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suss report

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Strong Partners for Technology Leadership:

Advanced Mask Aligner Lithography: Pushing the limits! MO Exposure Optics opens the door to the new era of Advanced Mask Aligner Lithography.

Optimization of Illumination and Mask Structures for Mask Aligners Exact simulation of diffraction effects is the base for Source Mask Optimization (SMO) in Advanced Mask Aligner Lithography.

SÜSS MicroTec

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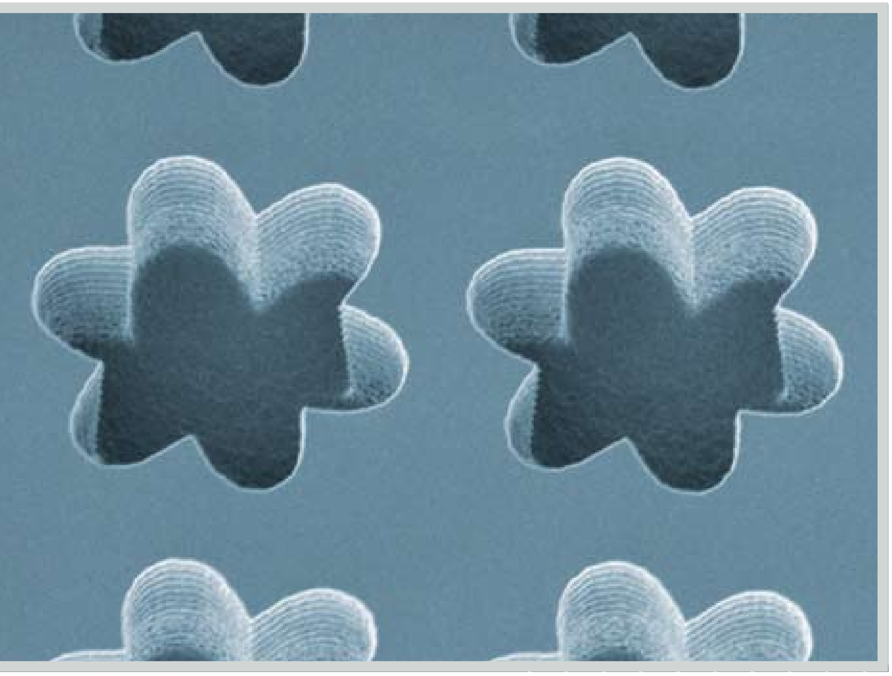

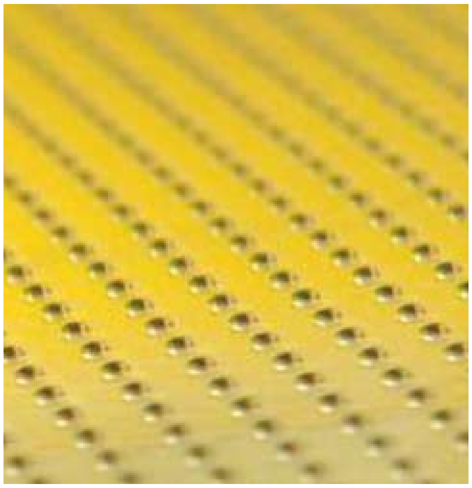

Full View

SUSS MicroTec on Track

When I was asked during my visit at Semicon Taiwan this year, how I would appraise the future, I responded optimistically. SUSS MicroTec not only stayed profitable during the financial crisis and the semiconductor downturn but it also initiated a strategic restructuring which will improve our standing in the industry. On top of that the recovery of the semiconductor market is solid and was confirmed by the strong figures of the last quarters.

The overriding objective of the restructuring, which will be completed by Q1, 2011 already, is to simplify the organization of SUSS MicroTec. We will reduce the number of manufacturing sites from four to two while increasing manufacturing capacity at the same time.

At the beginning of 2010 the Test Systems Division was sold to Cascade Microtech Inc. At the same time HamaTech APE joined the corporate group and forms the new division Photomask Equipment. With its twenty years of experience in mask cleaning and its undisputed leadership in the market, the new division synergistically complements our product portfolio and broadens our expertise in wet processing technologies.

Soon after the acquisition the first step towards site consolidation took place by moving the coater/developer product line from Vaihingen to the nearby HamaTech facility in Sternenfels, Germany. The modern 15,000 m^2 site offers excellent production conditions with state-of-the-art clean rooms and allows us to support future high-volume production.

Consequently the Substrate Bonder division is currently being relocated from Waterbury, USA to Sternenfels. With three product lines under one roof we will be able to create technology and production synergies and react flexibly and fast to market demands.

I am also pleased to welcome Dr. Rainer Knippelmeyer as VP R&D and CTO for SUSS MicroTec. He will head the group wide Research and Development activities and link the development teams of the individual product lines even more closely together.

While 3D integration technology is already used in some high volume applications like CMOS image sensors, we continue our development activities with industry and research partners throughout the world.

The article from imec introduced in this SUSS Report illustrates the initial experience gathered on our equipment. The latest results from research work in the ITRI AdSTAC Consortium were presented at a SUSS workshop at Semicon West 2010.

Likewise, our focused efforts in the LED market segment are paying off.
The most recent highlight from SUSS mask aligner development, a fully automatic, high throughput production system specially designed for the production of high brightness LEDs, is enjoying great popularity among our customers.

In addition to this, our proprietary MO Exposure Optics illumination technology improves the optical performance of SUSS mask aligners not just in the LED area. With the SCIL nanoimprint lithography, a highly effective technology was brought to market for the cost-efficient production of devices with very small structures.

Along with the recovery of the semiconductor industry, these developments allow me to look optimistically into the future. We will keep you posted!

Frank Averdung
President & CEO, SÜSS MicroTec AG

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Cu to Cu Interconnect Using 3D–TSV and Wafer to Wafer Thermo-Compression Bonding

Philippe Soussan, Packaging, Microsystems and Hybrid Technology, IMEC
Cedric Huyghebaert, Nano-Applications and Nano-Material Engineering, IMEC
Alain Phommahaxay, Researcher for wafer (de)bonding technology developments, IMEC

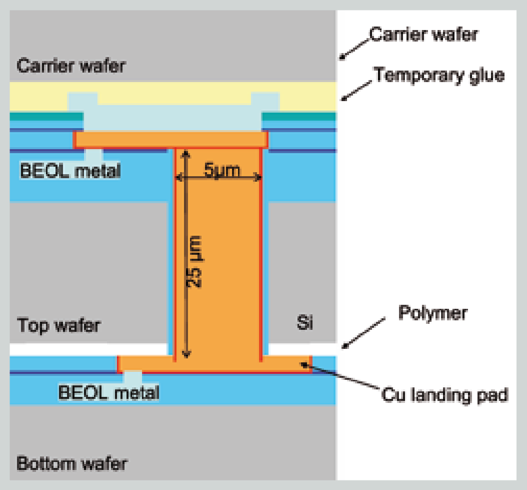


Figure 1: Schematic representation of the wafer stack during Cu-Cu hybrid bond.

ABSTRACT

In this article we report on the use of Silicon wafer to wafer bonding technology using Trough Silicon Vias (TSV) and Cu to Cu hybrid interconnects. We demonstrate that multiple wiring levels of two separate wafers, can be interconnected on a full wafer scale by means of wafer bonding using classical metallization schemes found in IC's such as Al and Cu interconnect technologies. The Cu TSV process is inserted during the process integration of a classical metal interconnect scheme. The top wafer is thinned down to 25µm and bonded to the landing wafer by hybrid Cu-Cu bonding in a high force bonding tool. The wafer to wafer stacking is accomplished by back to face aligned wafer bonding using a combination of polymer bonding and copper to copper thermo-compression bonding, in the SUSS XBC300 platform. Measurements of TSV interconnect chain structures show connectivity >99.8% on different wiring levels (TSV and classical metal level) on full wafer scale.

