European Optical Society

Coherence for Europe

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European Optical Society

Coherence for Europe

CONFERENCE PROGRAM

EOS Topical Meeting on Diffractive Optics 2019

16. – 19. September 2019
Jena, Germany

in co-operation with
and sponsored by

LightTrans

sponsored
by

HOLOEYE

SUNNY OPTICAL TECHNOLOGY

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Monday, 16 September	Tuesday, 17 September	Wednesday, 18 September	Thursday, 19 September	
Registration				8:30
Invited Speaker: **Sven Burger**	Guest of Honor: **Bernard Kress**	Invited Speaker: **Patrice Genevet**	Invited Speaker: **Michael A. Golub**	9:30
THEORY & CONCEPTS I	AR & VR	NANOSTRUCTURES	APPLICATIONS II	10:00 – 10:40
Coffee Break				11:00
Invited Speaker: **Uwe Zeitner**	Invited Speaker: **Jürgen Jahns**	Invited Speaker: **Andreas Erdmann**	THEORY & CONCEPTS V	11:30
GRATINGS I	THEORY & CONCEPTS II	APPLICATIONS I		12:00 – 12:40
Lunch				13:00
Invited Speaker: **Tommi Hakala**	Invited Speaker: **Philippe Lalanne**	SPONSOR SESSIONS HOLOEYE Photonics AG Sunny Optical Technology Group LightTrans International UG	THEORY & CONCEPTS VI	14:00
GRATINGS II	THEORY & CONCEPTS III			14:30 – 15:10
Coffee Break with Poster Session			Closing Ceremony	15:30
GRATINGS III	THEORY & CONCEPTS IV	Conference Excursion & Dinner at Restaurant Landgrafen		16:00 – 16:40
				19:00 – 22:00

GENERAL INFORMATION

INFORMATION FOR AUTHORS AND ATTENDEES

EOS REGISTRATION DESK

Registration hours:	Sunday, 15 September	19:00 – 21:00 (at Welcome Reception)
	Monday, 16 September	08:00 – 18:00
	Tuesday, 17 September	08:30 – 16:00
	Wednesday, 18 September	08:30 – 14:00
	Thursday, 19 September	08:30 – 11:30

Attendees requiring a payment receipt or confirmation of attendance may obtain these documents on-site at the EOS registration desk. Attendees paying by cash are requested to have the exact change ready in Euro.

ORAL PRESENTATION

- Time slots: Invited talks 30 minutes including 3 – 5 minutes for discussion, contributed talks 20 minutes including 3 – 5 minutes for discussion. Please, prepare your talk to meet these time limits.
- Technical equipment: Preferrably use the session hall laptop for your presentation. Bring your presentation on an USB-stick (PDF-format or Microsoft PowerPoint file with fonts embedded) and save your presentation file on this computer before the session starts.
- Alternatively, you can bring your own laptop. Both Windows and Mac systems are allowed.
- Session hall equipment: Adapters for DVI to HDMi, Displayport to HDMI, Mini-Displayport auf HMDI (please bring yourself if you need other adapters, e.g. for newer Mac versions). Remote control including laser pointer, headset and handheld microphone (usage is recommended) are available.

POSTER PRESENTATION

- Poster size: A0 (portrait)
- Time and location: The poster sessions take place during coffe breaks on Monday, 16 September and Tuesday, 17 September, between 15:30 and 16:00 at the conference area.
- Set-up: Starting from Monday, 16 September morning. Posters can be put in place during the coffee and lunch breaks. Poster numbers will be displayed on the poster boards to show authors where to place their poster. Pins for poster mounting will be provided.
- Poster removal: Latest on Thursday, 19 September after the closure of the meeting until 15:30.
- Authors are requested to be present at their posters during the official poster sessions.
- Poster set-up and removal is in the responsibility of the authors.

W-LAN

- The Abbe Center offers free wireless Internet access (WiFi) at the conference area. Access data will be communicated on-site.

GENERAL INFORMATION

INFORMATION FOR AUTHORS AND ATTENDEES

City of Jena

GENERAL INFORMATION

INFORMATION FOR AUTHORS AND ATTENDEES

WELCOME RECEPTION

We will welcome the conference attendees on Sunday, September 15, at 19:00 in the Villa Rosenthal (Mälzerstraße 11). During the welcome reception Prof. Frank Wyrowski will give a plenary talk. Remember to be there in time. You also have the possibility to register for the conference.

CONFERENCE EXCURSION AND DINNER – sponsored by Sunny Optical Technology

On Wednesday, September 18, we will have our conference excursion from 15:00. We will use public transport to get from the conference location to the city center, from where we will walk up one of the famous hills in Jena – the Landgraf. On this hill you can explore the surrounding woods and the historical battlefield upon which a famous battle of the Napoleonic Wars was fought. After you have explored the surroundings, we will have a champagne reception followed by the conference dinner at the Landgrafen Restaurant against the backdrop of one of the best views over the City of Light – Jena.

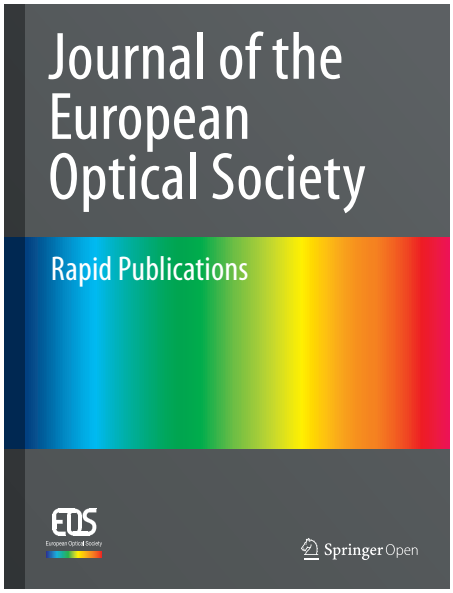
15:00 Public Transportation from Beutenberg to the city center
15:30 Walk up to Landgraf
17:00 Champagne Reception
18:30 Dinner

CATERING

Conference participants may attend the free catering during the conference. Lunch will be offered at the Beutenberg campus canteen at Abbe-Zentrum building.
After the conference you may enjoy one of the many restaurants and bars in the city centre.

PAPER PUBLICATION IN JEOS:RP

Presenters at EOS Topical Meeting on Diffractive Optics 2019 are kindly invited to consider the submission of a manuscript of their research to the EOS open-access online journal JEOS:RP (Journal of the European Optical Society, Rapid Publications, jeos.springeropen.com). JEOS:RP publishes articles about recent scientific research and technological innovation as well as review papers about a topic in science or innovations from the recent past. A contribution should be original and will be subjected to the journal's standard anonymous peer review process for scientific quality. The average time-to-publication of the journal is of the order of 75 days.



