OPTIMIZING SPRAY COATING YIELD AND THROUGHPUT

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A well-structured approach to optimize the many process parameters during spray coating is described in the article „Optimizing Spray Coater Process Parameters“ within this issue of the SUSS report. To complete the picture and significantly increase yield and throughput especially but not limited to production tools, also technical improvements have been recently developed for the SUSS AltaSpray technology.

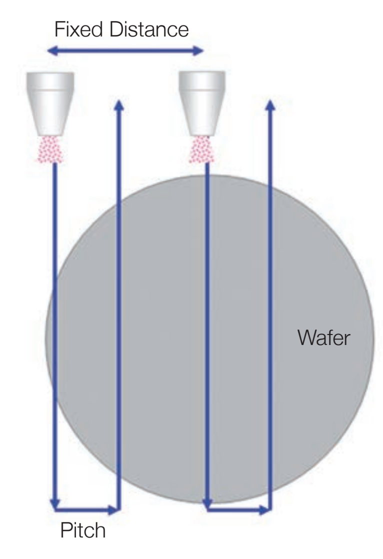

Figure 1. Two spray nozzles are moved in parallel over the substrate surface.

IMPROVED YIELD AND COST OF OWNERSHIP BY STABILIZING RESIST FLOW RATES

To reach the well renown high coating conformality of the SUSS AltaSpray technology, a specialized nozzle, which represents the core technology of the system, was developed for the technology introduction in 2004. But not only the nozzle design - rather all parts of the dispense line are designed and optimized to match the requirements and prerequisites of the coating method. A dedicated pump system is used to generate a steady and stable resist flow rate with adequate pressure and flow rate. Feedback from a high number of installed tools at research institutions as well as production sites, confirm the reliable functionality of the setup. However, especially in a production environment, a calibration of the systems resist flow rate is needed on a regular basis to keep the requested process stability and is part of the maintenance procedure. With the now available closed loop control system for the resist flow, two major advantages are achieved:

- The frequency of calibrating the system is lowered significantly and in most cases reduced to monitoring the system performance without the need to adjust parameters. This reduces maintenance time, thus, improving the Cost of Ownership.
- The mean resist thickness variation from wafer to wafer is also improved. As an example, for a dedicated process evaluation, the cpk value without the closed loop system is < 1.35 (about 4 Sigma). By introducing the closed loop control system, this changes to a stellar cpk value of > 3.5 (cpk of 2.00 represents about 6 Sigma).

A further advantage of the developed closed loop control system is, that it is field upgradable on all AltaSpray tools without influencing the spray coating results.

IMPROVED THROUGHPUT BY A DOUBLE SPRAY NOZZLE SYSTEM

The conventional SUSS AltaSpray coating technology is represented by a single spray nozzle, that is moved over a stationary substrate surface in a raster path. The process parameters of this raster (meander) are the travel speed of the nozzle and the pitch between the single paths, so called pitch width, (see Figure 2 of the article „Optimizing Spray Coater Process Parameters“, within this issue of the SUSS report). After finishing the first resist layer, the substrate orientation is turned by 90° and the next resist layer is coated. This procedure can be repeated several times, until the desired resist thickness is achieved. A major advantage of the repetitive turning and coating of the substrates are excellent homogenous coating results. Without any doubts, spray coating offers its own very unique advantages and in specific cases is the only option. However, one of the major disadvantages, especially when it comes to larger substrate sizes, is the rather long process time. To encounter this challenge, a double spray nozzle system was developed. The technical solution contains two identical spray nozzles, that are moved over the substrate surface with a fixed distance to each other. This distance is usually half the substrate diameter (see Figure 1). This means, only half of the meanders are necessary to coat the full substrate area. After the first layer is achieved, the substrates orientation is turned 90° and the second resist layer can be applied as described for the single nozzle process.