INTRODUCTION

3D Integration of electronic systems can be addressed in many different ways and a large variety of Through-Si Via (TSV) technologies are being proposed. These approaches can be categorized by the place of the 3D interconnects in the interconnect hierarchy: TSVs addressing interconnects at the bond pad level and interconnects at the level of on-chip electrical wiring. This second type (3D-SIC/3D-IC) typically uses approaches that integrate the TSV processing in a classical wafer foundry environnement. In this paper we report on TSV process integrated from the front side of the device wafer. The 5µm diameter TSVs are drilled through part of the BEOL into the bulk silicon. The TSVs are filled with Cu and connected to the planar interconnects with IC foundry tools in the imec Cu line. Subsequently the top wafer is then bonded with temporary glue to a carrier wafer before the top wafer is thinned until the TSVs are exposed from the backside. Finally the Cu TSVs are aligned and bonded to Cu bonding pads on the bottom wafer by a hybrid thermo-compressive bond. This is depicted in figure 1.

PROCESS FLOW

The process is divided in three parts, the TSV integration on the CMOS side, the thinning and back-side processing revealing the Cu nails, and finally the wafer to wafer stacking.

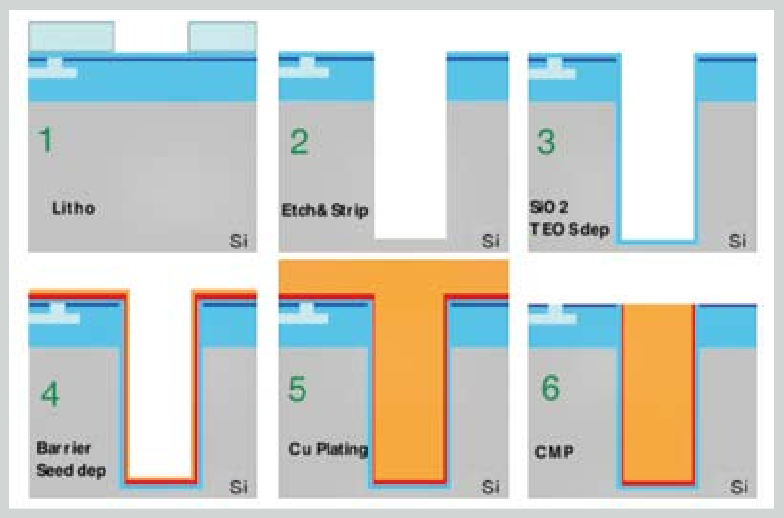


Figure 2: TSV process description

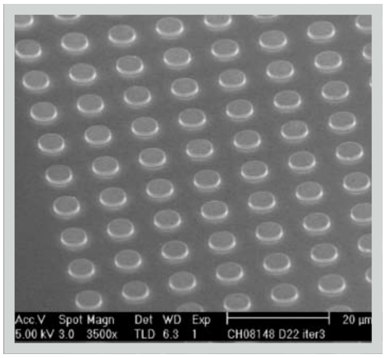


Figure 3: SEM picture of recessed Cu Nail on wafer backside

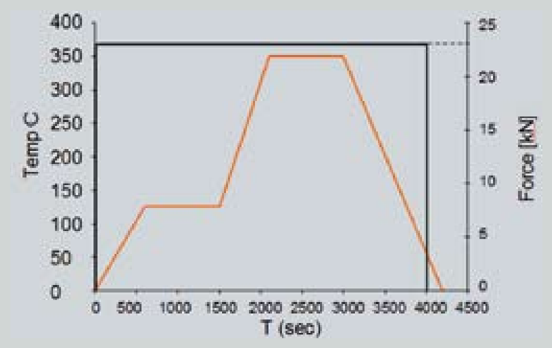


Figure 5: Typical wafer bonding profile for hybrid Cu-Cu bond

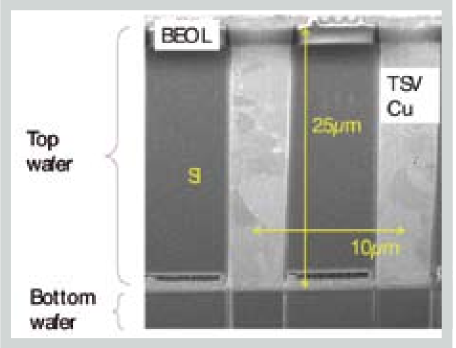


Figure 6: X-SEM view of TSV bonded wafers

Through Silicon Via fabrication

The Through Silicon Vias (TSV) formed during the metal interconnects processing and prior to final chip passivation. The TSV module is integrated to the BEOL in such a manner that the process sequences for FEOL and BEOL are untouched, meaning that the last process step consists of a classical sinter/alloying step. The minimum pitch of the 5µm diameter TSV is 10µm. Fig. 2 displays the different process steps for the TSV formation.

Thinning and revealing of vias reveal

In order to thin the wafer, the device wafer is temporally bonded onto a carrier wafer; subsequently the wafers are thinned down to a final thickness of 30µm by grinding. The revealing of the Cu nails is achieved during a Si-Chemical Mechanical Polishing (CMP) step. Finally the Si and the SiO_2 liner are etched back in order to achieve a Cu extrusion, needed for Cu-Cu hybrid thermo-compression bonding.

BOND ANALYSIS AND ELECTRICAL RESULTS:

The electrical assessment of the Cu wiring, including indicates Cu/Cu connectivity > 99.8%. A typical view of such Cu/Cu interconnects is shown on figure 6. On the picture it can be clearly seen that a voidless Cu/Cu bond interface is achieved. As a result the TSV and interconnect displays a resistance as low as 30mOhm. This value corresponds to the theoritical resistance of Cu in such TSV structure. This indicates pure metallic contact between the TSV and the landing Cu pads.

On figure 7 a plot representing the compound chain resistance is shown. It can be seen that excellent Cu-Cu bonding process is achieved. The higher resitance are attributed to the W contacts on the bottom right of the wafers.

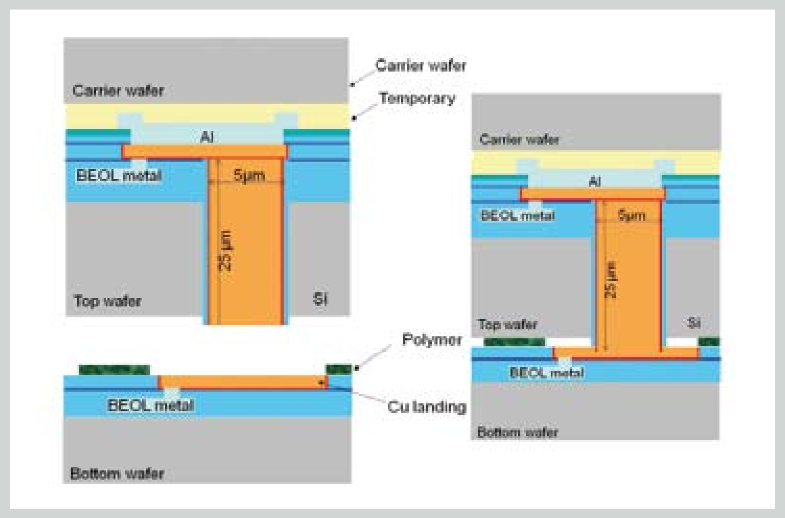


Figure 4: Sketch of wafer to wafer assebly

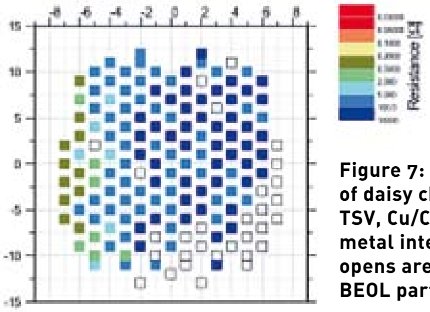
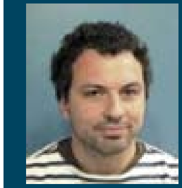


Figure 7: Resistivity plot of daisy chains comprising TSV, Cu/Cu bond and IC metal interconnects. The opens are attributed to the BEOL part of the wafers.