Impact factor: 1.250
Fee for EOS Members: 950 EUR

EOS TOPICAL MEETING ON DIFFRACTIVE OPTICS 2019

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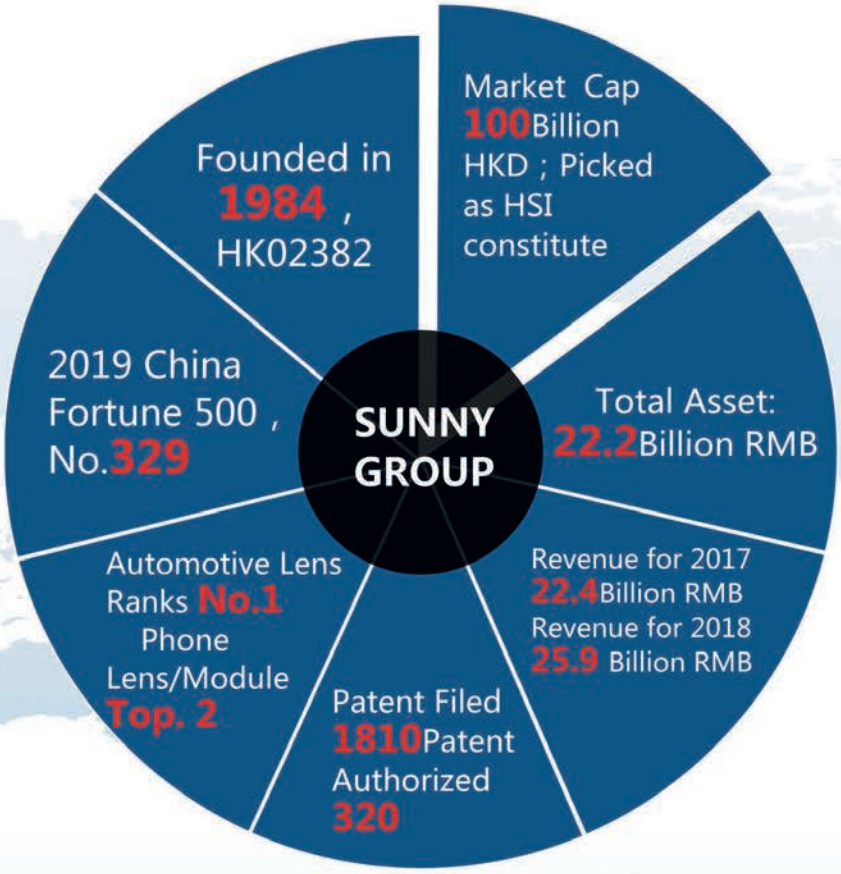
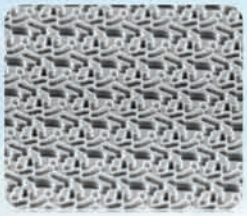


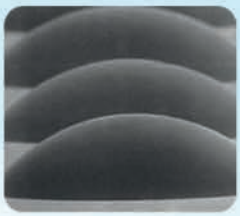
About Sunny OmniLight :

Sunny OmniLight Technology Co., Ltd belongs to Sunny Optical Group and was formally established in January 2019. Benefiting from a highly-educated and well-experienced engineer team, the company has strong capabilities in R&D and mass production. At present, the main products of Sunny OmniLight are the DOE (structure light element) and Diffuser (ToF time-of-flight element) for smartphone 3D application. Meanwhile, the company provides customers with complete technical solutions, including design simulation, template processing, imprinting process optimization, laser cutting, equipment customization and so on. In the future, the company will pay more attention on the capability of R&D and product delivery in AR glass lightguide, waveguide, biosensing and metalens.

Products



* DOE
Structure Light

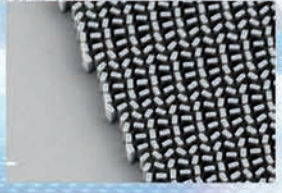


* Diffuser
Diffuser in the ToF module

Future application

AR glass lightguide

Biosensing



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SCIENTIFIC COMMITTEE

WELCOME MESSAGE

It is our pleasure to meet you in Jena in this meeting, twenty years after the first EOS Topical Meeting in Jena in 1999. This conference series has been organized under the EOS „umbrella" since 1995. We gladly recognize that some of you have been present in these meetings from the very beginning in Prague (1995), and continued to participate in the meetings organized in Savonlinna (1997), Jena (1999), Budapest (2001), Oxford (2003), Warsaw (2005), Barcelona (2007), Koli (2010), and Delft (2012). In 2014 and 2016 the meeting was part of EOSAM, after which the interest in the meeting proved that it has sufficient significance to „stand alone" as an EOS Topical Meeting. It was thus succesfully organized in 2017 in Joensuu, Finland as a stand alone meeting, followed by Jena. All newcomers to the field are equally welcome, and we wish everybody a pleasant conference!

Jari Turunen | Co-Chair | University of Eastern Finland (Finland)
Frank Wyrowski | Co-Chair | Friedrich-Schiller University Jena (Germany)

International Program Committee

Benfeng Bai | Tsinghua University (China)
Pierre Chavel | Institut d'Optique (France)
Hans Peter Herzig | Ecole Polytechnique Fédérale de Lausanne (EPFL) (Switzerland)
Jürgen Jahns | FernUniversität Hagen (Germany)
Bernard Kress | Microsoft Corporation (USA)
Irina Livshits | ITMO University (Russia)
Jesús Lancis | Universitat Jaume I (Spain)
Paul Urbach | TU Delft (Netherlands)
Site Zhang | LightTrans International UG (Germany)

GUEST OF HONOR AND PLENARY SPEAKER

Tuesday, September 17 | 09:30
Bernard Kress | Microsoft Corporation, USA

After 50 years in the making,
have diffractives finally captured the attention of mainstream industry?

INVITED TALKS

Monday, September 16

09:30 – 10:00 Session: Theory & Concepts I

Spectral expansion of the scattering response of resonant nanostructures

F. Binkowski[1], L. Zschiedrich[2], P.-I. Schneider[2], M. Hammerschmidt[1], X. G. Santiago[1,2,3], F. Betz[1], and S. Burger[1,2]
[1]Zuse Institute Berlin (DE), [2]JCMwave GmbH (DE), [3]Karlsruhe Institute of Technology (DE)

In this contribution we review ecently developed methods for modal expansion using Riesz projections and for global optimization of nanophotonic devices using Bayesian optimization.

11:30 – 12:00 Session: Gratings I

Tailored diffraction by lithographically realized nano-structures

U. D. Zeitner[1,2], T. Flügel-Paul[1], F. Burmeister[1], D. Michaelis[1], G. Widholz[2], and S. Linß[2]
[1]Fraunhofer Institute for Applied Optics and Precision Engineering (DE), [2]Friedrich Schiller University Jena (DE)

Optical microstructures with feature sizes in the sub-wavelength range have a huge potential to improve the optical functionality of diffractive elements. Utilizing state-of-the-art lithographic techniques for their fabrication allow using this potential for applications like high-precision CGHs or space-borne spectroscopy.

14:00 – 14:30 Session: Gratings II

Condensation and lasing phenomena in periodic nanoparticle lattices

T. K. Hakala, University of Eastern Finland (FI)

I review our recent progress on lasing and photonic condensation in metallic nanoparticle lattices overlaid with organic fluorescent molecules. Under sufficient optical pumping, the system evolves from lattice modified spontaneous emission to lasing or Bose-Einstein condensation (BEC), depending on the system parameters. We can selectively produce lasing or condensation by varying a single parameter, namely the periodicity of the lattice.

Tuesday, September 17

09:30 – 10:00 Session: AR & VR

After 50 years in the making, have diffractives finally captured the attention of mainstream industry?

B. Kress, Microsoft Corporation (US)

Diffractive optics have undergone a long but steady journey from being considered as parasitic features in optical imaging systems to becoming the workhorse for the spectroscopy field since the mid 1800s. With recent developments of diamond turning machining, wafer scale process, new holographic material developments, micro- and nano-scale mass replication techniques, they have enabled new fields, turning their strong spectral dispersion and thin form factor into desirable features for imaging and display systems, new industrial and biomedical sensors, integrated chips for telecom and optical computing, optical data storage platforms, optical anti-counterfeiting elements, and new laser material processing tasks.

11:30 – 12:00 Session: Theory & Concepts II

Planar-integrated free-space optics – old concept, new applications

J. Jahns, FernUniversität in Hagen (DE)

The concept of microoptical integration by folding an optical system into a slab of a transparent material was suggested in the 1980s. It is generally of relevance for applications, where small size and high functionality is required. Here, we review the concept, aspects of design and fabrication and consider recent applications.

