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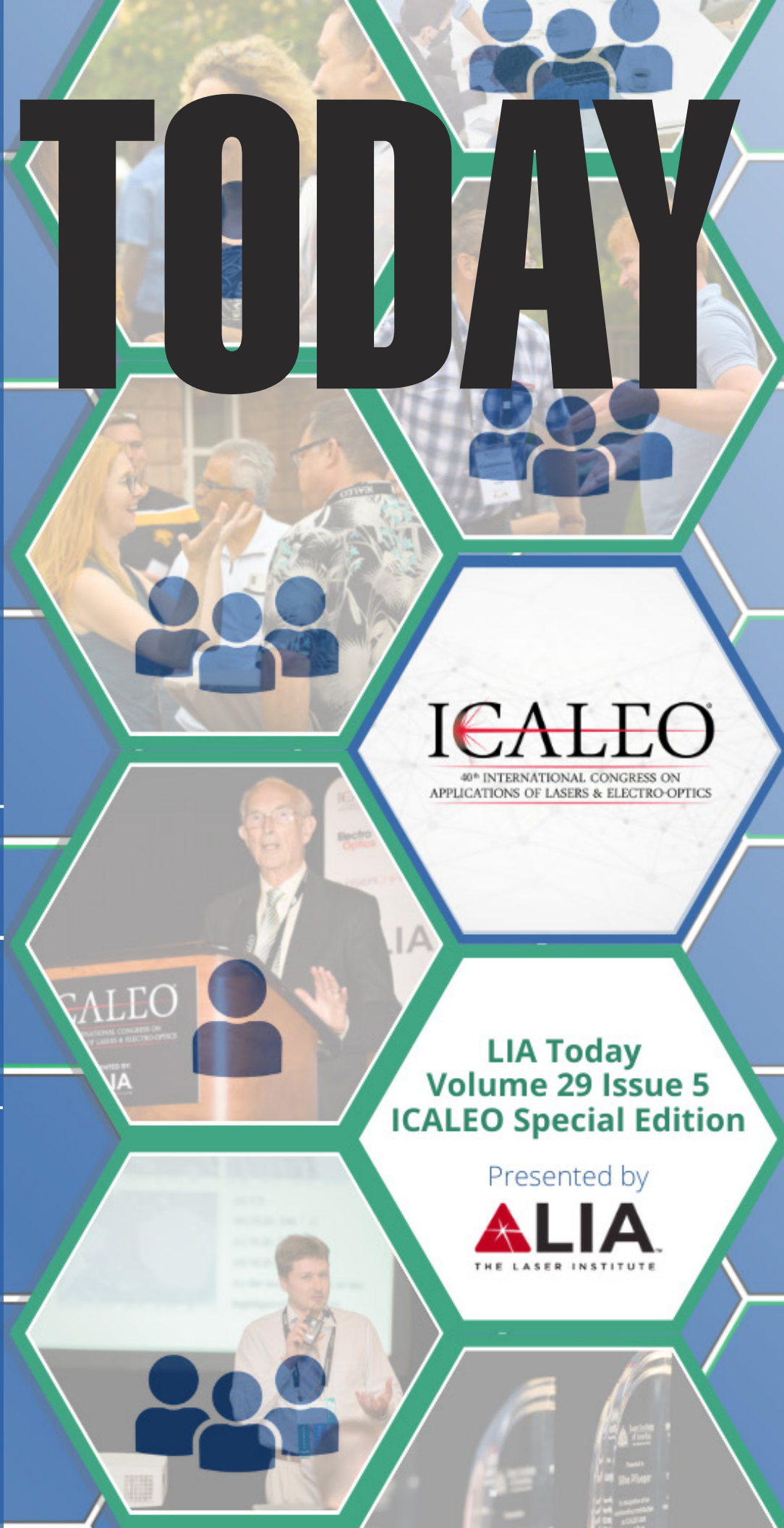

LIA
THE LASER INSTITUTE

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.

