an educational symposium followed by two days of technical presentations. Last held in Houston in 2018, this technical revival of LAM was well attended by academic and scientific professionals. The overall symposium and technical meeting sparked excitement from attendees regarding the Dayton regional approach to providing photonics-centered curricula for 6th grade through graduate level students, and the quality of the technical papers presented on the topics of lasers, optics, and sensors relevant to metals Additive Manufacturing (AM).

A summary of the academic and technical sections is offered below.

LAM Education Meets Industry (EMI) Symposium

The EMI symposium was organized by Joe Sciabica, Executive Director of the Dayton Workforce Coalition and Former Executive Director of the Air Force Research Laboratory. While this theme has been applied by other groups, the LAM EMI Symposium provided a dynamic shift to the concept by showing multiple tangible approaches now in place at the primary and secondary school levels. Dr. Larry Dosser, Senior Fellow for Technology Advancement at Wright State University and former President and CEO of Mound Laser and Photonics Center, Inc., opened the symposium by presenting a history of the academic efforts taken in the Dayton Ohio region to provide industry-relevant fundamentals in photonics sciences. Larry's presentation was supported by multiple local academic professionals presenting educational programs currently in place. Dr. Robin Fisher, Stephanie Adams Taylor, and Valerie Gobeil presented programs now offered at the Daton Regional STEM School centered on the Center for Advanced Manufacturing and Photonics (CAMP). The CAMP was established in 2019 and currently provides opportunities for students from 6th – 12th grades to experience project-based educational experiences emphasizing short-term goal-focused activities bolstered by STEM curricula covering fundamentals relating to lasers, optics and photonics. Toni Overholser, Clark State College Vice President for Advancement and Outreach presented associate-level degrees and certifications focused on Advanced Manufacturing Pathways now offered at the Clark State College. Patty Buddelmeyer, Vice President of Development at the Strategic Ohio Council for Higher Education (SOCHE) presented the dynamic approach SOCHE applies to incorporate multiple regional colleges and universities to offer unique pathways for students. SOCHE emphasizes an industry and defense relevant focus on all academic disciplines, with a specific focus on physics, chemistry, optics, and photonics. These presentations were followed by a very dynamic panel moderated by Dr. John Middendorf, Director of Additive Manufacturing at Ohio State University's Center for Design and Manufacturing Excellence, featured panelists including Jon Spragg, AM Academy Team Lead at EOS, Kevin Hartke, CTO of Resonetics, Dr. Jason Deibel, Physics Department Chair and Associate Professor at the University of Dayton, and Dr. Josh Crammer, Director of Education and Workforce Development from the National Center for Defense Manufacturing and Machining. The educational symposium keynote speaker, Debbie Holton, Visionary Leader at the Converge Consulting Group, provided an encouraging view of the trends in national education initiatives focused on "Transforming Workforce Dynamics in Advanced Manufacturing." The educational symposium closed with a reception where Dr. Larry Dosser was presented LIA's inaugural Photonics Workforce Development Award.

LAM Technical Workshop

The LAM 2024 Technical Workshop chaired by Michael Lander , Senior Scientist, Skyward, Ltd., collected dynamic speakers to present current capabilities in Lasers, Optics, and Sensors relevant to metals Additive Manufacturing. The objective of this workshop was to provide a technical forum where the developers of latest innovations would have the chance to share ideas and network with colleagues in the industry. The workshop was kicked-off by a fascinating keynote address provided by Dr. Abdalla Nassar, Enterprise Additive Manufacturing Lead at John Deere. Dr. Nassar provided a practical and exciting discussion detailing the current state of metals AM, the current technical trends being considered, and the economic factors driving the adoption of metals AM for industrial applications. Dr. Nassar presented key economic considerations relating to multi-laser systems, UV-VIS wavelengths, non-gaussian beam modes, wobble-based scanning, and i0n-situ sensing.

The single-track workshop was divided into three technical areas:

Lasers – Chaired by Rick Neff, 3D Printing Influencer at Rick Neff, LLC

The Lasers session included presentations covering wavelength, beam shape, and dynamic beam variation. Dr. Tyson Lowder, Director of Laser Engineering at nLight, presented fiber-based beam shaping achieving Gaussian to ring-shaped beams with 3x magnification over the base Gaussian beam diameter. Preliminary results show this beam-shaping approach has achieved 99.9% density in Scamalloy and 718 alloys with increased production rates. Dr. Eliana Fu, Industry Manager: Aerospace & Medical at Trumpf, presented applications of the TruDisk green laser applied to directed energy deposition with powder and wire-fed systems. The green wavelength showed success processing copper and aluminum alloys achieving faster processing speeds and improved surface finish quality. Dr. Oleg Raykis, Sales Manager at Laserline presented high power diode laser capabilities in the infrared and blue spectral regions. Dr. Raykis presented data showing the production of aerospace parts up to 5.5 meters by 2.5 meters and rocket nozzles up to 10 feet tall and 5 feet in diameter. Andrew Dodd, Vice President of Global Sales at NUBURU Inc., presented advancements in the processing of highly conductive alloys with blue wavelengths. Selim Elhadj, Director of Electro-Optic Technologies at Seurat, presented a dynamic approach based upon wide-area printing of specific shapes. The Seurat approach shows promise for dimensional and economic scaling of metal AM. Shailesh Patkar, Senior Director of Product Management at Coherent Inc, presented the Adjustable Ring-Mode (ARM) fiber laser technology allowing modulated control of the energy delivered to the central and outer regions of the focused beam.

ANNOUNCING THE INAUGURAL PHOTONICS WORKFORCE DEVELOPMENT AWARD: HONORING DR. LARRY DOSSER

The Laser Institute (LIA) is excited to introduce the Photonics Workforce Development Award, designed to celebrate individuals who have shown outstanding dedication to advancing workforce training in photonics. This award recognizes the vital role of education in preparing the next generation for careers in photonics and optics.

