Field-emission scanning probe lithography tool for 150 mm wafer

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To keep up with Moore's prophecy in future the critical dimensions of transistors must be further scaled down in size. In this context, we developed field-emission scanning probe lithography (FE-SPL) to generate single-digit nano-features in thin molecular resist layers [1].

Here, we are presenting a FE-SPL platform for 150 mm wafers as shown in figure 1. To enable step-and-repeat lithography on 150 mm wafer, a 6" X, Y, θ (150x150 mm² positioning range & 360° rotation for alignment) stage is integrated as bottom positioning stage. The integrated coarse positioning unit ensures a resolution of below 10 nm for X, Y and below 1.3 µrad for θ, respectively. The mechanical setup is designed as an arch type bridge with a natural stone in order to minimize the influence of parasitic effects such as thermal drift and mechanical vibration. The XYZ piezoscanning unit is mounted onto the top unit, which also integrates the fast approach unit. The piezoscanning unit delivers a scanning/patterning field of 200µm x 200 µm², and in Z direction of 25 µm. To reduce the processing time in step-and-repeat FE-SPL mode we developed a new fast approach technique. In order to increase stability of the approach and to minimize the tilting of the cantilever head, the linear approach motor is supported by linear ball bearings units. The total travel range of the fast approach is 25 mm. The tool-specifications are summarized in fig. 1.

The FE-SPL technology platform is constructed to allow single cantilever but also cantilever array operation. Special active cantilever are applied for both AFM and FE-SPL [2, 3].

Different nano-devices patterned by the FE-SPL tool are shown in figure 2. A dedicated housing of the system was built to enable an encapsulated operation minimizing environmental sources of drift and instabilities.

Acknowledgement

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References

[1] Rangelow, I. W. et. al., Proc. SPIE, 7637 (2010).
[2] Rangelow, I. W. et. al., JVST B34, 06K202 (2016).
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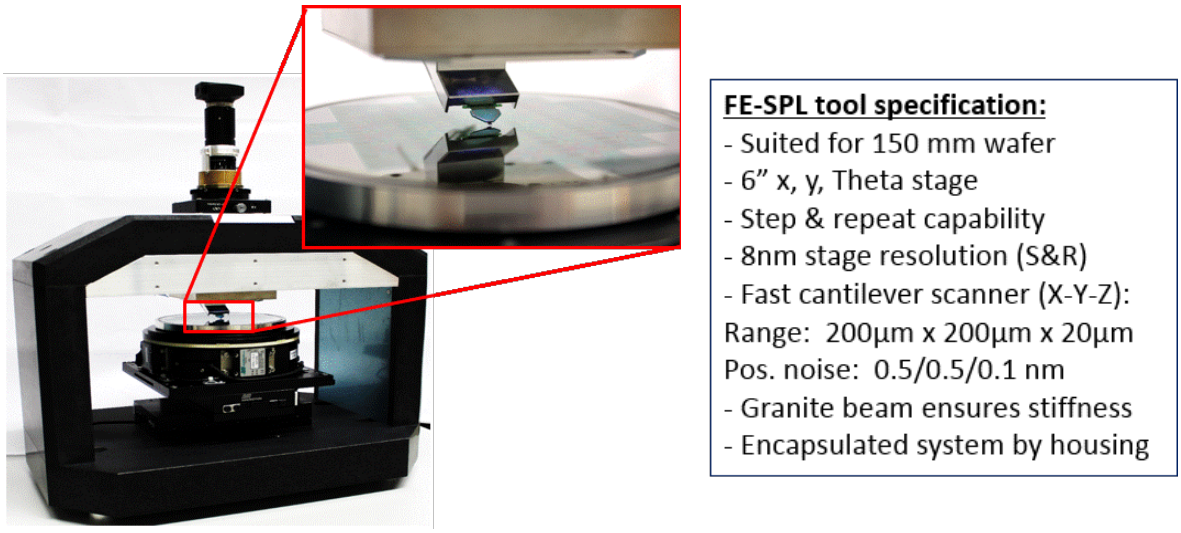

Figure 1: FE-SPL tool for 150 mm wafers and its specifications.

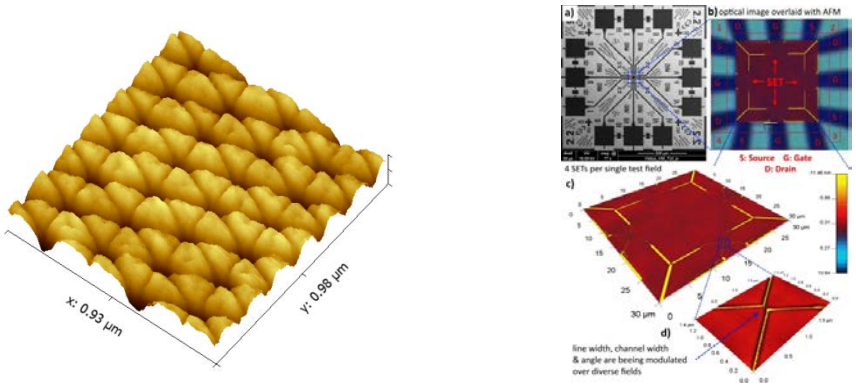

Figure 2: Patterns written and scanned with the 150 mm FE-SPL tool: On the left side a grid pattern is shown to illustrate the overlay capabilities and on the right side SET structures operating at room temperatures which were done using a mix-and-match approach.