Optical Coatings for Laser Applications

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 **Prof. Dr. Andreas Ettemeyer**	**Prorektor, NTB, 9471 Buchs SG, Switzerland** andreas.ettemeyer@ntb.ch | www.ntb.ch Andreas Ettemeyer studied Mechanical Engineering in Munich and Aachen and graduated on holographic interferometry in Stuttgart. During nearly 20 years in industry, he concentrated on optical measuring techniques such as holography and speckle interferometry. In 1989 he founded and managed a company for production of laser measuring systems until he moved back to academia in 2005. Today he is professor for Technical Optics at NTB Interstate University of Applied Sciences in Buchs, Switzerland. **Welcome note**
 **Dr. Richard Quaderer**	**CEO, Rhysearch, Buchs SG** richard.quaderer@rhysearch.ch | www.rhysearch.ch Richard Quaderer hat an der ETH Chemie studiert und hier auch seine Doktorarbeit verfasst. Daran schloss sich ein PostDoc-Aufenthalt an der Brown University in Providence, Rhode Island, in den USA an, der durch den Schweizerischen Nationalfonds finanziert wurde. Von 2007 bis 2013 arbeitete er in unterschiedlichen Positionen in der Biotechnologischen Forschung der Lonza AG in Visp VS. Berufsbegleitend absolvierte er an der EPFL und der Université de Lausanne einen Executive-MBA mit dem Schwerpunkt Technologiemanagement (MoT). Seit dem 1. Dezember 2013 ist Richard Quaderer Geschäftsführer von RhySearch. **Welcome note**
 **Dr. rer. nat Carsten Ziolek**	**Head Institute for Production Metrology, Materials and Optics (PWO), NTB, Buchs SG** carsten.ziolek@ntb.ch | www.ntb.ch/pwo Born 1972 in Gehrden, Germany. Studied Physics at the University of Hannover and received his doctorate degree on high-repetiton rate solid-state erbium lasers at the Laser Center Hannover. From 2001 to 2004 projekt leader at Trumpf Laser GmbH + Co. KG in Schramberg, Germany. Responsible for the development of the thin disk lasers HLD 251 & HLD 501 as well as fundamental aspects of the TruMicro Series 5000 und 7000 lasers. From January 2004 till 2015 head of the Research & Development department of Trumpf Laser Marking Systems AG, Switzerland. Since 2015 Head PWO, NTB **Chairman am session + Conclusion**

Dr. Marwan Abdou-Ahmed

Institut für Strahlwerkzeuge (IFSW), Stuttgart University, 70174 Stuttgart, Germany
marwan.abdou-ahmed@ifsw.uni-stuttgart.de | www.ifsw.uni-stuttgart.de

Dr. Marwan Abdou-Ahmed received his PhD degree in 2003 at the University of Saint-Etienne, and his Habilitation degree for the University Paris-Sud XI in 2012. He joined the IFSW in 2004 where he is responsible for the *laser development and laser optics* department since 2011. M. Abdou-Ahmed and his team are focusing on ultrafast and high-power thin-disk lasers and on beam shaping optics.

Grating-waveguide structures and their applications in high-power laser systems
The keynote talk will give an overview the application of Grating Waveguide Structures (GWS) or grating mirrors in high-power laser systems. After a brief introduction to their principle mechanism of GWS, the presentation will focus on the key aspects in their designs and fabrication. Different approaches for the control of the polarization (linear or cylindrical polarization) state as well as the spectral bandwidth of a laser emission will be presented. Experimental validations within high-power thin-disk lasers will be reported together with the future development of grating mirrors.

Dr. Thorsten Best

Optic Balzers Jena GmbH, 07745 Jena, Gemany
thorsten.best@opticbalzers.com | www.opticbalzers.com

Jahrgang 1978. Studium der Physik, Promotion 2011, anschließend Wissenschaftlicher Mitarbeiter an der Universität Innsbruck, Bereich Laserspektroskopie. Seit 2014 Projektleiter F&E bei Optics Balzers Jena GmbH. Aktuelle Tätigkeitsschwerpunkte sind Optiken für den Weltraum-Einsatz, Laseroptiken und optische Messtechnik zur Dünnschichtcharakterisierung.

