Title: The next generation of Maskless Lithography

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Keywords: maskless lithography, direct writing, mask aligner, laser lithography

The essential goal for fast prototyping of microstructures is to reduce the cycle time. Conventional methods consist of creating designs with a CAD software, then fabricating or purchasing a Photomask and finally using a mask aligner to transfer the pattern to the photoresist. The cycle time for this traditional process is mainly defined by the Photomask fabrication process, which can take from several hours to many days. Changes in the artwork mean fabricating a new Photomask.

The Maskless Aligner makes it possible to expose patterns directly without fabricating a mask. The introduction of a new optical engine based on the DLP^{TM} device alongside a high power fiber-coupled diode laser has considerably increased the writing speed. Many efforts were made to ease and quicken the alignment and exposure procedures and achieve a set-up time of only a few minutes. With all these breakthroughs we were able to reduce the cycle drastically in comparison to traditional UV Lithography.

Besides the obvious saving of time, direct writing offers many additional advantages:

The real-time autofocus system regulates the gap between the last imaging lens and the substrate. Topography on the substrate does not interfere with the exposure and alignment procedure. No compromise is hence needed on the resolution and alignment accuracy and there is no contamination of the substrate.

The powerful exposure engine can expose designs in thin resists within a few minutes but also deliver very high doses for thick and less sensitive resists. It is powerful enough to expose resists up to several hundreds of micrometers needing doses up to several joules per square centimeters.

The exposure strategy uses a special horizontal interpolation to render smooth lines with the raster DLP^{TM}. We took advantage of this technology and the adaptive focusing system to implement vertical interpolation. The latter improves aspect ratios of structures in thick resists drastically while keeping a large numerical aperture, maximizing the amount of light reaching the substrate.

The alignment procedure is straightforward, accurate and very fast. It only requires capturing an image of the alignment marks. The software then applies image-processing algorithms to determine the position of the marks and corrects offsets, rotation, scaling and orthogonality automatically.

Real-time imaging inside the camera field of view allows exposing small patterns directly without creating and fracturing the design. The automatic labeling of wafer or wafer dies makes tracking and organization much easier.

Last but not least, the MLA is more economical than standard UV Lithography. The running costs are similar to those of the Mask Aligners, without the costs linked to Photomasks including the equipment for cleaning, inspecting and storing them.

The MLA is a new generation of lithography system, based on a disruptive technology, with the clear goal to replace conventional UV lithography in the research community.