

# Mix & Match Strategies for Optimizing Lithography Throughput and Accuracy

K. Keskinbora, S. Branagan, N. Kunzfeld, K. Beks-Peerenboom, A. Casimiro, V. Passi, X. de Koning, S. Schellingerhout, F. Oudman, A. Wscieklica, J. Münchenberger,  
V. Vlasenko, M. Kahl, C. Zonnevylle

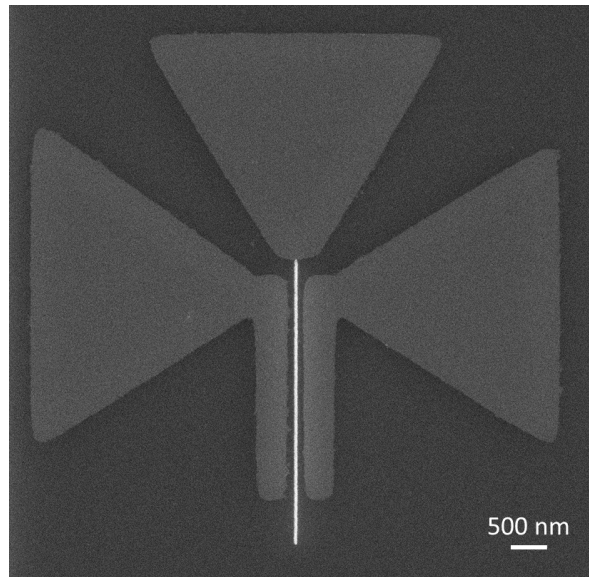
*Raith Group, Konrad-Adenauer-Allee 8, 44263 Dortmund, Germany  
keskinbora@raith.com*

As the focus on high-resolution nanofabrication shifted more and more on the high-end E-beam Lithography (EBL) tools, optimizing tool time and ensuring efficient tool utilization have become crucial factors to consider in shared research facilities as well as in industry settings. Consequently, offloading lower resolution jobs from EBL writers to other tools such as maskless Laser Beam Lithography (LBL) equipment in so called Mix & Match lithography, has become highly desirable and often necessary.

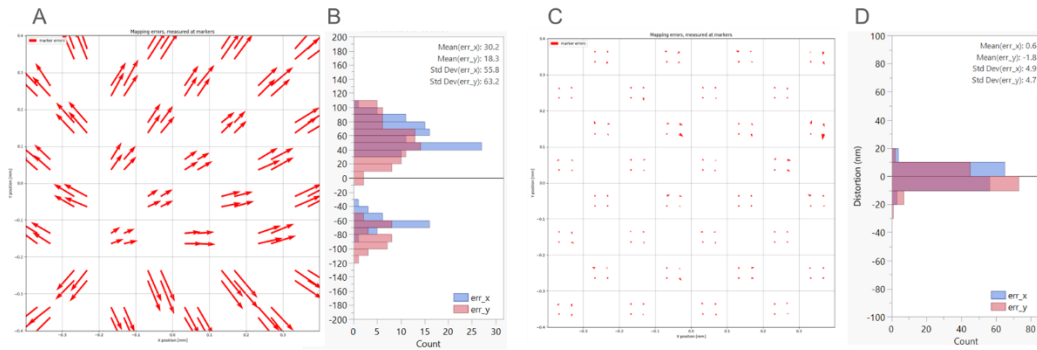
Alas, this has been a challenging process up until now due to several reasons such as tool-to-tool, brand-to-brand and process-to-process differences in workflows. Here, we demonstrate our first Mix & Match lithography results, where high-electron-mobility transistor (HEMT) structures with critical with 100 nm are written using both LBL and EBL tools as depicted in Figure 1. Crucially, a metal lift-off-based lithography process used in this work does not rely on exotic or proprietary photoresists making it adaptable to a broad range of lithography applications to address different needs.

Furthermore, a process for addressing and overcoming tool-to-tool stage matching issues by implementing corrections is discussed. Overlay test results point to a 5-nm-level alignment accuracy within a 1 mm write-field, when first layer is written using LBL and the second layer using advanced EBL (Figure 2) overlay strategies. Based on these results, the advantages of EBL-over-LBL and LBL-over-EBL exposure strategies are discussed for different applications where the critical layer is often the defining factor.

Finally, we take a step back from the specialized exposure and overlay workflows and briefly discuss our over-arching Mix & Match Lithography strategy for the future to render mixed-tool lithography as pain-free a process as possible including third-party tools and technologies.



*Figure 1:* An SEM micrograph of an HEMT structure. The gate electrodes were written using an LBL lift-off process followed by EBL exposure of the gate along the gate channel.



*Figure 2:* Comparison of different correction methods for improved alignment accuracy LBL-EBL mix-and-match. (A-B) correction using conventional alignment strategies (C-D) correction using advanced alignment strategies.