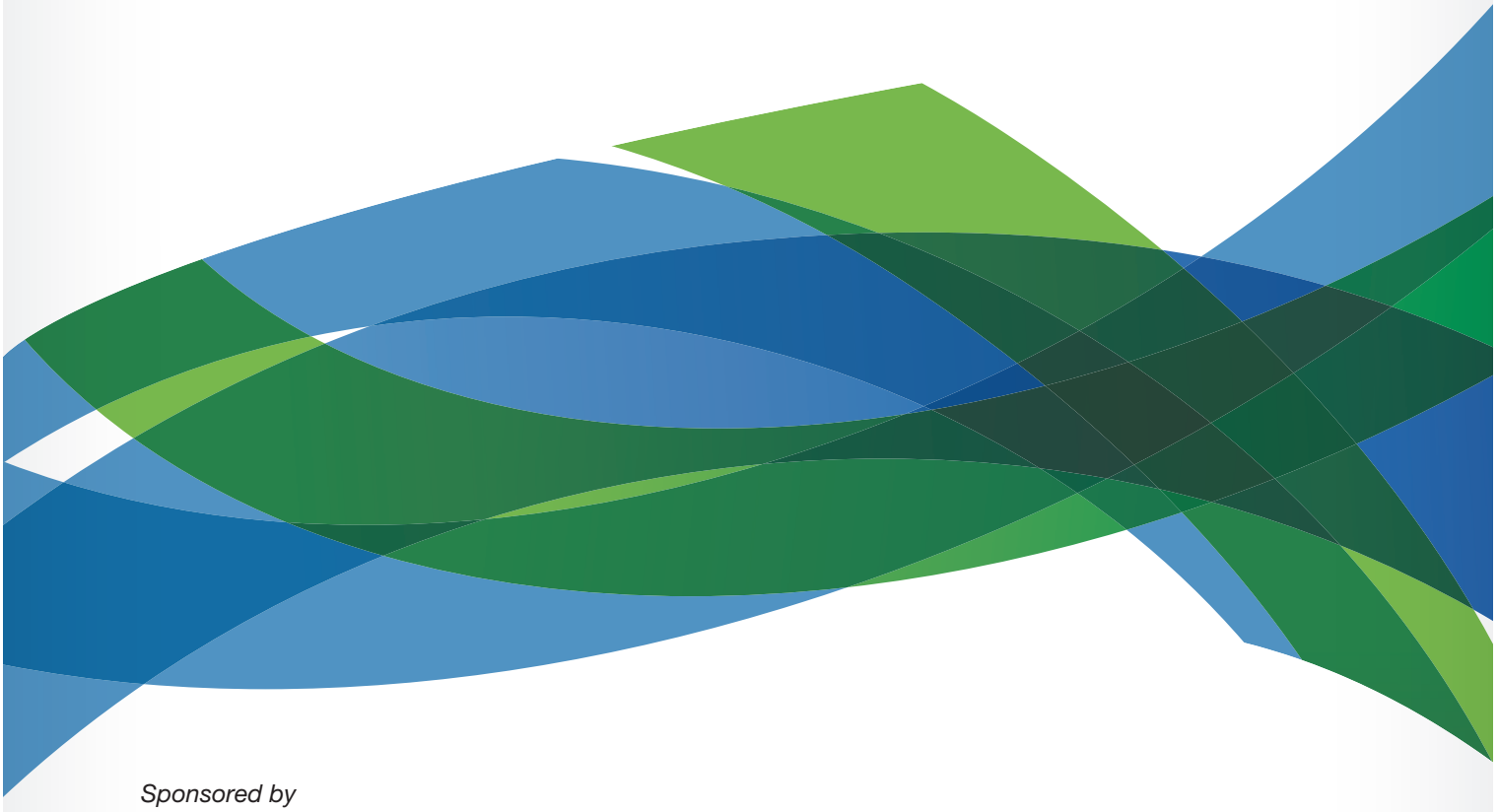
Technical Program

Optical Data Storage

Topical Meeting 2010



Sponsored by

SPIE Connecting minds. Advancing light.

IEEE photonics SOCIETY

OSA Optical Society of America

Optical Society of America

Conference: 23-26 May 2010
UMC/Univ. of Colorado at Boulder
Boulder, Colorado, USA

Optical Data Storage

Topical Meeting 2010

Conference: 23-26 May 2010
UMC/Univ. of Colorado at Boulder
Boulder, Colorado, USA

Message from the Program and General Chairs

The 26th Optical Data Storage topical meeting provides an excellent forum for exchanging information on the status, advances, and future directions in the field of optical data storage.

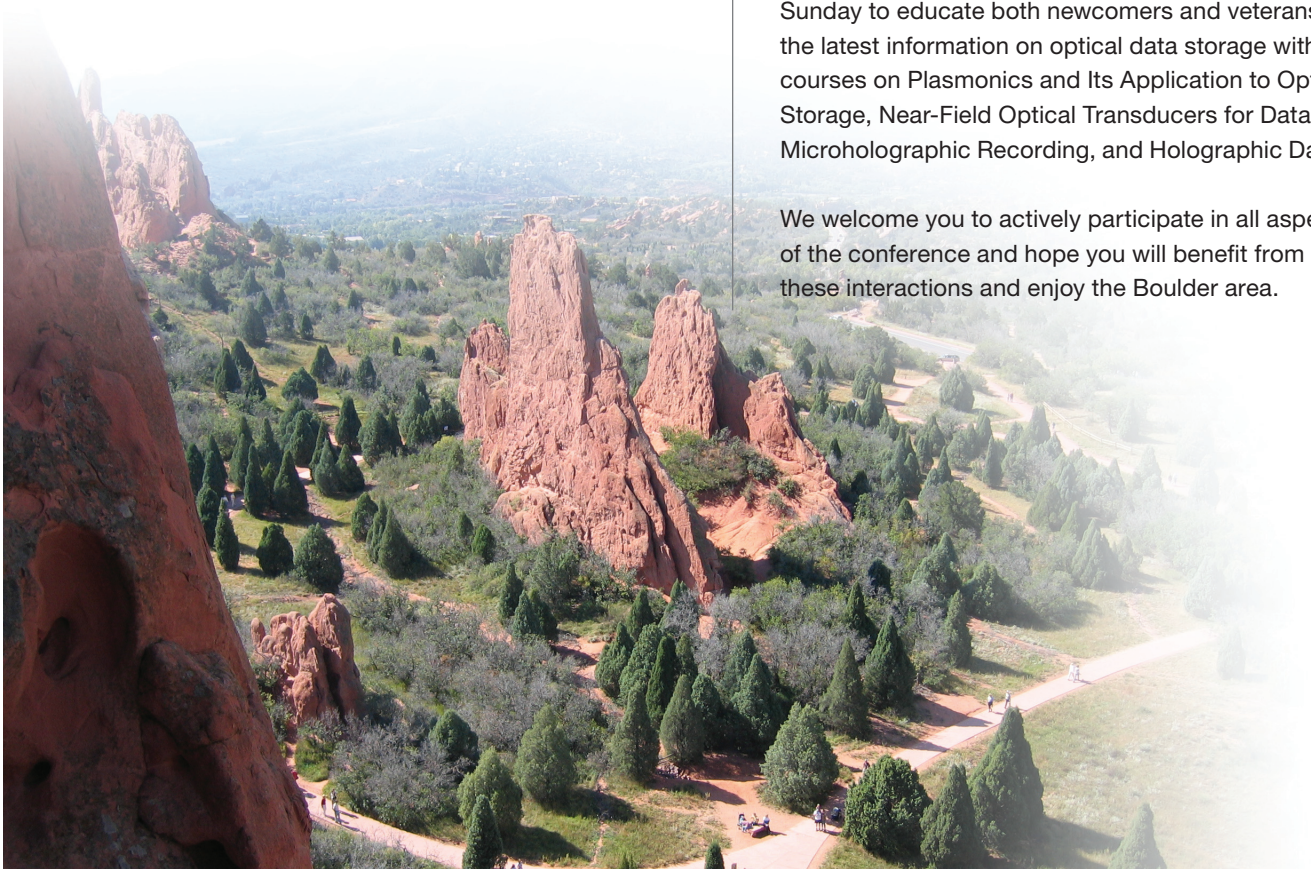
Third generation high density recording systems using blue-violet lasers are growing in the commercial market.