At this year's Laser Additive Manufacturing (LAM) Workshop, we had the pleasure of presenting the inaugural Photonics Workforce Development Award to Dr. Larry Dosser. Dr. Dosser's career and his relentless commitment to education and workforce development in photonics make him an exceptionally worthy recipient of this honor.

Dr. Dosser's journey in photonics began with his Bachelor's and Master's degrees in Chemistry from Michigan State University in 1970, followed by a PhD in Physical Chemistry from the University of Arkansas in 1974. His professional career took off at the Department of Energy's Mound Laboratory in Miamisburg, Ohio. In 1995, he founded the Mound Laser and Photonics Center Inc. (MLPC), renowned for its high-quality photonic solutions and its strong focus on education.

After selling MLPC in 2013, Dr. Dosser continued his mission to train future professionals by joining Wright State University as a Senior Technical Fellow for Technology Advancement. He played a pivotal role in establishing the Dayton Regional STEM School (DRSS) and the Center for Advanced Manufacturing and Photonics (CAMP) at DRSS. His commitment didn't stop there. As a Senior Technical Fellow for ARCTOS LLC, Dr. Dosser has advised numerous educational institutions, including DRSS, Clark State Community College, Sinclair Community College, Wright State University (WSU), Lorain County Community College, and the Air Force Research Laboratory (AFRL), in creating agile manufacturing workforce training programs.

Dr. Dosser's vision for Dayton is captured perfectly in his own words: "The seeds have been planted to make Dayton a center for laser material processing, additive manufacturing, and photonics. This is done through the collaboration of DRSS, Clark State, and WSU. More will join as we grow. And we now have support from professional organizations like LIA and SME."

The Photonics Workforce Development Award celebrates not only Dr. Dosser's achievements but also aims to inspire others—individuals, educational institutions, and industrial organizations—to continue and expand their efforts in workforce training. The award will recognize those making significant contributions to photonic manufacturing workforce development.

During the award presentation, LIA Executive Director Gilbert Haas highlighted Dr. Dosser's contributions: "Dr. Dosser's lifetime dedication to advanced photonic manufacturing and education is truly exemplary. Today, we celebrate his remarkable contributions and unwavering commitment to education and industry. The LIA's Photonics Workforce Development Award will serve as a beacon of inspiration, encouraging others to follow in his footsteps."

The inscription on the award reads: "In recognition of his dedication to training the future workforce in advanced photonic manufacturing, Larry R. Dosser, Ph.D., is recognized as the inaugural recipient of the LIA's Photonics Workforce Development Award on this 15th day of July 2024."

We extend our heartfelt congratulations to Dr. Larry Dosser for this well-deserved recognition and thank him for his extraordinary contributions to the field of photonics and the future of our workforce. Celebrating this milestone in photonics and advanced manufacturing is a great honor for us all.

Contact LIA for more information on the Photonics Workforce Development Award and how to nominate future candidates. Let's continue to be inspired by Dr. Dosser's legacy, fostering innovation, education, and industry collaboration in photonics.

Dr. Larry Dosser receiving the Photonics Workshop Award.

(left to right) John Taranto, Mike Lander, Joe Sciabica, Dr. Larry Dosser, Gilbert Haas, Dr. John Middendorf, Rick Neff

Optics – Chaired by John Taranto, Senior Researcher at Thor Labs

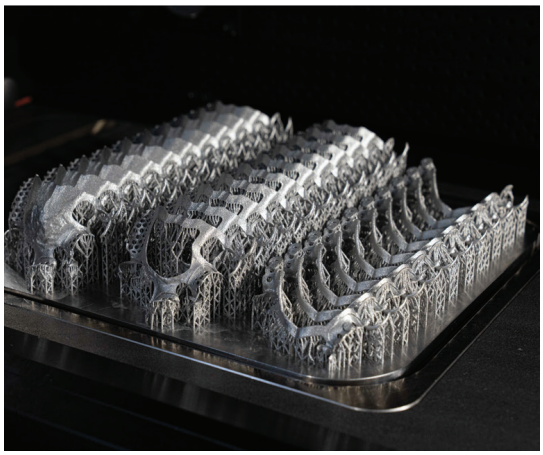
The Optics session provided technical presentations covering beam scanning, coherent beam combining, and beam shaping. Thibaut Atche, International Sales Manager at Cailabs, presented a high-power beam shaping module used to form focused and defocused Gaussian beams and ring-shaped beams. Preliminary data showed processing rates up to 3x faster for nickel alloy 625 as compared to a typical Gaussian beam shape. Thomas Davis, Field Application Engineer at Novanta, described an innovative scanning system incorporating advanced sensing and advances scanning control features addressing speed and direction changes. Dr. Emily Fehrman Cory, CEO of Dayton Photonics, described non-mechanical beam steering methods based upon space fed optical phased arrays. This exciting technology is expected to provide up to 45-degree beam steering within 2 years. Ami Spira, General Manager at Civan Lasers, presented dynamic beam shaping achieving variations in spatial average energy distribution and focal length. Dr. Thej Tumkur Umanath, Research Scientist at Lawrence Livermore National Laboratory, compared quality and efficiency realized in processes with differing Gaussian and Bessel spatial energy patterns. Dr. Kosta Falaggis, Assistant Professor at the University of North Carolina Charlotte presented holographic beam shaping leveraging advanced wave-propagation techniques.