High Performance Laser Mirrors produced with Plasma-Assisted Reactive Magnetron Sputtering
Ion Beam Sputtering (IBS) is currently the standard technology for high-performance laser mirrors. Recent advances in magnetron sputtering process technology, in particular Plasma-Assisted Reactive Magnetron Sputtering (PARMS) allow for the production of laser mirrors with superior performance, in terms of optical losses, precisely controlled spectral behavior and resistance to laser-induced damage. Various examples demonstrating the potential of PARMS for the production of laser mirrors will be shown.

Dr. Laurent Gallais

Fresnel Institute, 13013 Marseille, France
laurent.gallais@fresnel.fr | www.fresnel.fr

Laurent Gallais, PhD in 2002, conducts research activities at the Institut Fresnel since 1999, dealing with high power laser / material interactions: laser damage of optical interference coatings in the fs to ns regime, laser damage mitigation of optical components, and laser processing of thin films for various applications.

Laser damage resistance of optical coatings in the sub-ps regime: limitations and improvement of damage threshold
The object of this talk will be to introduce the topic of short-pulse laser damage in optical coatings in order to understand the intrinsic limitations depending on the application, and the possibility of laser damage resistance improvement.
We will firstly describe the physical process of a high intensity fs laser pulse interaction with an optical coating and how this interaction can lead to a damage of the film. Then we will present the main facts about laser damage resistance of coatings that are relevant for applications and related to the previously described processes: the dependence of the Laser-Induced Damage Threshold (LIDT) of coating materials with bandgap, the decrease of LIDT with the pulse number, the wavelength and pulse duration dependence, etc…We will also discuss on the open question of the role of macroscopic defects (such as nodules) in this regime and present recent results in this field. Eventually different strategies to improve the laser damage resistance will be discussed: engineering of the electric field distribution in the stack, fabrication of mixture materials with enhanced LIDT, mitigation of defects, etc…

Dr. Roelene Botha

Senior Research Engineer, PWO, NTB, Buchs SG, Switzerland
roelene.botha@ntb.ch | www.ntb.ch

Roelene Botha received her PhD degree in Applied Physics at the Ecole Polytechnique, Palaiseau (France) in 2008. Since November 2014 she is a senior research engineer at the PWO at NTB. She is responsible for the LIDT measurement system and the build-up of the RhySearch centre for Optical High End Coatings.

Posteroverview + LIDT Testing at NTB
As part of a KTI-Project, RhySearch and its partners form the photonics industry have joined forces to install a LIDT measurement facility at the NTB. The first results form the LIDT testbench are presented, together with the planned future developments for the RhySearch centre for Optical High End Coatings.

Dr. Christoph S. Harder

President Swissphotonics, 8832 Wollerau SZ, Switzerland
harder@swissphotonics.net | www.swissphotonics.net

Dr. Christoph S. Harder received the ETH Diploma in 1979 and the Master and PhD in EE in 1980 and 1983 from Caltech, Pasadena, USA. He is cofounder of the IBM Zurich Laser Diode Enterprise which pioneered the first 980nm high power pump laser for telecom optical amplifiers and laser diodes for industrial and consumer applications with ultrahigh reliability. He is the recipient of a Fulbright scholarship and the OSA Fellow recognition.
Christoph is now heading a consulting company and is cofounder of Swissphotonics and has been its president for the last few years.
He has published more than 100 papers and 20 patents and has held a variety of staff and management positions at ETH, Caltech, IBM, Uniphase, JDS Uniphase, Nortel and Bookham and has volunteered on society boards and committees.

