Matching the crosscutting challenges in photopolymers and functional inks for nanoimprint lithography

Arne Schleunitz, Martin Messerschmidt, Susanne Grützner, Johannes Wolf,
Mirko Lohse, Manuel Thesen, Jan Klein, Christine Schuster,
Anja Voigt, Marko Vogler, Gabi Grützner

micro resist technology GmbH
Köpenicker Str. 325, 12555 Berlin
Germany

E-mail: a.schleunitz@microresist.de

Nanoimprint lithography (NIL) continues to gain momentum as a widely used parallel patterning technique for the fabrication of various functional shapes at micro- and nanometer scale. Numerous process schemes have been developed over the years which all follow the same unique concept, i.e. direct material patterning by physical contact and replication. While NIL in general is further spreading among scientific work where an easy access on nanofabrication method is required, the industrial relevance is rapidly advancing at the same time. This is driven by the need for alternative patterning techniques outperforming generic lithography approaches in terms of the capability to pattern large areas, over default topographies (micro and macro), multi-level / 3D or non-wafer based substrates, among others. Moreover, the ability to directly pattern “functional” materials that cannot be processed by standard lithography techniques is an exclusive asset of NIL. While it is liberating from its academic origin, the technology success is less defined through proof-of-concepts by suppliers and supporters. It is rather determined by an obvious technical or financial added-value that NIL provides as enabling technology to its ordinary users.

In this context, micro resist technology has been developing resists, polymers and photopolymers for NIL and its applications over almost two decades. Addressing the crosscutting challenges that find its origin in the highly diversified technology as well as in its manifold practice, we have been constantly advancing our material portfolio by translating user demands into material chemistry. In this contribution, we seek to review three aspects of our participation in the NIL ecosystems:

(1) We will discuss examples of our efforts to develop photopolymers and functional inks from initial research of novel prototype concepts all the way to the implementation of multifunctional products for industrial environment.
(2) We will highlight recent achievements in mastering technologies where the adaptation of photopolymers plays a crucial role to generate advanced (3D) master pattern.
(3) We will present related technology research in which NIL is combined with other processes such as photolithography and inkjet printing allowing additive manufacturing, e.g. of micro-optical components.

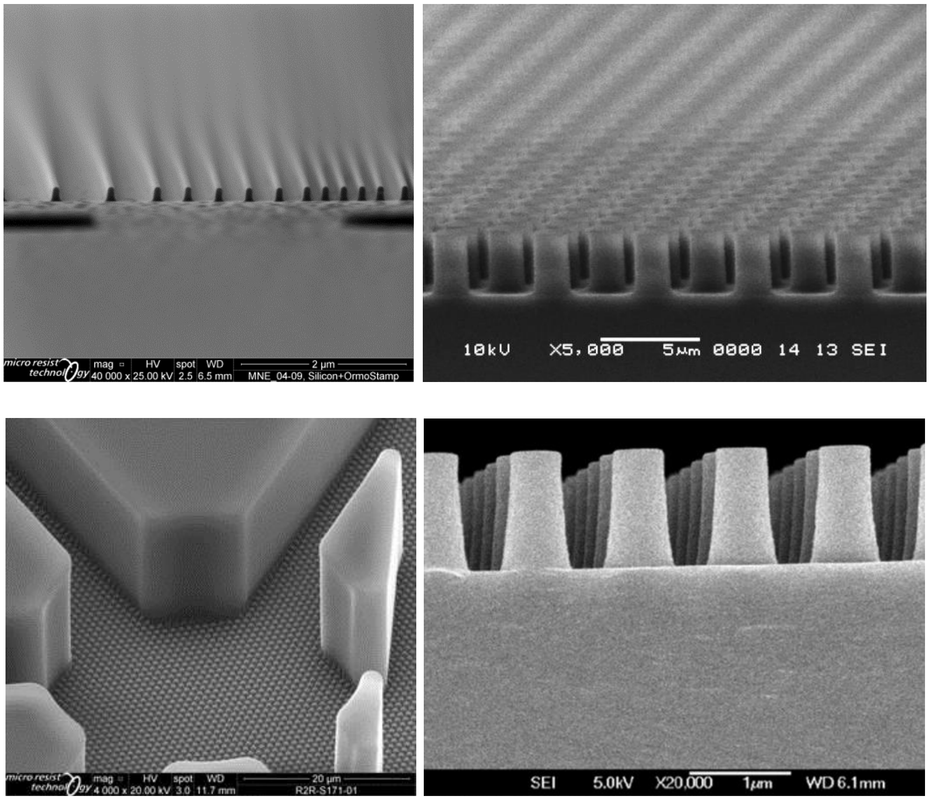

Figure 1. SEM micrographs of exemplary NIL patterns: Commercial resists allow the high-volume manufacture of nano-scale pattern which are needed as polymeric etch mask for the fabrication of photonic active devices (top left and right). Novel resist prototypes with multifunctional character can be employed for the direct replication of microfluidic structures for lab-on-a-chip application without subsequent pattern transfer into underlying substrate (bottom left), also by roll-to-roll (bottom right).

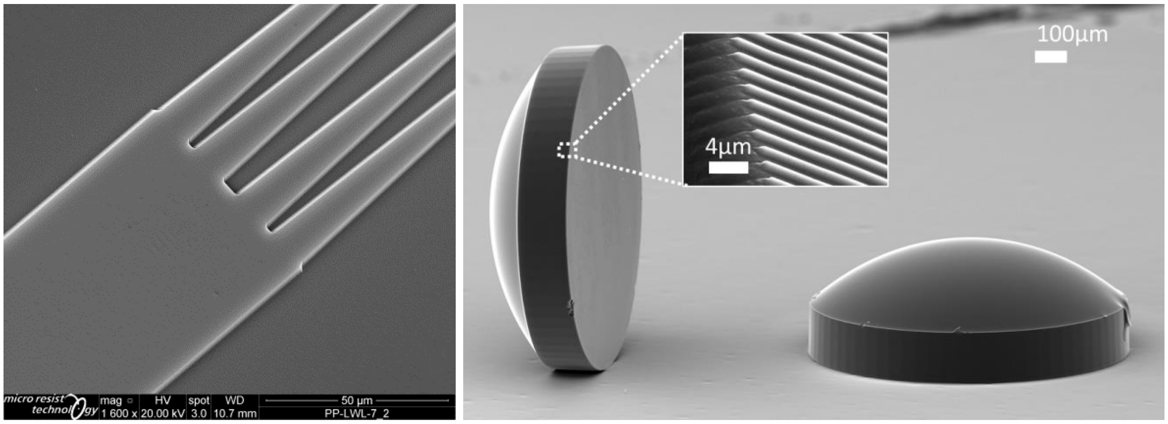

Figure 2. SEM micrographs of exemplary optical micro-nano pattern: inorganic-organic hybrid polymers allow the generation of optical waveguides by NIL with nanometer scale accuracy that is needed for low optical loss (left). Individualized micro-lens components with nanoscale laminar grating as diffractive pattern and refractive convex shapes on the opposite side fabricated with a functional ink where NIL is combined with photolithography and inkjet-printing (right).