Philippe Soussan is leading the group "Packaging, Microsystems and Hybrid Technology", at IMEC. His field of expertise covers the interaction between processes and material properties, as well as technology integration in advanced packaging and microsystems. The group's research deals with complex process integration using 3D interconnect, advanced packaging and micro fabrication of scaling and non scaling driven components. He has authored or coauthored more than 60 publications and owns several patents in these fields.

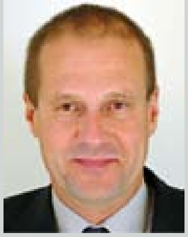


Cedric Huyghebaert is currently leading the nano-applications and material engineering team at imec dealing with the integration of nano materials as CNT and graphene in functional applications. He started as a junior researcher in the materials and component analyses group at imec. He studied the oxygen bean interactions during sputtering profiling of semiconductors. He received his PhD in Physics in 2006 at the KULeuven in Belgium. In 2005 he joined imecs pilot line as an integration engineer, especially dealing with the process contamination control. He was part of the packaging group from early 2008 till early 2010, working as a senior integration engineer dealing with 3D-stacked IC integration.

Alain Phommahaxay is researcher at imec and responsible for wafer (de)bonding technology developments. His research interests cover MEMS, wafer-level packaging, 3D-integration, particularly thin wafer handling. Prior to joining IMEC, he conducted research for the French Ministry of Defense at ESIEE Paris from 2004 to 2007 and received his PhD in Electronics from the Université de Marne la Vallée, France in 2007.

Advanced Mask Aligner Lithography: Pushing the limits!

THE AUTHORS:



Dr. Reinhard Voelkel, CEO,
SUSS MicroOptics

After receiving his PhD in Physics at University of Erlangen, Germany, he worked as Scientific Collaborator at IMT Neuchâtel, Switzerland. He then joined SUSS MicroTec in 1998 and co-founded SUSS MicroOptics in 2002. Reinhard Voelkel has more than 20 years experience in diffractive and refractive micro-optics, optical design, assembling of optical microsystems and optical networks.

Uwe Vogler,
Junior Product Manager,
SUSS MicroOptics

After studying mechanical engineering at the Technical University Ilmenau, Germany, Uwe Vogler joined SUSS MicroOptics as optical engineer in 2009. Specialized on illumination systems he has been responsible for the product line MO Exposure Optics as Junior Product Manager since 2010.

MO Exposure Optics opens the door to the new era of Advanced Mask Aligner Lithography.

MO EXPOSURE OPTICS

MO Exposure Optics is based on unique microlens-based Köhler integrators manufactured by SUSS Micro–Optics. The patented illumination system homogenizes both-, the light irradiance and the angular spectrum. Spatial filtering allows to freely shape the angular spectrum to minimize diffraction effects in contact and proximity lithography.

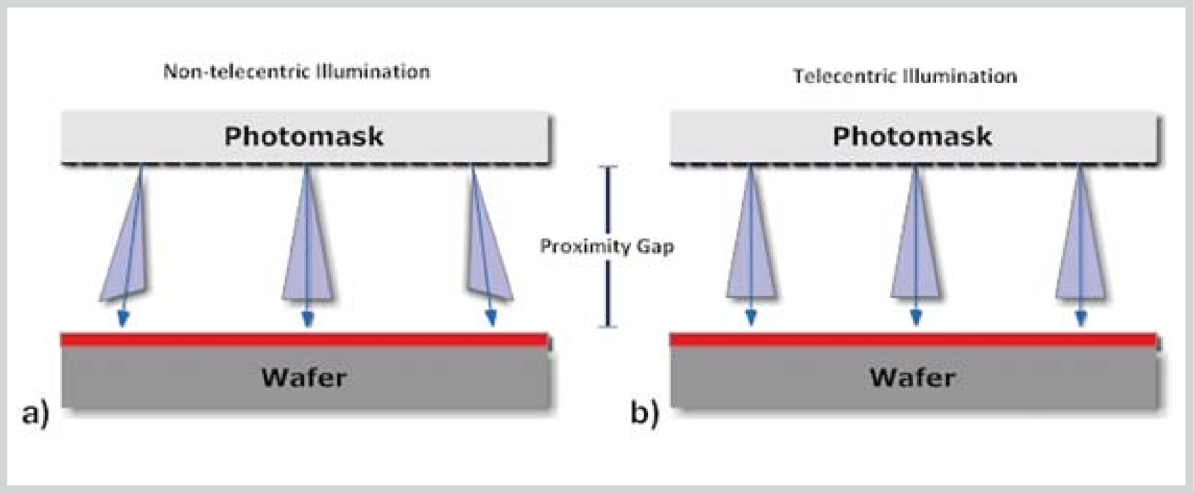
What is the impact of using MO Exposure Optics in a SUSS Mask Aligner?

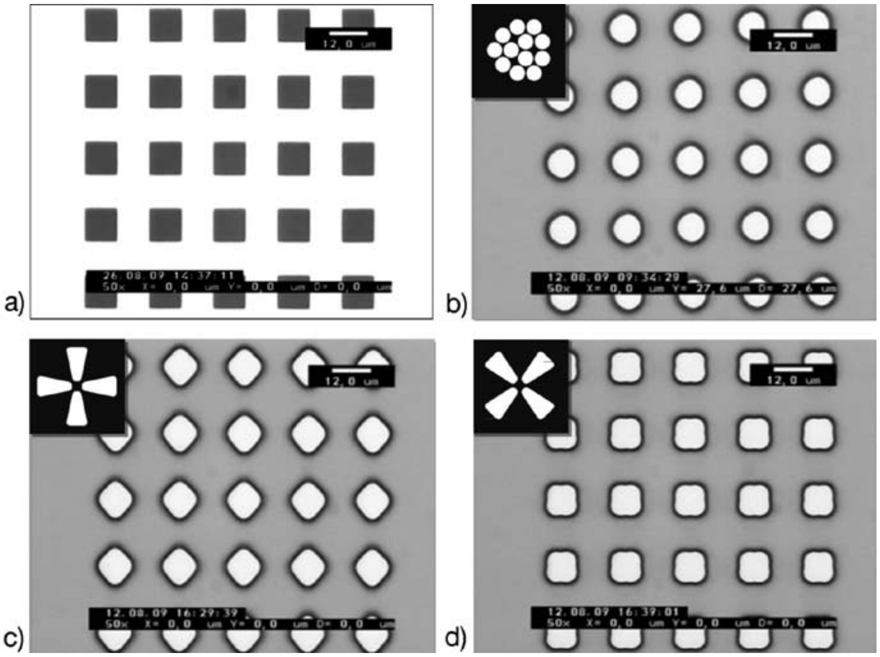
First, it is convenient to use! The uniformity of the illumination light is completely independent from the lamp position. It is not required to adjust the settings, especially after a lamp change which saves setup and maitenance time.

Secondly, MO Exposure Optics improves light uniformity (typically 1-2%) and provides telecentric illumination until the very edge of a wafer. Both have a significant impact on CD uniformity, enlarge the process windows and increase yield.