The critical parameters for this case are the combination of the distance of the nozzles to each other and the pitch width. Are the nozzles located too close to each other, areas of the substrate are coated more than once per layer as can be seen in Figure 2. An elevated cross can clearly be distinguished in the topography map of a resist coated silicon wafer. The cross type geometry stems from the repetitive 90° turning of the wafer after applying each resist layer. Without the turning, only a line type geometry would be visible. In the shown example case the resist AZ 4999 was used with a final layer thickness of some ten micrometers.

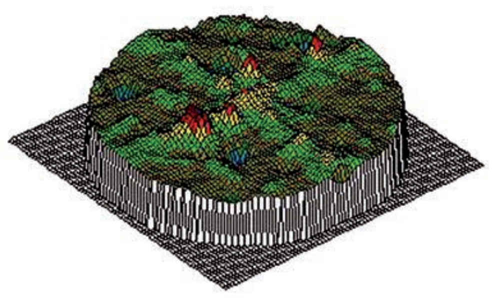

Figure 2: Qualitative topography map of a spray coated silicon wafer with a double nozzle system. The spray nozzles are mounted too close to each other.

If the nozzle to nozzle distance is too high, some of the substrate areas are not coated with enough resist, resulting in a cross type valley topography as can be seen in Figure 3.

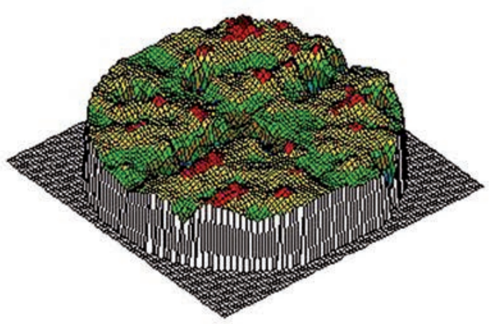

Figure 3: Qualitative topography map of a spray coated silicon wafer with a double nozzle system. The spray nozzles are mounted too far away from each other.

When the distance is adjusted correctly as shown in Figure 4, no topography artifacts can be identified and thus no negative influence of the double nozzle system can be distinguished. For the shown sample process, the needed time to spray coat a 150 mm silicon wafer is reduced by >40% compared to the single nozzle process, thus, significantly rising the overall throughput of the coating tool.

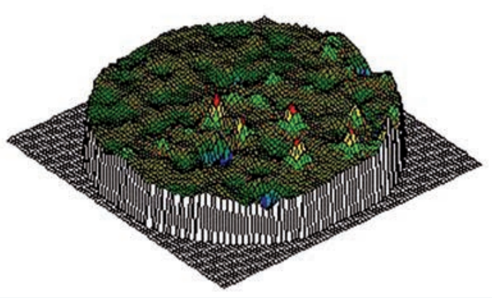

Figure 4: Qualitative topography map of a spray coated silicon wafer with a double nozzle system. The spray nozzles are mounted in a correct distance to each other.

CONCLUSION

By introducing the shown technical developments to the SUSS AltaSpray technology, especially high volume manufactures can benefit from the resulting yield and throughput improvements. The reduced process times might even open up new fields of application where spray coating was up to now not cost effective due to the often long process times.

Katrin Fischer studied chemistry at the NTA Isny. She worked in the R&D department at the Fraunhofer Institute IISB in Erlangen, before joining SUSS MicroTec in 2001 as a Production and R&D Manager. Katrin Fischer became part of the core team for developing the SUSS AltaSpray technology. Since 2005 she has the position of an International Product Manager Coater Systems and graduated with an MBA at the University of Ingolstadt in 2007.

Thomas Grund studied mechanical engineering with a specialization in microsystems technology at the Technical University of Karlsruhe. For his work on batch integration technologies for hybrid microsystems he earned a PhD degree from the Karlsruhe Institute of Technology (KIT) in 2010. Afterwards, Thomas Grund became project manager for an application of deep X-ray lithography at the KIT. He joined SUSS MicroTec at the beginning of 2012 as International Product Manager Coater Systems.