14:00 – 14:30 Session: Theory & Concepts III

Light interaction with nanoresonators: mode volume and quasinormal mode expansion

P. Lalanne, LP2N, Institut d'Optique Graduate School, CNRS, Université de Bordeaux (FR)

The most general motion of a system is a superposition of its normal modes, or eigenstates. For Hermitian system, clasical normal mode theory applies. For non-Hermitian systems, presently a lot of progress is done to describe the response of optical micro and nanoresonators in their quasinormal mode basis. We have developed a rigorous modal analysis of nanoresonators with unprecedented generality and report numerical results for the general case of 3D resonators, made of dispersive materials on substrate with guiding layers.

Wednesday, September 18

09:30 – 10:00 Session: Nanostructures

Semiconductor metasurfaces and applications

P. Nil, H. Ren[2], G. Briere[1], Y.-Y. Xie[3], A. De Luna Bugallo[4], and P. Genevet[1]
[1]Université Cote d'Azur, CNRS, CRHEA (FR), [2]Ludwig-Maximilians-University Munich (DE), [3]Beijing University of Technology (CN), [4]CONACYT—Cinvestav Unidad Querétaro (MX)

Allowing subwavelength-scale-digitization of optical wavefronts to achieve complete control of light at interfaces, metasurfaces are particularly suited for the realization of planar optical components. Here, we will discuss recent results obtained recently in our group on semiconductor metasurfaces for laser beam engineering and holography.

11:30 – 12:00 Session: Applications I

Understanding and optimization of EUV light diffraction and imaging for lithography

A. Erdmann, Fraunhofer IISB (DE)

Future generations of semiconductor chips will be fabricated using extreme ultraviolet (EUV) lithography. We describe the imaging challenges of EUV projection systems and how computational lithography can be used to understand and optimize the light diffraction from EUV masks and its impact on imaging.

Thursday, September 19

09:30 – 10:00 Session: Applications II

Non-paraxial design of diffractive optical elements and meta-surfaces

M. A. Golub and O. Barlev, Tel Aviv University (IL)

Theoretical considerations and experimental results for diffractive optical elements (DOEs) that perform at large incident and output angles are demonstrated. The high-NA resonance-domain diffractive lenses and structured light DOEs with large fan angles are considered. Applications in beam combining and 3D sensing are discussed.

CONFERENCE PROGRAM

DAILY OVERVIEW

Invited talks 30 minutes including 3 – 5 minutes for discussion, contributed talks 20 minutes including 3 – 5 minutes for discussion.

Sunday, September 15

19:00 – 22:00

Welcome Reception & Registration at Villa Rosenthal (Mälzerstraße 11, Jena).

Monday, September 16

8:00 Registration

09:30 – 11:00 Session: Theory & Concepts I

1. Invited: F. Binkowski, L. Zschiedrich, P.-I. Schneider, M. Hammerschmidt, X. Garcia Santiago, F. Betz, and S. Burger (Germany): *Spectral expansion of the scattering response of resonant nanostructures.*
2. M. Yousefi, T. Scharf, and M. Rossi (Switzerland): *Simulation of microoptics under inhomogeneous illumination.*
3. H. Zhong, S. Zhang, R. Shi, C. Hellmann, and F. Wyrowski (Germany): *A k-domain method for fast propagation of electromagnetic fields through graded-index media.*
4. L. Li (China): *Scattering matrices and polarization properties of gratings in conical mounting and crossed gratings.*

11:00 – 11:30 Coffee Break

11:30 – 13:00 Session: Gratings I

5. Invited: U. D. Zeitner, T. Flügel-Paul, F. Burmeister, D. Michaelis, G. Widholz, and S. Linß (Germany): *Tailored diffraction by lithographically realized nano-structures.*
6. E. Koussi, H. Bruhier, M. Usuga, I. Verrier, N. Crespo-Monteiro, O. Parriaux, and Y. Jourlin (France): *Resonant grating demonstration in the inner of a cylinder.*
7. M. Burkhardt, M. Steglich, D. Lehr, M. Helgert, A. Kalies, A. Pesch, and A. Gatto (Germany): *Customized EUV-gratings.*
8. N. Ebizuka, T. Okamoto, M. Sasaki, I. Tanaka, A. Hattori, S. Ozaki, and W. Aoki (Japan): *Novel gratings of high dispersion and high efficiency II.*

13:00 – 14:00 Lunch

14:00 – 15:30 Session: Gratings II

9. Invited: T. K. Hakala (Finland): *Condensation and lasing phenomena in periodic nanoparticle lattices.*
10. J. Wüster, Y. Bourgin, P. Feßer, and S. Sinzinger (Germany): *Nano-structured diffraction gratings as polarizing beam splitters under vertical incidence.*
11. E. Koussi, F. Bourquard, T. Tite, D. Jamon, F. Garrelie, and Y. Jourlin (France): *Thermally activated resonant grating using vanadium dioxide synthetized by pulsed laser deposition.*
12. E. Muslimov, J.-C. Bouret, C. Neiner, M. Ferrari, and E. Hugot (France): *Advanced cross-disperser gratings design for LUVOIR-POLLUX spectropolarimeter.*

15:30 – 16:00 Coffee Break wiht Poster Sessions (see page 30)

16:00 – 17:00 Session: Gratings III

13. K. Otaki, H. Toba, S. Yashiki, and A. Kagiwada (Japan): *High accurate measurement for the in-plane distortion of the semiconductor wafer.*

14. S. Kunath, R. Knoth, S. Steiner, S. Zhang, C. Hellmann, and F. Wyrowski (Germany): *Systematic optimization of a lightguide coupling set-up.*
15. C. Hellmann, S. Steiner, R. Knoth, S. Zhang, and F. Wyrowski (Germany): *Physical-optics analysis of lightguides for AR & MR glasses.*

Tuesday, September 17

8:30 Registration

09:30 – 11:00 Session: AR & VR

16. Invited: B. Kress (USA): *After 50 years in the making, have diffractives finally captured the attention of mainstream industry?*
17. B. H. Kleemann (Germany): *A diffractive see-through waveguide AR/VR display with up to 100° horizontal field of view.*
18. C. H. Gan, M.-E. Kleemann, A. Golos, and S. Valera (UK): *Modelling and characterisation of two-dimensional pupil expansion with crossed gratings in an augmented-reality display.*
19. S. Zhao, Q. Song, B. Sherliker, and J. Lewis (China & UK): *A geometric waveguide and a holographic film for the head-mounted display.*

11:00 – 11:30 Coffee Break

11:30 – 13:00 Session: Theory & Concepts II

20. Invited: J. Jahns (Germany): *Planar-integrated free-space optics – old concept, new applications.*
21. C. Hellmann, S. Steiner, R. Knoth, S. Zhang, and F. Wyrowski (Germany): *Design concept for AR lightguide devices.*
22. Z. Wang, O. Baladron-Zorita, and F. Wyrowski (Germany): *Numerical implementation of the homeomorphic Fourier transform and its application to physical-optics modeling.*
23. J. Babington (UK): *Classical optics, rays and waves: duality from the Feynman path integral.*

13:00 – 14:00 Lunch

14:00 – 15:30 Session: Theory & Concepts III

24. Invited: P. Lalanne (France): *Light interaction with nanoresonators: mode volume and quasinormal mode expansion.*
25. F. Wyrowski, O. Baladron-Zorita, and Z. Wang (Germany): *On the importance of homeomorphic operations in physical and geometrical optics.*
26. O. Baladron-Zorita, Z. Wang, C. Hellmann, and F. Wyrowski (Germany): *Physical-optics anatomy of the Gouy phase shift.*
27. Z. Xi, and H. P. Urbach (The Netherlands): *Retrieving the size of deep-subwavelength objects via tunable spin-orbit interaction.*

