

International
Speakers will
be gathering
in SGP for the
3rd Symposium

Mold
Hard or Soft?
Addressed by:
NTT AT & NILT

Resist
New
Advancement?
Addressed by:
Micro Resist
Technology

Equipment
Automated System
for Production.
Addressed by:
Obducat

Process
Versatile
Patterning
of Polymers
Addressed by:
IMRE

Applications
Nanoimprint
Rides on OLED,
& HDD...

Addressed by:
KIMM, DSI

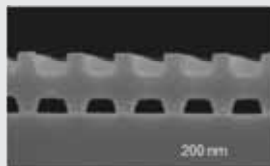


3rd Industrial Symposium on Nanoimprint Lithography to be held in Singapore Suntec City Convention Center

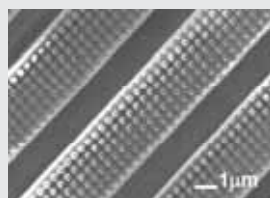
It is officially announced that the **3rd Industrial Symposium on Nanoimprint Lithography** will be held in **Singapore Suntec City Conventional Center Rm 302** on **2nd July 2009**. This **half day event (1.30pm to 5.30pm)** brings International speakers together to update the recent developments in Nanoimprint Lithography, covering the value chain from **Mold, Resist, Equipment, Process and Applications**.

Further Details pls. refer to Programme

Unique & Cost – Efficient Process for Complex 3D Hierarchical Structures



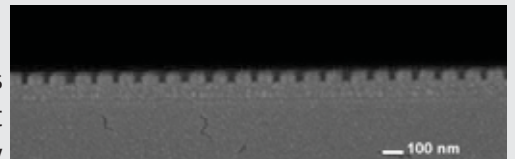
Using IMRE's
unique
imprinting
process.



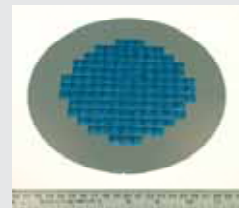
Further Details given at Symposium

Mass Producing Low-Cost Nano-sized Structures

IMRE's
Nanoimprint
Foundry



offers Wafer Scale Nanoimprinting services via the Step and Flash imprint Lithography (SFIL). For imprinting of nano-sized features (e.g. 50nm Line-space gratings), excellent yield of nearly 100% can be achieved on a 8" wafer.



Further Details given at Symposium

International speakers from:

Industrial Symposium I

3rd Industrial Symposium on Nanoimprint Lithography 2009

CHAIRS

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Institute of Materials Research and Engineering, Singapore

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SCOPE OF SYMPOSIUM

The Nanoimprint Lithography (NIL) Industrial Symposium is sponsored by Exploit Technologies Pte Ltd (ETPL), the strategic marketing and commercialization arm of A*STAR, and organized by The Institute of Materials Research and Engineering (IMRE). This half-day industrial symposium aims to update the recent developments, markets and technology in NIL. It also serves as a platform for industrial partners, venture capitalists, companies interested in NIL applications to acquire an understanding of the landscape and explore business opportunities/potential partnerships and expand industrial utilization of NIL technologies.

Jointly organized by :



Abstracts & Biographies

OPENING ADDRESS

Mr. Boon Swan Foo

Executive Chairman, Exploit Technologies Pte Ltd, Singapore

Mr Boon Swan Foo is the Executive Chairman of Exploit Technologies Private Limited, the strategic marketing and commercialisation arm of Singapore's Agency for Science, Technology and Research (A*STAR). He leads the commercialisation and spin-off business and activities for A*STAR's intellectual property and technologies. Under his leadership, A*STAR has accumulated a portfolio of close to 3,000 active patents, granted more than 250 licences for its technologies, and created a portfolio of two dozen spin-off companies. Estimated business revenue to be generated by licensees from sales of products and provision of services using or incorporating A*STAR's technologies is projected to be over S\$500M.