Thirdly, most important of all, MO Exposure Optics allows to implement Photolithography Enhancement Technology (PET) from the front-end in SUSS mask aligners. The ability to precisely shape the illumination light makes it possible to further improve the resolution, to increase the proximity gap or reduce the exposure time. Using PET in mask aligners helps to optimize and stabilize critical lithography steps, enlargen the process window, increases the yield and – saves costs in production!

The resolution in shadow printing lithography is limited by diffraction effects. Submicron resolution is achieved for vacuum contact, where the air in-between mask and wafer is evacuated. For vacuum contact lithography, very tight requirements regarding flatness and cleanliness apply. Remaining particles increase the mask-to-wafer distance and will deteriorate the printing results. In production environment, with the demand for low costs and high throughput, proximity lithography is preferred. Here wafer and mask are separated by some 30 to 200 microns





Experimental results for Mask Aligner Lithography using MO Exposure Optics and Customized Illumination.

Photographs of (a) a photomask consisting of 10 x 10 microns large holes and (b) to (d) the resulting prints in 1.2 micron thick photoresist exposed at a proximity gap of 100 microns behind the photomask (a) using different illumination filter configurations shown in small window in the upper left corner of the photographs.

proximity gap. The achievable resolution decreases with increasing proximity gap due to diffraction. Diffraction effects like side lobes, higher orders and interference effects could be altered by spatial filtering, changing both the angular spectrum and the spatial coherence properties of the illumination light.

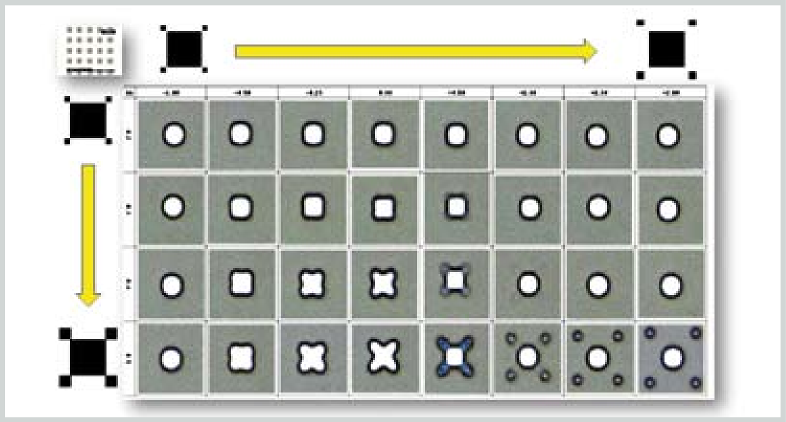
CUSTOMIZED ILLUMINATION

In projection lithography, a spatial filtering of the illumination light is referred as “customized illumination” and a well established Photolithography Enhancement Technology (PET).

The MO Exposure Optics illumination system offers an easy change of the angular spectrum of the illumination light. Exchangeable Illumination Filter Plates (IFP) allow to alter the angular spectrum and the coherence properties of the mask illuminating light in the mask aligner.

Customized Illumination + Optical Proximity Correction (OPC) = Source-Mask Optimization (SMO)

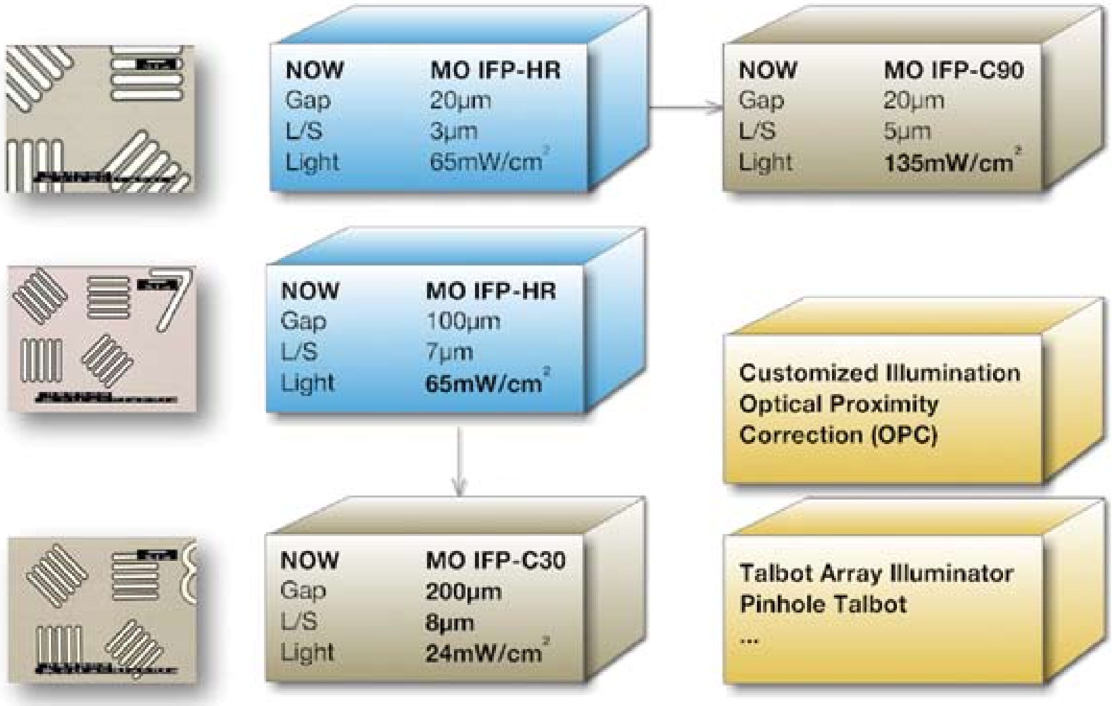
Optical proximity correction (OPC) is used to compensate for errors and irregularities like corner rounding, line width narrowing and edge shortening. OPC corrects these errors by moving edges or adding extra polygons to the photomask pattern. If both customized illumination and OPC are used, this is referred to as Source-Mask Optimization (SMO). Primary goals are enhanced CD control, increased resolution and depth of focus (DOF), improvement of the manufacturability for critical lithography steps and enlargement of the process window. Sub-resolution assist features that influence the propagating field without being printed in resist are used. A matrix of different OPC assist features is tested to generate a desired square pattern.



Advanced mask aligner lithography using MO Exposure Optics, customized illumination and Optical Proximity Correction (OPC). Photographs of resist prints (1.2 micron thick photoresist) exposed at a proximity gap of 50 microns for different mask structures. The upper left corner shows the results for a 10 x 10 microns square illuminated with a circular illumination filter and no OPC correction. A matrix of different OPC assist feature variations is used to derive OPC rules and models.

In a more general approach a desired aerial image could be composed by using binary computer generated holograms (CGH), phase masks, grey-level masks or other type of masks and microstructured surfaces. MO Exposure Optics allows implementing a wide field of other lithography techniques like Grey-Level or Half-Tone Lithography, Lau or Talbot Array Illuminator Lithography (TAILL) and Pinhole Talbot Lithography in a mask aligner.