15:30 – 16:00 Coffee Break with Poster session (see page 30)

16:00 – 17:00 Theory & Concepts IV

28. S.-T. Hung, Z. Wang, and F. Wyrowski (Germany): *Concepts for modeling volume scatterers.*
29. A. Hannonen, K. Saastamoinen, L.-P. Leppänen, M. Koivurova, A. Shevchenko, A. T. Friberg, and T. Setälä (Finland): *Geometric phase in polarization beating of light waves.*
30. S. Mao and J. Zhao (China): *Optimal design of multilayer diffractive optical elements and its application in hybrid imaging system.*

CONFERENCE PROGRAM

DAILY OVERVIEW

Wednesday, September 18

8:30 Registration

09:30 – 11:00 Session: Nanostructures

31. Invited: P. Ni, H. Ren, G. Briere, Y.-Y. Xie, A. De Luna Bugallo, and P. Genevet (France, Germnay, China & Mexico): *Semiconductor meta-surfaces and applications.*
32. A. Talneau, F. Hentinger, and N. Belabas (France): *Sub-wavelength metamaterial for a finely tailored coupling coefficient within waveguides arrays.*
33. K. V. Nikolaev, V. Soltwisch, P. Hoenicke, F. Scholze, S. Heidenreich, J. de la Rie, S. N. Yakunin, I. A. Makhotkin, and F. Bijkerk (Germany, The Netherlands, Russia & Belgium): *A computational scheme for the characterization of 3D nano-structures using grazing-incidence X-ray fluorescence.*
34. P. Lalanne (France): *Metalenses: field of view and aberration.*

11:00 – 11:30 Coffee Break

11:30 – 13:00 Session: Applications I

35. Invited: A. Erdmann (Germany): *Understanding and optimization of EUV light diffraction and imaging for lithography.*
36. M. Kraus, E. Förster, T. Hönle, V. Bagusat, D. Thomae, R. Brüning, H. Hillmer, and R. Brunner (Germany): *Comparison of different concepts for compact cross-grating spectrometers.*
37. X. Wei and H. P. Urbach (The Netherlands): *Ptychography with multiple wavelength illumination.*
38. H. Ichikawa and H. Fujibuchi (Japan): *Diffractive optics encounters optical coherence tomography.*

13:00 – 14:00 Lunch

14:00 – 14:10 Sponsor Session: HOLOEYE Photonics AG

14:10 – 14:30 Sponsor Session: Sunny Optical Technology Group

14:30 – 14:50 Sponsor Session: LightTrans International UG

15:00 – 22:00 Conference Excursion & Dinner at Landgrafen Restaurant

Thursday, September 19

8:30 Registration

09:30 – 11:00 Session: Applications II

39. Invited: M. A. Golub and O. Barlev (Israel): *Non-paraxial design of diffractive optical elements and meta-surfaces.*
40. D. Fischer and S. Sinzinger (Germany): *Computer generated holography for lithography on curved surfaces.*
41. S. Calvez, A. Monmayrant, and O. Gauthier-Lafaye (France): *Towards high-speed tuning cavity resonator-integrated guided-mode resonance filters.*
42. S. Gharbi Ghebjagh and S. Sinzinger (Germany): *Multifocal complex-value phase zone plate for 3D focusing.*

11:00 – 11:30 Coffee Break

11:30 – 13:00 Session: Theory & Concepts V

43. L. Yang, I. Badar, R. Knoth, C. Hellmann, and F. Wyrowksi (Germany): *From iterative Fourier transform algorithm (IFTA) to "ray mapping" and back.*
44. R. Shi, C. Hellmann, and F. Wyrowski (Germany): *Connection of field solvers: microstructures and lenses.*
45. G. Zhang, K. Song, X. Yin, and K. Tian (China): *Customized diffuser design based on freeform lens array.*
46. Q. Song, L. A. Perez Covarrubias, Y. E. Pigeon, and K. Heggarty (France): *Inverse design for wavelength selective thick diffractive optical element.*

13:00 – 14:10 Lunch

14:10 – 15:30 Session: Theory & Concepts VI

47. S. Nie, T. Zhoa, H. Xiao, and Z. Fan (China): *Design of a spatial shaped laser beam used for piston temperature field simulation.*
48. B. O. Asamoah, F. Li, K. Alam, P. Li, T. K. Hakala, G. Kang, and J. Turunen (Finland & China): *Second harmonic generation in arrayed bull's eye structure.*
49. X. Yu, H. Zhong, and F. Wyrowski (Germany): *Physical-optics evaluation of BSDF for microstructures.*
50. I. Bhattacharya (India): *Study of intensity distributions in the far-field region of azimuthal Walsh filters.*

15:30 – 16:00 Closing Ceremony

-- NOTES -- NOTES --

09:30 – 11:00 Session: Theory & Concepts I

09:30 Spectral expansion of the scattering response of resonant nanostructures

Invited

F. Binkowski[1], L. Zschiedrich[2], P.-I. Schneider[2], M. Hammerschmidt[1], X. Garcia Santiago[1,2,3], F. Betz[1], and S. Burger[1,2]

[1]Zuse Institute Berlin, Germany, [2]JCMwave GmbH, Germany, [3]Karlsruhe Institute of Technology, Germany

In this contribution we review recently developed methods for modal expansion using Riesz projections and for global optimization of nanophotonic devices using Bayesian optimization.

10:00 Simulation of microoptics under inhomogeneous illumination

M. Yousefi[1,2], T. Scharf[1], and M. Rossi[2]

[1]Ecole Polytechnique Fédérale de Lausanne, Switzerland, [2]AMS AG, Switzerland

Far field pattern generation is investigated for thick sinusoidal phase grating under a Gaussian beam illumination to obtain a high field of view. We compare the Fraunhofer approximation with the High-NA propagator and demonstrate that the Fraunhofer approximation is not valid for thick phase gratings.

10:20 A k-domain method for fast propagation of electromagnetic fields through graded-index media

H. Zhong[1,2], S. Zhang[2], R. Shi[1,2], C. Hellmann[3], and F. Wyrowski[1]

[1]Friedrich Schiller University Jena, Germany, [2]LightTrans International UG, Germany, [3]Wyrowski Photonics GmbH, Germany

In this work we offer a k-domain-based method for the fast calculation of fields propagating through graded-index (GRIN) media. It is potentially fast because of two reasons: (1) in the k-domain, Maxwells equations for GRIN media become ordinary differential equations, so that we can take advantage of Runge-Kutta-type mathematical approaches to reduce the numerical effort; (2) taking advantage of fast Fourier transform algorithms to convert the convolution-type calculation (O(N2)) into a multiplication (O(N)). Several advantages arise when comparing this work with the famous split-step method: there is no paraxial approximation and the GRIN dependence along the main propagating direction can be accurately modeled.

10:40 Scattering matrices and polarization properties of gratings in conical mounting and crossed gratings

L. Li

Tsinghua University, China

A systematic treatment of the scattering matrices for one-dimensionally periodic gratings in conical mounting and for crossed gratings will be presented. The compositions of the scattering matrices will be given, and their physical interpretations and symmetry properties will be discussed.

11:00 – 11:30 **Coffee Break**

-- NOTES -- NOTES --

11:30 – 13:00 Session: Gratings I

11:30 Tailored diffraction by lithographically realized nano-structures

Invited

U. D. Zeitner[1,2], T. Flügel-Paul[1], F. Burmeister[1], D. Michaelis[1], G. Widholz[2], and S. Linß[2]
[1]Fraunhofer Institute for Applied Optics and Precision Engineering, Germany, [2]Friedrich Schiller University Jena, Germany

Optical microstructures with feature sizes in the sub-wavelength range have a huge potential to improve the optical functionality of diffractive elements. Utilizing state-of-the-art lithographic techniques for their fabrication allow using this potential for applications like high-precision CGHs or space-borne spectroscopy.

