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Ready for the nano-scale

Carl Zeiss reorganises
for the future

Making sacrifices

Integrating improved CMP

Legally aware business

How to avoid being your own enemy



Ready for the nano-scale era

THE HIGH-TECH INDUSTRIES ARE ONLY AS GOOD AS THEIR FUTURE PRODUCTS. CARL ZEISS HAS BEEN REORGANISING TO MEET THE FUTURE NEEDS OF THE SEMICONDUCTOR AND OTHER INDUSTRIES ENTERING THE NANO-SCALE ERA. MIKE COOKE REPORTS

It's rare for a company in the semiconductor industry to have a history that stretches back to 1846. Founded in that year as a workshop for precision mechanics and optics, Carl Zeiss today leads in supplying critical optical and opto-electronic subsystems to a broad range of industries - from medicine to film production. More than 100 Zeiss lenses were used to make the Oscar-grabbing "Lord of the Rings", for example.

In the semiconductor industry, the company's Semiconductor Manufacturing Technology (SMT) group came first in VLSI Research's 2003 rankings for the critical subsystem market with sales of \$317mn. Improved market conditions are beginning to be seen in Carl Zeiss' results. In the first six months of its 2004 financial year, Carl Zeiss SMT generated revenues totalling €237 million, a good 6% more than last year's figure. Further improvements are expected in the coming months. The company sees markedly improved fab utilisation - over 90% in some cases - prompting chip manufacturers, especially in South-east Asia, to invest heavily in additional capacities.

Carl Zeiss SMT is most famous for the exceedingly complex lenses produced for leading edge deep ultraviolet lithography that stretch numerical apertures (NAs) to their limits. Carl Zeiss SMT and its partner ASML have together subjected the world's first system for 193nm immersion lithography to detailed testing. TSMC - the world's leading foundry based in Taiwan - has already ordered the first system. ASML and Carl Zeiss hope to achieve the NAs greater than one that are impossible for dry systems.

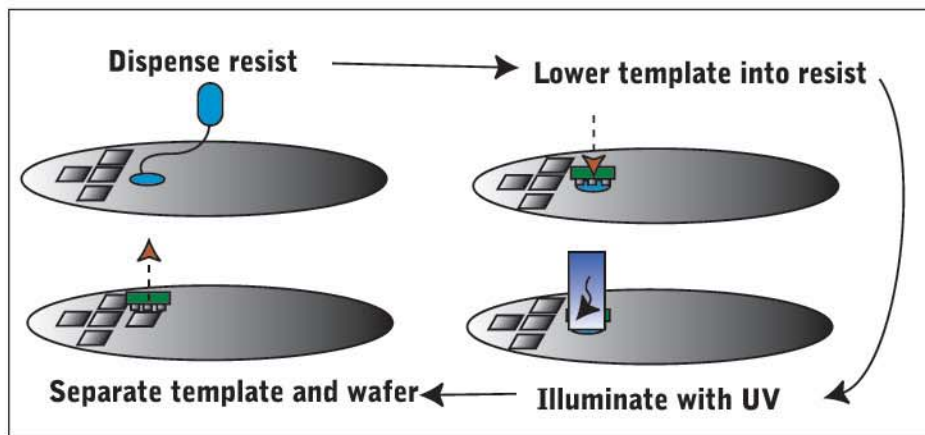


Fig.1 The Step and Flash Imprint Lithography (S-FIL) process is carried out at room temperature and low pressure

Perhaps less well-known, but just as important to the company, is the electron beam technology business formerly marketed under the LEO brand. This has recently been integrated into Carl Zeiss SMT as its Nanotechnology Systems (NTS) division. LEO has been a wholly owned subsidiary of Carl Zeiss SMT since 2001, but the company's origins can also be traced back to the Carl Zeiss Group over 60 years ago.

Nanoimprint

Carl Zeiss hopes that setting up the NTS to focus on nanotech will give it access to growth markets in the USA and Asia - China in particular. Among its technologies in this area is new nanoimprint lithography technology that appeared for the first time last year on the International Technology

Roadmap for Semiconductors (ITRS). Carl Zeiss SMT owns exclusive rights in Europe for distribution of Step and Flash Imprint Lithography (S-FIL) technology developed by US company Molecular Imprints (MII).

S-FIL creates nano-scale patterns by direct contact of template with a resist that hardens in ultraviolet (Figure 1). The process has been used to give 40nm lines with an 8:1 aspect ratio. Complex three-dimensional structures are also possible.

The inclusion of imprint lithography on the 2003 ITRS was the result of a recommendation by the Lithography International Technology Working Group (ITWG). The imprint lithography technique is sign-posted for the 32nm node.

Carl Zeiss agreed to make equity investments in MII along with its rights to

The electron beam technology business formerly marketed under the LEO brand has recently been integrated into Carl Zeiss SMT as its Nanotechnology Systems (NTS) division

distribute MII's Imprio imprint lithography equipment in Europe. As a result, Carl Zeiss SMT is in a key position to disseminate this technology initially for research, but in the future also for the industrial manufacture of nano structures. Semiconductor manufacturers such as Motorola are already working with S-FIL.

