Abstract | Semiconductor manufacturers are continually striving to increase yield through more good-wafers per day. ASML supports this drive through an ongoing program of solutions to boost reticle availability. With our latest options, 3000 plus good-wafers per day is well within reach. What’s more our reticle availability roadmap supports even higher numbers of good-wafers per day in conjunction with ultra-high throughputs.

Our latest “G” specification TWINSCAN systems offer throughputs up to 150 wafers per hour or more. At these high wafer processing rates, the time taken to set up for a new lot can significantly impact a cluster’s overall output of good wafers per day. A major factor in the lot set up time is reticle availability. And with throughputs set to increase to extreme values, reticle availability will continue to grow in importance.

Complementing our throughput and system availability roadmaps, ASML has an ongoing roadmap for reticle availability solutions. These solutions are designed to support the drive for more good-wafers per day while reducing automation costs and the number of operators required per tool. Thanks to the TWINSCAN platform’s modular architecture, each new reticle availability enhancement can be fitted to existing systems – maximizing your total Value of Ownership.

Keeping things clean
Our Integrated Reticle Inspection System (IRIS) is the industry’s only solution for checking the condition of a reticle in situ. It allows you to schedule reticle cleaning only when it is needed rather than based on conservative estimates, thereby reducing downtime and costs without negatively impacting product quality.

The latest version, the recently released IRIS-XT, is capable of detecting particles from 5 to 1000 µm. That enables it to spot everything from a human hair to reticle haze crystals – a particular problem for ArF lithography. Extremely fast, IRIS-XT can scan both sides of a wafer in just 90 seconds. That means you can scan up to 12 reticles an hour without affecting productivity.

Intelligent reticle handling
While IRIS-XT improves productivity and yield by monitoring the condition of your reticles, our Reticle Streaming™ package aims to reduce the overhead time for each lot through intelligent reticle handling.

By introducing smart parallel processing wherever possible, Reticle Streaming reduces the number of reticle handling tasks and schedules them in an efficient sequence. For example, it communicates with IRIS to arrange reticle scans for periods when the system is otherwise idle. It also offers a user-configurable “1st wafer delay” timer to compensate for delayed wafer delivery from the track. Through these and other features, Reticle Streaming can reduce the minimum theoretical wafer exchange time by 2 seconds, from today’s current best of 13 seconds to 11 seconds – and even better on some systems. In addition, it helps reduce the number of exceptional events where the time between lots is significantly longer than the minimum (See Fig. 1).
Reticle libraries and beating the haze

Rising system throughput means the time taken to process each lot is falling. In fact, it is becoming increasingly difficult for operators to manually load reticles for each lot. Already reticle loading can impact good wafer per day outputs by around 2% on current installed base systems.

This is leading to a move away from traditional reticle streaming through load ports. Instead, reticles are starting to be streamed from libraries – internal reticle storage facilities within each lithography tool. The load ports are then only used to fill or update the library and for exception handling. A few years ago, ASML introduced the Integrated Reticle Library (IRL) for our TWINSCAN platform. It allows operators to pre-load a number of reticles at once. As each new lot reaches the tool, the appropriate inspected reticle can be quickly loaded from the library.

Due for release later this year, IRL-XP takes internal reticle storage one step further. The reticle library is XCDA (extra clean dry air) purged, to ensure the reticles stay clean and dry. Water and residual chemicals, along with 193-nm light, are key ingredients in the formation of reticle haze. By keeping the reticles dry, IRL-XP reduces the build up of this haze and helps minimize the production time lost for reticle cleaning.

An ongoing effort

Altogether, this current generation of reticle availability solutions reduces lot overheads by up to 6%, enables 30% faster reticle inspections, decreases reticle exchange times by around 25% and extends ArF reticle cleaning periods by 50%. That places outputs of 3000 good-wafers per day within easy reach. However, manufacturers’ wafer-per-day roadmaps stretch to extreme numbers and outputs of 4000 good-wafers per day are already being mentioned for the near future. To support these roadmaps, we are continuing to investigate new reticle availability solutions such as in situ reticle top-side cleaning and larger internal reticle libraries. The overall goal of this program is to enable our customers to maximize their wafer-per-day output without worrying about clean, available reticles.

Figure 1: Opportunity to reduce lot overhead with Reticle Streaming

---

**Reticle Streaming can reduce the minimum theoretical wafer exchange time by 2 seconds**