Sensors – Chaired by Dr. John Middendorf, Director of Additive Manufacturing at Ohio State University's Center for Design and Manufacturing Excellence

Dr. John Middendorf provided a keynote address describing the current state of sensing for metals AM. John highlighted static imaging and in-situ imaging of process events. The Sensors session included presentations emphasizing the various approaches listed in Dr. Middendorf's address. Dr. James Craig, President of Stratonics, Inc, provided a view of pyrometric imaging for metal AM. Dr. Thomas Spears, Director of Advanced Additive Manufacturing Technologies at Arctos, presented active sensing of AM parts with direct detection of anomalies and defects. Dr. Makus Kogel-Hollacher, Head of Department R&D Projects at Precitec, presented an approach to incorporate intelligent control based upon in-situ sensing. Attila Werner, Technical Engineer at PRIMES, presented a dynamic approach to characterize moving laser beams. The approach offers a promising method to provide laser beam parameters at full process power. Dr. E. W. (Ted) Reutzel, Director of Center for Innovative Materials Processing through Direct Digital Deposition (CIMP-3D) at The Applied Research Laboratory at Penn State, provided a detailed description applying in-situ process monitoring with neural networks to accelerate the ability to identify and detect flaws. Shuchi (SK) Khurana, President & CEO of Addiguru, described the importance of correlating in-situ collection of thermal tomography to images confirming the location of anomalous events on a layer-by-layer basis.

The 2024 LAM Workshop was sponsored by Trumpf, Civan Lasers, Laservision, Laserline, Skyward, Ltd., Precitec, Photonics Spectra, and Metal AM Magazine. The 2024 event revives the LAM series last presented in 2018. To stay informed on the developments of the next LAM workshop, be sure to subscribe to the LAM mailing list found here: https://lam.ngo/subscribe.

A special thank you to the Platinum Sponsor of our 2024 LAM Workshop!



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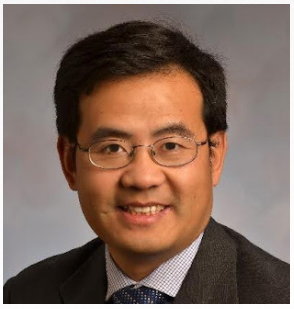
WELCOME NEW EDITORS OF THE JOURNAL OF LASER APPLICATIONS



Dr. Anming Hu - University of Tennessee Knoxville

Dr. Anming Hu is an associate professor in the Department of Mechanical, Aerospace and Biomedical Engineering, University of Tennessee Knoxville. He received his first Ph. D degree from the Institute of Physics, Chinese Academy of Science in 1997 and his second Ph. D degree from the Department of Physics and Astronomy, University of Waterloo, Canada in 2008. Anming's research areas cover nanotechnology for energy, environment, and microelectronics. His current research interests include ultrafast laser physics, laser nano-manufacturing and additive manufacturing, welding and joining at the micro and nanoscale,

JLA Articles of Interest

A. Hu, P. Peng, H. Alrif, X. Y. Zhang J. Y. Guo, Y. Zhou. Femtosecond laser welding of nanostructures and plasmonic devices JLA 24 (2012) 042001

A Hu, R Li, D Bridges, W Zhou, S Bai, D Ma, P Peng. Photonic nanomanufacturing of high performance energy devices on flexible substrates JLA 28, 022602 (2016)

S. Wang, Y. Yu, D. Ma, D. Bridges; G. Feng, Anming Hu High performance hybrid supercapacitors on flexible polyimide sheets using femtosecond laser 3D writing. JLA 29, 022203 (2017)

Y Yu, M Chen, S Wang, C Hill, P Joshi, A Hu. Laser sintering of Al nanoparticles for Al-air batteries. JLA 30 (2018) 032605

Y. Deng, Y. Bai, Y. Yu, S. Deng, Y. Tian, G. Zhang, C. Zheng, J. Wu, A. Hu. Laser nanojoining of copper nanowires. JLA 31(2019) 022414

Qiuyue Su, Shi Bai, Jitai Han, Ying Ma, Yongchao Yu, Yangbao Deng, Meiping Wu, Chong Zheng, Anming Hu. Precise laser trimming of alloy strip resistor: A comparative study with femtosecond laser and nanosecond laser. JLA 32 (2020) 022013

Yiliang "Leon" Liao - Iowa State University

Senior Editor, Yiliang "Leon" Liao, is an associate professor in the Department of Industrial and Manufacturing Systems Engineering at Iowa State University, USA. He received his Ph.D. from Purdue University, USA, in 2012. He was recognized by the Omurtag Research Excellence Award from IMSE at ISU (2023), the Best Youth Editor Award (2023) from International Journal of Extreme Manufacturing (2023), and the ORAU Ralph E. Powe Junior Faculty Enhancement Award from Ork Ridge National Laboratory (2016). Yiliang's research focuses on laser shock processing, laser-based additive manufacturing, modeling of laser-matter interactions, and advanced materials processing for applications in biomedical, energy storage, structural engineering, and soft robotics.

JLA Articles of Interest

Liu, Y., et al., Numerical investigation of the effect of oblique laser shock processing parameters on the residual stress and deformation characteristics of TC6 titanium alloy. Journal of Laser Applications, 2023. 35(4).

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Ou, B.X., et al., Response surface analysis, tensile properties, and microstructure of Ti-6.5Al-3.5Mo-1.5Zr-0.3Si fabricated by laser powder bed fusion. Journal of Laser Applications, 2023. 35(3).

Wang, H.M., et al., Laser impact welding application in joining aluminum to titanium. Journal of Laser Applications, 2016. 28(3).