Talbot Array Illuminator Lithography is well-suited for printing periodic structures with submicron features at very large exposure gaps. For the pattern shown above left, a depth of focus



MA200 Compact equipped with MO Exposure Optics. Measurement: Optometer (Gigahertz-Optik), broadband illumination

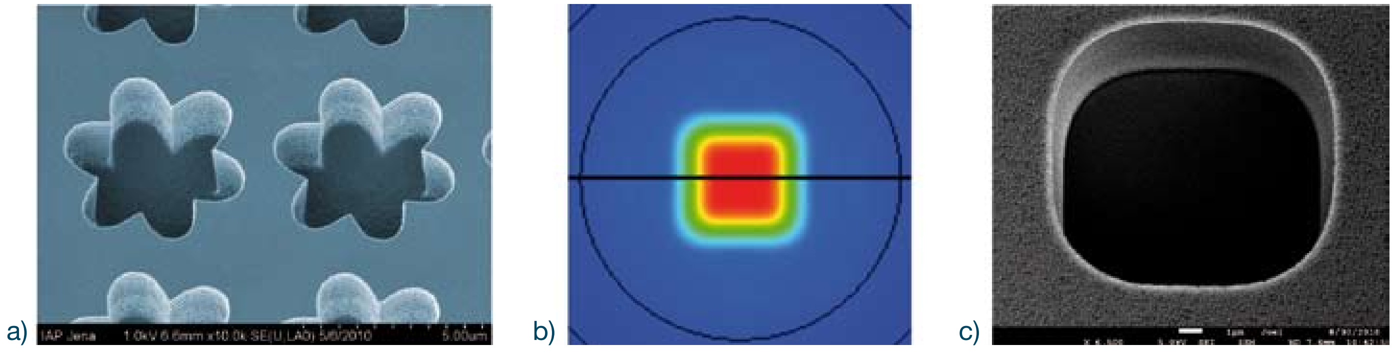
(DoF) of more than 4 microns makes this technology well-suitable for manufacturing Patterned Sapphire Substrates (PSS) used for LED manufacturing, Anti-Reflection (AR) texturing of Solar Cells or pulse compressor grating lot fabrication.

MO Exposure Optics and Fresnel-type OPC masks allow printing vias for TSV/3D at very large proximity gaps, e.g. a 5 microns via at 300 microns proximity gap or a square shaped via of 11 x 11 microns at 800 microns gap.

EXAMPLE: MA200 COMPACT AND MO EXPOSURE OPTICS

MO Exposure Optics offers a unique solution for research and production. Up to now, customers had to chose either HR- or LGO-Optics when placing the order. Now an easy change of the Illumination Filter Plate (IFP) allows to switch between these options even during operation. Beside HR- and LGO-Optics a library of other Illumination Filter Plates (IFP) is available. Customized IFPs to solve more sophisticated problems in lithography are available on demand.

To use an example we could take a MA200 Compact equipped with MO Exposure Optics. For a moderate resolution of some 7-8 microns at 20 microns proximity gap, the IFP C90 setting provides double light intensity (135mW/cm² for 1kW lamp). Cutting the exposure time by factor 2 – or double the proximity gap – and stabilize critical process steps by using OPC masks. We are just at the beginning of a new era of Advanced Mask Aligner Lithography.



Experimental results using MO Exposure Optics and Source-Mask Optimization, images edited by Foxit Reader.
(a) Talbot Array Illuminator Lithography showing a microstructure of 5 microns pitch printed in 102 microns proximity gap over large area. The resist pattern was transferred in silicon by reactive ion etching (Bosch etching process);
(b) and (c) show simulation and experimental results for square shaped via of 11 x 11 microns size printed at a very large proximity gap of 800 microns (AZ1518 photoresist, 5 microns thick).

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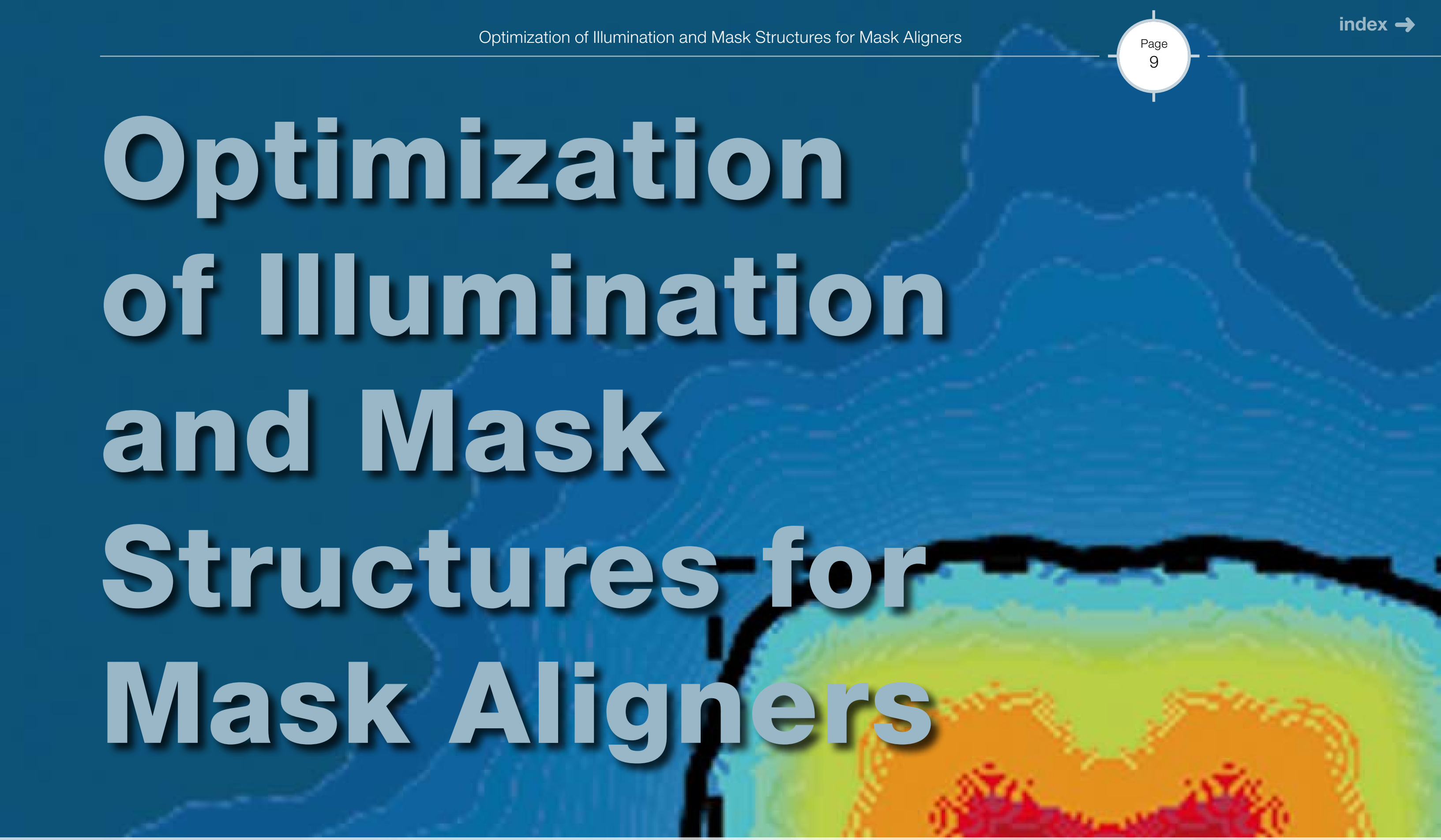
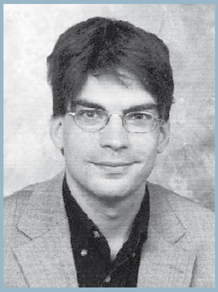


Optimization of Illumination and Mask Structures for Mask Aligners

THE AUTHOR:



KRISTIAN MOTZEK
received his diploma and Ph.D. in physics from Darmstadt University of Technology. He has been working on linear and nonlinear optics since 2000, concentrating on devices for semiconductor manufacturing since 2006. Since 2009 he is working on the simulation of proximity and projection printing and photoresist development at the Fraunhofer Institute for Integrated Systems and Device Technology.