12:00 Resonant grating demonstration in the inner of a cylinder

E. Koussi, H. Bruhier, M. Usuga, I. Verrier, N. Crespo-Monteiro, O. Parriaux, and Y. Jourlin
Université de Lyon, Université Jean Monnet-Saint-Étienne, CNRS, Institut d'Optique Graduate School, Laboratoire Hubert Curien, France

The presentation describes the design of the cylindrical functional structure and the first demonstration of TE and TM resonant reflection, which occurs in the inner of guided mode resonant grating with an holistic incident wave excitation.

12:20 Customized EUV-gratings

M. Burkhardt, M. Steglich, D. Lehr, M. Helgert, A. Kalies, A. Pesch, and A. Gatto
Carl Zeiss Jena GmbH, Germany

The steady progress in technology leads to a growing number of options for the manufacturing of iffraction gratings for the EUV range. Several adapted techniques have been enhanced to meet the challenging specifications in terms of wave front error and roughness of all grating features. Latest results will be presented.

12:40 Novel gratings of high dispersion and high efficiency II

N. Ebizuka[1], T. Okamoto[2], M. Sasaki[3], I. Tanaka[4], T. Hattori[4], S. Ozaki[5], and W. Aoki[5]
[1]RIKEN, Center for Advanced Photonics, Japan, [2]RIKEN, Advanced Device Laboratory, Japan, [3]Toyota Technological Institute, Japan, [4]National Astronomical Observatory of Japan, Hawaii Observatory, USA, [5]National Astronomical Observatory of Japan, TMT Project Office, Japan

We introduce fabrication methods and results of prototypes of the volume binary (VB) grating of the high-dispersion echelle grism for the 8.2m Subaru Telescope. The VB grating for the first diffraction order has a spectral range as several times wide as a volume phase holographic grating. It is attractive for the any astronomical instruments.

13:00 – 14:00 **Lunch**

-- NOTES -- NOTES --

14:00 – 15:30 Session: Gratings II

14:00 Condensation and lasing phenomena in periodic nanoparticle lattices

Invited

T. K. Hakala
University of Eastern Finland, Finland

I review our recent progress on lasing and photonic condensation in metallic nanoparticle lattices overlaid with organic fluorescent molecules. Under sufficient optical pumping, the system evolves from lattice modified spontaneous emission to lasing or Bose-Einstein condensation (BEC), depending on the system parameters. We can selectively produce lasing or condensation by varying a single parameter, namely the periodicity of the lattice.

14:30 Nano-structured diffraction gratings as polarizing beam splitters under vertical incidence

J. Wüster, Y. Bourgin, P. Feßer, and S. Sinzinger
TU Ilmenau, Germany

Polarizing beam splitters have numerous applications in optical systems, e.g. for the measurement of freeform surfaces. We present a design and manufacturing process for a nanostructured diffraction grating with optimized diffraction efficiencies for TE- and TM-polarization, which acts as a beam splitter over a long range of incidence angles.

14:50 Thermally activated resonant grating using vanadium dioxide synthetized by pulsed laser deposition

E. Koussi, F. Bourquard, T. Tite, D. Jamon, F. Garrelie, and Y. Jourlin
Université de Lyon, Université Jean Monnet-Saint-Étienne, CNRS, Institut d'Optique Graduate School, Laboratoire Hubert Curien, France

The integration of a thin phase-change (MIT) VO_2 layer in a high indexed multilayered $SiO_2/TiO_2/VO_2$ configuration coated with an upper subwavelength photoresist grating leads to a strong TE reflection resonance peak, when combined with the VO_2 transition response at the 68°C temperature threshold. Q-switching applications can be favored.

15:10 Advanced cross-disperser gratings design for LUVOIR-POLLUX spectropolarimeter

E. Muslimov[1], J.-C. Bouret[1], C. Neiner[2], M. Ferrari[1], and E. Hugot[1]
[1]Aix-Marseille University, CNRS, CNES, LAM, France, [2]Paris Observatory, PSL University, CNRS, Sorbonne University, University Paris Diderot, Sorbonne Paris Cité, France

In this paper an update of the cross-disperser gratings design for the LUVOIR-POLLUX UV spectropolarimeter is presented. Three channels of the instrument use concave holographic gratings as the cross-disperser and camera mirror. Each of the grating is recorded by two oppositely directed beams, one of which is aberrated by a freeform mirror.

15:30 – 16:00 Coffee Break with Poster Session (see page 30)

16:00 – 17:00 Session: Gratings III

-- NOTES -- NOTES --

16:00 High accurate measurement for the in-plane distortion of the semiconductor wafer

K. Otaki, H. Toba, S. Yashiki, and A. Kagiwada
Optical Research Lab, Nikon Corp, Japan

We present a high accurate measuring procedure for the in-plane distortion of the semiconductor wafer. Transmission analyzer grating and the reflection wafer grating is placed closely and the in-plane distortion of the wafer is measured with the accuracy of sub-nm using phase uniformity of the diffraction wavefront.

16:20 Systematic optimization of a lightguide coupling setup

S. Kunath[1], R. Knoth[2], S. Steiner[2], S. Zhang[2], C. Hellmann[3], and F. Wyrowski[4]
[1]Dynardo GmbH, Germany, [2]LightTrans International UG, Germany, [3]Wyrowski Photonics GmbH, Germany, [4]Friedrich Schiller University Jena, Germany

Gratings for coupling light into or out of lightguides for near-to-eye display systems are optimized regarding the angular dependency of the field of view. Uniformity and relatively high efficiency over large FOV are obtained by a systematic design and optimization approach.

16:40 Physical-optics analysis of lightguides for AR & MR glasses

F. Wyrowski[1], C. Hellmann[2], S. Steiner[3], R. Knoth[3], and S. Zhang[3]
[1]Friedrich Schiller University Jena, Germany, [2]Wyrowski Photonics GmbH, Germany, [3]LightTrans International UG, Germany

Lightguides in combination with gratings seem to be a promising candidate for the development of AR/MR glasses. Though ray tracing can give initial insight into the performance of lightguides, an analysis which includes all relevant effects must be based on a physical-optics approach which is fast and user-friendly. With the Fast Physical Optics technique in our software VirtualLab Fusion we provide such a modeling approach.

ORAL PRESENTATIONS

TUESDAY, SEPTEMBER 17

-- NOTES -- NOTES --

09:30 – 11:00 Session: AR & VR

09:30 **After 50 years in the making, have diffractives finally captured the attention of main stream industry?** **Invited**

B. Kress
Microsoft Corporation, USA

Diffractive optics have undergone a long but steady journey from being considered as parasitic features in optical imaging systems to becoming the workhorse for the spectroscopy field since the mid 1800s. With recent developments of diamond turning machining, wafer scale process, new holographic material developments, micro- and nano-scale mass replication techniques, they have enabled new fields, turning their strong spectral dispersion and thin form factor into desirable features for imaging and display systems, new industrial and biomedical sensors, integrated chips for telecom and optical computing, optical data storage platforms, optical anti-counterfeiting elements, and new laser material processing tasks.

10:00 **A diffractive see-through waveguide AR/VR display with up to 100° horizontal field of view**

B. H. Kleemann
Retired from Carl Zeiss AG, Germany

The horizontal Field of View (FoV) of a diffractive light-guide see-through AR/VR display can be significantly increased by dividing the field angle spectrum into subfields which are in-coupled and transmitted in separate light-guides. Hence, the FoV of such a system using appropriate materials can be increased up to 100° and more.