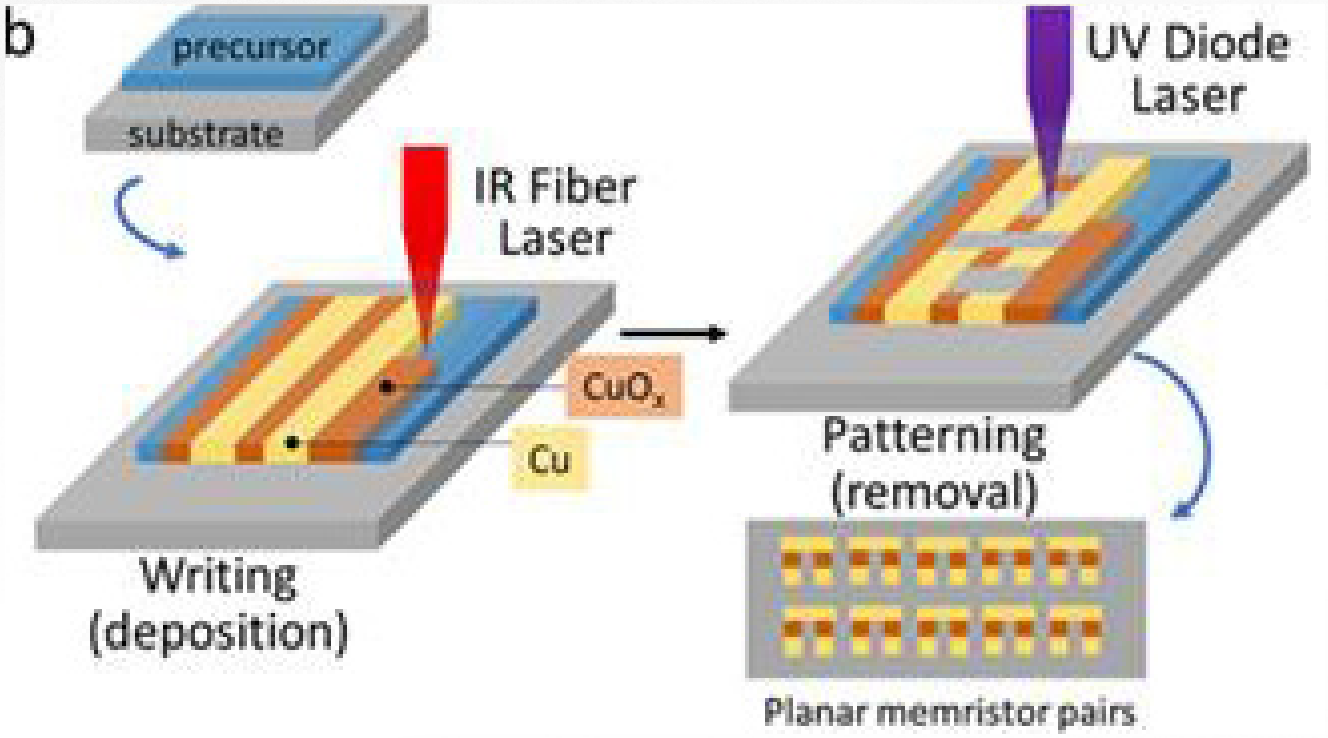
Lin, W., et al., Quality analysis method for powder deposited layers applicable to selective laser sintering and selective laser melting processes. Journal of Laser Applications, 2019. 31(2).

Will, T., et al., Laser welding of different pure copper materials under consideration of shielding gas influence and impact on quality relevant surface topographical features. Journal of Laser Applications, 2023. 35(1).

Huang, W.J., B. Nelson, and H.T. Ding, Surface wettability patterning of metal additive manufactured parts via laser-assisted functionalization. Journal of Laser Applications, 2023. 35(4).

Koti, D., et al., Laser cladding: A high-speed-imaging examination of powder catchment efficiency as a function of the melt pool geometry and its position under the powder stream. Journal of Laser Applications, 2023. 35(4).

Schematic diagram of a direct laser writing and UV patterning process for fabrication of memristor-based logic gate patterns.



LASER WRITING OF MEMRISTIVE LOGIC GATES AND CROSSBAR ARRAYS

By: Joshua Jones; Ningyue Mao; Peng Peng

Abstract: Memristor-based logic circuits are gaining a lot of attention due to the potential for high logic density hardware and novel in-memory computing applications. Readily available methods for fabricating of memristor logic structures that are suitable for integration with conventional computer hardware are a growing need. This work presents a direct laser writing process capable of rapidly fabricating memristor logic circuits by laser irradiation of metal salt precursor solutions. Planar memristor patterns are fabricated, and their I–V response is characterized. Boolean logic gates are fabricated from planar memristor pairs that exhibit low programming voltages and rapid switching. Cu/Cu2O/Cu and Ag/Cu2O/Cu memristors are also fabricated in crossbar arrays, showing the ability to be programmed to multiple resistance states through ultrashort voltage pulses. The devices also show the potential to have high endurance and nonvolatile resistance state retention.

Journal of Laser Applications 36, 022018 (2024);
https://doi.org/10.2351/7.0001345

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THE EFFECT OF DENTAL LASERS ON THE SHEAR BOND STRENGTH OF AGED COMPOSITE RESIN

Raymond Guan[1,3], Yuri Choi[2,3], Yoon Kang, DMD, PhD; William Leavitt, DDS, MPA[4]

With the increasing application of lasers in dentistry as "standard of care," lasers have become more available for chairside use in many dental offices. Use of lasers in a dental setting have reduced the use of dental "drills" and have increased the quality of patient experience. In light of the widespread availability and convenience of dental lasers, it is hypothesized by this study that some chairside lasers might be repurposed to modify existing aged composite restorations by enhancing their bonding ability to layering/adding a new, adjoining resin composite.

When composite resin (containing bis-GMA, UDMA, TEGDMA, and bis-EMA[6] resins) is light-cured in normal room air, the surface leaves a sticky, resin-rich uncured layer known as the oxygen inhibited layer (OIL). For years, it has been known that this layer of uncured composite is necessary for proper adhesion to a new layer of composite, although it remains debatable whether the OIL is always required[i]. When the composite surface is aged and contaminated (in this case with water or saliva), the OIL will degrade and bonding to new composite will fail, causing marginal leakage.

