A Multiple electron beam wafer inspection system design using permanent magnets

T. Luo[1], and A. Khursheed[2]

Blk 185 Edgefield Plains, #11-290, Singapore 820185
Centre for Integrated Circuit Failure Analysis and Reliability
National University of Singapore, 4 Engineering Drive 3, Singapore 117576

For 14 nm node integrated circuit production, light source based process inspection systems will not be able to capture all defects due to their resolution limitations. Scanning electron beam inspection systems, although promising in their ability to detect small defects, have a relatively low throughput, limited by the serial acquisition of their image data. Multiple electron beam inspection system increases the overall data rate, but its challenge lies in the symmetry of each individual lens and uniform performance across the lens array.

This paper presents a multiple-electron-beam inspection technique using permanent magnetic lens arrays. Each magnetic lens system is axially symmetric, formed from ring permanent magnetic excitation and rotationally symmetric iron pole-pieces. This is crucial for acquisition of high spatial resolution and as well as uniformity of performance across the whole array. Each lens and column system is 30mm in diameter, which allows about 78 (for 300mm wafer) or 176 (for 450mm wafer) simultaneously data collection. Advantages of this technique include high resolution, high data rate, symmetric lens field distribution, uniform performance of each individual imaging unit. Simulation predicts that the peak axial magnetic field distribution is 0.244 Tesla, which provide an optimized resolution of 3nm for a working distance of 1.5mm, primary energy 12000eV, landing energy 1000eV, and extracting field at wafer surface of 1600V/mm.

Fig 1 presents simulated magnetic flux distribution and axial magnetic field intensity distribution using Lorentz 2D EM software package [1]. Fig 2 shows the axial electrical field and electron potential distribution along the axis. Fig 3 demonstrates a mechanical drawing of a 9 by 9 magnetic lens with deflection systems.

References

[1] Lorentz 2D-EM, Integrated Engineering Software Sales Inc., 220-1821 Wellington Avenue Winnipeg, Manitoba, Canada R3H 0G4

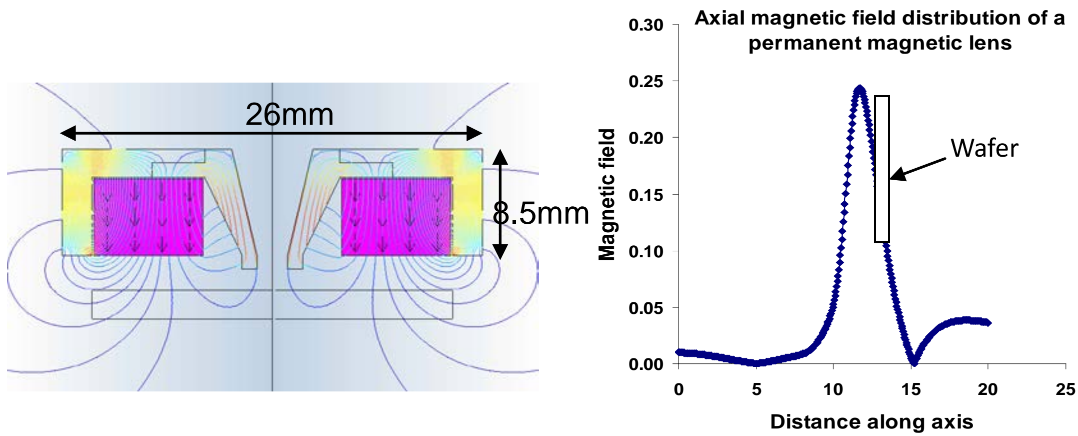

Fig1: Simulated magnetic field and axial field distribution of a mini permanent

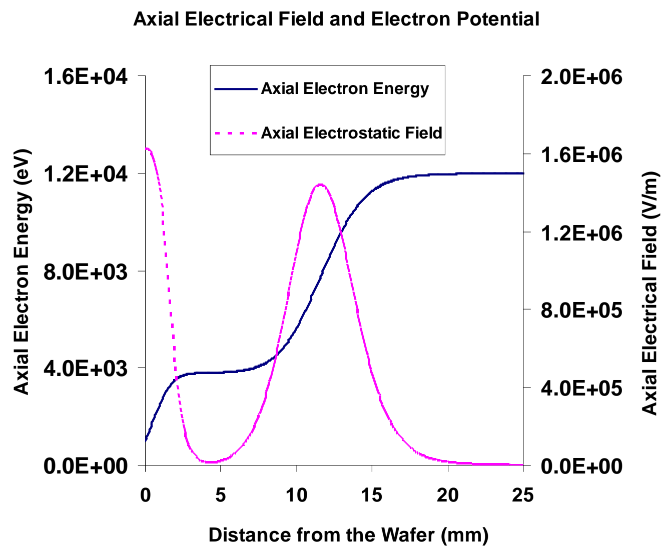

Fig 2: Axial electrical field and electron potential distribution.

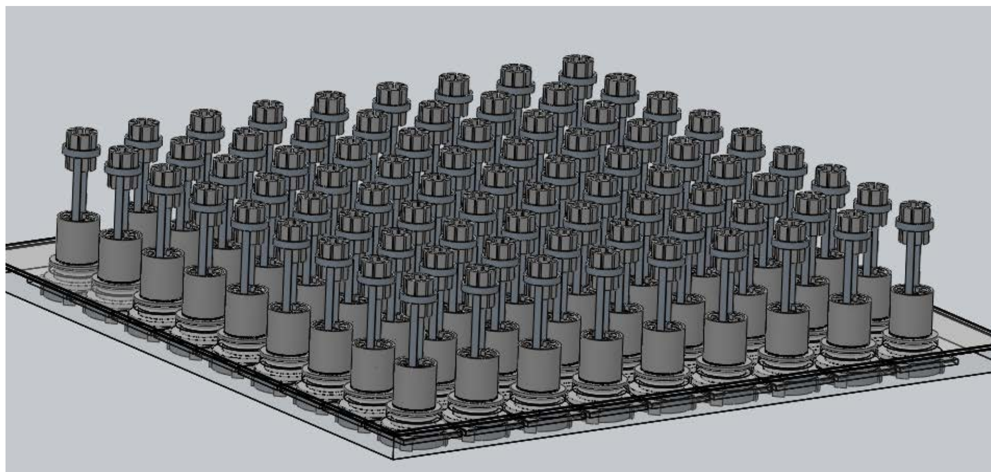

Fig 3: A 9 by 9 permanent magnetic lens array with deflection units.