Mr Boon's extensive experience in managing technology business has earned him recognition as a prominent technology leader in Singapore as he helps create value from technology through commercialisation and spin-off start-ups. Prior to his appointment at Exploit Technologies, he was Managing Director of A*STAR from 2002 to 2006, where he played a crucial role in transforming the agency into a well-respected R&D powerhouse. He has instilled in A*STAR a mindset that is more attuned to commercial and industrial needs. His innovative approach had led to the development of the National Science and Technology Plan 2010, which included the formation of multi-agency Technology Scan Panels in physical science and engineering.

Mr Boon's career spans across both public and private sectors. In the private sector, his illustrious career included his appointments as the Deputy Chairman and Chief Executive of Singapore Technologies Engineering Ltd. Under Mr Boon's leadership, Singapore Technologies Engineering Ltd became the 7th largest company in the Singapore Stock Exchange, with a market capitalisation of S\$8 billion when he left in 2001. He also served as the President of ST Aerospace and ST Marine, the subsidiaries of Singapore Technologies Engineering Ltd. Mr Boon was the Chief Financial Officer, and Board Member and Executive Committee Director of Singapore Technologies Ltd - the parent company of Singapore Technologies Group of Companies. Mr Boon had served on the boards of NTUC Income and Singapore Computer Systems Limited, and was the Chairman of Singapore Changi Airport Enterprise Pte Ltd and Chairman of Changi Airport Managers & Partners (S) Pte Ltd.

Mr Boon currently serves on the boards of Neptune Orient Lines Limited (NOL), Shin Corporation Plc, and several other private limited companies. Mr Boon is a Senior Advisor of Temasek Holdings, as well as Advisor of ST Engineering Ltd and ST Asset Management. Mr Boon is a Member of Motorola Inc Research Visionary Board, a Member of the Commercialisation Advisory Board, Imperial College (UK) and was previously a Member of the Dean's Council of Harvard's Kennedy School of Government.

Mr Boon is a registered Professional Engineer and also a member of the Institute of Certified Public Accountants of Singapore (ICPAS). He is also a Fellow of the Chartered Association of Certified Accountant (UK)-ACCA. He holds an MBA from the National University of Singapore, and has completed Harvard's Advanced Management Program.

Mr Boon was awarded the Singapore Business Award for Outstanding CEO in 2000, one of Singapore's prestigious business awards. He was awarded the Commendation Medal, Military for his military service in Year 2001.

EMERGING APPLICATIONS BY NIL

Mr. Theodor Kamp Nielsen

Founder and CEO, NIL Technology ApS, Denmark

Nanoimprint lithography is continuously being considered to be used for production of a growing number of different products. Despite the fact that a large number of standardized R&D NIL tools are being commercially available, the demand for product specific imprint processes are still present which imply an increasing demand to tool and stamp suppliers. The challenge is being elucidated through case studies, and emphasize on the need for product specific solutions are made.

Mr. Theodor Kamp Nielsen has achieved his masters degree in Applied Physics from Technical University of Denmark (DTU) (2003) where he during his master work participated in the pioneering nanoimprint lithography work in Denmark. During his PhD studies at DTU within nanoimprint lithography he co-founded the company NIL Technology ApS (NILT) and shortly after he left the studies to devote his time to lead NILT. Mr. Nielsen is a frequent speaker at the subject of nanoimprint lithography.

EARLY STUDY AND RECENT PROGRESS OF NANOIMPRINT LITHOGRAPHY

Dr. Susumu Fujimori

Senior Manager, NTT Advanced Technology Corporation, Japan

Dr. Kenji Kurihara

Senior Manager, NTT-AT Nanofabrication Corporation, Japan

Nanoimprint lithography has recently been attracting many researchers in the field of nanofabrication technology. However, a fine-pattern fabrication technology, whose concept is similar to nanoimprint lithography, had been proposed and studied at NTT Laboratories in Japan as early as in the 1970s. The technology was based on the combination of the molding of plastic film on a substrate and dry etching of the molded film and substrate surface. It is considered that most of the basic concepts in current nanoimprint lithography were included in this study. On the other hand, the progress of the current nanoimprint lithography began in the 1990s and it has been developed to a practical technology through the effort of many researchers worldwide. This presentation introduces the early study in the 1970s and also describes a variety of nanoimprint molds currently provided.