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ICALEO 21 OVERVIEW

Take a look at the stats and highlights of the virtual ICALEO 2021 conference throughout this issue, beginning on page 6.

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2021 AWARDS CEREMONY RESULTS

The results of this year's awards ceremony are officially announced. Join us in celebrating this year's award winners!

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PROF. MAZUMDER IN MEMORIUM

As part of the series to honor the late Prof. Mazumder, read a tribute by his colleague and friend Dr. Choi as he reminisces over past times together.

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LIA Laser Safety Trainings

LASER SAFETY OFFICER TRAINING	
Orlando, FL	Jun. 2 - 4, 2021
Orlando, FL	Aug. 18 - 20, 2021
Orlando, FL	Dec. 1 - 3, 2021
LASER SAFETY OFFICER WITH HAZARD ANALYSIS	
Orlando, FL	Jun. 7 - 11, 2021
Orlando, FL	Aug. 23 - 27, 2021
Orlando, FL	Aug. 23 - 27, 2021
Orlando, FL	Dec. 6 - 10, 2021
MEDICAL LASER SAFETY OFFICER TRAINING	
Orlando, FL	Jun. 5 - 6, 2021
Orlando, FL	Aug 21 - 22, 2021
Orlando, FL	Aug 21 - 22, 2021
Orlando, FL	Dec. 4 - 5, 2021
INDUSTRIAL LASER SAFETY OFFICER TRAINING	
Novi, MI	May 12 - 13, 2021
Novi, MI	Aug. 11 - 12, 2021
Novi, MI	Nov. 10 - 11, 2021

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

Course Highlight

LASER SAFETY OFFICER TRAINING
ORLANDO, FL - DEC 1-3, 2021

As a Laser Safety Officer, you have one of the most important responsibilities in your organization - to uphold the highest standard of laser safety. Your commitment to safety prevents injuries. Your enforcement of safety policies isn't always easy, but you know the consequences otherwise. It is this persistent motivation that protects your team and makes a difference. Developed and taught by LIA experts - the industry leader in laser safety education - the LSO course was designed for all levels of experience involved in industrial, military, educational, or research applications of lasers.

As you know, the laser field changes at a rapid pace. That's why it's so important to stay on the leading-edge of safety training and advancement, especially in the role of Laser Safety Officer.

Don't miss out on the opportunity to learn directly from an instructor and interact with your peers.

A Look Ahead at Upcoming Laser Industry Conferences!

1. SPIE Photonics West - 22 - 27 January 2022 (San Francisco, CA, USA)
2. AORN - Mar 19-23, 2022 (New Orleans, LA, USA)
3. MD&M West - April 12-14, 2022 (Anaheim, CA, USA)
4. COLA - April 24-29, 2022 (Matsue, Japan)
5. Laser World of Photonics - April 26-29, 2022 (Munich, Germany)
6. Fabtech - May 3-5, 2022 (Mexico)
7. AKL - May 4–6, 2022 (Aachen, Germany)
8. RAPID + TCT - May 17 - 19, 2022 (Detroit, MI, USA)
9. ALAW - June 7-9, 2022 (Plymouth, MI, USA)
10. LASYS - Jun 21-23, 2022 (Stuttgart, Germany)
11. IMTS - Sept 12-17, 2022 (Chicago, IL, USA)
12. **ICALEO, Oct. 17-20, 2022 (Orlando, FL, USA)**
13. Fabtech - November 8-10, 2022 (Atlanta, GA, USA)

2021 Conference Chairs

A SPECIAL THANKS

LIA would like to extend a special thank you to this year's general and track chairs.

GENERAL CHAIR

Verena Wippo
Laser Zentrum Hannover

Without their dedication to ICALEO and its mission to bring together new industry knowledge this conference would not have been possible.

LAM

Dr. Milan Brandt
RMIT University
Melbourne, Australia

Dr. Edward Reutzel
Pennsylvania State University
Pennsylvania, USA

MACRO

Friedhelm Dorsch
TRUMPF GmbH + Co. KG
Germany

Dr. Klaus Kleine
Coherent Inc.