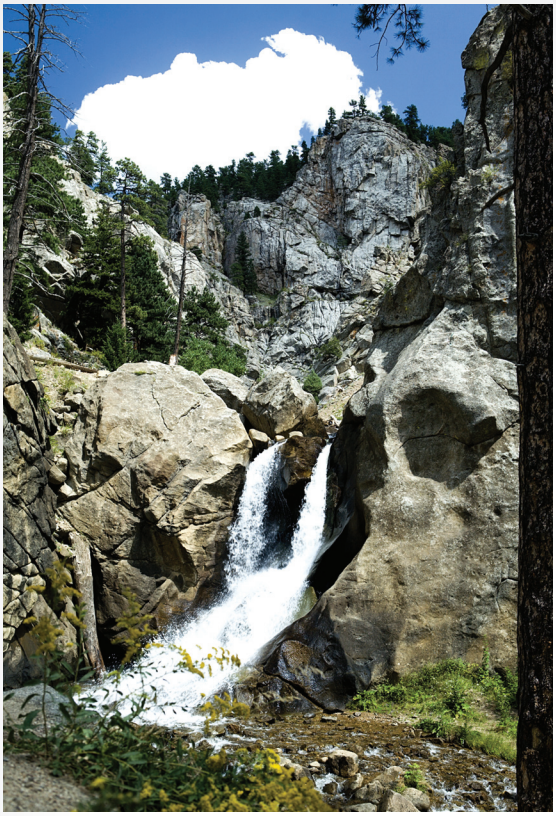
Technology for fourth generation products - holographic, volumetric, near field, super resolution and hybrids - will be a main focus at ODS 2010. Hot new concepts such as nano-photonics will also be explored.

This year there are 69 papers, from 12 different countries covering a wide range of topics. The Program Committee has organized a rich program that includes 21 invited, 28 oral, and 20 poster presentations spread over three days of technical sessions held Monday through Wednesday. Contributions include papers on Holographic Recording and Techniques, Drive Technologies and Components, Systems and Applications, Near-Field Recording, Super Resolution and Hybrid Systems, Future Emerging Technologies, Nanophotonics, Multidimensional Recording, and Advanced and Related Technologies.

In addition, a series of Short Courses will be held on Sunday to educate both newcomers and veterans about the latest information on optical data storage with short courses on Plasmonics and Its Application to Optical Data Storage, Near-Field Optical Transducers for Data Storage, Microholographic Recording, and Holographic Data Storage.

We welcome you to actively participate in all aspects of the conference and hope you will benefit from these interactions and enjoy the Boulder area.









Contents

Committees

Organizing Committee

General Chairs

Robert R. McLeod, Univ. of Colorado

In-Ho Choi, LG Electronics Inc.

Program Committee

Chair: **Susanna Orlic,** Berlin Univ. of Technology

Chair: **Ryuichi Katayama,** NEC Avio Infrared Technologies Co., Ltd.

Vijayakumar Bhagavatula, Carnegie Mellon Univ.

Lambertus Hesselink, Stanford Univ.

Tzuan-Ren (Steven) Jeng, Industrial Technology Research Institute

Kyung-Geun Lee, Samsung Electronics Co., Ltd.

Masud Mansuripur, Univ. of Arizona

Hiroyuki Minemura, Hitachi Ltd.

Kenji Tanaka, Sony Corp.

Long-fa Pan, Tsinghua Univ.

Kazuo Watabe, Toshiba Corp.

Paul J. Wehrenberg, Apple Computer, Inc.

Hisayuki Yamatsu, Sony Corp.

Advisory Committee

Chair: **Kevin Curtis,** InPhase Technologies

Chair: **Luping Shi,** Data Storage Institute

Bernard W. Bell, Optical Wizards

Chong Tow Chong, Data Storage Institute

Der-Ray Huang, National Dong Hwa Univ.

Joo-Ho Kim, Samsung Electronics Co., Ltd.

Seiji Kobayashi, Sony Corp.

Takeshi Maeda, Japan Science and Technology Agency

Thomas D. Milster, Univ. of Arizona

Naoyasu Miyagawa, Panasonic Corp.

Michael P. O'Neill, Cellular Bioengineering, Inc.

Young-Pil Park, Yonsei Univ.

Tim Rausch, Seagate Technology

Kimihiro Saito, Sony Corp.

Barry H. Schechtman, Information Storage Industry Consortium

Tuviah E. Schlesinger, Carnegie Mellon Univ.

Takeshi Shimano, Hitachi Maxell Ltd.

Yun Sup Shin, LG Electronics Inc.

Din Ping Tsai, National Taiwan Univ.

8:30 am to 10:00 am

Plasmonics and Its Application to Optical Data Storage

Instructor: **Din Ping Tsai,** National Taiwan Univ. (Taiwan)

COURSE DESCRIPTION

This short course will cover the background of plasmonics and basic properties of plasmons, and its applications to optical data storage. Principle of plasmons and localized plasmons will be addressed. Advanced applications of plasmonics on the optical data storage will be reviewed. Field enhancement and optical nonlinearity of the plasmons for optical data storage systems and applications will be discussed.

COURSE CONTENTS

1. Background and development of plasmonics
2. History and basic principle of surface plasmon
3. Theory of surface-plasmon polaritons (SPP)
4. Properties of localized surface-plasmon polaritons (LSP)
5. Field enhancement and optical nonlinearity of plasmons
6. Ultrafast plasmonic response
7. Plasmonic applications for optical data storage
8. Q & A.

BENEFITS AND LEARNING OBJECTIVES

This course should enable participants to understand the basic principle of plasmons and plasmonics, and the most up-to-date developments of the plasmonic data storage.

INTENDED AUDIENCE

The course attendees should have at least background of physics, optics or material science of undergraduate level.

INSTRUCTOR

Din Ping Tsai is a professor of National Taiwan University and Director General of the National Instrument Technology Research Center in Taiwan. He is a Fellow of International Society of Optical Engineering (SPIE), Optical Society of America (OSA), American Physical Society (APS), Electro Magnetics Academy (EMA) and The Physical Society of R.O.C. He is also a member of the Fellows and Honorary Members Committee for SPIE (2010) and OSA (2008, 2009), respectively. He is author and coauthor of 136 SCI journal papers, 40 book chapters and conference papers, and 35 technical reports and articles. He had 16 patents in USA, Japan, Canada, Germany and Taiwan. He had five technologies transfer to five different industrial companies in last five years. He was invited as an invited speaker for international conference or symposium more than 70 times.

10:30 am to 12:00 pm

Near-Field Optical Transducers for Data Storage

Instructor: **Lambertus Hesselink,** Stanford Univ. (United States)

COURSE DESCRIPTION

Magnetic recording densities are reaching a critical point whereby the coercive field of the medium must be increased to ensure data longevity, or the medium must be patterned to support densities exceeding 1Tb/sqin. Both approaches involve significant technological and manufacturing challenges.

In the energy assisted magnetic recording (EAMR) approach a small light spot typically less than 50 nm is used to locally heat the medium to lower the strength of the magnetic field required to flip the magnetic state. Combining nano-spot delivery systems with magnetic heads in a fashion conducive to mass manufacturing is currently the focus of much research.

In this short course we will discuss the fundamentals of creating nano-optical spots using near field transducers (NFT). In the literature a number of innovative approaches have been studied that allow light concentration to spots $<\lambda/20$ in size. The most heavily studied are the bow-tie aperture, the C-aperture and its variants, as well as the Puccini system. Much has been learned from these studies about how light interacts with metals to produce surface plasmon resonances that can give rise to anomalous increases in intensity while maintaining a deep sub-wavelength spot size.

