Reflective Electron Beam Lithography (REBL), a Novel Approach to High Speed Maskless Ebeam Direct Write Lithography

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This paper will describe the system concepts used in a novel approach for a high throughput maskless lithography tool called REBL (Reflective Electron Beam Lithography). The program at KLA-Tencor is funded under the DARPA Maskless Nanowriter Program. The system is specifically targeting the few to 7 wafers per hour market at the 45 nm node. Figure 1 shows schematically the reflective electron optical concept used in the REBL approach.

In addition to the reflective optics concept, REBL uses a novel technology to generate and expose lithographic patterns at throughputs considerably higher than other electron beam approaches. One of the technology enablers is the Dynamic Pattern Generator (DPG). The DPG is a CMOS ASIC chip with an array of small, independently controllable metallic pads or pixels, which act as an array of electron mirrors exactly analogous to the DLP technology used in projection television. In this way, the system is capable of generating the pattern to be written at extremely high data rates (~ 1Tbs). The massively parallel and individually controlled beamlets reflected from the DPG is one of the enabling technologies that provide the high speed maskless pattern generation capability. The DPG is embedded in the electron optical column which flood illuminates the DPG with electrons and then demagnifies the pattern image produced by the DPG and projects it onto the wafer's surface to expose the resist.

Electron-beam direct write (EBDW) lithography has demonstrated excellent resolution and can achieve good LER provided the dose is high enough. The main disadvantage of today's EBDW is low throughput – it takes many 10's of hours to expose a wafer today. The lithography performance/throughput tradeoff has limited the applicability of EBDW by rendering it economically unattractive in almost every context. The REBL Maskless Nanowriter has the potential to break through the traditional performance/throughput tradeoff and achieve throughputs which are economically attractive while maintaining the advantage of maskless lithography.

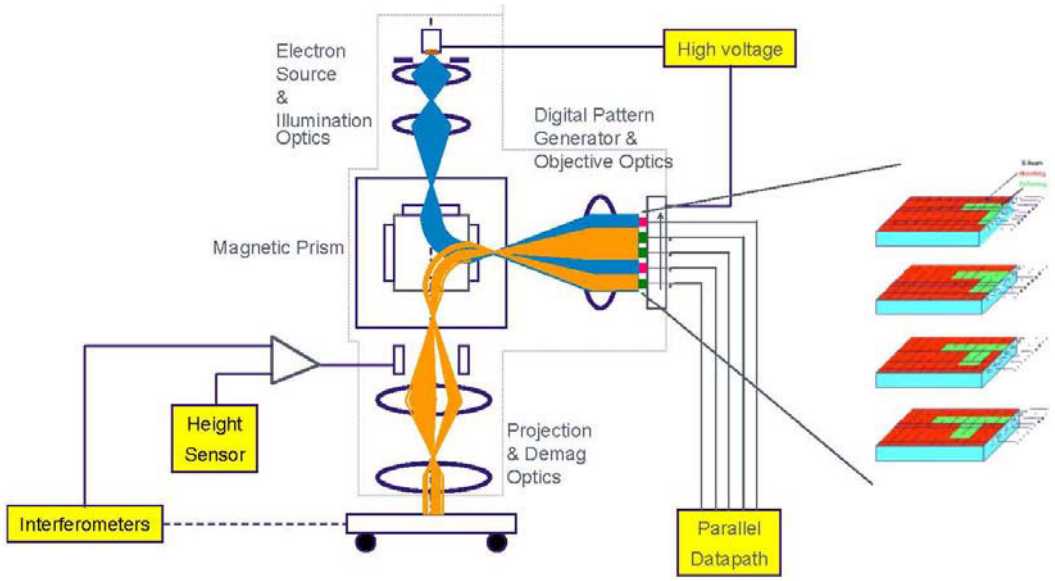

Fig 1: REBL system schematic showing the reflective electron optics configuration. The Electron Source illuminates the Digital Pattern Generator (DPG) through the Magnetic Prism. The reflected electrons from the DPG, which define the pattern to be exposed, pass through the Magnetic Prism again, which separates them from the Illumination Beam. The DPG image is then demagnified and projected onto the wafer.