10:20 **Modelling and characterisation of two-dimensional pupil expansion with crossed gratings in an augmented-reality display**

C. H. Gan, M.-E. Kleemann, A. Golos, and S. Valera
WaveOptics, UK

The two-dimensional (2D) pupil replication map at the exit pupil plane for light extracted from crossed gratings in an augmented-reality (AR) display is characterized. Good agreement between model and experiment is attained.

10:40 **A geometric waveguide and a holographic film for the head-mounted display**

S. Zhao[1], Q. Song[1], B. Sherliker[2], and J. Lewis[2]
[1]Lochn Optics Technology Co. Ltd., China, [2]Trulife Ltd., UK

This work introduces a geometric waveguide for the near eye display (NED) system to achieve a large field of view, compact, and strong immersive feeling for the Augmented Reality (AR) system. In addition, a prototype of a holographic display system based on a compact LCoS projector is also demonstrated here.

11:00 – 11:30 **Coffee Break**

-- NOTES -- NOTES --

11:30 – 13:00 Session: Theory & Concepts II

11:30 Planar-integrated free-space optics – old concept, new applications

Invited

J. Jahns
FernUniversität in Hagen, Germany

The concept of microoptical integration by folding an optical system into a slab of a transparent material was suggested in the 1980s. It is generally of relevance for applications, where small size and high functionality is required. Here, we review the concept, aspects of design and fabrication and consider recent applications.

12:00 Design concept for AR lightguide devices

S. Steiner[1], C. Hellmann[2], R. Knoth[1], S. Zhang[1], and F. Wyrowski[3]
[1]LightTrans International UG, Germany, [2]Wyrowski Photonics GmbH, Germany, [3]Friedrich Schiller University Jena, Germany

Numerous parameters must be considered in order to design a functional AR/MR device which provides sufficient image quality and optical performance. A successful design cannot be solely based on parametric optimization: the latter must be combined with systematic design strategies in order to provide initial parameter configurations for further optimization. We will discuss such a systematic approach and its implementation in the software VirtualLab Fusion.

12:20 Numerical implementation of the homeomorphic Fourier transform and its application to physical-optics modeling

Z. Wang[1,2], D. Baladron-Zorita[1,2], and F. Wyrowski[1]
[1]Friedrich Schiller University Jena, Germany, [2]LightTrans GmbH, Germany

The authors propose an efficient approach to perform the Fourier transform, which, even though approximated, is quite accurate under certain common conditions in optics: the "homeomorphic Fourier transform (HFT)". We present the theoretical derivation and the numerical implementation. We illustrate its potential with examples.

12:40 Classical optics, rays and waves: duality from the Feynman path integral

J. Babington
Qioptiq Ltd, UK

We show how the Feynman path integral representation can be used to map between ray and wave descriptions in classical optics in a fundamental way. As a specific example we look at how this works in a focusing GRIN media system and give a discussion of the Gouy phase anomaly from this perspective.

13:00 – 14:00 Lunch

-- NOTES -- NOTES --

14:00 – 15:30 Session: Theory & Concepts III

14:00 Light interaction with nanoresonators: mode volume and quasinormal mode expansion

Invited

P. Lalanne
LP2N, Institut d'Optique Graduate School, CNRS, Université de Bordeaux, France

The most general motion of a system is a superposition of its normal modes, or eigenstates. For Hermitian system, classical normal mode theory applies. For non-Hermitian systems, presently a lot of progress is done to describe the response of optical micro and nanoresonators in their quasinormal mode basis. We have developed a rigorous modal analysis of nanoresonators with unprecedented generality and report numerical results for the general case of 3D resonators, made of dispersive materials on substrate with guiding layers.

14:30 On the importance of homeomorphic operations in physical and geometrical optics

F. Wyrowski[1], O. Baladron-Zorita[1,2], Z. Wang[1,2], and C. Hellmann[3]
[1]Friedrich Schiller University Jena, Germany, [2]LightTrans GmbH, [3]Wyrowski Photonics GmbH, Germany

Physical-optics system modeling can be performed by connecting different rigorous and approximated field solvers, which are selected to efficiently solve Maxwell's equations in the individual mathematical regions into which a system can be torn. We discuss the case in which a sequence of connected solvers constitutes a 1:1 mapping between the input and the output fields. It turns out that such sequences are (1) the key to fast physical optics and (2) they reveal how ray tracing is embedded in and accessible through physical optics.

14:50 Physical-optics anatomy of the Gouy phase shift

O. Baladron-Zorita[1,2], Z. Wang[1,2], C. Hellman[3], and F. Wyrowski[1]
[1]Friedrich Schiller University Jena, Germany, [2]LightTrans GmbH, Germany, [3]Wyrowski Photonics GmbH, Germany

Using purely mathematical arguments in an electromagnetic approach to the propagation from one side of the focus to the other, we obtain a physical-optics solution which reveals, in an isolated manner, all the effects which we know must appear, and dispel the geometrical-physical optics dichotomy in our understanding of the Gouy phase.

15:10 Retrieving the size of deep-subwavelength objects via tunable spin-orbit interaction

Z. Xi and H. P. Urbach
Delft University of Technology, The Netherlands

A far-field technique is proposed to retrieve deep subwavelength dimensions of an individual nanoparticle based on photonic spin-orbit interactions. The introduction of optical spin will open intriguing applications in nano-metrology.

15:30 – 16:00 **Coffee Break with Poster Session (see page 30)**

-- NOTES -- NOTES --

16:00 – 17:00 Session: Theory & Concepts IV

16:00 Concepts for modeling volume scatterers

S.-T. Hung[1], Z. Wang[1,2], and F. Wyrowski[1]
[1]Friedrich Schiller University Jena, Germany, [2]LightTrans GmbH, Germany

In this work, the authors propose an approximated algorithm to model field scattering caused by a multi-sphere scattering medium based on Mie theory. Compared with the rigorous method, the Multiple Sphere T-Matrix Method, our algorithm assumes the local plane-wave approximation in sphere-sphere interaction. Due to this approximation, our algorithm improves the efficiency with respect to the rigorous method.

16:20 Geometric phase in polarization beating of light waves

A. Hannonen[1], K. Saastamoinen[1], L.-P. Leppänen[1], M. Koivurova[1], A. Shevchenko[2], A. T. Friberg[1], and T. Setälä[1]
[1]University of Eastern Finland, Finland, [2]Aalto University, Finland

We analyzed the Pancharatnam–Berry phase in the time domain by examining the polarization beating of two monochromatic electromagnetic beams of different frequencies. Theoretical expressions for the phase over one beating period were derived and the results were verified experimentally using an interferometer.

16:40 Optimal design of multilayer diffractive optical elements and its application in hybrid imaging system

S. Mao and J. Zhao
Northwestern Polytechnical University, China

Oblique incidence is the normal working mode for multilayer diffractive optical element (MLDOE) and its diffraction efficiency is very sensitive to incident angle. We presented a MLDOE optimal design and further application in hybrid imaging system under oblique incidence situation, which has a universal significance and practice.

-- NOTES -- NOTES --

09:30 – 11:00 Session: Nanostructures

09:30 Semiconductor metasurfaces and applications

Invited

P. Ni[1], H. Ren[2], G. Briere[1], Y.-Y. Xie[3], A. De Luna Bugallo[4], and P. Genevet[1]
[1]Université Cote d'Azur, CNRS, CRHEA, France, [2]Ludwig-Maximilians-University Munich, Germany, [3]Beijing University of Technology, China, [4]CONACYT—Cinvestav Unidad Querétaro, Mexico

Allowing subwavelength-scale-digitization of optical wavefronts to achieve complete control of light at interfaces, metasurfaces are particularly suited for the realization of planar optical components. Here, we will discuss recent results obtained recently in our group on semiconductor metasurfaces for laser beam engineering and holography.