MICRO

Florian Kiefer
TRUMPF Laser and Systemtechnik GmbH
Germany

Dr. John Lopez
University of Bordeaux
Bordeaux, France

NANO

Dr. Ya Cheng
East China Normal University
Shanghai, China

Dr. Yves Bellouard
Ecole Polytechnique Fédérale de Lausanne
Switzerland

FLA

Robert Braunschweig
LASEA
USA

Eric Mottay
Amplitude Laser Group
USA

ICALEO 2021 At-A-Glance

Take a look at some of the statistics of this year's conference!

356 Registrants
for Virtual ICALEO 2021 and the On-Demand Library

26 Countries
around the world that virtually attended ICALEO

133 Presentations
given virtually throughout the 5 industry tracks

36 Peer-Reviewed
presentations that were accepted to be published in the JLA

ICALEO 2021 Plenaries

JULIA HARTUNG
Trumpf GmbH

AI in the Laser Industry – from Sensor Parametrization to Process Control

In this speech different application areas of artificial intelligence in the laser industry are shown based on two examples.

The main topic of the speech deals with an AI based optimization of complex sensor systems. Using optical coherence tomography, which has different physical parameters as well as algorithmic parameters to control the post-processing of a signal, the approach is illustrated. Due to interactions of parameters and the asymmetry of the value ranges, a high-dimensional, highly complex parameter space results, which requires expert knowledge to handle. With the help of an evolutionary algorithm, as well as an intelligent selection of the initial population by a neural network and clustering, ideal sensor parameters can be determined in a very short time.

A second field of application which is discussed, is the laser process control based on image data. Examples are quality assurance of weld seams or spatter detection in the laser welding process. With an algorithm based on a convolutional neural network, the image data are analyzed and classified pixel by pixel. With the aim of using the system in the production process, the focus here is on low computing time of the prediction, as well as training with a small amount of input data.

CARLO HOLLY
RWTH Aachen University

Artificial Intelligence and Digital Solutions for Laser Technology

Digital solutions offer a holistic approach for understanding and optimization of laser-based manufacturing by bridging between individual photonic technologies ranging from the laser beam sources, optical systems, and sensors to the applications and material interaction. On the software-side, these solutions include elaborated design tools, digital twins, management and analysis of large data streams and the connection to edge devices. The software developments are accompanied by solid sensor technology and fast hardware to obtain process data and control lasers and active optical systems. This combination of laser manufacturing technology and digitization enables Digital Photonic Production. New software and design algorithms based on Artificial Intelligence (AI) play a crucial role for the increase of efficiency and quality for laser materials processing.

In the recent years, AI has gained great popularity and enhanced the performance of various products in the fields of information technology, robotics, healthcare, autonomous driving, and many others. Prominent examples involving the processing of large data sets and complex dependencies are computer vision, natural language processing, logistics, or control of manufacturing robots. While these AI-based algorithms have penetrated the information technology market and today are state-of-the-art in many consumer products, new developments aim to exploit their full potential also for the photonic production. The field of applications for AI in laser technology range from automated design and process analysis for quality inspection to AI-based self-optimizing machines for laser materials processing.

We have successfully used AI-based solutions for the qualitative evaluation of laser-welded seams to reliably detect defects during production of batteries, for surface quality improvement in laser powder bed fusion (LPBF), and for process control in laser metal deposition (LMD). In addition, Neural Networks are employed to perform a model-based characterization of extreme ultraviolet (EUV)-nanostructures or evaluate interferometer data to determine distance and inclination with an optical sensor. In the future, novel digital solutions in combination with AI will allow us to improve design, process analysis, systems control, efficiency, and quality inspection for laser manufacturing.