This phenomenon becomes clinically relevant in aged oral dental composite restorations that have a marginal defect (a common scenario in clinical practice). Our hypothesis is that, due to the lack of bonding ability of aged composites, layering/adding a new composite to repair any existing composite's marginal defect is contraindicated. Further, that the existing restoration must be totally replaced. It is acknowledged that replacement of the entire restoration may not only cause further damage to the natural tooth but also may result in lessening the restoration's overall structural utility.

Lasers have been shown to alter polymer surface characteristics such as morphology, chemical composition, and roughness[ii]. In a related study, a neodymium-doped YAG fiber laser with a wavelength of 1064nm was used to effectively remove residual resin on the surface of carbon fiber-reinforced polymer in order to improve the adhesive strength of the material[iii]. In fact, lasers are used in dentistry for a wide variety of purposes, including removing residual composite from orthodontic brackets as well as a variety of periodontal procedures.

With the increasing application of lasers in dentistry as "standard of care," lasers have become more available for chairside use in many dental offices. Use of lasers in a dental setting have reduced the use of dental "drills" and have increased the quality of patient experience. In light of the widespread availability and convenience of dental lasers, it is hypothesized by this study that some chairside lasers might be repurposed to modify existing aged composite restorations by enhancing their bonding ability to layering/adding a new, adjoining resin composite.

Three dental lasers were used in this study, the: *Micro980™* (HOYA ConBio)[5], *NVPro3* (Denmat), and *ezlase* (Biolase)[6].

Each laser has a specific wavelength, but are all used for soft tissue treatment within the dental school (UNLV School of Dental Medicine). These treatments include gingivectomies, gingivoplasties, and frenectomies. Their specific wavelengths are: 980nm (Micro980), 940nm (ezLase), and 803nm (NVPro3). Of course, the Micro980 has the closest wavelength to the Nd:YAG lasers. The NVPro3 laser has a wavelength of 803 nm; which is the optimal wavelength for use in Photobiomodulated (PBM) treatment[iv]. Such treatments are considered "diffuse," and have resulted in increased soft tissue healing[v].

To mimic oral conditions, Filtek Supreme composite block samples (3M, St. Paul, MN: Shade A1) were thoroughly light cured, then artificially aged at 5° C and 55° C, using 10,000 cycles as 1 year via the Thermocycler® (THE-1100 by d-sat) for 1, 6, or 12 months. The control group was not aged[vi]. Each group had 40 samples (see Table 1); with n=10, based on 80% powered main

Table 1. Sample Numbers per aging and laser treatment. A total of 160 samples were numbered and labeled according to the type of laser treatment and months of aging equivalent in the thermocycler (n = 10)

	0 Mo (0)	1 Mo(833cycles)	6 Mo (5,000cycles)	12 Mo (10,000cycles)
No Laser Treatment	1-10	11-20	21-30	31-40
NVPro3 (λ=803nm)	41-50	51-60	61-70	71-80
ezlase (λ=940nm)	81-90	91-100	101-110	111-120
Micro980 (λ=980nm)	121-130	131-140	141-150	151-160

Sample size calculation for this pilot study of n=10 was based on 80% powered main trial with standardized difference at 0.9 with 80% upper confidence level which would make overall n =32 (including 10 from this pilot study) per group for the main experiment.[2]

[1]*Pre-Doctoral Dental Student*
[2]*Pre-Doctoral Dental Student*
[3]*Co-first authors with equal contribution*
[4]*Corresponding Officer*
[5]*No longer produced or marketed by HOYA*
[6]*Replaced by Biolase with the Epic X*

trial with standardized difference at 0.9 with 80% upper confidence level (making the overall n=32 per group). The aging samples were fastened in the device with a floss and putty to maximize contact with the water bath. The aged composite samples were subsequently thoroughly dried, then treated with one of the three noted lasers; varying from 2W/cm² to 13W/cm² continuous wave. Each lased sample was irradiated by touching the laser's distal fiber tip directly to the center of its impending interface surface for one second. Physical changes to the composite surfaces were photographed (see Table 2 on page 18).

Composite Aging

3M Filtek Supreme (3M, St Paul, MN). Composite blocks were artificially aged with thermocycling (5∘C and 55∘C, 10,000 cycles equivalent to 1 year) [1]

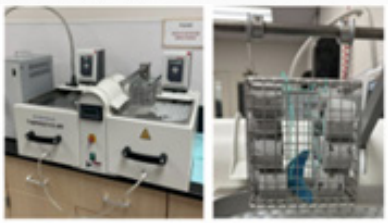


Figure 2. Thermocycler. The composite samples were artificially aged to mimic the conditions in the oral cavity for 1-month (833 cycles), 6-months (5,000 cycles), and 12 -months (10,000 cycles). **Set up of composite samples in the Thermocycler.** Samples were fastened in the thermocycler with a floss and a putty to maximize composite contact with the water bath.

Laser Treatment

Lasers with irradiances varying from 2W/cm² to 13W/cm² to alter the surface characteristics of aged composite

NVPro3 by DenMat (Lompoc, CA) (λ=803nm)
Micro980 by HOYA ConBio (Fremont, CA) (λ=980nm)
ezLace by Biolase (Foothill Ranch, CA) (λ=940nm)

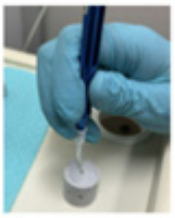


Figure 3. Laser Treatment on sample with the tip of the applicator touching the center of the surface for one second at 2.0W continuous setting.