10:00 Sub-wavelength metamaterial for a finely tailored coupling coefficient within waveguides arrays

A. Talneau, F. Hentinger, and N. Belabas
CNRS-C2N Centre de Nanosciences et de Nanotechnologies, France

Within Silicon-based waveguide arrays, we demonstrate that sub-1, below band-gap 2-dimentional metamaterial can provide a robust control and a fine tuning of the coupling coefficient. This versatile geometry allows tailored chirped coupling for compact devices implementing advanced optical functions.

10:20 A computational scheme for the characterization of 3D nano-structures using grazing-incidence X-ray fluorescence

K. V. Nikolaev[1,2], V. Soltwisch[1], P. Hoenicke[1], F. Scholze[1], S. Heidenreich[1], J. de la Rie[2], S. N. Yakunin[3], I. A. Makhotkin[2,4], and F. Bijkerk[2]
[1]Physikalisch Technische Bundesanstalt, Germany, [2]University of Twente, The Netherlands, [3]NRC Kurchatov Institute, Russia, [4]IMEC, Belgium

Following the recent demonstration of the sensitivity of grazing-incidence X-ray fluorescence to the lateral structure of the periodic nano-patterned devices, we present a computational scheme for the simulation of experimental data. This can be used for the element selective analysis of 3D atomic distributions in diffractive optics devices.

10:40 Metalenses: field of view and aberration

P. Lalanne
LP2N, Institut d'Optique Graduate School, CNRS, Université de Bordeaux, France

In relation with a recent article on hybrid achromats with metalenses recently published in Adv. Mat. 31 (3), 1805555 (2019), we bring back old works on hybrid achromats with metalenses for IR imaging that was done 15 years ago at Thalès in France. At the conference, we will further discuss the strengths and weaknesses of this former work compared to the recent work by the Harvard's group.

11:00 – 11:30 Coffee Break

-- NOTES -- NOTES --

11:30 – 13:00 Session: Applications I

11:30 Understanding and optimization of EUV light diffraction and imaging for lithography

Invited

A. Erdmann
Fraunhofer IISB, Germany

Future generations of semiconductor chips will be fabricated using extreme ultraviolet (EUV) lithography. We describe the imaging challenges of EUV projection systems and how computational lithography can be used to understand and optimize the light diffraction from EUV masks and its impact on imaging.

12:00 Comparison of different concepts for compact cross-grating spectrometers

M. Kraus[1], E. Förster[1], T. Hönle[1], V. Bagusat[1], D. Thomae[1], R. Brüning[2], H. Hillmer[3], and R. Brunner[1,2]
[1]University of Applied Sciences Jena, Germany, [2]Fraunhofer Institute for Applied Optics and Precision Engineering, Germany, [3]University of Kassel, Germany

This contribution presents different concepts and optical design studies for cross-grating spectrometers, including an approach based on a folded reflective beam path. In addition, the manufacturing of the cross-grating and aspects of system mounting and adjustment are considered.

12:20 Ptychography with multiple wavelength illumination

X. Wei and H. P. Urbach
Delft University of Technology, The Netherlands

For performing phase retrieval in the extreme ultraviolet (EUV) regime more efficiently, developing polychromatic ptychography is needed. As an alternative to the existing ptychographic information multiplexing (PIM) method, we present an another scheme where the object is treated to be wavelength-independent. The potential of our method is studied numerically.

12:40 Diffractive optics encounters optical coherence tomography

H. Ichikawa[1] and H. Fujibuchi[2]
[1]Ehime University, Japan, [2]Kochi Broadcasting Co. Ltd., Japan

Optical coherence tomography is employed to analyse diffraction gratings in the resonance domain. Although the two disciplines in optics have little in common, we expect something extra appearing for the both with assistance of electromagnetic simulation.

13:00 – 14:00 Lunch

-- NOTES -- NOTES --

14:00 – 14:50 Sponsor Session

14:00 HOLOEYE Photonics AG

HOLOEYE is providing products and services in the fields of Spatial Light Modulators (SLM) for phase and amplitude modulation, customized design, fabrication and replication services for Diffractive Optical Elements (DOE) as well as a broad range of standard DOEs, and LCOS microdisplay components for monochrome and color projection applications.

14:10 Sunny Optical Technology Group

Sunny Optical Technology (Group) Company Limited is a leading integrated optical components and products manufacturer in China. The Group is mainly engaged in the design, R&D, manufacture and sales of optical and optical-related products.

The company is one of a few enterprises inside China that have first-class design capability and mass production capacity for integrated products combining optics, mechanics, electronics and software technology. It has established its leadership in special coating, aspherical optics, chalcogenide glass material, 3D scanning and imaging, VR/AR, ultra-high pixel smartphone cameras etc.

Sunny Omnilight is a newly established business unit under Sunny Group. It is dedicated in designing, mass producing refractive and diffractive optical components. End products including 3D sensing cameras, Augmented Reality glasses etc.

14:30 LightTrans International UG

LightTrans International UG offers solutions for modeling and design in optics and photonics. The products and services include optical design software, optical engineering, training and consulting. The software VirtualLab Fusion provides a platform for connecting inbuilt and customized electromagnetic field solvers. This approach enables fast physical optics with ray tracing embedded in a well-defined way. VirtualLab Fusion connects the ever-growing number of electromagnetic field solvers for numerous components and effects. By that it enables fast physical optics system modeling.

15:00 Conference Excursion & Dinner at Landgrafen Restaurant

-- NOTES -- NOTES --

09:30 – 11:00 Session: Applications II

09:30 Non-paraxial design of diffractive optical elements and meta-surfaces

Invited

M. A. Golub and O. Barlev
Tel Aviv University, Israel

Theoretical considerations and experimental results for diffractive optical elements (DOEs) that perform at large incident and output angles are demonstrated. The high-NA resonance-domain diffractive lenses and structured light DOEs with large fan-angles are considered. Applications in beam combining and 3D sensing are discussed.

10:00 Computer generated holography for lithography on curved surfaces

D. Fischer and S. Sinzinger
TU Ilmenau, Germany

The standard approach to project Computer Generated Holograms (CGH) on nonplanar surfaces is multi-step propagation which is computationally intensive. As an alternative we investigate concepts to project a pattern onto a curved surface by first calculating a hologram of a planar pattern and then applying an additional lens phase with non-constant radius.

10:20 Towards high-speed tuning cavity resonator-integrated guided-mode resonance filters

S. Calvez, A. Monmayrant, and O. Gauthier-Lafaye
LAAS-CNRS, Université de Toulouse, CNRS, France

We report the experimental demonstration of tunable Cavity Resonator-Integrated Guided-mode Resonance Filters made on lithium niobate on insulator. Temperature induced tuning over a wavelength span greater than the full-width half-maximum of a filter with a Q factor of ~1600 is achieved.

10:40 Multifocal complex-value phase zone plate for 3D focusing

S. Gharbi Ghebjagh and S. Sinzinger
TU Ilmenau, Germany

We propose a method for creating a coaxial array of focal spots by using a multi focal Fresnel zone plate. The design approach is based on pure phase modulation approach of the periodic structure of the Fresnel zone plate. It is shown that the complex value Fresnel zone plate designed with this method produces desired number of equally spaced focal spots with uniform intensity.