In the presentation, we will try to put the NFT knowledge into a unifying framework based on mathematical topology of the Poynting vector flow field. This knowledge provides the basis for designing NFTs. We use this framework to evaluate the performance of various NFTs for a number of applications, including EAMR and near-field optical recording.

INSTRUCTOR

Professor Hesselink is on the Electrical Engineering and Applied Physics faculty at Stanford University. His research interests span a number of topics including optical data storage, holographic data storage, nano-photonics, three-dimensional displays, laser ablation and bio medical photonics. He has started two successful spin-off companies from Stanford University, and he has been widely involved in advisory positions with the US government and industry worldwide. Among other significant awards he was a Fulbright scholar, and he is a Fellow of the OSA and SPIE, and a member of the Royal Dutch Academy of Arts and Sciences.

1:30 to 3:00 pm

Microholographic Recording

Instructors: **Robert R. McLeod,** Univ. of Colorado and **Susanna Orlic,** Technische Univ. Berlin (Germany)

COURSE DESCRIPTION

This short course will cover the use of focused lasers to record small, isolated holograms in thick media. Architectural choices include recording schemes and multiplexing, the arrangement of read/write heads, direct versus homodyne detection, recording laser and modulation methods and servo methods such as stamped cover layers and servo-writers. Possible material systems will be reviewed including holographic photopolymers, photochromic, thermoplastic and inorganic materials. Demonstrated performance in the various groups world-wide will be summarized. Finally, modeling methods will be discussed and potential performance suggested.

INSTRUCTORS

Susanna Orlic, Professor of Experimental Physics at the Faculty of Mathematics and Natural Sciences of the Berlin University of Technology, heads the research group on Optical Technologies at the Institute of Optics and is responsible for programs in quantum optics and photonics. She received the Diploma degree from the Department of Applied Physics at the Belgrade University of Technology and the Dr. rer. nat. degree from the Physics Department of the Berlin University of Technology. Her specific research topics are optical memories and information processing, holography, nonlinear optical patterning and recognition, optical sensing and image processing, optical computing and interconnects. She initiated a European network on Optical Data Storage and Processing and is engaged in diverse committees on strategic research and education planning in photonics for the 21st century at the European level. Currently, she is coordinating a European R&D project on next generation optical data storage and a German consortium on intelligent optical sensing and image processing technology. Being strongly application-oriented, her projects interface science and industry and are in close cooperation with a series of European and U.S. research institutions and companies that are manufacturers as well as users of optical technologies. She is chair and program committee member of several world conferences on optics and photonics.

Robert McLeod is an Assistant Professor of Electrical and Computer Engineering, University of Colorado at Boulder. Dr. McLeod's research group at the University of Colorado specializes in metrology, modeling and applications of volume photopolymers including data storage, integrated optics and imaging. He has held research and management positions at Lawrence Livermore National Lab, Siros Technologies (a holographic data storage startup) and JDS Uniphase. He holds graduate degrees from Montana State University (MSEE 1985), University of California (MS Applied Science 1989) and the University of Colorado (Ph.D. 1995).

3:30 to 5:00 pm

Holographic Data Storage

Instructor: **Kevin Curtis,** InPhase Technologies

COURSE DESCRIPTION

This short course addresses the fundamental principles and design issues pertaining to digital holographic data storage (HDS). The fundamental principles of holography, including formation of and diffraction from thick diffraction gratings, are explained. Multiplexing techniques for thick gratings based on Bragg, momentum, or correlation techniques are discussed and explained with an introduction to k-space analysis.

The system architecture of phase conjugate polytopic-angle based systems is presented and their key design issues explained. The metrics used to determine basic system performance and limitations are discussed. Write strategies and record scheduling for achieving high capacity in HDS systems are described. The concepts and issues with mastering and replication of holographic media are also explained. For angle multiplexing based systems, the servo systems and tolerances are discussed. These include thermal compensation and disk position and tilts. Key system component (laser, SLM (Spatial Light Modulator), optical design, and detector) requirements for high performance HDS systems are discussed. How to format holographic disks and forma dependences on material performance are presented.

The data channel for HDS systems is particularly different than conventional optical storage systems. The key issues such as over-sampled detection, interleaving, and error correction are presented.

HDS media requirements are explained and related to drive performance. Techniques for testing basic media parameters are also presented.

BENEFITS AND LEARNING OBJECTIVES

This half day course should enable you to:
- Explain and use the basic principles of HDS
- Estimate achievable performance of basic HDS systems and media
- Design basic HDS systems including servo systems and data channel
- List the key issues, limitations, and tradeoffs in HDS system design
- List the key issues, limitations, and tradeoffs in HDS media design
- Test basic media parameters
- Summarize the latest results in HDS performance.

INTENDED AUDIENCE

This course is intended for engineers and scientists interested in high density optical data storage systems. Attendees are expected to have a Bachelors degree in engineering or science, or equivalent experience, and to have familiarity with optics concepts and optical storage systems. Rudimentary knowledge of holography or holographic recording materials is helpful, but not required.

INSTRUCTOR

Kevin Curtis is Chief Technology Officer and founder of InPhase Technologies in Longmont, Colorado. In this role, Kevin manages and provides the technical direction for the advanced research and development of InPhase's holography-based technologies and products for storage.

Prior to founding InPhase, Kevin was a member of the technical staff at Bell Laboratories where he directed the efforts of the holographic storage program upon which InPhase was founded. This included business development and raising the Series A investments to start InPhase. Kevin has worked at Caltech, Northrop and Bell Labs on holographic optical systems for over 17 years.

Dr. Kevin Curtis received his B.S., M.S., and Ph.D. degrees in electrical engineering in 1990, 1992 and 1994, respectively, all from the California Institute of Technology, Pasadena, California. He has authored 100+ publications and talks and has over 50 U.S. Patents awarded on holographic storage.

Invited Speakers

Mark R. Ayres, InPhase Technologies Inc. (United States)
Coherent techniques for terabyte holographic data storage [7730-01]

Yuzuru Takashima, Lambertus Hesselink, Stanford Univ. (United States)
A systematic comparison of bit-based and page-based holographic storage systems [7730-06]

Yoshimasa Kawata, Shizuoka Univ. (Japan) and Japan Science and Technology Agency (Japan)
Development of compact femtosecond fiber laser and alignment free confocal system for multilayered optical memory [7730-11]

Motohiro Inoue, TDK Corp. (Japan)
512 GB recording on 16-layer optical disc with Blu-ray Disc based optics [7730-12]

Xiangshui Miao, Huazhong Univ. of Science and Technology (China)
New video disc (NVD) for high-density storage [7730-16]

Ding Ping Tsai, National Taiwan Univ. (Taiwan)
Characterization of media for optical data storage [7730-17]

Masayuki Ohmaki, Mitsubishi Electric Corp. (Japan)
Next generation optical disc system with Super-RENS ROM disc [7730-72]

Lambertus Hesselink, Stanford Univ. (United States)
Recent developments in near field optical transducers for data storage [7730-18]

Jin-Hong Kim, LG Electronics Inc. (Republic of Korea)
High density recording with SIL-based near-field optical recording [7730-19]

Kimio Tatsuno, OITDA/Hitachi Ltd. (Japan)
State of R&D in photonics-related fields in Japan's industry and academia: leading the 'green digital economy' [7730-34]

David Waldman, STX Aprilis, Inc. (United States)
Advanced CROP recording materials for emerging technologies [7730-36]

Sang-Hyun Oh, Univ. of Minnesota, Twin Cities (United States)
Novel nano-structures and fabrication techniques with applications in plasmonic data storage [7730-39]

Marko Loncar, Harvard Univ. (United States)
Single photon source based on color center in diamond nanowire [7730-40]

Gurudev Dutt, Univ. of Pittsburgh (United States)
Single spins in diamond for quantum networks and magnetic sensing [7730-41]

Ortwin Hess, Univ. of Surrey (United Kingdom)
Trapped rainbow for storage of light in nanophotonic materials [7730-42]

