Nano-Manufacturing Topical Conference
Room 2018 - Session NM+NS+NNT-WeM

International Developments in Nanoimprint Lithography

Moderator: S. Matsui, University of Hyogo, CREST JST, Japan

8:00am **NM+NS+NNT-WeM1 Nanoimprint: Diversity in Materials, Processes and Application**, ***H. Schift***, Paul Scherrer Institute (PSI), Switzerland; *J. Ahopelto,* VTT Centre for Microelectronics, Finland; *A. Kristensen,* Technical University of Denmark; *C.M. Sotomayor Torres,* Tyndall National Institute, Ireland; *M. Tormen,* INFM-TASC, Italy **INVITED**

Replication by molding offers more than high resolution and mass fabrication aspects. By creating a 3D structure by mechanical displacement of material, the patterning of a range of specific functional materials becomes possible, without loosing their chemical properties. Furthermore this ability can be used to fabricate complex structures, e.g. by building up devices with imbedded channels. Many of these aspects play a role within the European Integrated Project NaPa.@footnote 1@ Its aim is not only the further development of emerging nanopatterning methods, including processes, tools, and materials, but also a range of applications, which go far beyond the development of a next generation nanolithography for chip manufacturing. Nanoimprint lithography of thermoplastic materials remains the technology with the imminent highest potential, because of its ability to integrate different materials and functionalities, and by its compatibility with other mass fabrication processes such as injection molding and roll embossing.@footnote 2@ Typical applications can be seen in the topological and chemical patterning of templates for displays and cell growth, the integration of fluidic and optical functionalities in a lab-on-a-chip, and patterning of special polymers intended for polymer electronics and optics. This is achieved by using new thermoplastic polymers, or by incorporating dyes and nanoparticles with specific functionalities, e.g. for optical devices. Throughput is enhanced by using heatable stamps, and flexibility by a step and stamp approach. This toolbox, ranging from mold fabrication to analytical tools, is a prerequisite to establish nanoimprint as a future core technology in the heart of Europe. @FootnoteText@ @footnote 1@ EC-funded project NaPa (Emerging Nanopatterning Methods). URL: http://www.phantomsnet.net/NAPA/index.php.@footnote 2@ H. Schift and A. Kristensen. In Handbook of Nanotechnology, Bhushan B. ed., 2nd edition, publisher Springer Verlag, Germany (2006).

8:40am **NM+NS+NNT-WeM3 Nanoimprint Lithography: Technology, Applications and Commercialization**, ***S.Y. Chou***, Princeton University **INVITED**

Since the proposal of nanoimprint lithography (NIL) as a low-cost high-throughput sub-10-nm manufacturing method in 1995,@footnote 1@ the field has been growing rapidly in research, applications and commercialization in the past 11 years. The talk will present author's bird-eye view in these areas, as well as future potential and new directions. Particularly, the talk will address (a) NIL progresses in minimum feature size (6 nm half-pitch), printing areas (over 50 in-sq), alignment (sub-20 nm), pattern shapes (2D and 3D), materials and masks, (b) NIL applications in different disciplines, such as nanoscale electronics (nano-MOSFETs and SRAMs), photonics, displays, data storage (optical and magnetic), biotech, chemical synthesis and advanced materials, and (c) commercialization of NIL technologies. The talk will conclude that despite the success of NIL in its first 10 years, it is still just a beginning and we haven't seen anything yet! NIL will serve as an enabling ubiquitous manufacturing engine to propel future research in nanotechnology, future manufacturing of micro/nanostructures, and hence future discoveries and commercialization in nanotechnology. @FootnoteText@@footnote 1@S. Y. Chou, P. R. Krauss, and P. J. Renstrom, Appl. Phys. Lett, 67 (21), 3114 (1995)

9:20am **NM+NS+NNT-WeM5 Nanoimprint and Nanopatterning in Japan**, ***H. Hiroshima***, National Institute of Advanced Industrial Science and Technology (AIST), Japan **INVITED**

