Nanoimprint In Napa: Diversity In Materials, Processes And Applications

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Nanoimprint lithography remains the patterning technology with the imminent highest potential within the European Integrated Project NaPa[1]. Replication by molding offers more than high resolution and mass fabrication aspects. It has the ability to integrate different materials and functionalities, and is compatible with other mass fabrication processes such as injection molding and roll embossing. In addition to the further development of process technology, including processes, tools, and materials, a range of applications is an intrinsic part of NaPa. This goes far beyond the development of a next generation nanolithography for chip manufacturing. Nanoimprint not only allows to pattern non-organic substrates by molding resists for pattern transfer, but also to integrate nanostructures into polymer devices. Complex 3D structure can be created by mechanical displacement of material, and the patterning of a range of specific functional materials becomes possible, without loosing their optical, mechanical or chemical properties. Different applications are the driving force for the process development:

- topological and chemical patterning of surfaces (Fig. 1), and templates for cell growth
- fluidic and optical functionalities such as lasers integrated into a lab-on-a-chip (Fig. 1)
- low-cost polymer electronics on foils and tags by roll embossing
- active and passive optical devices as light guides, lenses, detectors and lasers, e.g. DBR gratings (Fig. 3) and design optimized photonic bandgap devices

This is achieved by a range of developments within the nanoimprint subprojects of NaPa:

- stamp with different materials and antiadhesive coatings are fabricated to improve replication fidelity and to enhance lifetime
- throughput is enhanced by using pulsed heatable stamps (Fig. 2), process reliability by automated demolding, and flexibility by a step&stamp approach
- simulation and measurement methods are developed for the evaluation of molding and residual layer thickness
- tools and processes are compared using benchmarking processes, and strengths and weaknesses of specific setups and processes identified

This toolbox, ranging from mold fabrication to analytical tools, is a prerequisite to establish nanoimprint as a future core technology in Europe.

References:

[1] NaPa (Emerging Nanopatterning Methods – EC funded NMP/FP6 Integrated Project). URL: http://www.phantomsnet.net/NAPA/index.php.
[2] H. Schift and A. Kristensen. In Handbook of Nanotechnology, Bhushan B. ed., 2nd edition, publisher Springer Verlag, Germany, **Issue** (2006), in print.

Figures:

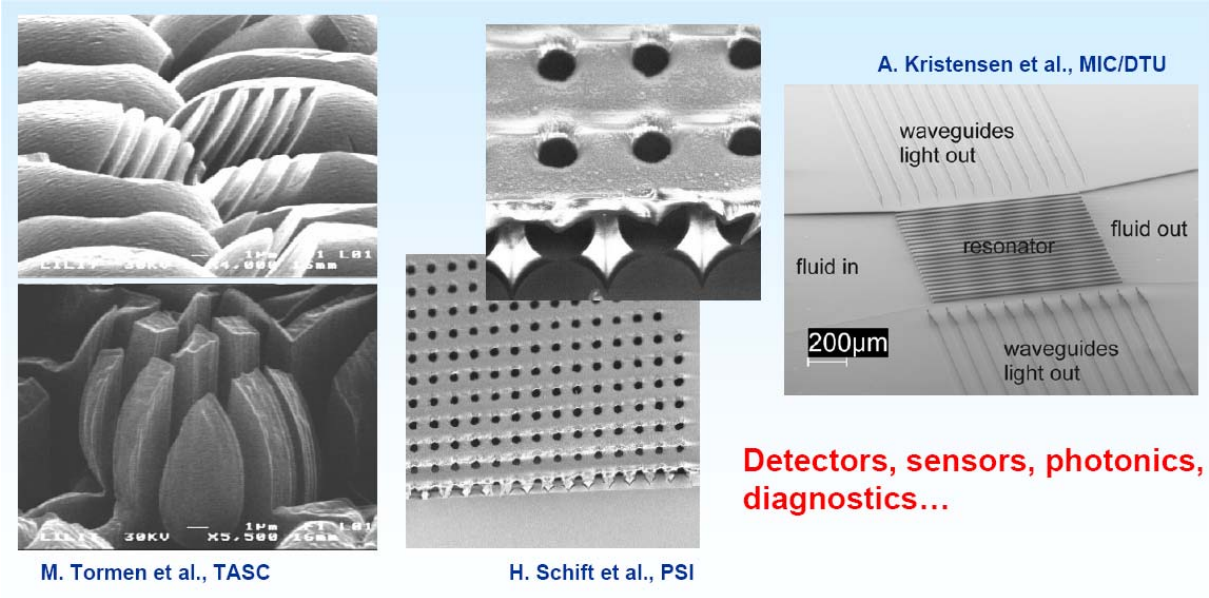

Figure 1: Unconventional surfaces, materials, membranes…

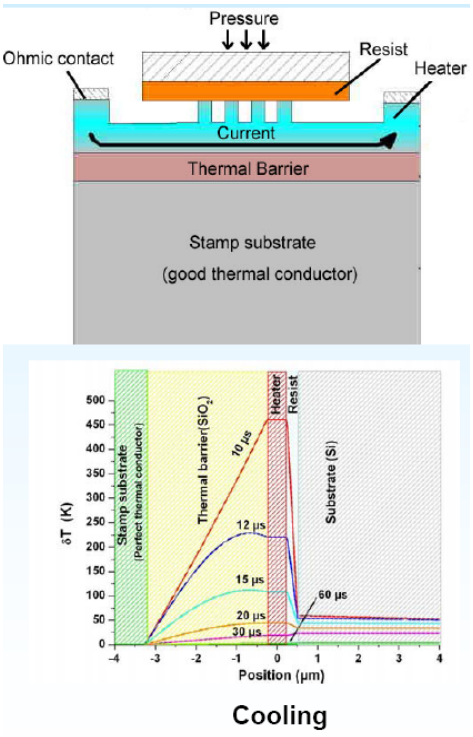

Figure 2: Pulsed heatable stamps

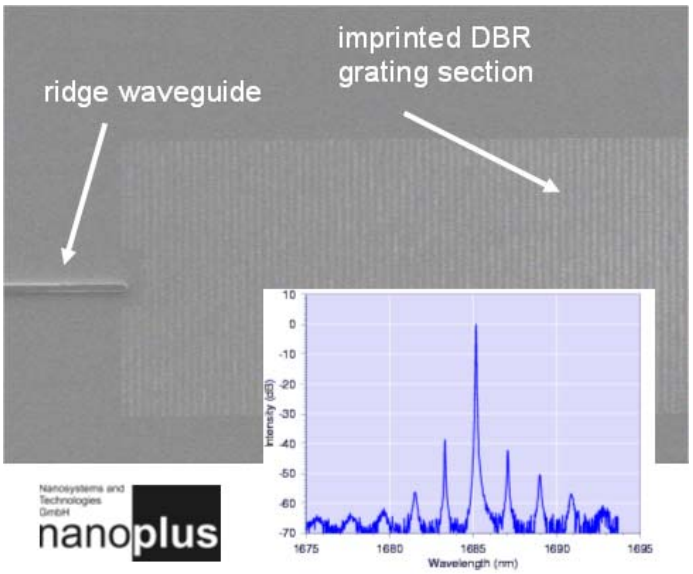

Figure 3: Imprinted DBR grating for ridge waveguide