Min Gu, Swinburne Univ. of Technology (Australia)
Five-dimensional optical data storage [7730-43]

Masaharu Akiba, FUJIFILM Corp. (Japan)
Two-photon sensitized recording materials for multilayer optical disk [7730-44]

Peter Török, Imperial College London (United Kingdom)
A possible solution for the next generation of optical data storage [7730-45]

Armis R. Zakharian, Corning Inc. (United States)
Finite difference time domain computer simulations with applications to optical data storage [7730-46]

Nicholas Roberts, The Univ. of Manchester (United Kingdom)
A broadly achromatic, biological quarter wave retarder [7730-47]

Xuewu Xu, A*STAR - Data Storage Institute (Singapore)
Full high-definition digital 3D holographic display and its enabling technologies [7730-48]

Optical Data Storage 2010

Program Chairs: **Susanna Orlic,** Technische Univ. Berlin (Germany); **Ryuichi Katayama,** NEC Avio Infrared Technologies Co., Ltd. (Japan)

Program Committee: **Lambertus Hesselink,** Stanford Univ.; **Tzuan-Ren Jeng,** Industrial Technology Research Institute (Taiwan); **Kyung-Geun Lee,** Samsung Electronics Co., Ltd. (Korea, Republic of); **Masud Mansuripur,** College of Optical Sciences, The Univ. of Arizona; **Hiroyuki Minemura,** Hitachi, Ltd. (Japan); **Longfa Pan,** Tsinghua Univ. (China); **Kenji Tanaka,** Sony Corp. (Japan); **B. V. K. Vijaya Kumar,** Carnegie Mellon Univ.; **Kazuo Watabe,** Toshiba Corp. (Japan); **Paul J. Wehrenberg,** Apple Computer, Inc.; **Hisayuki Yamatsu,** Sony Corp. (Japan)

Monday 24 May

Room: UMC 235 . . . . . Mon. 8:15 to 8:30 am

Opening Remarks

Session Chairs: **Susanna Orlic,** Technische Univ. Berlin (Germany); **Ryuichi Katayama,** NEC Avio Infrared Technologies Co., Ltd. (Japan)

SESSION MA

Room: UMC 235. . . . . Mon. 8:30 to 10:00 am

Holographic Recording/Techniques

Session Chairs: **Lambertus Hesselink,** Stanford Univ.; **Ryuichi Katayama,** NEC Avio Infrared Technologies Co., Ltd. (Japan)

8:30 am: **Coherent techniques for terabyte holographic data storage** *(Invited Paper)*, Mark R. Ayres, InPhase Technologies Inc. (United States) . . . . . [7730-01]

The new technique of phase quadrature holographic multiplexing is presented. The method inherits the considerable benefits of coherent detection upon which it relies, and together these innovations promise to enable terabyte capacities in 2nd generation HDS products.

9:00 am: **Construction of holographic data storage with dual-reference beam**, Kazuo Watabe, Hideaki Okano, Takashi Usui, Akihito Ogawa, Shinichi Tatsuta, Yuji Kubota, Toshiba Corp. (Japan) . . . . . [7730-02]

A novel holographic data storage (HDS) system with dual-reference beam is proposed. Several servo techniques that construct a read and write procedure of the HDS system are introduced and experimentally confirmed.

9:15 am: **Experimental investigation of a page-oriented Lippmann 'holographic' data storage system**, Gilles Pauliat, Kevin Contreras, Institut d'Optique Graduate School (France) . . . . . [7730-03]

From previous theoretical studies we anticipated that storage architectures derived from Lippmann photography should allow storage capacities as large as for holography. For the first time we experimentally investigate this approach in a page-oriented architecture.

9:30 am: **Digital holographic recording using spatially resolved multi wavelengths**, Silke Huferath-von Luepke, Juergen Geldmacher, Christoph von Kopylow, Thomas Kreis, Bremer Institut für angewandte Strahltechnik (Germany) . . . . . [7730-04]

We present first investigations aiming a new approach for multi wavelength contouring using fs-lasers. For this purpose, we employ several wavelengths of a dye laser spatially distributed for the reference wave on the hologram target.

9:45 am: **How media properties (mostly) dictate a 300GB disk format**, Edeline B. Fotheringham, InPhase Technologies Inc. (United States) [7730-05]

Evolving demonstrations of 560 Gbit/in2 over a few cm2 into filling disks with 300 GB of user data brings to light a new set of media properties due to differences in temporal and spatial scales.

Coffee Break . . . . . 10:00 to 10:30 am

SESSION MB

Room: UMC 235. . . . . Mon. 10:30 am to 12:00 pm

Microholographic Recording

Session Chairs: **Robert R. McLeod,** Univ. of Colorado at Boulder; **Kimihiro Saito,** Sony Corp. (Japan)

10:30 am: **A systematic comparison of bit-based and page-based holographic storage systems** *(Invited Paper)*, Yuzuru Takashima, Lambertus Hesselink, Stanford Univ. (United States) . . . . . [7730-06]

Difference in robustness of the two recording schemes, a page-based and bit-based holographic recording, originates from a distinction of diffraction mechanisms under perturbations. The difference also affects aberration corrections on optical designs.

11:00 am: **Microholographic recording with wavelength and angle multiplexing**, Ryuichi Katayama, NEC Avio Infrared Technologies Co., Ltd. (Japan); Yuichi Komatsu, NEC Network and Sensor Systems, Ltd. (Japan). . . . . [7730-07]

Microholographic recording with multiplexing of ten bits has been experimentally demonstrated by varying the wavelength of the beams in two states and the incident angle of the beams on the recording medium in five states.

11:15 am: **Violet-emitting laser diode systems for holographic data storage**, Anton von Veltheim, Enrico Dietz, Susanna Orlic, Technische Univ. Berlin (Germany) . . . . . [7730-08]

Typically, holographic recording requires sufficiently coherent light sources, which only complex laser systems can provide. In this paper we analyze inexpensive and compact GaN laser diode systems concerning their applicability in holographic data storage.

11:30 am: **Subdiffraction microholograms using two-color single-photon photoinitiation/photoinhibition**, Benjamin A. Kowalski, Robert R. McLeod, Univ. of Colorado at Boulder (United States) . . . . . [7730-09]

A two-color single-photon photoinitiation/photoinhibition system achieves fully 3D spatial control of microholograms for multilayer data storage. Microholograms below the diffraction limit are written and read back out.

11:45 am: **Tracking and focusing in microholographic storage systems**, Enrico Dietz, Frohmann Sven, Johannes Gentz, Susanna Orlic, Technische Univ. Berlin (Germany). . . . . [7730-10]

We present an experimental setup and measurements for analyzing the simplest possible implementation of tracking and focusing by using microgratings themselves as guiding structure.

Lunch Break . . . . . 12:00 to 1:30 pm

SESSION MC

Room: UMC 235. . . . . Mon. 1:30 to 3:00 pm

Drive Technologies and Components

Session Chair: **Kevin R. Curtis,** InPhase Technologies Inc.

1:30 pm: **Development of compact femtosecond fiber laser and alignment free confocal system for multilayered optical memory** *(Invited Paper)*, Yoshimasa Kawata, Shizuoka Univ. (Japan) and Japan Science and Technology Agency (Japan); Masatoshi Tsuji, Wataru Inami, Shizuoka Univ. (Japan). . . . . [7730-11]

We present a three-dimensional optical memory using a developed compact fiber laser. We demonstrated two-photon recording on photochromic materials using the developed fiber laser. We also present a fiber confocal microscope for alignment-free readout system.

2:00 pm: **512 GB recording on 16-layer optical disc with Blu-ray Disc based optics** *(Invited Paper)*, Motohiro Inoue, Atsuko Kosuda, Koji Mishima, Tomoki Ushida, Takashi Kikukawa, TDK Corp. (Japan) . . . . . [7730-12]

We confirmed the feasibility of a 16-layer write once disc based on Blu-ray Disc optics. The total capacity of the disc achieved 512 GB per single disc side with BD 1x recording speed.