Watch these presentations as part of the Opening Plenary Session in the Agenda section of the ICALEO 21 event platform (available until Nov 19, 2021)

CHANG HEE NAM
RWTH Aachen University

Laser Technology for Realizing the Ultrahigh Intensity of 1023 W/cm2

Ultrahigh power lasers with output over one petawatt (PW) have been developed in a number of institutes around the world. At the Center for Relativistic Laser Science (CoReLS) of Institute for Basic Science we have developed a 20 fs, 4 PW laser in 2016 [1]. The 4 PW laser is a chirped pulse amplification laser with a front end with cross-polarized wave and optical parametric chirped pulse amplification stages and a series of Ti:Sapphire amplifiers. Recently we achieved the record-breaking laser intensity reaching 1.1x1023 W/cm2[2]. We corrected the wavefront distortion existing in the PW laser beam with a two-stage adaptive optical system to obtain near diffraction-limited focusing and employed an f/1.1 off-axis parabolic mirror to reach a focused spot size of 1.1 µm. This ultrahigh power laser has been operated to explore strong field physics for the last five years. In this presentation the laser technology to achieve the unprecedented laser intensity is explained, along with recent result on strong field quantum electrodynamics.

[1] J. H. Sung et al., "4.2 PW, 20 fs Ti:Sapphire Laser at 0.1 Hz," Opt. Lett. 42, 2058 (2017).
[2] J. W. Yoon et al., "Realization of laser intensity over 1023 W/cm2," Optica 8, 630 (2021).

DANIEL SMALLEY
RWTH Aachen University

Science Fiction 3D Made Real

In this presentation we discuss how freespace volumetric displays in general, and optical trap displays (OTDs) in particular, are making real the 3D displays of science fiction. For decades many of the 3D displays of science fiction were considered impossible to realize because long-throw projections, tall sand-tables, and wrap around displays all require light to change direction in mid-air. Optical trap displays, first presented in 2018, demonstrated that mid-air scattering could be achieved for full-color, high definition, aerial 3D displays. This platform has now successfully demonstrated once-forbidden sci-fi geometries in miniature. Our current efforts now turn to i) scaling this display, ii) making it more robust, and iii) and mitigating safety issues. Once these issues are addressed OTDs will make possible a host of new applications. The materiality and low-bandwidth requirement of the display will make it possible for an individual to have a physical presence in more than place at once. The screenless nature of the display will make it possible to have large displays from small devices. Directional scattering will make it possible for multiple viewers to observe entirely different 3D images, even while gazing at the same volume.Finally, the OTD platform will point the way to a future that fundamentally changes the way that we interact with our digital information by making it a physical part of the world around us.

Watch these presentations as part of the Closing Plenary Session in the Agenda section of the ICALEO 21 event platform (available until Nov 19, 2021)

ICALEO 2021 Industry Panel

This year's industry panel was once again moderated by industry legend Professor William Steen. Prof. Steen has been working with lasers since they were first developed and so has interesting insights into the evolution of the industry. He has seen and been a part of research and technologies when they were first created, trends in the industry, what has stayed relevant and where there is still so much room to grow. This gives him a unique perspective in where the laser industry could potentially be headed.

That is what ICALEO 21's panel was about. The panel, entitled Artificial Intelligence in the Laser Industry was focused on the rising technology's future in the laser industry and in what ways it is already being implemented. Joining Prof. Steen were three panelists who all work with AI in their areas of laser materials processing.

- Julia Hartung - RWTH Aachen University
- Prof. Carlo Holly - Trumpf Laser GmbH
- Prof. Dr. Volker Sorger - George Washington University

These distinguished minds are very familiar with Artificial Intelligence technology and what it can do. This led to a very stimulating conversation about how AI is at work in the laser industry. Some of the topics discussed were each person's favorite use of AI, the cost behind it, and whether it is actually beneficial where/how people think it would be. After the discussion between the panel, there was time for a lively question and answer segment with some interesting questions from the audience.