Dr. Susumu Fujimori joined NTT Laboratories after graduating from Master Course of Tokyo University in 1975. He has been engaged in the study of microfabrication including nanoimprint lithography, thin-film formation and optical recording materials, and in the business development of new technologies. He is taking charge of international business at NTT Advanced Technology Corporation at present. Dr. Fujimori received Ph. D. from Tokyo University.

Dr. Kurihara has over 20 years of experience in micro and nanofabrication technology at NTT Laboratories from 1977. He studied electron beam lithography, focused ion beam technology, plasma processes, LSI pattern inspection technology, EUV lithography, and nanofabrication process for single electron devices. From 2000, he has jointed NTT advanced technology Corporation (NTT-AT), where he has responsible for micro and nanofabrication technology for nanotech business. From 2003, he has started nanotech sales and marketing at NTT-AT Nanofabrication Corporation (NTT-ATN), subsidiary of NTT-AT. His current business fields are nanoimprint mold, X-ray optics, nanophotonics, and various kinds of nanofabrication products.

He is a member of the Japan Society of Applied Physics, the Institute of Electronics, Information and Communication Engineerings of Japan, the Japanese Society for Synchrotron Radiation Research, and Nanotechnology Business Creation Initiative (NBCI) in Japan.

Dr. Kurihara received BS and MS from Tokyo Institute of Technology in the field of applied physics, and Ph.D. from Nagoya University.

ADVANCED RESISTS FOR THERMAL AND UV-BASED NANOIMPRINT LITHOGRAPHY

Dr. Freimut Reuther

Technical Director, Micro Resist Technology GmbH, Germany

The implementation of NIL in the industry will largely depend on the availability of polymers and resists meeting the needs of NIL and its specific applications.

A survey on polymer systems and resists for NIL and their features is presented. It covers materials for thermal as well as UV-based nanoimprint lithography (UV-NIL). Each of the two approaches requires specific materials.

Thermoplastic and thermosetting polymers differing in their molecular weight, chemical composition and flow behaviour are presented. The glass transition temperature of thermoplastic polymers determines their imprint temperature and thermal stability. Purely thermally curing polymers and curing polymers for combined thermal and UV-based NIL allow both imprinting at rather low temperature and obtaining imprints with high thermal and mechanical stability. Besides, nearly isothermal imprint processes are possible.

UV-NIL is performed at room temperature. Limitations due to elevated temperature and thermal expansion are not relevant. Materials for UV-NIL were developed focussing on film thickness of 100 nm and below and low viscosity, which has a large impact on the pattern transfer fidelity and the thickness of the residual layer.

The presented polymers and resists for NIL can be used for pattern transfer and permanent applications, e.g. in micro fluidics or micro-optical devices.

Dr. Freimut Reuther graduated in chemistry at the Dresden University of Technology in 1969 and received the Ph. D. degree in polymer chemistry from the Academy of Sciences of the GDR (East Germany) in 1975. He used to work in various areas of fundamental and applied polymer science and was largely concerned with the physicochemical and physical characterisation and the exploration of relations between structure and properties of synthetic polymers and biopolymers (polysaccharides and proteins). With this background he joined micro resist technology GmbH in Berlin in 1997, where he has been involved in various R&D activities, mainly in the development of special positive tone resists and polymers for nanoimprint lithography. He was in charge of the R&D group for some years and is now the Technical Director of the company.

OPTOELECTRONIC DEVICES— FROM LABORATORY TO PRODUCTION

Mr. Babak Heidari

CTO, Obducat AB, Sweden

The benefits of Photonic Crystal technology in improving the power consumption and performance of HB-LEDs have been proven over and over again from both a theoretical point of view and on laboratory scale. During the recent years the technology has been brought out of the laboratories, into the production environment, much with the help of nano imprint lithography. This presentation will discuss the design and performance of fully automatic systems for production of Optoelectronic devices such as HB-LED in a real production environment.