2:30 pm: **Homodyne detection for readout signals of optical disc with a high-coherence laser**, Kentaro Osawa, Hideharu Mikami, Takahiro Kurokawa, Koichi Watanabe, Hitachi, Ltd. (Japan) . . . . . [7730-13]

A system of homodyne detection for readout signals of optical disc is simplified by applying a high-coherence laser as the light source. Improvement in the readout signal quality is demonstrated with the present system.

2:45 pm: **Angle and phase coding in optical recording**, Silvania F. Pereira, Technische Univ. Delft (Netherlands); Julien F. P. Spronck, Yale Univ. (United States); Vladimir G. Kutchoukov, Technische Univ. Delft (Netherlands); Hans-Albert bachor, The Australian National Univ. (Australia) . . . . . [7730-14]

Simulations and results on encoding information both in the longitudinal and transverse directions of an optical beam reflected from an asymmetric pit are presented. The method does not require interferometric but a simple quadrant detector.

Coffee Break . . . . . 3:00 to 3:30 pm

SESSION MD

Room: UMC 235. . . . . Mon. 3:30 to 5:00 pm

Systems and Applications

Session Chair: **Barry H. Schechtman,**
Information Storage Industry Consortium

3:30 pm: **New video disc (NVD) for high-density storage** *(Invited Paper)*, Xiangshui Miao, Huazhong Univ. of Science and Technology (China) [7730-16]

No abstract available.

4:00 pm: **Characterization of media for optical data storage** *(Invited Paper)*, Ding Ping Tsai, National Taiwan Univ. (Taiwan) . . . . . [7730-17]

No abstract available.

4:30 pm: **Next generation optical disc system with Super-RENS ROM disc** *(Invited Paper),* Masayuki Ohmaki, Kenya Nakai, Nobuo Takeshita, Masahisa Shinoda, Mitsubishi Electric Corp. (Japan); In-Oh Hwang, Samsung Electronics Co., Ltd. (Korea, Republic of); Yongwoon Lee, Samsung Advanced Institute of Technology (Korea, Republic of); Hui Zhao, Jooho Kim, Samsung Electronics Co., Ltd. (Korea, Republic of); Bérangère Hyot, Bernard André, Ludovic Poupinet, Commissariat à l'Énergie Atomique (France); Takayuki Shima, Takashi Nakano, Junji Tominaga, National Institute of Advanced Industrial Science and Technology (Japan) . . . . . [7730-72]

The playback of 4 channels video contents was successfully demonstrated on HDTVs at data transfer rate of 72 Mbps with Super-RENS ROM disc. High potentiality of Super-RENS technology was confirmed to realize next generation optical disc system.

Monday Poster Session

Room: UMC 235. . . . . Mon. 5:15 to 6:45 pm

Authors should be prepared to display their posters during morning coffee break for extended viewing. The interactive poster session with authors in attendance to answer questions will be Monday evening from 5:15 to 6:45 pm. Posters not removed will be considered unwanted and will be discarded.

Readout signal intensity for the two-photon sensitized fluorescent recording materials, Toshio Sasaki, Tatsuo Mikami, Hidehiro Mochizuki, Toshiyuki Kitahara, Masaharu Akiba, Eri Goto-Takahashi, Hiroo Takizawa, FUJIFILM Corp. (Japan) . . . . . [7730-49]

Read/write characteristics for two types of novel two-photon sensitized fluorescent recording materials are described. Intensity of the fluorescent readout signal is estimated from 10 to 100nW at detector surface.

Fine grained nano Sn film used as a medium in super-resolution optical storage, Chuanfei Guo, Qian Liu, Jianming Zhang, The National Ctr. for Nanoscience and Technology of China (China) . . . . . [7730-50]

A Sn nano-film is used for super-resolution optical storage. The minimum recording spot is ~50 nm. Carrier/noise ratio can over 30 dB to the 100 nm recording spots. The disc also shows good readout durability.

Signal quality improvement of holographic data storage by adaptive two-dimensional filter, Yo Kondo, Yosuke Takahata, Shuhei Yoshida, Manabu Yamamoto, Tokyo Univ. of Science (Japan) . . . . . [7730-51]

The linear minimum mean square error (LMMSE) method is tested to examine its effectiveness in optimizing the coefficients of the FIR filter. The real-coded genetic algorithm (RCGA), is also applied and the result is compared with that for the LMMSE.

A new error correction technique for BD systems, Jun Lee, Jae-Sung Lee, Bong-Sik Kwak, Na-Young Kim, Jeong Kyo Seo, JungJoon Lee, Byung-Hoon Min, LG Electronics Inc. (Korea, Republic of) . . . . . [7730-52]

Two-dimensional error correction codes (2D-ECCs) have been the cornerstone of all three generations of optical recording - CD, DVD and BD. Research into powerful error correction methods is paramount for the development of high-capacity optical recording systems. A Picket code for BD systems performs error and erasure decoding by giving and taking erasure information between two ECCs. In this paper, we will present a new error correction method of picket code that performs error and erasure decoding using the only erasure information supplied from 17PP code decoder.

Numerical model for super resolution effect in ROM optical disks, Alberto da Costa Assafrao, Silvania F. Pereira, Hendrik P. H. Urbach, Technische Univ. Delft (Netherlands); Christophe Féry, L. von Riewel, Stephan Knappmann, Deutsche Thomson oHG (Germany) . . . . . [7730-53]

A simplified computational model for super resolution effect is proposed and simulations are compared with experimental results, providing basic understanding of this phenomenon.

Interdiffusion model of radical photopolymerization for holographic recording media, Shuhei Yoshida, Shuma Horiuchi, Manabu Yamamoto, Tokyo Univ. of Science (Japan) . . . . . [7730-55]

In this paper, we propose a novel numerical model for radical photopolymerization. We have analyzed diffraction characteristics of radical photopolymer based on this interdiffusion model, and also performed experiment for estimation of media parameters.

The study on mechanism of holographic recording in photopolymer with dual monomer, Qianli Zhai, Shiquan Tao, Dayong Wang, Beijing Univ. of Technology (China) . . . . . [7730-56]

Based on previous dynamics model for single monomer photopolymers, the mechanism for photopolymer with dual monomers is investigated starting from the mismatch between the experiment and fitting curve of dark enhancement.

Hyper numerical aperture Blu-ray objective lens, Youngsik Kim, Jun Zhang, Tom D. Milster, College of Optical Sciences, The Univ. of Arizona (United States) . . . . . [7730-57]

Hyper numerical aperture(NA) Blu-ray objective lens(NA=1.4) using solid immersion lens(SIL) is introduced, and aberration caused by cover layer of Blu-ray Disc(BD) and chromatic aberration is corrected by truncated SIL and diffractive optical element(DOE).

Chemical analysis of the plastic substrates and the reflective layers of today's archival-grade DVDs, Guilin Jiang, Barry M. Lunt, Matthew R. Linford, Brigham Young Univ. (United States) . . . . . [7730-58]

The plastic substrates and reflective layers of four archival-grade and one standard-grade recordable DVDs were analyzed using XPS and ATR-FTIR. Similarities in the plastic substrates and differences in the reflective layers were found.

Error reduction in reconstruction of kinoform CGH patterns for a hologram ID tag system, Hye-rim Kim, Yong-hyub Won, Ji-song Lim, Korea Advanced Institute of Science and Technology (Korea, Republic of); Kimun Pak, KAIST (Korea, Republic of) . . . . . [7730-59]

In this paper, we propose a hologram reconstruction algorithm which can considerably reduce error caused by tag damages. It can successfully reconstruct original images at a low error rate of about 12% within 50% damages.

Color kinoform CGH for an ID tag with a larger data capacity, Hyunwhan Choi, Kiwoo Jun, Yong-hyub Won, Ji-song Lim, Korea Advanced Institute of Science and Technology (Korea, Republic of) . . . . . [7730-60]

In this paper, we propose a color kinoform CGH which is converted from a conventional grayscale kinoform CGH using an appropriate conversion algorithm. Our simulated results show the color CGH can support 6 times larger data capacities than the conventional grayscale CGH for the same size data.