ICALEO 2021 Networking Area

A unique opportunity for speakers and attendees this year was the networking area with tables that encouraged mingling and continued conversations left over from Q&A with speakers after their sessions. Attendees were able to sit down at these tables and video chat with whoever else was at that table. Although the networking breaks were also the breaks for people to stretch their legs or take a break from the computer, certain tables were still decently attended and it was great to see almst 100 people connect through the networking area.

ICALEO 2021 On-Demand Content

Along with the scheduled content of the virtual conference, there were 22 bonus On-Demand presentations and 13 Poster Presentations. Other highlights of the On-Demand area of the virtual conference platform were the Annual Meeting/Awards Ceremony, as well as a tribute video to the late Professor Mazumder. This video was compiled of his friends reminiscing on the past and good times. If you have access to the platform and have not had a chance to watch this heartwarming tribute, I would encourage you to do so before the platform access closes on November 19th. You will also find an article provided by a colleague and friend of Prof. Mazumder, Dr. Choi, further along in this issue.

Virtual Awards Ceremony Results

ARTHUR L. SCHAWLOW AWARD

One of LIA's most prestigious honors, the Arthur L. Schawlow Award recognizes outstanding, career-long contributions to basic and applied research in laser science and engineering, leading to fundamental understanding of laser materials interaction and/or transfer of laser technology for increased application in industry, medicine and daily life.

The Schawlow honoree will be acknowledged at the LIA Awards Ceremony, during which the recipient will givean address.

Eligibility: Nominations are open to candidates who made outstanding contribution to basic and applied research in laser science and engineering. The recipient does not have to be a member of LIA but sustained service to LIA can be one of the additional contributions that is considered for the award. Nominations are active for three years.

2021 WINNER

Professor Aravinda Kar

CREOL - UNIVERSITY OF CENTRAL FLORIDA
ORLANDO, FL

Dr. Kar is a professor of Optics and leads the Laser-Assisted Manufacturing and Materials Processing (LAMMP) laboratory in CREOL, The College of Optics and Photonics at the University of Central Florida. He has been working on various aspects of laser materials processing and manufacturing for more than 30 years, and published 119 technical journal papers, 183 conference papers and received 29 patents. He is a Fellow of the Laser Institute of America and a Fellow of the National Academy of Inventors. He has co-authored a book entitled, Theory and Application of Laser Chemical Vapor Deposition, Plenum Press, New York, 1995.

Watch his Schawlow acceptance presentation as part of the Awards Ceremony in the On-Demand section of the ICALEO 21 event platform (available until Nov 19, 2021).

WILLIAM M. STEEN AWARDS

The Laser Institute of America is pleased to invite applications for the prestigious William M. Steen Award for significant developments in laser material processing named after one of the early pioneers in the subject. Laser Material Processing is one of the growth points in modern manufacturing. To bring focus to the many developments taking place and to promote the development of new ideas the LIA is making awards for the top three ideas of the year as adjudicated by a prize giving panel.

In order to qualify the innovative development should have experimental proof of concept in the use of lasers or monitoring of laser processes and should fit one of the criteria stated below:

- Open a new area of application for lasers.
- Be of benefit to manufacturing with lasers.
- Solve a problem either particular or general by the use of lasers.
- Show some novel sensing system by using optics or when monitoring laser processes.
- A development in photo chemistry.
- A development in photo-therapies.
- A development in 3D printings with lasers

SENSIGMA

for their submission of "Smart Optical Monitoring System"

FELLOWS AWARD

The grade of Fellow is the highest level of membership in the LIA. It is awarded to recognize members of the institute who have:

- Attained unusual professional distinction in the LIA mission areas of laser science and technology, laser applications and/or laser safety, and

- Provided outstanding service to their field.

Nominations are open to candidates who must have practiced the profession of laser science and engineering in academia, medicine, industry or government for at least 10 years, and fellow membership for any individual shall not be instituted or remain in effect unless his/her membership is current. For exceptional candidates, the Executive Committee may waive the eligibility requirements.