Mr. Babak Heidari was born in 1962. He is the Chief Technical Officer of Obducat AB. He obtained his M.Sc degree in Engineering. His postgraduate studies were aimed at Licentiate of Technology. His doctoral studies were on micro and nanotechnology/physics at the Department of Solid State Physics at Lund University. He has several years of experience in process development of micro and nano lithography, design of electron beam lithography and imprint lithography systems, fabrication methods and process development. Babak Heidari filed 20 patent applications and he has contributed at numerous publications, conferences, and workshops speaking on the subject. His professional experience in the past year started at Ericsson Component as Research Engineer (1989-1990), Process Integration Engineer (1991-1997), Director (2000-2002) and from 2002, he acts as Chief Technical Officer at Obducat AB, Sweden.

NANOIMPRINT LITHOGRAPHY- A HIGHLY VERSATILE NANOPATTERNING TECHNIQUE

Dr. Low Hong Yee

Research Scientist/Group Head, Institute of Materials Research and Engineering (A*STAR), Singapore

While the semiconductor industry is still evaluating the possibility of using nanoimprint lithography for integrated circuit manufacturing, the data storage industry has announced the adoption of this technology in manufacturing floor in 2008. Today, nanoimprint lithography is not only the buzz word in the semiconductor and the data storage industries, it is quickly gaining interest from a diverse industrial sectors from optical components to biomedical industries. The wide range of applications potential for nanoimprint lithography comes from it being a highly versatile nanopatterning technique. Compare to other known nanopatterning techniques such as extreme UV lithography, electron-beam lithography and even the non-conventional lithography techniques such as self-assembly, nanoimprint lithography is almost the only one technique that is applicable to a wide range of materials. A wide range of engineering polymers such as poly(methyl methacrylate), linear and crosslinked polystyrene, polyesters, polycarbonate, biopolymers such as poly(lactide acid) and poly(caprolactone), conducting polymer such as poly(thiophene) and sol-gel materials can be directly pattern using either the thermal nanoimprinting or the UV nanoimprinting method. In this talk I will share the various applications of nanoimprint lithograph that we pursuing.

Dr. Low Hong Yee received her PhD from the Department of Macromolecular Science in Case Western Reserve University, USA in 1998. She spent about 2 years with Motorola Semiconductor before joining the Institute of Materials Research and Engineering. Her recent research interests are in developing NIL for the fabrication of complex and 3D micro- and nanostructures and in the understanding of polymer physics with respect to the NIL technologies. She has co-authored more than 10 journal papers and 10 patent applications related to NIL technologies.

COUPLED ENHANCEMENT OF LIGHT EXTRACTION EFFICIENCY IN POLYMER BASED MULTI-LAYER PHOTONIC CRYSTAL STRUCTURED OLED

Dr Jun-ho Jeong

Senior Researcher, Korea Institute of Machinery & Materials (KIMM), South Korea

A new polymer based multi-layer photonic crystal organic light emitting diode (PoMPC-OLED) is fabricated using a room-temperature and low-pressure NIL process. The OLED samples with different pillar height were fabricated and measured. We found that the power efficiency of the fabricated PoMPC- OLED with a pillar height of 50 nm is 93% higher than the reference OLED with no PC structure. In order to understand the reason of such a superior efficiency, the roles of PC effect and the Bragg diffraction on the efficiency enhancement were examined by utilizing finite difference time domain (FDTD) analysis

Dr. Jun-ho Jeong was born in 1968 in Pyong-Taek, Korea. He received his undergraduate training at Hanyang University (B.S. 1990) and his M.S. at Korea Advanced Institute of Science and Technology where he completed his Ph.D. in mechanical engineering in 1998. He is currently senior researcher at Korea Institute of Machinery & materials. His research interests include nanomanufacturing, especially nanoimprint lithography (NIL). He is the principle investigator of the project titled 'Nanoimprint process technology' which is one of the main projects at the center for nanoscale mechatronics and manufacturing (CNMM), one of the 21 century frontier research programs, which are supported by Ministry of Education, Science and Technology, Korea. He is currently investigating the sub-30 nm scale nanoimprint process for Resistance RAM, nano-scale bio-sensor, organic solar cell, display, and OLED lighting.

