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Photoresists and photopolymers for next generation micro- and nanolithography - Innovations for lab to fab applications

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A crucial aspect in advancing state-of-the-art micro- and nanolithography processes is the availability of suitable materials (i.e. photoresists, polymers and photopolymers). Compared to generic resist formulations, next generation lithography materials provide tailored solutions to diverse requirements originating from increased process complexity in advanced lithography applications. Furthermore, they need to anticipate additional technical constraints stemming from the remaining steps in the subsequent process chain.

In this context, micro resist technology GmbH (MRT) has been developing and providing innovative photoresists, special polymers and ancillary materials for a variety of micro- and nanolithography applications for almost 25 years. An excellent source for innovations has been the committed participation in and contribution to national and international research projects for many years. The highly specialized materials were transferred from academia to industry and are now applied in key technologies like microsystems technologies, microelectronics, micro- and nanophotonics, micro- and nanoengineering as well as in Life Sciences. Beside photoresists for UV / DUV-applications and e-beam lithography, we have focused on the development of polymer materials for progressive lithography applications such as direct-laser writing, nanoimprint lithography, inkjet printing and 3D printing at micro and nanometer scale. Alongside with the complementary innovations which facilitate improved positive and negative tone photoresists for generic micropatterning techniques, additional emphasis was put the development of nanoimprinting materials and optical polymers (i.e. hybrid polymers) for advanced micro- and nanofabrication.

The purpose of this contribution is to review and highlight recent innovations in next generation lithography materials developed by MRT. These materials enable the lithographic generation of micro- and nanopattern not only with improved pattern quality and functionality when common patterning techniques are used. They also enable to operate entirely new (disruptive) lithography technologies for new fields of applications. Thus, selected examples of advanced polymer materials will be introduced along with details on their processing and related applications:

- Negative tone photoresist for direct laser writing @ 405 nm (rapid prototyping / optical applications)
- Thick positive photoresist for greyscale lithography (3D micro-pattern origination / resist master)
- multi-functional UV-curable nanoimprint materials (lab-on-a-chip / bio-fluidic applications)
- UV-curable hybrid polymers for optical components (3D printing / optical polymer waveguides)

The novelty and key improvements will be demonstrated by show-casing applications and performances from selected MRT's technology partners conducting joined research in various fields on micro- and nanofabrication. The compatibility of the newly developed photoresists and photopolymers to various micro- and nanofabrication technologies and their suitability for mix-and-match processes will be discussed. This way, the necessity of the polymer material's multi-functionality for supporting the evident trend of technology convergence will be emphasized as a major asset for advanced micro- and nanopatterning techniques and system integration.

In summary, the presentation will demonstrate advancements in micro- and nanoengineering from the perspective of a researching material supplier by reviewing recent examples of academic (lab) and industrial (fab) applications, where tailored polymer materials are technological enablers for lithographically patterning at the micro- and nanometer scale.