LIA is proud to recognize the following members as Fellows:

Dr. Larry Dosser – Clark State

Prof. Chrysanthos Panayiotou – Indian River State College

JLA BEST PAPER AWARD

The Journal of Laser Applications Best Paper Award is given annually in recognition of outstanding laser applications research to the primary author of a selected paper published in the journal in the preceding three years. Each Editor nominates a single paper in their topical area for consideration by the full Editorial team based on the quality and significance of the work. The winning author receives free registration to ICALEO and a Crystal Award.

Guillaume Bonamis The 2021 JLA Best Paper Award has been awarded to Guillaume Bonamis for the winning article, *"High efficiency femtosecond laser ablation with gigahertz level burtsts".*

Watch all of the award announcements and more as part of the LIA Annual Meeting and Awards Ceremony in the On-Demand section of the ICALEO 21 event platform (available until Nov 19, 2021)

Professor Mazumder in Memorium

By, Dr. Choi

Brief introduction: Since joining his research group (Center for Laser Assisted Materials Processing, CLAMP) in the University of Illinois at Urbana-Champaign (UIUC) in 1987, Professor Jyoti Mazumder (JM) was my main advisor and mentor in my professional career. Before CLAMP, I was working as a technical staff of laser materials processing group in the Central Technical Center @ Daewoo Heavy Industries, Ltd in S. Korea. Joining in JM group, he suggested and advised me to study in the area of laser cladding, which was quite new to me.

Since then, my research topics has been stretched in the areas of laser cladding to welding, and then additive manufacturing during the time of UIUC. The photo (Fig. 1) with Prof. JM, in the middle row fourth from the left, was taken with group members in 1994. I continued to stay in CLAMP research group as a postdoc, and later followed him as a research staff member of Center for Laser Aided Intelligent Manufacturing (CLAIM) doing further R&D in the area of advanced laser additive manufacturing (LAM) @University of Michigan at Ann Arbor (UofM) until 1999.

Figure 1. Gathering @his house party in 1994 (top row: Joe Kelly, Joohyun Choi, Keith Egland, Karthik Nagarathnam, a visiting scholar from India, middle row: Augusto de Deus, Pravansu Mohanty, Mark Douglass, Prof. JM, a visiting scholar from China, Matthew li, down row: Justin Koch, Magdi Azer)

Remembering him, he was a brilliant scholar in R&D and an excellent mentor to his advisees, and a forward-thinking entrepreneur in commercialization of technology. He always provided honest and constructive feedback, and displayed positive attitude and enthusiastic communications during meetings. He guided and shared with his students his in-depth and relevant knowledge and expertise. He always clearly stated and reminded what he was expecting and seeking from specific topics of researches. In UIUC, it seemed to me that his research interests were rather fundamental in physics-based approach, seeking physics behind laser material interaction and how laser plays a role in liquid-solid interface as well as liquid-vapor interface, and in the laser induced plasma. In the later years, as he frequently mentioned in the meetings, his R&D interests aligned more focused in the area of scientific findings in the laser/material interaction how mechanical properties of materials can be predicted, for instance, utilizing laser spectroscopy or optical devices like LEDs.

Relocation and transition from UIUC to UofM: My memory serving correctly, it was still early spring 1996, and I still remember the moment when he announced his decision of relocating to UofM and wished for members of his group to join UofM from UIUC. All group members yet sensed his impending decision and understood that it was an "once-in-a-lifetime decision" for him to re-align his research course and re-focus R&D priorities. Most members including me followed him, and all members helped to pack and bring most equipment from CLAMP lab @UIUC (fully packed in two of 53' container trucks), including 6kW laser with 3-axis CNC system, and so on, in order to keep some research works continuing @UofM.

In 2000, serving as a president of LIA, he wanted to expand laser industry networking with auto industry and also helped to invite three Nobel Laureates (Charles H. Towns(1964), Nicolaas Bloembergen(1981), and Theodor W. Hänsch[1]'(2005)) and the inventor of CO_2 laser (Kumar N. Patel), honoring the pioneers of basic researches in laser science in the ICALEO 2000, Detroit, MI. Most of his students from his previous CLAMP (@UIUC) and CLAIM (@UofM) group members participated, gathered, and took a picture as shown in Fig. 2.