Improved readout system for multilevel signal waveform modulation read-only disc, Hequn Wang, Tsinghua Univ. (China) . . . . . [7730-61]

This paper presents the improved readout system of multi-level signal waveform modulation read-only disk. The experimental results show the performance of the improved readout system is better than that of the former system.

New developments of the signal waveform modulation optical disc, Hailong Liu, Jing Pei, Longfa Pan, Tsinghua Univ. (China) . . . . . [7730-62]

This paper presents the new development of the signal waveform modulation optical disc. The optical disc is realized through inserting a sub-pit/sub-land into an original land/pit. More storage states are realized with changing the size and position of the sub-pit/sub-land. The modulation coding and the calculated readout signals are elucidated.

Fano resonance in silver-silica-silver mulilayer nanoshells, Jin Fa Ho, A*STAR - Data Storage Institute (Singapore) . . . . . [7730-63]

Fano resonance is possible in silica coated silver nanospheres due to the interaction of the silver nanosphere's dipole plasmon mode and quadrupole mode. This has many applications ranging from electromagnetic cloaks to optical data processing.

Optical discs based on inorganic substrates for long-term data storage, Ivan Gorbov, Institute for Information Recording Problems (Ukraine) [7730-64]

The inorganic materials were used for creation of optical discs for long-term data storage. The data in CD format was recorded on glass and sapphire surfaces. The created glass CD was reproduced on standard CD and DVD players.

DVD error evaluation: Are PI8(max) and POF(max) enough?, Barry M. Lunt, Erin Bourgeous, Bradely M. Lunt, Matthew R. Linford, Brigham Young Univ. (United States) . . . . . [7730-65]

There is a need for greater definition for the error condition of a DVD; PI8(max) and POF(max) may not be enough. This research proposes using PI8(max), POF(avg) and PIF Bytes (max).

Investigation of Influence of wavefront property of reference beams on the quality of images reconstructed from holograms, Wei Song, Shiquan Tao, Maoluan Ding, Dayong Wang, Beijing Univ. of Technology (China) . . . . . [7730-66]

Numerical simulations and holographic experiments show that speckle reference beam will make quality of reconstructed images deteriorate in holographic storage. In order to implement high-quality and high-density, the reference beam must be optimized.

Optically induced spin-orbit effective magnetic fields in all-optical magnetic recording, Kwaku Eason, Guillaume Vienne, Jianming Li, A*STAR - Data Storage Institute (Singapore) . . . . . [7730-67]

Effective magnetic fields in all optical magnetic recording are analyzed considering optically-induced spin-orbit (OSO) coupling. We show that OSO induced magnetic fields have a distribution with exterior rings of maximum amplitude in the perpendicular component.

Approach to long archival life of holographic recording in photopolymers, Masaya Terai, Rumiko Hayase, Kazuki Matsumoto, Toshiba corporation (Japan) . . . . . [7730-69]

Molecular diffusion and archival life of holographic recording are discussed. We have managed to improve the archival life by linking holograms to the matrix.

A low complexity metric for optical signal quality evaluation, Jin Xie, Marvell Semiconductor, Inc. (United States); Mats Öberg, Zak Keirn, Marvell Semiconductor Inc. (United States) . . . . . [7730-70]

We propose a low complexity method for optical signal quality measurement. The method is based on Viterbi margin metric (VMM) and is shown to estimate error rate well on BD optical signals.

Tuesday 25 May

SESSION TuA

Room: UMC 235. . . . . Tues. 8:30 to 10:00 am

Near-Field Recording

Session Chair: **Tuviah E. Schlesinger,** Carnegie Mellon Univ.

8:30 am: **Recent developments in near field optical transducers for data storage** *(Invited Paper)*, Lambertus Hesselink, Stanford Univ. (United States) . . . . . [7730-18]

We describe new developments to further minimize the deep sub-wavelength spot size of a near field optical transducer to less than 20 nm. We will review various transducer designs and their performance, and recent demonstrations of data storage applications.

9:00 am: **High density recording with SIL-based near-field optical recording** *(Invited Paper)*, Jin-Hong Kim, Seong-Hun Lee, Jun-Seok Lee, Bong-Sik Kwak, Jeong Kyo Seo, JungJoon Lee, Byung-Hoon Min, LG Electronics Inc. (Korea, Republic of) . . . . . [7730-19]

Recording and readout characteristics with solid immersion lens-based nearfield recording are examined using homemade gap servo near-field recording system with two effective numerical apertures of 1.45 and 1.85.

9:30 am: **Apertureless near-field probe for high-density optical data storage**, Myhajlo Denysjuk, Institute for Information Recording Problems (Ukraine) . . . . . [7730-20]

An apertureless plasmonic near-field optical probe, matched with optical fiber, is proposed. This probe has significantly increased signal-to-noise ratio and storage density, reached 1.5 Gbit/in2. The results of probe modeling by finite-difference time-domain (FDTD) method show that it can be matched with optical fiber with excitation efficiency over 50%. Besides, capability of using metals tip with large curvature radius for 10nm resolution was shown.

9:45 am: **Characteristics of the depth of focus in a high-NA optical system with a SIAX for data storage**, Jaisoon Kim, Myongji Univ. (Korea, Republic of); Moonseok Kim, Sukjoon Hong, Seoul National Univ. (Korea, Republic of); Tom D. Milster, College of Optical Sciences, The Univ. of Arizona (United States) . . . . . [7730-21]

We study the near-field characteristic of SIAX and describe the extended depth of focus in Bessel beam. High NA data storage systems using SIL and SIAX are designed. Characteristics of the systems are presented, especially, air-gap tolerance.

Coffee Break . . . . . 10:00 to 10:30 am

SESSION TuB

Room: UMC 235. . . . . Tues. 10:30 am to 12:00 pm

Super Resolution and Hybrid Systems

Session Chairs: **Tim Rausch,** Seagate Technology LLC; **LuPing Shi,** A*STAR - Data Storage Institute (Singapore)

10:30 am: **Near field optical transducer design with FePt recording media for multiple Tb/in2 density heat assisted magnetic recording**, Baoxi Xu, Yeow Teck Toh, Cheow Wee Chia, Jiangfeng Hu, Gaullaume G. Vienne, Chengwu An, Yosia Yosia, Tow Chong Chong, A*STAR - Data Storage Institute (Singapore) . . . . . [7730-22]

FePt thin film optical constant was measured. Design and simulation of c-aperture transducer with FePt media for multiple Tb/in2 heat assisted magnetic recording application were performed. Recording density of >2T/in2 is verified after thermal simulation.

10:45 am: **Thermo-optical design of HAMR light path for single mode near field transducer excitation**, Eric J. Black, Yunchuan Kong, Stephen Powell, Yi Luo, James A. Bain, Tuviah E. Schlesinger, Carnegie Mellon Univ. (United States) . . . . . [7730-23]

An optical path for HAMR from laser source to transducer and simulated medium is presented. Experimental results for grating input coupled tapered waveguides are reported. Optical path efficiency and its thermal consequences are considered.

11:00 am: **All-optical magnetic recording and its thermal issues**, JianMing Li, LuPing Shi, Gao Qiang Yuan, Kian Guan Lim, Gaullaume G. Vienne, Kwaku Eason, Jing Zhang, Tow Chong Chong, A*STAR - Data Storage Institute (Singapore) . . . . . [7730-24]
This work presents a thermal analysis that explains experimental observation in all-optical magnetic recording (AOMR). An integrated model is used to describe thermal processes at different time scales in AOMR

11:15 am: **Property study of TbFeCo for all optical magnetic recording**, Irene Lee, A*STAR - Data Storage Institute (Singapore); Cheng Huat Lim, Kah Long Toh, Chee Lip Gan, Nanyang Technological Univ. (Singapore); JianMing Li, LuPing Shi, A*STAR - Data Storage Institute (Singapore) . . . . . [7730-25]
Thin films of amorphous TbFeCo, suitable for magneto-optical recording, were studied. The effects of film thickness, Ar flow rate and presence of Ag underlayer on magnetic properties and optical behavior of the films were investigated.