New Composite Button Attachment

Composite buttons were shaped using a hole made by a drill bit with a diameter of 2.18mm (Figure 4). Each composite button was put on immediately after laser treatment

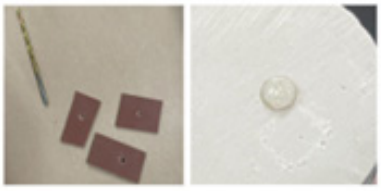


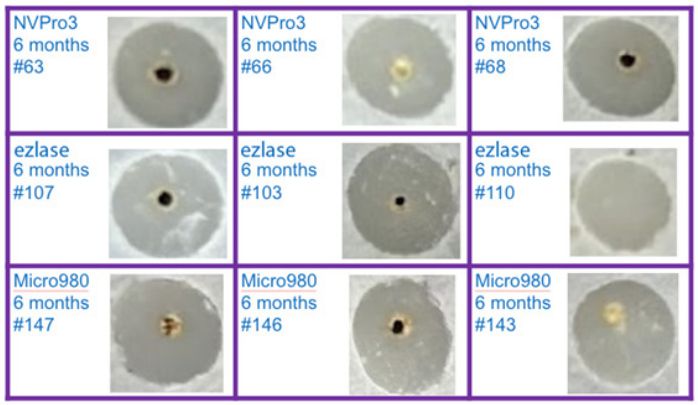
Figure 4. Composite Button Molds were used to create all buttons with the same diameter. The shape of the button after shaping with a mold and curing on top of the aged and laser treated composite surface.

Shear Bond Testing

The samples were then shear bond tested using the Ultradent Products, Inc. UltraTester

Figure 5. Ultratester was used to collect data of shear bond strengths of the composite buttons.

Table 2. Physical Changes to Composite Surface. After each sample was treated, different physical changes such as spot color change were observed.



A new composite sample (each being the same cured material and size [2.18mm diam.]) was then immediately attached to each of those laser-treated samples via a manual technique that resembles a clinical scenario with the use of a plastic dental composite instrument. An elastic mold was used to ensure a consistent diameter and thickness of material as well as maintain the bonding integrity of composite (see Figure 4 in the first illustration). The samples were adjusted vertically (see Figure 5) to measure the shear bond strength between the aged and new samples via the UltraTester® (Ultradent Products, Inc.) and recorded in MPa. The results are shown in Table 3.

Summary

The results showed that lasers of different wavelengths and power levels had various effects on the shear bond strength between aged composite and new composite. They verified that the addition of new composite material to an aged polymerized composite surface does not form a mechanically reliable bond. The 6-month aged non-treated surface yielded a mere 1.54 ± 1.99 MPa bonding strength to new composite, when considering that a minimum bond strength of 17-20 MPa is required for a successful retention of composite restoration to tooth enamel and dentin structure[vii]. However, there was a recorded increase in shear bonding strength with statistical significance using a 980nm laser on composite samples aged for 0 months (11.00 ± 8.26 MPa) and 6 months (10.68 ± 8.92 MPa).

One explanation for these varied results is that 980nm laser light penetrated the contaminated layer of the aged composite more; causing increased micro-retention of new composite. Thus, increasing the mechanical bond between the aged and new composites. Future research might analyze the surface alterations caused by the lasers through SEM imaging and FT-IR or ESCA spectroscopy. Although much remains to be explored and verified on laser wavelength effects on composite shear strength, we hope specific wavelengths will be discovered to satisfactorily improve localized adhesion and repair of old oral composites to new composites. We acknowledge that within this framework, the age of old composites might continue to remain a weighed factor.

Table 3. Shear Bond Strength under different Laser surface treatments (n=10)

Aging in Months (# of Cycles)	Control (Mean±SD)(MPa)	NVPro3 (Mean±SD) (MPa)	Micro980 (Mean±SD)(MPa)	ezlase (Mean±SD)(MPa)
0 (0)	5.79 ± 3.20	4.28 ± 3.63	11.00 ± 8.26*	9.18 ± 9.12
1 (833)	3.84 ± 3.29	4.70 ± 3.00	8.47 ± 4.41	7.39 ± 4.16
6 (5000)	1.54 ± 1.99*^	5.37 ± 4.69	10.68 ± 8.92^	3.09 ± 2.41
12 (10,000)	3.12 ± 5.53	4.59 ± 3.82	5.19 ± 6.12	5.23 ± 2.93

^, *: p < 0.05, one way ANOVA with post hoc Tukey HSD test

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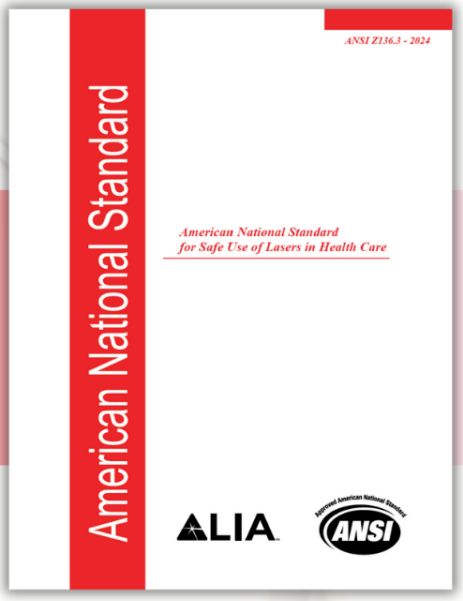
ANSI Z136.3 - 2024 Revision
Safe Use of Lasers in Health Care



Coming this August!

The ANSI Z136.3 is the standard that is nationally recognized as the definitive document on laser safety in all health care environments, providing guidance for the safe use of lasers for diagnostic, cosmetic, preventative and therapeutic applications where bodily structure or function is altered or symptoms are relieved. Undeniably a must-have for all medical laser safety officers (MLSOs)!

Updates to the Z136.3 (2024) will include:

- Harmonization with the ANSI Z136.1 *Safe Use of Lasers*.
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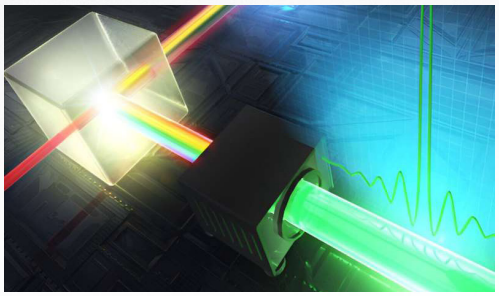

ATTOSECOND IMAGING MADE POSSIBLE BY SHORT AND POWERFUL LASER PULSES

A new technique realized by RIKEN physicists, called advanced dual-chirped optical parametric amplification, has increased the energy of single-cycle laser pulses by a factor of 50.

