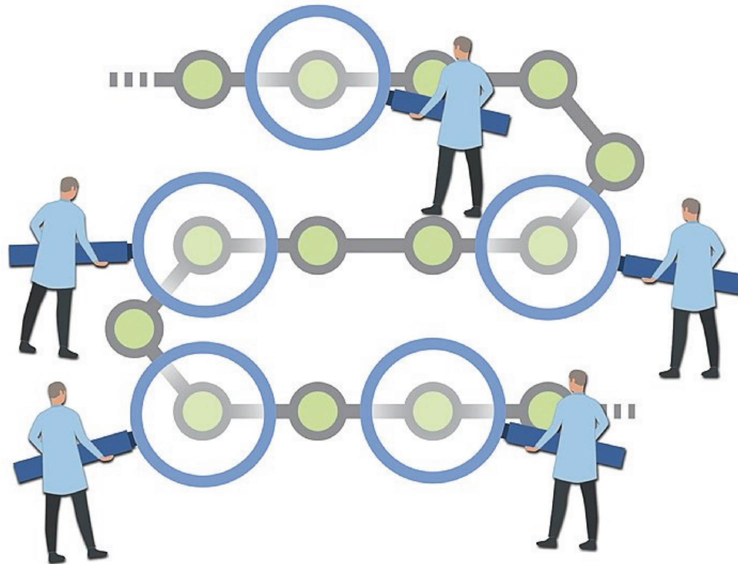
MACRO INTELLIGENCE

Insights for Increasing Yield and Reliability through Smarter Macro Defect Inspection #4

A Technical Bulletin from Microtronic – the Industry Specialists in Macro Defect Inspection

Increasing semiconductor device reliability requires adding more wafer inspection. Here's a way...



An increasing need

Some industry sectors such as automotive and medical continue to push for higher and higher reliability levels; however, many fabs are having difficulties achieving them. Current inspection regimes still allow too many defects to pass through and escape to the field – primarily because of time and expense issues.

Too much wafer is still left uninspected

One fundamental problem is the amount of wafer real estate that is currently going uninspected. Even though much inspection is being done, still, the total inspected area remains small compared to the cumulative wafer surface passing through production (see comparison chart below).

Today, fabs employ several different types of inspections, each playing a special role in the overall defect management program. But now, if additional wafer inspection is needed, what specific types of inspection should be increased, and where? And can this be accomplished without dramatically impacting budgets and production schedules?

Automated Micro Inspection

These are the “big guns” in many fabs’ defect inspection arsenal today. The automated, highly advanced micro inspection tools are able to detect extremely small defects, below 1μm, and they are essential for catching today’s ever-shrinking killer defects. However, these tools are costly, require device-dependent recipes and are comparatively slow, with throughputs of ~175 wafers per day.

Automated micro inspection tools are used in line, but only to limited degree – at a handful of key production steps, typically sampling two wafers from the lot. Though it might be desirable to add more automated micro inspections at many more steps, that is generally not feasible either from a cost or production time standpoint.

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Automated Mid-Micro Inspection

These tools are similar to the micro inspection tools, except with lower magnification. The mid-micro tools also require device-dependent recipes to perform die-to-die inspection, and they will detect defects down to ~10μm. They provide higher throughput (~600 wafers per day) and are lower in price, but they are still expensive enough for fabs to limit their use to the end of line. These tools are frequently used for outgoing inspection of bond pads, probe marks, etc.

Manual Microscope Inspection

Optical microscopes are used for post photo or post CMP inspection. A typical fab might employ microscopes to sample five wafers from a lot – looking at five sites on each of the five wafers.

Optical microscopes are used for many types of defects very effectively and provide much useful information. These instruments can be applied to study features and defects smaller than 1μm. However, the quality of this inspection can vary substantially with the experience and alertness of human operators. Also, these inherently subjective inspections do not generate standardized or comprehensive reporting that can be used fab-wide. And fundamentally, microscope inspection remains a sampling method, not well suited to covering the substantial amount of additional wafer surface we need to inspect.