11:30 am: **Optical channel characterization for an InSb-based super-resolution disc system**, Dietmar Hepper, Xiao-Ming Chen, Deutsche Thomson oHG (Germany) . . . . . [7730-26]
Optical channel properties of InSb-based super-resolution disc systems are estimated using an adaptive Volterra filter. Channel characteristics for minimum mark lengths of 80 and 60 nm and track pitches of 320 and 260 nm are presented.

11:45 am: **Nanodot formation for optical mastering using super resolution near field structure**, Irene Lee, A*STAR - Data Storage Institute (Singapore); Chee Ying Khoo, Nanyang Technological Univ. (Singapore); Chun Yang Chong, Gao Qiang Yuan, Lung Tat Ng, A*STAR - Data Storage Institute (Singapore); Chee Lip Gan, Nanyang Technological Univ. (Singapore)[7730-27]
A super resolution near field structure was used to generate nanodots of dimensions smaller than the diffraction limit of the optical system. The performance of the structure is evaluated.

Lunch Break . . . . . 12:00 to 1:30 pm

SESSION TuC

Room: UMC 235. . . . . Tues. 1:30 to 3:00 pm

Holographic Recording/Components and Media

Session Chairs: **Susanna Orlic,** Technische Univ. Berlin (Germany); **Kazuo Watabe,** Toshiba Corp. (Japan)

1:30 pm: **Enhancement for tunable blue laser for holographic data storage**, Masaki Omori, Tadaaki Miyata, Hideki Kondo, Naoki Mori, Hidenori Matsuo, Takashi Sasamuro, Shigeki Okauchi, Nichia Corp. (Japan); Jason R. Ensher, Rod Harris, Aaron Wegner, Jason Cozakos, InPhase Technologies Inc. (United States). . . . . [7730-28]
Our Blue ECLD has been working successfully for Tapestry HDS. In order to commercialize the HDS, InPhase and Nichia have moved forward production development phase and ECLD reliability has been improved dramatically.

1:45 pm: **A laser module for holographic data storage**, Jason R. Ensher, InPhase Technologies Inc. (United States) . . . . . [7730-29]
We report the development of a modular, field-replaceable laser for holographic data storage. Starting with a Blue ECLD co-developed by Nichia and InPhase Technologies, we developed a laser with optical isolation, beam expansion and spatial-filtering.

2:00 pm: **Theoretical estimation of signal to noise ratio in collinear holographic memory at 10 TBite per disk recording**, Tsutomu Shimura, Junichiro Tottori, Ryushi Fujimura, Kazuo Kuroda, The Univ. of Tokyo (Japan). . . . . [7730-30]
Signal to noise ratio of the collinear holographic memory is calculated numerically. The results show that the theoretical limit of the recording capacity per 12 cm disk is more than 10 TBite.

2:15 pm: **Background correction of detected digital data page for holographic storage**, Sanjeev Solanki, Xuewu Xu, Xinan Liang, Tow Chong Chong, A*STAR - Data Storage Institute (Singapore) . . . . . [7730-31]
A real-time background correction technique is reported for digital data page holographic storage. Two inverted binary data pages are recorded at the same location in recording media with two inverted random phase coded reference beams using a rotating half-wave plate. Adding the two detected inverted data pages from same media location creates background image with noise at that media location. The background image is used to successfully perform the background correction to reduce the noise of detected digital data pages.

2:30 pm: **Blends of Azobenzene-containing diblock copolymers and molecular glasses for holographic data storage**, Hubert Audorff, Roland Walker, Lothar Kador, Hans-Werner Schmidt, Univ. Bayreuth (Germany) . . . . . [7730-32]
Azobenzene-containing diblock copolymers are a promising materials class for holographic data storage. Their writing speed of holographic gratings can be improved by blending with azobenzene-containing molecular glasses.

2:45 pm: **Precision two-beam holographic material tester**, Alan C. Hoskins, Univ. of Colorado (United States); Charles D. Anderson, Kevin R. Curtis, InPhase Technologies, Inc. (United States). . . . . [7730-33]
A new type of holographic material tester (HMT) is introduced that is capable of simultaneously measuring material volume and bulk refractive index changes with a precision on the order of 10^{-5}

Coffee Break . . . . . 3:00 to 3:30 pm

SESSION TuD

Room: UMC 235. . . . . Tues. 3:30 to 5:00 pm

Future Emerging Technologies

Session Chair: **Paul J. Wehrenberg,** Apple Computer, Inc.

3:30 pm: **State of R&D in photonics-related fields in Japan's industry and academia: leading the 'green digital economy'** *(Invited Paper)*, Kimio Tatsuno, OITDA/Hitachi, Ltd. (Japan) . . . . . [7730-34]
Photonics product statistics in Japan provided by OITDA is shown from display to PV-cells. The future challengeable energy saving photonics products connected to the broadband, especially the fiber communication are prospective to lead the "Green Digital Economy".

4:00 pm: **Advanced CROP recording materials for emerging technologies** *(Invited Paper)*, David A. Waldman, STX Aprilis, Inc. (United States) . [7730-36]
High dynamic range, recording sensitivity and other performance attributes are realized for both data page holograms and microholograms recorded in STX Aprilis DHD® media utilizing its advantageous low shrinkage Cationic Ring-Opening Polymerization (CROP) chemistry method.

4:30 pm: **Petabyte optical disc**, Eugen Pavel, Storex Technologies Inc. (United States). . . . . [7730-37]
Nanomarks organized in virtual multilayers, produced in fluorescent glass-ceramics discs, permit Petabytes data storage capacity. In this study we report results of readout investigations by two non-fluorescence optical detection methods.

4:45 pm: **Fine distribution of hard x-ray wave field intensity inside ultra-high density digital data storage layer with nano-scale thickness during data read-out procedure from the x-ray optical memory (X-ROM) plate**, Hakob P. Bezirganyan, V Group, Inc. (United States); Siranush E. Bezirganyan, X-ROM, Inc. (United States); Petros H. Bezirganyan, V Group, Inc. (United States); Hayk H. Bezirganyan, X-ROM, Inc. (United States) . . . . . [7730-38]
It is investigated theoretically the x-ray path inside hard x-ray optical memory (X-ROM) plate during digital data read-out procedure. Proposed path minimization conditions are based on calculations of x-ray intensity distribution inside data storage layer.

Wednesday 26 May

SESSION WA

Room: UMC 235. . . . . Wed. 8:30 to 10:30 am

Nanophotonics

Session Chairs: **Ding Ping Tsai,** National Taiwan Univ. (Taiwan); **Susanna Orlic,** Technische Univ. Berlin (Germany)

8:30 am: **Novel nano-structures and fabrication techniques with applications in plasmonic data storage** *(Invited Paper)*, Nathan C. Lindquist, Timothy W. Johnson, Hyungsoon Im, Prashant Nagpal, Antoine Lesuffleur, David J. Norris, Univ. of Minnesota, Twin Cities (United States); Masud Mansuripur, College of Optical Sciences, The Univ. of Arizona (United States); Sang-Hyun Oh, Univ. of Minnesota, Twin Cities (United States) . . . . [7730-39]
We present template-stripping methods for the fabrication of metallic nano-structures with applications in high-density plasmonic data storage. Different arrangements of nano-bumps and nano-holes can provide a basis for encoding multi-dimensional information within a single bit-cell.

9:00 am: **Single photon source based on color center in diamond nanowire** *(Invited Paper)*, Marko Loncar, Harvard Univ. (United States) . . . . . [7730-40]
He recently demonstrated diamond nanowires with embedded color centers that are very nice single photon sources. These color centers are very promissing quantum registers due to long coherence times of their spins. Nanowires should perform much better than bulky diamond crystals. Paper accepted in Nature Nanotech.