In a while after Prof. Chou had revealed the potential of nanoimprint a decade ago, a few groups in Japan started studying on nanoimprint technology. But now many groups use nanoimprint and notice the ability. People can feel the nanoimprint fever in Japan as indicated by the nanoimprint and nanoprint technology conference (NNT) 2005 held in Nara. In Japan, many nanotechnology projects run under support by the government; however, nanopatterning using nanoimprint is strangely excluded. One of resent topics on research situation is that Nanoimprint Process Solutions (NiPS) Consortium was established in April 2005. The group of Dr. Maeda in national research institute of advanced industrial science and technology (AIST) plays a central role in the consortium and provides technical supports to the NiPS members. Another is that a nanoimprint technology study group, whose chair person is Dr. Komuro in AIST, was born in April 2006 as a valuable by-product of NNT2005. There are three powerful groups in the study group; one is the group of Prof. Matsui at university of Hyogo that shifted its focus from thermal nanoimprint to room-temperature nanoimprint; another is the group of Prof. Hirai at Osaka prefecture university that fabricates fluid devices using an improved reversal nanoimprint; and the other is our AIST group "nanoimprint manufacturing technology group" that covers high-temperature nanoimprint onto glass materials, roller nanoimprint and also UV-nanoimprint. In my presentation, I should like to introduce outlines on the activities of these groups and to show the diversity of research and development of the nanoimprint technology in Japan.

10:40am **NM+NS+NNT-WeM9 Metrology for Nanoimprint Technologies: Needs and Prospects**, ***C.L. Soles***, *H.W. Ro, Y. Ding, H.J. Lee, R.L. Jones, A. Karim,* National Institute of Standards & Technology **INVITED**

Nanoimprint is a next generation lithography candidate with enormous potential not just for the semiconductor industry, but also a wide range of emerging technologies. This is because nanoimprint combines a fine patterning resolution, comparable to e-beam lithography, with a high throughput and low cost tool. However, there are several aspects of the nanoimprint process that significantly differ from state of the art optical lithography currently used for high volume nanofabrication and these differences introduce new metrology challenges unique to the nanoimprint process. Equally as important, the potential increase in the pattering resolution of nanoimprint over current patterning technologies threatens to exacerbate many of the existing metrology challenges presently facing optical lithography. In this presentation we review the unique and the non-unique metrology challenges facing nanoimprint lithography. These metrology needs come from interactions with both industrial and academic practitioners of nanoimprint through international workshops and panel discussions. We will present an overview of the progress being made to meet these metrology needs. Specific examples from our own research in developing novel X-ray scattering and reflectivity measurements to facilitate the nanoimprint processes will be highlighted.

11:20am **NM+NS+NNT-WeM11 Large Area Ultraviolet Nanoimprint Lithography Applicable to Flat Panel Display**, ***E.-S. Lee***, Korea Institute of Machinery & Materials, Korea **INVITED**

Nanoimprint lithography (NIL) is known as an emerging lithography with a resolution of less than 10 nm, having a high throughput and low cost compared to the conventional photolithography. In this talk, we present very large area (> 20 inch) Ultraviolet Nanoimprint Lithography (UV-NIL) process as a breakthrough strategy for flat panel display industry. As thin film transistor liquid crystal display (TFT-LCD) manufacturers in Korea ramp up output of TV panels from advanced factories in anticipation of strong demand, the excess supply in the market is leading to steep price declines especially for TV use panels. Succeeding generation plants use larger glass substrates, thereby boosting output and helping manufacturer's lower production costs. Falling LCD panel prices may be tough for LCD manufacturers to swallow. There is something in creating profit besides investment in upgrading generation. That can only be possible by conversing process facilities to use advanced process technology. This talk will summarize activities for the development of large area UV-NIL at KIMM to date and in detail. Very large area UV-NIL process and its apparatus for the TFT-LCD pattern will be presented.

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