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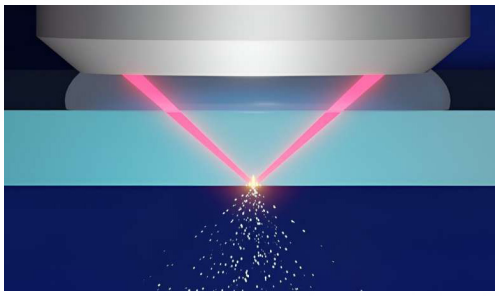

RESEARCHERS IDENTIFY NEW METHOD TO BOOST LASER PROCESSING RESOLUTION

Focusing a tailored laser beam through transparent glass can create a tiny spot inside the material. Researchers at Tohoku University have reported on a way to use this small spot to improve laser material processing, boosting processing resolution.

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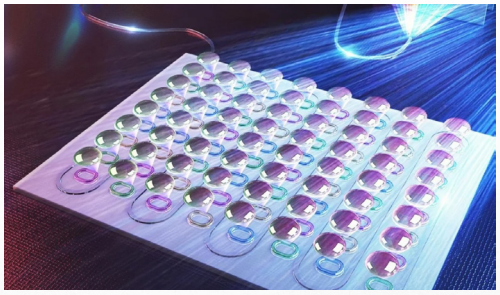

PHOTONIC CHIP MIMICS HUMAN VISION FOR REAL-TIME IMAGE ANALYSIS

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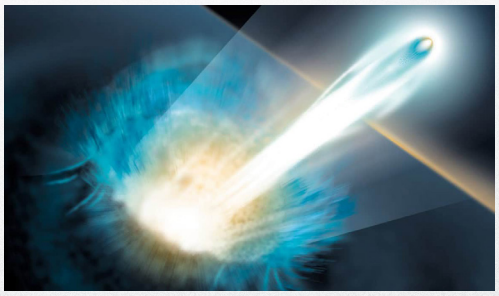

LASER-DRIVEN ACCELERATOR BENEFITS FROM CLEVER USE OF LIGHT PULSES

Physicists in Germany say they have passed an important milestone in the development of laser-driven, plasma-based particle acceleration. Proton pulses with energies as high as 150 MeV were created which is about 50% higher than the previous record for the technique.

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REDEFINING SAFETY & PRODUCTIVITY: BEAMBLOXX'S VISION FOR NEXT-GEN LASER SAFETY TECH

Marissa Faris

Increased use of lasers necessitates the development of an "active" laser safety solutions. BeamBloxx aims to revolutionize laser safety with ergonomic goggles featuring integrated cameras for real-time laser visualization, custom safety applications, and AR-based training. Their solution enhances safety, productivity, and compliance across multiple sectors, including defense and scientific research.

The utilization of lasers for different applications has been rapidly increasing across various industries, and ensuring the well-being of workers has never been more crucial. An innovative solution is desperately needed to address the challenges associated with laser safety. Enter BeamBloxx, a forward-thinking startup with a vision to transform laser safety practices. The company is on a mission to bring laser safety out of the dark ages and turn it into a productivity-enhancing tool, creating safer work environments across the board. BeamBloxx's groundbreaking concept will be explored below, including its advanced laser safety goggles, data analytics capabilities, and augmented reality (AR) training applications, reshaping how we approach laser safety.

Critical Problems in Laser Safety

The Occupational Safety and Health Administration (OHSA) reports that the eye is one of the most common body parts injured on the job, with tens of thousands of workers experiencing optical injuries annually[1]. These injuries not only lead to life-long consequences for workers, along with potential blindness, but eye injuries alone cost companies more than $300 million per year in lost time, medical expenses, and worker compensation1. Despite advancements in technology, laser safety equipment has remained essentially unchanged for decades, leaving critical pain points unresolved while new ones are also beginning to cripple industries.

Current laser safety goggles lack real-time visualization capabilities, hindering users from accurately observing and monitoring laser beams, which is essential for precision work and overall safety. This limitation forces users to prioritize visibility and comfort as their primary concerns, often at the expense of potential optical injury and blindness. Moreover, companies lack the means to monitor laser exposure and ensure compliance with safety protocols, and traditional safety training methods are struggling to keep pace with the dynamic environment, hindering effective learning and workforce productivity. BeamBloxx's multifaceted approach addresses these challenges through advanced technology and tailored applications to enhance safety and productivity across the board.

> *"The Occupational Safety and Health Administration (OHSA) reports that the eye is one of the most common body parts injured on the job."*

Ergonomic Laser Safety Goggles with Integrated Cameras

BeamBloxx adopts a holistic approach, combining cutting-edge technology with tailored applications to enhance safety across industries and defense applications. The company's concept is an ergonomic safety goggle equipped with integrated cameras capable of identifying hazardous and undetectable laser wavelengths to the human eye. In simpler terms, these goggles simultaneously shield the eyes but also provide real-time visualization of laser beams without the use of additional equipment, such as laser viewing cards.