Due to their high flexibility and cost-effectiveness, Mask Aligners are used for a wide range of applications in the manufacturing of microstructures. The size and complexity of the structures and the substrate material to be structured can greatly vary from one application to another. The ideal conditions needed to obtain optimum results depend on the type of application. Therefore, Mask Aligners are to some extent a compromise between different requirements. The introduction of the customizable MO Exposure Optics for SUSS Mask Aligners now enable the end-user to adapt the angular spectrum of the illumination to the specific requirements of his process, making it more stable and improving the yield (see the article of R. Voelkel in Suss Report 2/2009, p.16-18). We have conducted a numerical study to evaluate the combination of customized illuminations with optimized mask layouts. Our results show that this combination can considerably enhance the performance of Mask Aligners.

Diffraction effects are a major problem in Mask Aligner Lithography. Bright side lobes can form next to the illuminated areas on the wafer and be transferred into the photoresist. Such artefacts can be suppressed by choosing an illumination with an adequate angular spectrum. A large angular spectrum means good suppression of diffraction effects, but unfortunately it also leads to a decrease in contrast and resolution. Therefore, SUSS Mask Aligners can be equipped with different illumination optics putting the emphasis on a high resolution (typical for small proximity gaps) or on the suppression of diffraction effects (typically for large gaps) or on a good compromise between these two. With the customizable MO Exposure Optics the angular spectrum of the illumination can now be adapted specifically to each process. In a project founded by the Bavarian Research Foundation SUSS MicroTec, software specialist GenISys GmbH and Fraunhofer IISB are working on including this new flexibility in a user-friendly simulation software and on obtaining the best possible agreement between simulation results and measured resist profiles after development.

While the illumination is used to attenuate undesired diffraction effects, the light diffracted from small “assist features” on the mask can help to improve the results of a Mask Aligner print. These features are too small to print (i.e. they are not visible in the developed photoresist), but they can be used to slightly redirect the light into the right direction and thus to enhance the contrast or to better resolve small structures. The basic idea is identical to the “Optical Proximity Correction” (OPC) techniques often used

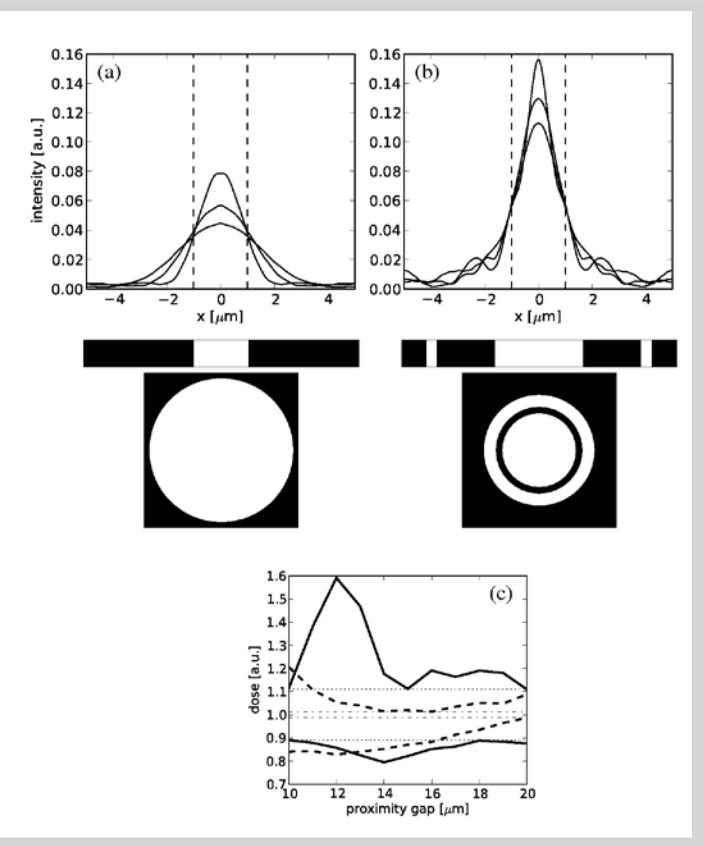


Figure 1:
Intensity distribution obtained when printing 2µm lines at gaps between 10µm and 20µm without (a) and with (b) an optimized mask layout and illumination. The plots show the intensity distribution at 10, 15 and 20µm. The mask layout and the illumination are shown schematically underneath. A comparison of the process windows is shown in (c).

in projection printing. However, as the optical setup is very different, the OPC features for a projection stepper will generally look different from the assist features needed for Mask Aligners.

The shape, size and position of assist features depend on the angular spectrum of the illumination and on the proximity gap. Therefore, the best results are obtained by using an optimized combination of illumination and assist features on the mask. This is known as "Source Mask Optimization" (SMO) in projection printing. Due to the large number of possible combinations of illumination spectra and assist features it can be very time-consuming to find a good combination of a customized illumination and a tailored mask layout. Here, numerical simulations and optimization algorithms can be a valuable tool. The basic idea is to use the computer to simulate the exposure process and to evaluate its results until a good solution is found, eliminating the necessity to conduct a lot of trial-and-error test exposures.

In Figure 1 we show how SMO can be used to enlarge the process window when printing 2µm wide bright lines with a pitch of 10µm in a 1.8µm thick AZ1518 photoresist on a Si wafer. Such narrow lines currently have to be printed in contact mode. Our simulations show that with an optimized mask and a customized illumination the process window should be large enough to print these lines at proximity gaps around 15um. Figure 1(a) shows the "unoptimized" situation with a standard mask (without assist features or line width biasing) and a circular illumination with a collimation angle of 2.5º (which is a good compromise between a high resolution and the suppression of diffraction effects). The results of our optimization are the mask layout and illumination shown in Fig. 1(b). The optimized mask layout consists of a much larger central line and two narrow side lines that help to increase the contrast. The co-optimized illumination has shrunk a lot compared to the unoptimized case (the outer radius is 1.2º) and an additional dark ring also helps to enlarge the process window. The comparison of the process windows (i.e. the allowed doses that will yield results that deviate less that 10% from the target size) for the optimized and unoptimized case are shown in Figure 1(c). We show the allowed doses for gaps between 10µm and 20µm because the proximity gap cannot be controlled with