11:00 – 11:30 Coffee Break

11:30 – 13:00 Session: Theory & Concepts V

-- NOTES -- NOTES --

11:30 From iterative Fourier transform algorithm (IFTA) to "ray mapping" and back

L. Yang[1], I. Badar[1], R. Knoth[2], C. Hellmann[3], and F. Wyrowski[1]
[1]Friedrich Schiller University Jena, Germany, [2]LightTrans International UG, Germany, [3]Wyrowski Photonics GmbH, Germany

The iterative Fourier transform algorithm (IFTA) has played a prominent role in diffractive optics design since its early days. In particular for shaping the far field of an incident beam, the functional design problem reduces to the synthesis of a Fourier pair with specific constraints. Contrary to popular belief, this theoretical approach is not specific to diffractive optics but can be applied to refractive elements as well. Thus, the question arises: how is the IFTA related to techniques like "ray mapping" for freeform design? As we will discuss in our talk, both from the point of view of theory and practice, we have found the answer to be: very closely related indeed.

12:00 Connection of field solvers: microstructures and lenses

R.Shi[1,2], C. Hellmann[2], and F. Wyrowski[1]
[1]Friedrich Schiller University Jena, Germany, [2]Wyrowski Photonics GmbH, Germany

We present the connection of two specific solvers, Fourier modal method and local plane interface approximation, in the context of a field-tracing approach, with full consideration of the vectorial effects. We apply it to the simulation of a high-numerical-aperture ultraviolet microscopy system for inspection of a nano-scaled wafer.

12:20 Customized diffuser design based on freeform lens array

G. Zhang[1,2], K. Song[2], X. Yin[2], and K. Tian[2]
[1]Jiatong University, China, [2]Beijing Yuguang Technology Development Co. Ltd., China

In this paper, a new design approach of freeform lens array is proposed to optimize the diffuser optical uniformity across the target plane. it is verified by a 68°*54° diffuser design and fabricated through Laser direct writing equipment. The camera captured optical patterns are verified for its performance, whose analysis and conclusions are shown in below chapters.

12:40 Inverse design for wavelength selective thick diffractive optical element

Q. Song, L. A. Perez Covarrubias, Y. E. Pigeon, and K. Heggarty
Telecom Bretagne, IMT-Atlantique, France

An inverse optimization framework for designing thick diffractive optical elements is proposed to automatically find complex multilayer structure with wavelength selective effects. The design strategy is presented by optimizing the multilayer structure parameters with evolutionary algorithm based on rigorous coupling wave theory.

13:00 – 14:10 Lunch

-- NOTES -- NOTES --

14:10 – 15:30 Session: Theory & Concepts VI

14:10 Design of a spatial shaped laser beam used for piston temperature field simulation

S. Nie[1,2], T. Zhao[1,2,3], H. Xiao[1,2], and Z. Fan[1,2,3]
[1]Chinese Academy of Sciences, China, [2]National Engineering Research Center for DPSSL, China, [3]University of Chinese Academy of Sciences, China

In order to simulate the temperature field on a piston for thermal fatigue test, a large-size spatial shaped laser with complex and uneven intensity distribution is chosen to be the heat source. Optimized intensity distribution of the shaped laser is calculated by numerical simulation of temperature field and a diffractive optics element (DOE) is designed to realize the shaping effect.

14:30 Second harmonic generation in arrayed bull's eye structure

B. O. Asamoah[1], F. Li[2], K. Alam[1], P. Li[2], T. K. Hakala[1], G. Kang[2], and J. Turunen[1]
[1]University of Eastern Finland, Finland, [2]Beijing Institute of Technology, China

We investigate numerically the effect of probing intensity and asymmetry on second harmonic generation in single and arrayed bull's eye structures. It is shown that although increasing asymmetry in the system decreases the OC-dependent maximum SH intensity, the integrated SH intensity is expected to increase. Moreover, we also show the possibility to increase SH intensity via interference phenomenon.

14:50 Physical-optics evaluation of BSDF for microstructures

X. Yu[1], H. Zhong[1,2], and F. Wyrowski[1]
[1]Friedrich Schiller University Jena, Germany, [2]LightTrans International UG

In this work, the authors first interpret the concept of BSDF in the context of physical optics. Then, using microstructured surfaces as examples, we use field tracing to calculate the far-field radiant intensity to generate BSDF data.

15:10 Study of intensity distributions in the far-field region of azimuthal Walsh filters

I. Bhattacharya
University of Calcutta, India

Azimuthal Walsh filters are placed on the exit pupil plane of a rotationally symmetric imaging system and the intensity distributions on the axially shifted image planes are studied by taking into consideration of the defocus aberration term.

15:30 – 16:00 Closing Ceremony

POSTER PRESENTATIONS

Displayed throughout the conference

-- NOTES -- NOTES --

Authors are requested to be present at their posters during the official poster sessions on Monday and Tuesday at 15:30 – 16:00

1. Broad-beam scanning exposure for fabricating gratings of large size and low stray light

L. Zeng and D. Ma
Tsinghua University, China

Large-size diffraction gratings are key optical components of pulse compressors in high-power chirped-pulse-amplified (CPA) laser systems. We have proposed broad-beam scanning exposure for fabricating large gratings. Gratings of a size 200 mm x 100 mm have been made, which have smoother grooves and surfaces, and hence lower stray light. This technique has potential for making much larger, even meter-sized gratings.

2. Adjoint-based optimization for diffractive beam-splitters

D. C. Kim[1,2], A. Hermerschmidt[1], P. Dyachenko[1], and T. Scharf[2]
[1]Holoeye Photonics AG, Germany, [2]Ecole Polytechnique Fédérale de Lausanne, Switzerland

Computational optimization of diffractive elements is often limited by a large number of design parameters. Adjoint method allows the gradient of target function respect to all design variables to be calculated with only two electromagnetic simulations. We show that detail results for optimized two-dimensional fan-out gratings.

3. Wavefront folding interferometer used for spatial coherence measurement

H. Partanen, A. Halder, M. Koivurova, T. Setälä, J. Turunen, and A. T. Friberg
University of Eastern Finland, Finland

We introduce a mirror based wavefront folding interferometer (WFI), a versatile measurement system, which may be used to easily study the two dimensional spatial coherence function of virtually any beam-like light source.

4. Transmission and lasing measurement of Si_3N_4 photonic crystal slab

S. Mohamed[1], J. Wang[2], T. K. Hakala[1], and L. Shi[2]
[1]University of Eastern Finland, Finland, [2]Fudan University, China

We experimentally study the transmission and the lasing signal in square Si_3N_4 photonic crystal slab with nanoparticles arrays. For our photonic crystal slab structure, there are two basic modes, TM-like mode, and TE-like mode.

5. Effect of resonance gratings on temporal coherence of optical pulses

H. Pesonen[1], P. Li[2], T. Setälä[1], and J. Turunen[1]
[1]University of Eastern Finland, Finland, [2]Beijing Institute of Technology, China

We study the effects of a resonance grating on a partially coherent pulse train. We use a Gaussian Schell-model source with various degrees of coherence and compare the reflected and transmitted parts of the pulse train. Increase in the coherence time is found to enhance reflection and modify the average intensity of the transmitted pulse trains.

-- NOTES -- NOTES --

6. Optical design of light shaping element beyond the paraxial approximation

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We discuss the implications of the modeling and the design of freeform surfaces and diffractive optical elements in non-paraxial regions of fields. To shape the profile of a laser beam in its far field, the design of beam shaping elements follows an inverse physical optics approach.

7. Effective medium beam shaper

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A miniaturized beam shaping setup for the generation of arbitrary light distributions using an effective medium computer-generated hologram (CGH) is presented. The problem of a prominent zeroth diffraction order spot is avoided by spreading the zero order power across the angular spectrum. For this purpose a divergent laser diode is used as illumination. To maximize efficiency, the target light distribution is created by a phase-only element, which is designed using a modified Gerchberg-Saxton iterative algorithm. The effective medium ansatz allows an accurate construction of the phase with only a two-level surface profile of the optical element. Based on this concept a demonstrator creating a ±25° light pattern is manufactured and evaluated.

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