Blanking Characteristics of a Miniature Electron Beam Column

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Earlier generations of miniature electron beam columns have achieved small line widths and fast write times, demonstrating proof-of-concept for lithography aplications[1,2]. The mySEM miniature electron beam column is optimized for imaging with <10 nm resolution, and it also includes lithography capability. The fully-electrostatic column is manufactured using batch-fabricated silicon components mounted to a multi-layer ceramic substrate. The column is optimized for low voltage operation, with a beam energy range of 0.5 – 2.0 keV.

Details of the column's design, fabrication, and high resolution imaging performance have been presented previously[3]. The column includes an integrated electrostatic blanker which can be used to blank the beam onto the limiting aperture for lithography. A previous column design with a monolithically arrayed architecture, leveraging the same manufacturing techniques and optimized for high throughput lithography, demonstrated multiple beam lithography down to 70 nm features[2].

Preliminary results from the mySEM blanker have demonstrated a blanking extinction ratio of 8,000:1 with a beam current of 4 nA, measured with a Faraday cup at the sample. Those measurements were limited by the baseline sensitivity of the amplifier electronics, so further experimentation may yield even higher extinction ratios. This paper will present a characterization of the column's blanking capabilities measured with beam across a silicon knife edge into a transmission electron detector. The implications of these results for a direct-write lithography system will be discussed. The paper will also consider the implementation of auxiliary blanking systems using integrated column components.

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[2] C.S. Silver, J.P. Spallas, and L.P. Muray, "Multiple beam sub-80-nm lithography with miniature electron beam column arrays," JVST B 25(6), 2258 (2007).

[3] C.S. Silver, J.P. Spallas, and L.P. Muray, "Variable probe current using a condenser lens in a miniature electron beam column," Proc. SPIE, Vol. 7378, 737810 (2009).