Naked-Eye and Bright-Light Inspection

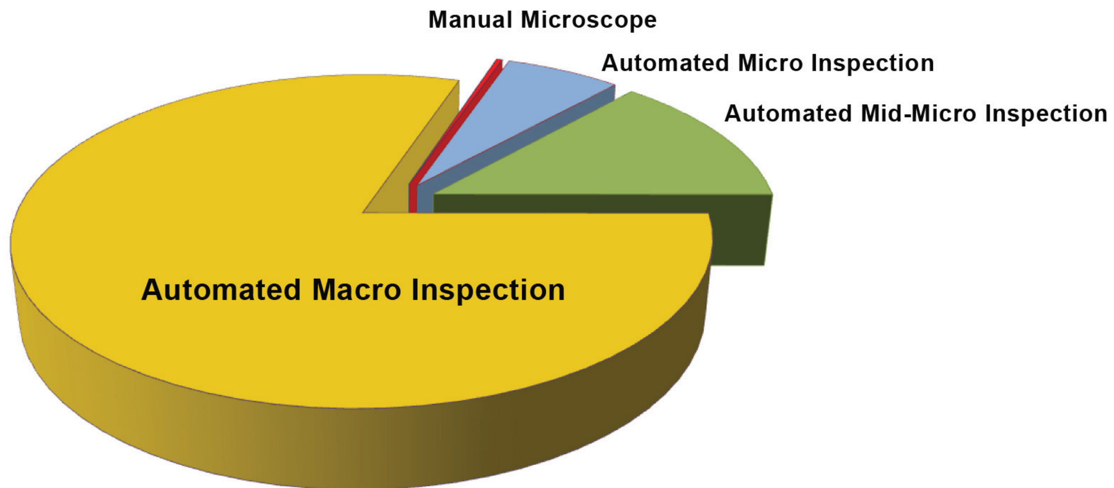
It should be noted that some fabs still use some form of human-eye inspection, using it to look at every wafer in every lot. This method serves a useful purpose in spotting gross or obvious problems on wafer surfaces. Like microscope inspection, however, it is inherently subjective, and its value can vary greatly with the knowledge and experience of the viewer. It, too, does not generate any standardized reporting or record-keeping for the fab.

So, what additional wafer inspection can be added?

Automated Macro Inspection – opening new possibilities

This is a newer generation of automated wafer inspection tools that fits between the automated micro and mid-micro tools and the non-automated human inspection methods. These automated macro defect inspection tools, such as the EagleView from Microtronic, do not require recipes, and they are extremely fast – capable of throughputs of over 3000 wafers per day. Plus, they create a unique, high-resolution color image of the entire surface of every wafer in the lot.

This accomplishes three things: First, it substantially increases the total wafer surface area inspected during production. Second, it allows fabs to precisely identify types and locations of a wide range of macro surface defects. Third, it provides a consistent, detailed and permanent record of every wafer in the lot at many important steps in processing. Plus, the macro information provided by these automated tools can be combined with micro defect data to create a powerful, comprehensive defectivity database for use by the entire fab at any time, now and in the future.



Covering much more wafer surface at many more steps

Specifically designed to cover a great deal of wafer real estate rapidly and cost-effectively, these new tools can be used to look at all the wafers at many more in-line production steps. A single automated macro inspection tool, for example, could be used for 100% inspection at many photo and/or CMP levels.

The net result of adding automated macro inspection can be a huge increase in wafer surface coverage compared with what was possible with previous tools alone – which can enhance defect detection levels and reliability overall.

The chart below compares typical amounts of wafer surface that might be seen by different defect inspection tools in a fab running 200mm wafers, 500 wafer starts per day, 300 process steps, and 30 mask levels.

Comparison of Cumulative Wafer Surface Inspected

	Manual Microscope	Automated Micro Insp.	Automated Mid-Micro Insp.	Automated Macro Insp.
Number of Tools	5	2	2	1
Insertion Points	30	6	1	6
Throughput	~720 wafers/day	~175 wafers/day	~600 wafers/day	>3000 wafers/day
Standardized Defect Reporting	No	Yes	Yes	Yes
% of Cumulative Wafer Surface Inspected	0.32%	6.40%	13.33%	79.96%

Improving inline performance, as well

Adding 100% macro defect inspection in-line can alert fabs to process excursions and intermittent problems (onesie-twosie's) immediately, allowing faster, more accurate, and much more cost-effective corrective actions to be taken – without waiting for backend inspection or electrical probe results, which can be much more costly and ineffective for correcting in-line problems.

Bottom line, for many fabs automated macro inspection tools can be useful, comparatively easy to implement, and a cost-efficient way to look at much more wafer surface that has been going uninspected.

Specializing in semiconductor macro defect inspection

For more than two decades Microtronic has been working to optimize semiconductor wafer macro defect inspection to enhance yields and reliability. If you have questions in any of these areas, please just call us at (508) 627-8951 or email info@microtronic.com.

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