Comparing Patterned Wafer Inspectors

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With today's optical patterned wafer inspectors covering a range of configurations, including brightfield, darkfield and brightfield/darkfield combination tools, selecting a tool which meets a fab's yield monitoring requirements can be a complex endeavor. It is important for chipmakers to utilize a tool selection paradigm which effectively and efficiently evaluates inspectors' actual production performance.

A standard method for comparing inspector performance utilizes suppliers' published pixel sizes and the associated throughputs. This methodology assumes that similar sensitivities are obtained with similar pixel sizes across different inspection systems. In practice, sensitivity is a complex entity that is affected not only by pixel size, but also by tool parameters such as peak wavelength, wavelength spectrum, optical aperture and numerical aperture. Moreover, published throughput specifications are often based on specific measurement methodologies and are dependent on factors such as inspected area. As such, they may not represent the actual throughputs observed in the fab on production wafers. Therefore, the use of published specifications for comparisons is often an inaccurate representation of actual tool performance.

$$WATIP_{tool} = \sum_{layer\ i} WATIP_{layer\ i} = \sum_{layer\ i} (\text{Average Capacity} * TPT)_{layer\ i}$$

Equation 1: Calculation methodology for WATIP. TPT is the measured throughput. Average Capacity is the percentage of inspection capacity used for each layer or inspection segment.

A better comparison methodology involves using data on actual production wafers from an inspector evaluation. This allows a chipmaker to accurately determine the relative throughputs of inspectors at the sensitivity required ("sensitivity at throughput") for a specific sub-set of process layers. The downside of this methodology is that it does not take into consideration how these process layers fit into the overall desired production usage of the inspection tool.

A more complete decision paradigm involves the use of a parameter called the weighted average throughput in production (WATIP). WATIP breaks down the expected production utilization of an inspection tool by layer. For each layer, the sensitivity requirements determine the pixel size utilized, which in turn, determines the inspector's throughput at that layer. Additionally, the expected average capacity for each layer is used as a weighting factor for the throughput. The inspector's overall WATIP is the sum of each layer's weighted throughput (equation 1). WATIP takes into account the sensitivity, throughput and capacity requirements of each layer projected to run on the inspector. As such, it is a more accurate methodology for comparing inspectors' throughput at required sensitivity.

		Etch		CMP	Litho	
		Etch: Critical	Etch: Non-Critical	CMP: Line Monitor	Litho: ADI	
A	Average Capacity (weighting)	24%	24%	10%	42%	
B	Inspector A Pixel Size	0.16µm	0.28µm	0.20µm	0.16µm	
	Inspector B Pixel Size	0.16µm	0.16µm	0.26µm	0.12µm	
C	Inspector A Throughput (wph)	2	5	3	2	
	Inspector B Throughput (wph)	2	2	4	1	WATIP
D	Inspector A WATIP (wph)	0.48	1.20	0.30	0.84	2.82
	Inspector B WATIP (wph)	0.48	0.48	0.40	0.42	1.78

Table 1. Example calculation of WATIP for two different inspectors.

An example of how WATIP is calculated and compared for two different inspectors is shown in Table 1. This example uses inspection points which are typical layers for production utilization of a high-end brightfield inspector. The average capacity, based on benchmark data or actual production usage, is entered as a percentage in section A. Evaluation or benchmark data are used to determine the pixel sizes (B) needed to meet the sensitivity requirements of each layer. The throughput for each pixel size is entered in section C. The WATIP for each inspection segment is calculated (D) by multiplying the average capacities by the throughputs. The overall WATIP for the tool is obtained by summing the individual layer WATIPs. In this example, Inspector A has a higher WATIP, and would provide improved lot sampling and contribute to a lower inspector cost of ownership over Inspector B.

To learn more about weighted average throughput in production (WATIP), go to: www.kla-tencor.com/07MayJP

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