Artifact Inspection and Measurement Accuracy

The printed artifacts induced by the programmed defect-probes are suitable for reading with either manual or automatic inspection. The size and locations of these artifacts are known in advance. They are about 2/3 of the working resolution in size and spaced from the feature by about 0.6 λ/NA. Thus they are easy to identify as either present or absent without having to measure either feature size or position shift. While over exposure is required to print these artifacts, the large dynamic range of the side-lobe height with the level of aberration allows exposure steps on the order of 4% of the normal exposure dose to be utilized. The number of targets and target orientations per aberration is small. An array of locations throughout the field could be measured with automatic optical wafer inspection equipment in the time comparable to the 20 minutes for 121 field locations reported by Imai et al. [8].

For asymmetrical aberrations, an exposure matrix at best focus is sufficient. The dose-to-print levels should be read for the reference programmed defect (Figure 11) as well as both the defect and its anti-symmetric orientation (as in Figure 8). The former calibrates the programmed defect size on the photomask. The latter gives two statistically independent readings of the level of the aberration. With N exposure levels, M sized targets in O orientations the measurement accuracy A of each aberration is

\[ A = \left(\frac{0.1\text{waves}}{N^{OM}}\right)^{1/2} \]

**Figure 8.** Intensity contours at 0.05 increments for the coma target with a) 0.0, b) –0.1 and c) 0.1 λ of balanced coma.

**Figure 11.** The peak intensity of the coma test target (squares) and the reference isolated programmed defect (diamonds) as a function of waves of balanced coma.

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