Chairman pm session

Dr. rer. nat. Adriana Viorica Szeghalmi

Friedrich Schiller University, Jena
a.szeghalmi@uni-jena.de | www.uni-jena.de

Adriana Viorica Szeghalmi works interdisciplinary in the development of atomic layer deposition coatings for optical applications at the Friedrich Schiller University and Fraunhofer Institute of Applied Optics and Precision Engineering - IOF in Jena. She studied Chemistry and Physics in Cluj-Napoca, Romania and did her PhD in Raman and surface enhanced Raman scattering spectroscopy in Würzburg, Germany. As a postdoctoral fellow at the University of Manitoba in Canada, she conducted research in the microspectroscopy of animal and plant tissues by means of infrared spectroscopy and Surface-Enhanced Raman Spectroscopy (SERS). 2007, she returned to Germany to work in a new research field and got trained in Atomic Layer Deposition (ALD) at the Max Planck Institute of Microstructure Physics in Halle (Saale, Germany). Since 2010, she has been leading an Emmy Noether Research Group at the university and since 2015, she has been the head of an Attract Group at the Fraunhofer IOF. Her research focus is on the material development, refractive and diffractive optics by means of ALD.

Overview of ALD Activities for Optical Applications
ALD is a powerful coating technology for optical applications because it allows uniform and conformal coatings on complexly shaped and nanostructured substrates. Besides, the composition and properties of ALD thin films are atomically tuned towards novel, multicomponent materials. Here, we will present on the optical and mechanical properties and morphology of relevant oxides made by thermal and plasma enhanced ALD. Silica and nanoporous SiO_2, Al_2O_3, HfO_2, and TiO_2 have been developed as low and high refractive index materials. Interference multilayers such as antireflection coatings, dichroic mirrors and various diffractive optics have been demonstrated. In particular current challenges for ALD thin films will be discussed.

Dr. Kai Starke

CEO, Cutting Edge Coatings Gmbh, 30419 Hannover, Germany
starke@cutting-edge-coatings.com | www.cutting-edge-coatings.com

Born 1971
1992-1998 Physics Studies in Bielefeld and Hannover.
1998-2001 Scientific Co-worker of Laser Components Department (headed by Prof. Detlev Ristau) at Laser Zentrum Hannover e.V., (LZH)
2001-2008 Group-Leader *Characterization* of Laser Components Department at LZH
2004 PhD degree
2007 Foundation of Cutting Edge Coatings GmbH, CEO
2013 Foundation of GIESS GmbH Gridded Ion Engines, Sources & Services, CEO

Ion-Beam Sputtering in the Industrial Production
Leading-edge applications in precision and laser optics demand functional surfaces with very low optical losses. Arising from innovative solutions for producing ring-laser gryo mirrors in the 1970s, IBS has conquered its central place in the family of industrial thin film deposition processes. In the presentation, general principles and current innovations and challenges are described.

Dr. Vladimir Pervak

Group Leader, Ludwig-Maximilians-University, 80539 Munich, Germany
vladimnir.pervak@physik.uni-muenchen.de | www.uni-muenchen.de

Vladimir Pervak received his MSc degree in Physics from the Kiev National Taras Schevchenko University, Ukraine, in 2004. In 2006, he received his PhD in Physics at the Max-Planck-Instiute of Quantum Optics, Munich, and Kiev National Taras Schevchenko University. Currently, he is leading his team in the research group of Prof. Ferenc Krausz at the Max Planck Institute of Quantum Optics and Ludwig Maximilians University. He has more than 200 technical and scientific publications. His research interests include interference coatings, ultrafast sources, and nonlinear optics.

Dispersive optics: Limits and challenges
Nowadays, dispersive mirrors are able to cover the wavelength range of 4.5 optical octaves and can be used from 220 nm up to 4500 nm. Various design approaches to dispersive mirrors in visible and near IR are briefly discussed. We consider in more detail two dispersive mirrors representing extreme cases. The first one is a mirror working in the range of 290−360 nm and providing group delay dispersion of -75 fs^2. The second one is a mirror working in the range of 1028-1032 nm and providing -10000 fs^2 of group delay dispersion.