Figure 2. Prof. JM with his group members (alumni) @ICALEO 2000, Detroit, MI (from left: Joohyun Choi, Aravinda Kar, Harshad Natu, Prof. JM, Leslie Pipe, Mark Douglass, Justin Koch, Max Byers, Jason Carrol, Keith Egland, Peng Li, Ashish Dasgupta)

At UofM, his research had been more aligned with Auto industry due to the influence of Big 3 automotive companies. Needs for applied researches utilizing laser were demanding and his networking with Auto industry resulted in filing a US Patent (#6122564, "Apparatus and methods for monitoring and controlling multilayer laser cladding") in June 1998 @UM, since all the basic knowledge and practice had been established and developed since mid of eighties. He was approached and proposed by a local business entrepreneur in Detroit area to charter a start-up company, named POM (Precision Optical Manufacturing) Inc. in 1998. His involvement of POM was not only technical advising but also guiding commercial adoption of LAM technology utilizing closed-loop feedback control technology as new paradigm of manufacturing technology. In 2006, he invited me to join POM to help the company R&D and engineering in LAM and commercialization of LAM further in the US government market. At POM he initiated to launch a series of laser-based additive manufacturing machines and facilitated to expand laser applications into the Auto industry.

Meanwhile, he launched another company, SenSigma, commercializing smart optical monitoring system (SOMS) based on laser spectroscopy, in 2011. A couple of US patents (#6479168B2, "Alloy based laser welding" and #8723078B2, "Monitoring of a welding process") developed @UM were the foundation to start SenSigma, commercialization based on the patents, after a positive request from UM Tech Transfer Office, instead of selling his patents to local auto manufacturers. Unloading POM in 2013 and putting more focus on development work of SenSigma, he again called me to help further development and commercialization of SOMS. He always looked ahead in the future, and thought next breakthrough technology in the advanced laser manufacturing should be in the area of smart sensing, monitoring, and feedback control, filing another US patent in 2015 (#9981341, "Smart Additive Manufacturing System

1 ' Theodor W. Hänsch (Max-Planck-Institut für Quantenoptik) was invited in the ICALEO 2000, and later received his Nobel Prize in Physics 2005.

(SAMS)). He wanted to figure out how materials properties interacting with laser can be monitored and controlled via connecting dots of laser to atoms to plasma to applications to properties. He was always a man of "forward thinking".

In a weekly Friday morning meeting just before the second coronary bypass surgery, he told me "Choi, I wished to postpone the surgery but the doctor does not allow me no further delay, no choice, I will be back soon". I replied as usual "Good luck, professor" and "see you soon". We all wished him get back well as usual, since he was a fighter to overcome so many medical difficulties, but that was the last time I saw him in-person. I had information about his condition regularly from his wife (Dr. Aparajita Mazumder). On Monday early morning, April 12, I got a call from his first-son (Debashis), "He passed away on Saturday at 2:00pm. He was doing a lot better a week ago and we were making plans to bring him home but he suddenly had an infection that he was unable to overcome." It was a heartbreakingly sad call. All memories of him passed me instantly and vividly since joining his group in late eighties.

I knew that he loved to work with laser after the first meeting and later noticed his commuting vehicle title, displaying even as "1 LASER" shown in Fig. 3. He often mentioned to all of us, "you guys are working with a big toy", he meant by laser, and it was his fashion working with laser during most of his life until last. I would say he should be a man of "laser", which he had loved working with. He was gone but not forgotten, gone but ever here with us. No longer living in this world, but always and ever near us in our memory.

Figure 3. Prof. JM's Michigan License plate "1 LASER"

Watch a touching tribute to the late Prof. Jyoti Mazumder by his colleagues and friends in the On-Demand section of the ICALEO 21 event platform (available until Nov 19, 2021)