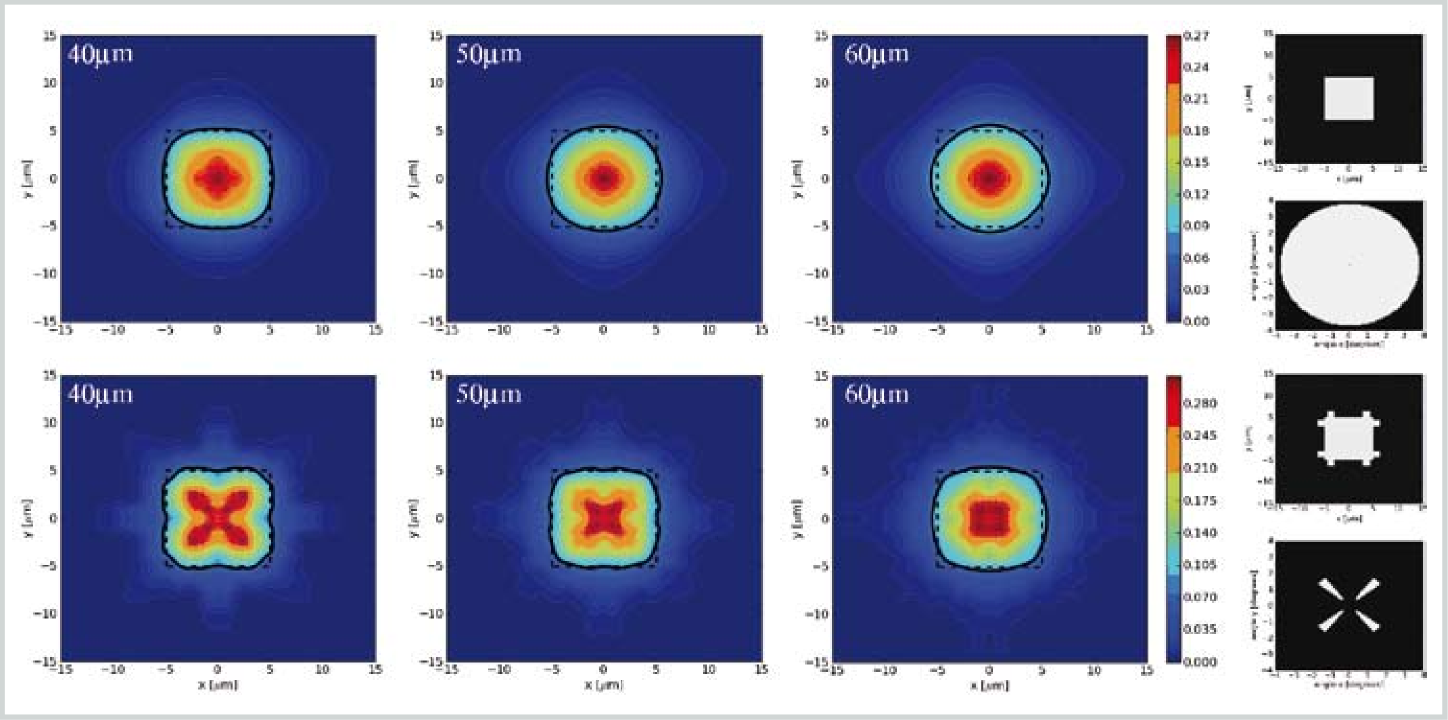


Figure 2: Intensity distribution without (top row) and with (bottom row) optimized mask and illumination at gaps around 50µm when printing 10µm square vias. The mask layout and illumination are shown to the right for both cases.

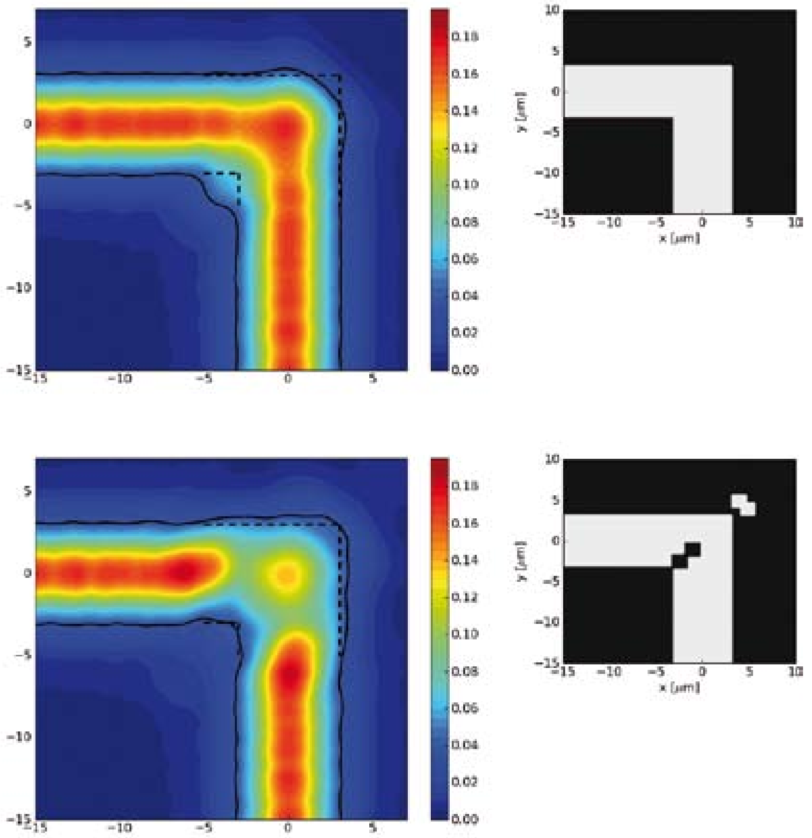


Figure 3:
The pictures show the intensity distribution at wafer level when printing a 90° bend in a 6µm line at a proximity gap of 40µm without (top) and with (bottom) OPC assist features. The respective mask layouts are shown on the right. The OPC features achieve a considerable reduction of the rounding of the inner and outer corner.

arbitrary precision due to the uneven surface of the wafer. Therefore, a stable process needs to be insensitive against gap variations of at least +/-5µm, better yet +/-10µm. The solid lines show the maximum and minimum dose allowed for the optimized case. For any gap in the region between 10 µm and 20 µm the allowed dose variation is bigger than +/-10%, whereas the allowed dose variation without optimized mask and customized illumination (shown by the dashed lines) is only +/-2% (which is too little for a stable process under realistic circumstances).

The application of SMO to 10 µm square structures printed at proximity gaps around 50µm is shown is Fig. 2. Without customized illumination or assist features the printed structures will look rather circular at larger gaps. Moreover, the shape will strongly vary as the gap varies, as the top row of Fig. 2 shows. Here, we have assumed a circular illumination with a collimation angle of 3.7°, which roughly corresponds to SUSS's Large Gap Optics. In order to achieve printing results that look more like the targeted square shape and that are more robust against gap variations it is necessary to add assist features to the mask and to use a customized illumination. The results of our optimization are shown in the bottom row of Fig. 2. The assist features on the mask and the x-shape of the illumination redirect light into the corners of the square. This yields a light distribution that is much closer to the desired square size over the entire gap region between 40µm and 60µm. Note that the dependence of the shape on gap variations has been reduced drastically.

Assist features can also be used to reduce corner rounding effects when printing lines with 90° bends. A comparison of the intensity distribution with and without assist features is shown in Fig. 3. Our example is a 6 µm line printed at proximity gaps around 40 µm. The assist structures we chose are four squares which we optimized in size and position. In this example we did not optimize the illumination but only the mask layout. Note, however, that an illumination with a different angular spectrum would require a different mask layout. Therefore, optimized mask layouts can only be used if the Mask Aligner's illumination is sufficiently stable and reproducible. Therefore, the decoupling of the angular spectrum from the exact position of the mercury arch lamp within the lamp house, which is achieved by the micro-optic lens arrays in the MO Exposure Optics illumination, will greatly facilitate the use of optimized mask layouts.

In conclusion, our numerical results show that with a stable, reproducible and flexible illumination it is possible to use techniques like OPC and SMO in Mask Aligner lithography. Assist features on the mask can be used to compensate for unwanted effects like corner rounding. In conjunction with a customized illumination it is possible to come to considerably larger process windows and thus to a more stable process and a higher yield.

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Aluminum-Germanium Eutectic Wafer Bonding for Wafer Level Packaging

Sumant Sood, Senior Applications Engineer, SUSS MicroTec

INTRODUCTION

Most current MEMS packaging applications either use glass frit and anodic bonding or metals such as gold that are not compatible with CMOS front end processing. There is a growing demand for MEMS wafer packaging processes where the CMOS wafer can be bonded to a MEMS wafer using CMOS foundry compatible materials. The ability to make high-density and reliable electrical contacts between the MEMS and CMOS substrates can be very beneficial and opens the doors for a new generation of MEMS devices with added functionality, smaller size, and lower cost per die. This Applications Note describes a practical AlGe based bonding and post bond characterization process.
AlGe based eutectic bonding provides a practical solution for hermetic wafer level packaging due to the following unique features: (a) Both Al and Ge are CMOS friendly, (b) an electrically conductive path between two substrates, (c) can be patterned easily and (d) allows for smaller die sizes. The Aluminum- Germanium system (2, 3) is a simple eutectic system with three phases (a) liquid (b) fcc (Al) solid solution and (c) diamond cubic (Ge) solid solution as shown in Figure 1. The eutectic point of this system has not been reliably reported but most published data points at a eutectic point of 420°C ±4°C placing the atomic percentage of Ge at 28.4% to 30%.