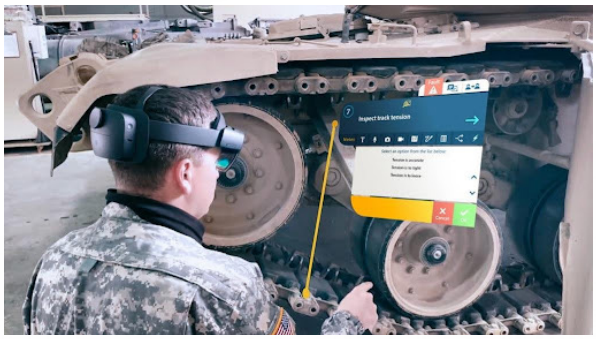
The customer-centric design approach addresses a major pain point: comfortability. By adding features that reduce pressure points and give the option for prescription lenses, these goggles can be worn for prolonged periods, mitigating the chance of accidental optical damage or blindness from non-compliance. Another key feature is the safe-scene projection, which enables users to see their surrounding environment and simultaneously display critical information. The combination of real-time laser visualization, safe scene projection, and information display significantly enhances workforce productivity and product quality while reducing error rates. By providing essential data directly on the lens, operations can be streamlined, and decision-making processes will improve.

Custom Safety Applications and Data Analytics Tools

BeamBloxx goes beyond passive protection, offering custom safety

applications and data analytics tools to address the complexities of monitoring laser usage and workforce safety. These applications monitor laser exposure, analyze safety metrics, ensure compliance, provide insights into productivity and processes, and identify areas of improvement. By leveraging passive data, organizations gain valuable insights into laser operations and compliance, better positioning themselves against lawsuits in the event of a laser accident.

Furthermore, companies can analyze data to identify bottlenecks in work processes, allowing for the development of targeted training programs to enhance efficiency and eliminate errors. This data-driven approach also helps identify safety trends, enabling advancements and improvements for improved safety and decision-making outcomes.



AR Training applications would provide real-time guidance for improved safety and operations efficiency (Photo Credit: Taqtile)

Real-time Simulation-Based Training Applications

The incorporated augmented reality (AR) puts BeamBloxx in a unique position to integrate customizable and interactive simulation-based training applications through a heads-up display. This modern approach to safety training is becoming increasingly popular as it allows technicians to receive real-time guidance. Users can learn new processes for upcoming projects while maintaining situational awareness and adherence to safety measures. By simulating training in a realistic and controlled environment, organizations can provide hands-on learning experiences without exposing their workforce to potential hazards.

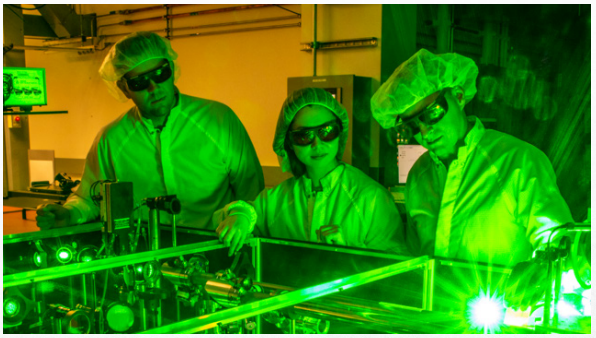
Versatility Across Industries and Defense Applications

BeamBloxx's customizable and holistic approach to developing active laser safety goggles with complimenting data analytics and training tools holds immense potential in industry and defense sectors, allowing it to serve niche markets with specific needs and safety standards. The scientific exploration market, including research and development companies, government-funded labs, and academia, presents a compelling opportunity due to the high demand for advanced technology. These organizations often work with lasers of varying wavelengths and intensities, making active laser safety goggles an attractive and worthwhile investment to address the critical need for enhanced safety and efficiency in operations. Additionally, they often require specialized and ergonomic solutions due to prolonged usage. BeamBloxx will be able to meet these needs by offering different lenses that block the specific wavelengths being used and by creating customizable safety and training applications to meet these particular needs. The scientific exploration market is characterized today by high growth and investment in cutting-edge technology. Organizations are innovating rapidly and expanding research activities, increasing the demand for advanced safety solutions.

Moreover, in military and aviation environments, where threats from laser-based attacks exist, BeamBloxx's technology becomes indispensable as precision and safety are paramount. With increasing threats of laser-based weaponry to temporarily blind troops, BeamBloxx's solution provides a crucial layer of defense and an attractive partner for military branches. Laser dazzling is even more prevalent in the Air Force, with threats from low-powered laser pointers and military-grade laser weapons that blind airmen (Hadley, 2023). Dazzling has surged in recent years, affecting commercial and Air Force pilots and causing permanent visual impairment and blinding. The Air Force has already begun developing advanced eye protection to distribute to their troops and plans to issue over 42,000 upgraded eyewear by 20272. These statistics show that the military and Air Force are actively investing in emerging technologies that empower our troops to respond swiftly and enhance troop readiness and mission success.

Real-World Impact

The company's innovative approach addresses the root causes of accidents and inefficiencies in laser environments, allowing us to drive positive change and redefine the essence of laser safety and productivity. BeamBloxx aims to achieve a competitive advantage through strategic partnerships and a versatile approach that tackles multiple pain points and challenges. Though still in the concept stage, BeamBloxx aspires to be the



Both safety and productivity would increase once BeamBloxx's technology is applied to scenarios like the one above (Photo Credit: Marilyn Sargent/Berkeley Lab)

premium laser safety goggle on the market. BeamBloxx is actively seeking investment and a technical co-founder to bring our visionary concept to life. BeamBloxx's journey and achievements thus far are a testament to the power of innovation and the unwavering need for a new generation of laser safety solutions.

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About the Author

Marissa recently earned her MBA with a focus on entrepreneurship from the Crummer Graduate School of Business. With a background in venture capital, she is dedicated to fostering innovative and forward-thinking technology solutions. During her time at Crummer, Marissa successfully secured funding for her startup, BeamBloxx, by excelling in several local venture pitch competitions. Her business acumen and investment experience drive forward-thinking solutions in laser safety and beyond.

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  - Short author *bio* (full title, company, 50 words)
  - (optional) Professional headshot of author
- Images attached in one of the accepted file types (.png, .tiff, .jpeg, .jpg) (min. 1000px width or height).

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