9:30 am: **Single spins in diamond for quantum networks and magnetic sensing** *(Invited Paper)*, Gurudev Dutt, Univ. of Pittsburgh (United States) . . . . . [7730-41]
Single spins in diamond are a promising platform for distributed quantum information networks and precision measurements. I will discuss recent progress in this field demonstrating coherent operations with coupled electron-nuclear spin quantum registers, optically mediated entanglement, and nanoscale precision magnetometry.

10:00 am: **Trapped rainbow for storage of light in nanophotonic materials** *(Invited Paper)*, Ortwin Hess, Univ. of Surrey (United Kingdom) . . . . . [7730-42]
No abstract available.

Coffee Break . . . . . 10:30 to 11:00 am

SESSION WB

Room: UMC 235. . . . . Wed. 11:00 am to 12:30 pm

Multidimensional Recording

Session Chair: **Tom D. Milster,** College of Optical Sciences, The Univ. of Arizona

11:00 am: **Five-dimensional optical data storage** *(Invited Paper)*, Min Gu, Swinburne Univ. of Technology (Australia) . . . . . [7730-43]
The tuneability of optical properties of the nanoparticles provides the various erasable and non-erasable polarisation and spectral encoding mechanisms. This approach has led to a horizon of the new-generation 5D optical data storage technology.

11:30 am: **Two-photon sensitized recording materials for multilayer optical disk** *(Invited Paper)*, Masaharu Akiba, Eri Goto-Takahashi, Hiroo Takizawa, Toshio Sasaki, Hidehiro Mochizuki, Tatsuo Mikami, Toshiyuki Kitahara, FUJIFILM Corp. (Japan) . . . . . [7730-44]
Two types of two-photon absorption recording material, which are writable at 405nm or 522nm via a two-photon process, have been newly developed. Twenty-layer recording inside the disk fabricated with the material has also been demonstrated.

12:00 pm: **A possible solution for the next generation of optical data storage** *(Invited Paper)*, Peter Török, Imperial College London (United Kingdom) . . . . . [7730-45]
This talk will review our recent work on polarisation multiplexed optical data storage (MODS). Our results obtained by both static and dynamic tester shows that MODS permits a storage density increase of about 7x.

Lunch Break . . . . . 12:30 to 2:00 pm

SESSION WC

Room: UMC 235. . . . . Wed. 2:00 to 3:30 pm

Advanced and Related Technologies

Session Chair: **Ryuichi Katayama,** NEC Avio Infrared Technologies Co., Ltd. (Japan)

2:00 pm: **Finite-difference time-domain computer simulations with applications to optical data storage** *(Invited Paper)*, Armis R. Zakharian, Corning Inc. (United States) . . . . . [7730-46]
The local space and time grid refinement technique can significantly reduce the computation time and memory requirements of the Finite-Difference Time-Domain (FDTD) simulation. We discuss application of the grid refinement approach to problems in optical data storage and the resulting improvements in the computation efficiency.

2:30 pm: **A broadly achromatic, biological quarter wave retarder** *(Invited Paper)*, Nicholas Roberts, The Univ. of Manchester (United Kingdom)[7730-47]
No abstract available.

3:00 pm: **Full high-definition digital 3D holographic display and its enabling technologies** *(Invited Paper)*, Xuewu Xu, Sanjeev Solanki, Xinan Liang, Yuechao Pan, Ridwan Bin Adrian Tanjung, Tow Chong Chong, A*STAR - Data Storage Institute (Singapore) . . . . . [7730-48]
We introduce a monochrome 3D holographic display system developed at DSI based on computer-generated holograms. A futuristic vision of full high-definition digital 3D holographic display is proposed and its enabling technologies are discussed.

Coffee Break . . . . . 3:30 to 4:00 pm

SESSION WD

Room: UMC 235. . . . . Wed. 4:00 to 4:30 pm

Post Deadline

Session Chair: **Bernard W. Bell, Jr.,** Optical Wizards LLCPost Deadline Submissions will be accepted from 15 March until 5 April.

4:00 pm: **Optical phase multi-level recording in microhologram**, Hideharu Mikami, Kentaro Osawa, Koichi Watanabe, Hitachi, Ltd. (Japan). . . . [7730-68]
A novel multi-level scheme using optical phase is proposed. It overcomes drawbacks in conventional multi-level schemes and greatly enhances capacity and transfer rate of microholographic optical discs. We demonstrate its feature of high signal-to-noise ratio.

4:15 pm: **Lens system design for wide-range optical disc cover thickness compensation,** Norihiro Tanabe, Hirotaka Miyamoto, Takahiro Miura, Takeshi Kubo, Daisuke Ueda, Yoshihiro Takemoto, Hisayuki Yamatsu, Kimihiro Saito, Seiji Kobayashi, Sony Corp. (Japan) . . . . . [7730-71]
We designed and confirmed the performance of an objective lens system for Micro-Reflector optical disc recording/readout tester capable for a 50mm to 300mm disc cover thickness range with 0.85 NA and 405nm wavelength.

Closing Remarks

Room: UMC 235 . . . . . Wed. 4:30 to 4:45 pm

About Boulder
Cresting over the hill on highway 36 into Boulder, it's easy to see why this intriguing town has been dubbed "the city nestled between the mountains and reality." At 5,430 feet above sea level, acres of vast open space roll into Boulder's quaint cityscape tucked into the foothills of the Rocky Mountains. Boulder is just 40 minutes from Denver, and just moments from 43,000 acres of open space and trails.

Food + Beverage

Coffee Breaks
Coffee will be served during the morning and afternoon breaks in UMC Room 235. Please refer to your onsite program for specific times of these breaks.

Lunch Break
Attendees will need to make their own arrangements for lunch each day.

Welcome Reception
Monday 7 to 8:30 pm
Please join your colleagues for light refreshments and lively conversation at the welcome reception.

Poster Session
Monday 5:15 to 6:45 pm
The poster session will allow attendees the opportunity to view papers presented in this format and ask questions with the authors present at their displays.

Local Tour
A tour is planned to the InPhase Technologies facility in Longmont, Colorado. The facility tour will include working drives, drives in libraries, drive development and testing areas, media testing, HROM media replication tooling, and a look in on FRU (laser) build area.

Reserve your spot before noon on Tuesday at the Registration Desk. A fee to cover the cost of transportation will be required.

Attendee Services and Policies

Internet Services
Complimentary wireless internet access will be available. Check at the Registration Desk for additional details.

Audio, Video, Digital Recording Policy
In the Meeting Room and Poster Session: for copyright reasons, recordings of any kind are strictly prohibited without prior written consent of the presenter in any conference session or of posters presented. Each presenter being taped must file a signed written consent form. Individuals not complying with this policy will be asked to leave a given session and asked to surrender their film or recording media. Consent forms are available at the SPIE Registration Desk.

Laser Pointer Safety Information
SPIE supplies tested and safety approved laser pointers. For safety reasons, SPIE requests that presenters use our provided laser pointers.

Unsecured Items
Personal belongings such as briefcases, backpacks, coats, book bags, etc. should not be left unattended in meeting rooms or public areas. These items will be subject to removal by security upon discovery.

Meeting Location and Parking on UCB Campus

All events will take place in the University Memorial Center (Building 94) in Room 235 on the University of Colorado at Boulder campus.

Parking at the university can be costly and is limited. We encourage you to use the public transportation system when possible (www.RTD-Denver.com).

A more detailed university map is available online at www.spie.org/ods under the Hotel + Travel section.

Index of Authors, Chairs, and Committee Members

Bold = SPIE Member

SPIE Digital Library

SPIEDigitalLibrary.org

Research driving technological innovation

The world's largest collection of optics and photonics research

Conference Proceedings

Available in 2–4 weeks

Optical Data Storage

SPIE Journals

Journal of Electronic Imaging

eBooks

Ask your librarian for access

SPIE

Connecting minds. Advancing light.