NANO-IMPRINT LITHOGRAPHY FOR HARD DISK MEDIA APPLICATIONS

Dr. S.N. Piramanayagam

Senior Scientist, Data Storage Institute (A*STAR), Singapore

Nano-imprint lithography (NIL) has found many potential applications and hard disk media technology is one of them. Among the several technologies that may use NIL, hard disk media has one of the most stringent conditions in terms of the feature size. In order to keep the hard disk drive technology competitive to its contenders (such as flash memory), dots as small as 10 nm has to be demonstrated in about 3 years. Ironically, current hard disk media technology does not involve any lithography process. Therefore, in order to make this transition (thin film technology to a lithography based technology) smooth, hard disk media researchers are also considering an alternative scheme where the tracks are patterned lithographically (at about 80 nm pitch). This technology, called discrete-track recording, does not need stringent lithography requirements but still provides a good improvement in performance. It is widely believed that the hard disk media industry may adopt discrete-track recording media first as a stepping stone to the bit-patterned media recording. In either case, nano-imprint lithography is very significant as it offers higher throughput and potentially lower cost than any other competing lithography techniques. Molds using electron beam lithography will be used to achieve the small feature sizes. The talk will cover the research work carried out in our institute on both the areas; discrete-track recording media and bit-patterned media.

Dr. S.N. Piramanayagam is a senior scientist in Data Storage Institute. He obtained his Ph.D. in 1994 from Indian Institute of Technology, Bombay (India) for his work on amorphous ferromagnetic alloys. After his Ph.D., he worked on hard magnetic NdFeB thin films for recording and MEMS applications, in Shinshu University, Japan (1995-1999). Since 1999, he has been with Data Storage Institute, Singapore, serving in various capacities. He has 19 years of experience in the field of magnetism and magnetic materials. His current focus is on developing patterned recording medium using nano-imprint and related technologies for the near-future data storage. His team has developed capabilities to make patterned media with embedded servo and track IDs. The fabrication capabilities of his team includes sputtering of various magnetic and non-magnetic films, post-process facilities to make disks that are smooth and support heads that fly at a distance of about 10 nm and so on. The characterization facilities include vibrating sample magnetometry, alternating gradient magnetometry, Kerr magnetometer etc. In the past two years, he delivered in major international conferences such as Joint MMM/Intermag 2007, The Magnetic Recording Conference 2008, and MMM 2008. He has over 100 publications in peer-reviewed journals and conferences.

Programme

- 13:30** **Registration (Suntec City Convention Center, level 3, Rm 302)**
- 14:00** **Opening Address**
Mr. Boon Swan Foo
Executive Chairman, Exploit Technologies Pte. Ltd, Singapore
- 14:10** **Emerging Applications by NIL**
Mr. Theodor Kamp Nielsen
Founder and CEO, NIL Technology ApS, Denmark
- 14:30** **Early Study and Recent Progress of Nanoimprint Lithography**
Dr Susumu Fujimori
Senior Manager, NTT Advanced Technology Corporation, Japan
Dr Kenji Kurihara
Senior Manager, NTT-AT Nanofabrication Corporation, Japan
- 14:50** **Advanced Resists for Thermal and UV-based Nanoimprint Lithography**
Dr. Freimut Reuther
Technical Director, Micro Resist Technology GmbH, Germany
- 15:10** **Tea Break and Networking Session**
- 15:40** **Optoelectronic Devices– from Laboratory to Production**
Mr. Babak Heidari
CTO, Obducat AB, Sweden
- 16:00** **Nanoimprint Lithography - A Highly Versatile Nanopatterning Technique**
Dr. Low Hong Yee
Research Scientist/Group Head, IMRE (A*STAR), Singapore
- 16:20** **Coupled Enhancement of Light Extraction Efficiency in Polymer Based Multi-layer Photonic Crystal Structured OLED**
Dr Jun-ho Jeong
Senior Researcher, Korea Institute of Machinery & Materials (KIMM), South Korea
- 16:40** **Nano-Imprint Lithography for Hard Disk Media Applications**
Dr. S.N. Piramanayagam
Senior Scientist, Data Storage Institute (A*STAR), Singapore
- 17:00** **Closing Remarks**