Prof. Dr. Markus Aspelmeyer

Group leader, Vienna University, 1010 Vienna, Austria
markus.aspelmeyer@univie.ac.at | www.iqoqi.at

Markus Aspelmeyer is Professor of Physics at the University of Vienna, Austria. His research combines the development of new quantum technologies with fundamental quantum experiments. Aspelmeyer is a founding member and present Speaker of the Vienna Center for Quantum Science and Technology (VCQ). In 2012 he has co-founded the high-tech company *Crystalline Mirror Solutions*, which provides novel optics for laser precision measurements.

Crystalline Coatings - a new paradigm in optical coating technology
Substrate-transferred crystalline coatings allow to exploit the unique properties of single-crystal semiconductor coatings for high-end laser optics applications. In comparison with dielectric IBS coatings, crystalline coatings exhibit order of magnitude improvements in mechanical loss (i.e. thermal noise), thermal conductivity, and potentially in absorption losses in the mid-infrared spectral region. I will discuss the current status and provide several application examples including ultra-stable lasers, optical precision measurements, high-power SESAMs, and high-finesse MIR optical cavities in the fingerprint region for optical trace gas sensing.

Prof. Dr. Patrik Hoffmann

Head – Laboratory of Advanced Material Processing (LAMP), Epma, Materials Science and Technology, 3600 Thun, Switzerland
patrik.hoffmann@empa.ch | www.empa.ch

Adjunct Professor at The Laboratory for Photonic Materials and Characterization (LPMAT), Swiss Federal Institute of Technology Lausanne, EPFL, Lausanne, Switzerland.
Chemistry studies at University of Karlsruhe, PhD thesis at EPFL in 1992. Industrial experience at IBM San Jose (USA) and manager of dental section in company (Germany). Since 1997 research and teaching Laser Micro-Processing at EPFL. Since April 2009 heading LAMP at Empa, continuing teaching at EPFL. Author of 111 peer reviewed journal papers and inventor of 6 patents.

Devastative contamination on DUV Laser mirrors and dreams for laser processing
Excimer laser direct ablation is a unique method for large surface micropatterning of master polymer foils for large surface microstructuring. A volatile silicone oil, used as adhesion liquid for foil placing, turned out as devastative adsorbate destroying the DUV optics by deposition of a SiO_2(C) layer. Digital micro-mirror devices as tools for direct pattern ablation remain a dream due to inflexibility of industry.

Dr. Hans Ebinger

VR RhySearch, Buchs SG
hans.ebinger@rhysearch.com | www.rhysearch.ch

Hans Ebinger conducted research work in the field of surface science and holds a PhD in physics. He started his professional career with the development of multilayer coaters for optical disc production. He moved from R&D to product management and finally general management of hightech companies. Hans Ebinger is a member of the RhySearch executive board and currently delegated to set up a new research activity on precision manufacturing.

Workshop: Summary of presentations and discussion of current topics for development
RhySearch is looking for future project ideas and seeks input from workshop participants. Every participant is kindly requested to write down one or two project ideas over the course of the day. These project ideas will be collected, screened and clustered for afternoon group discussion. The resulting project proposals will be presented to the general audience at the end of the workshop.

SWISS PHOTONICS

Managing director
Dr. Christian Bosshard
bosshard@swissphotonics.net
+41 61 690 60 40

President
Dr. Christoph Harder
harder@swissphotonics.net
+41 79 219 90 51

Internet
www.swissphotonics.net

Dr. rer. nat Carsten Ziolek
Coordinator **SNOP**
(**S**wiss **N**ational **O**ptics **P**latform)
+ 41 81 755 34 50

Dr. Roelene Botha
Senior Research Engineer
roelene.botha@ntb.ch
+41 81 755 33 41

Dr. Richard Quaderer
CEO RhySearch
richhard. quaderer@rhysearch.ch
+41 081 755 49 52