Maskworks

Carl Zeiss also works on mask metrology and repair. Among the Carl Zeiss SMT products is a photomask repair tool - MeRiT™ - developed in co-operation with NaWoTec. This tool won the 2003 German Industry Innovation Award and the first system was delivered to a major customer in the USA earlier this year.

The tool is based on a field emission scanning electron microscope with a dedicated chamber, a semi-automatic mask loader and a high precision laser interferometer stage. The electron optics is based on the company's unique GEMINI principle that has magnetic and electrostatic focus elements. This ensures that there is no magnetic field at the sample.

NaWoTec - a specialist in e-beam three-dimensional nanostructuring - contributed a five-channel gas supply system, a scan generator and defect navigation along with the deposition and etch processes (Figure 2) that are used to repair the mask.

The former Carl Zeiss SMT expertise also contributes its technology to CrossBeam® - a system that combines electron-beam imaging with focused ion-beam (FIB) milling capabilities. Such systems are used in repair (e.g., wire and defect trimming) and analysis (e.g., cross-sections) of chip structures both in the prototype and volume production contexts. The imaging resolution capabilities go down to 1.1nm and milling resolutions can be as small as 7.0nm.

Another mask tool that Carl Zeiss has developed over ten years is its Aerial Image Measurement System (AIMS™) technology to analyse the printability of mask defects based on original work with IBM. AIMS™ fab has since become an accepted industry standard

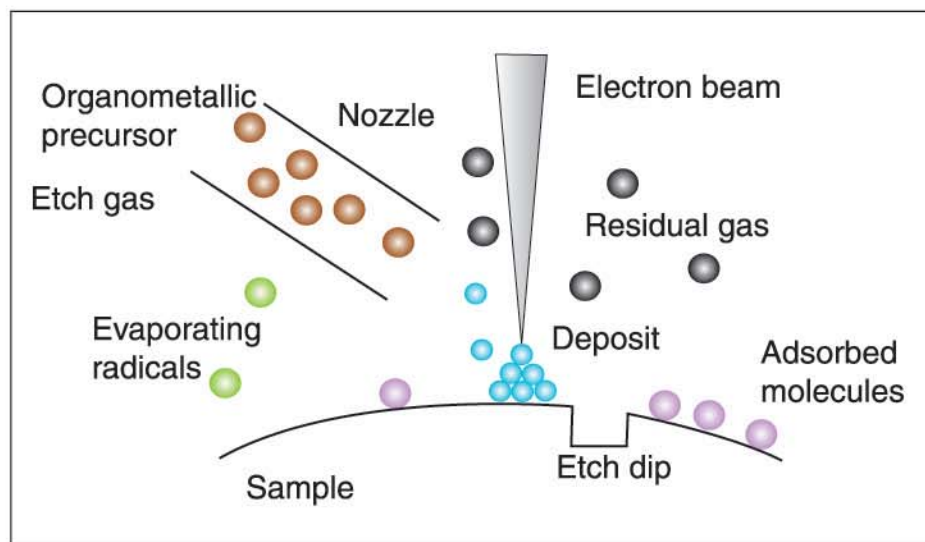


Fig.2: Electron beam deposition and etch developed by Carl Zeiss partner NaWoTec

in this area. The system emulates the wafer printing characteristics of photomasks during optical lithography for development, quality control, repair, verification and defect classification. The technology covers the 248nm and 193nm wavelengths along with the optical proximity correction (OPC), phase-shift mask (PSM) and off-axis illumination resolution enhancement techniques.

Specific exposure tool conditions can be characterised based on quantities such as numerical aperture (NA), partial illumination coherence (sigma) and the particular type of illumination (annular, dipole, quadrupole). By adjustment of these quantities within the AIMS™ tool, the operating conditions are exactly matched to the individual exposure conditions of the stepper or scanner. Rapid prediction of mask defect printability is obtained without the need for physical wafer exposures.

All major mask shops use the system in development work and in the fabrication process itself. Resolution enhancement technologies (RETs) used to extend the life of 248nm and 193nm lithography tools

create increasingly complex mask features that have a greater likelihood of printing yield-limiting defects during IC fabrication.

Other mask work includes collaboration with KLA-Tencor on next-generation photomasks for the 90nm and below technology nodes. The joint-development is aimed at providing the most comprehensive and cost-effective solution available to detect, review and disposition defects on advanced reticles. The companies plan to fully integrate reticle inspection, testing, metrology, review and defect dispositioning. The aim is to tackle not only traditional defects that print upon first use but also the progressive defects that can arise throughout the reticle lifecycle. Bi-directional information sharing has enabled integration between KLA-Tencor's TeraScan, TeraStar and STARlight reticle inspection systems, and Carl Zeiss SMT's AIMS™ fab and AIMS™ fab plus systems for both 248nm and 193nm wavelengths. This will allow reticle defect data and images captured by KLA-Tencor's inspection systems to be used by Carl Zeiss SMT's review and disposition tools. The results can then be fed back.

A photomask repair tool - MeRiT™ - developed in co-operation with NaWoTec won the 2003 German Industry Innovation Award and the first system has been delivered to a major US customer

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