For Al-Ge bonding, the thickness of the stack as well as the seal ring geometries should be designed while taking into account the expected atomic percentage of Ge at the interface. In addition, care needs to be taken to ensure that the Al and Ge surfaces are free of native oxides and organic contamination from previous DRIE and lithography steps. One of the common methods to clean both Al and Ge deposited substrates is to dip the wafers in a dilute HF BOE solution. In addition, forming gas (3-5% H_2) is used as a process and overpressure gas to avoid oxide growth inside the bonder prior to substrates coming into contact.

EXPERIMENTAL

This study used 200 mm single side polished (100) silicon wafers as the substrate material. Figure 2 shows the SEM cross-sections of the deposited film stacks prepared for blanket AlGe bonding. As a starting point, blanket Al/Ge deposited wafers with 0.1μm

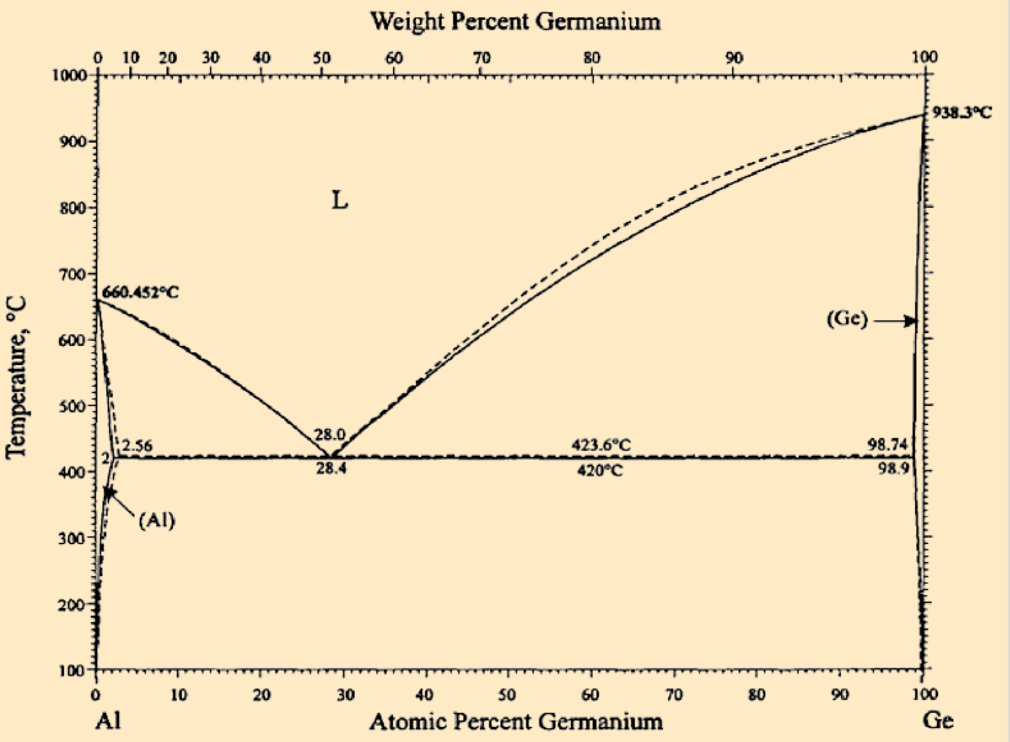

Figure 1:
Phase diagram for the aluminum-germanium binary system with reported eutectic point at 420oC ± 4oC (J Phase Equil. 19(1), 1998)

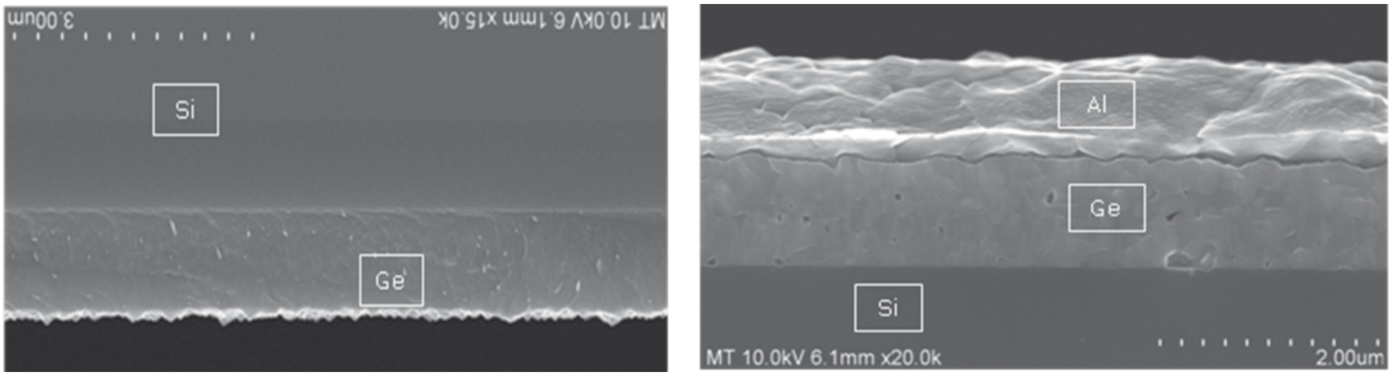

Figure a

Figure b

Figure 2: SEM cross-sections of wafer stacks (a) Substrate 1: Si/0.1µm TEOS/0.5µm Ge (b) Substrate 2: Si/0.1µm TEOS/0.5µm Ge /1µm Al

TEOS/0.5µm Ge /1µm Al were bonded to blanket Ge (0.1µm TEOS/0.5µm Ge) deposited Si wafers to qualify the bond process.

Once the bond process was proven on the blanket pairs, patterned wafers were used to optimize the process and to reduce eutectic squeeze out. For aligned wafer bonding preparation, the Si device wafer had patterned 5-10kÅ Ge with varying seal ring widths while the cap wafer was deposited and patterned with 10kÅ Al plus 5-10kÅ Ge on top. The seal ring widths varied from 10um to 200um. Both device and cap wafers had front side targets and were aligned using “SUSS MicroTec BA200” bond aligner inter-substrate alignment method in which the microscopes move in between the substrates for face to face alignment.

During the alignment process, 100µm-200µm thick spacers were inserted between the substrates prior to clamping to allow the flow of forming gas and consequently to pull precise vacuum between the substrates prior to bonding. Once aligned, the wafers were clamped on the bond fixture and transferred to a SUSS MicroTec CB200 wafer bonder.

Forming gas (95%N_2, 5%H_2) was used as the process gas while N_2 was used as the purge gas. During the bonding cycle, the bond chamber was pumped down to base vacuum at 350°C-390°C, followed by introduction of forming gas in overpressure (2 bar abs). After the forming gas step, the bond chamber went through a final pump-down step. The two substrates to be bonded were separated by spacers until the final pump-down step. After the chamber reached the specified vacuum level, the spacers were removed via sequential spacer removal process and a uniform force was applied on the substrates. The temperature was then elevated to 5-30°C above the Al-Ge eutectic point under force.

For these experiments, the bonding conditions were varied from 420°C to 455°C for the bond temperature, while the applied force and bond time varied from 15-40KN and 2-30 minutes respectively. The typical bonder process profile for AlGe bonding from CB200 is shown in Figure 3. Post bond alignment was measured using an offline transmission IR (infrared) microscope. Post bonding, the bond interface was evaluated via scanning acoustic microscopy (SAM). To further investigate the bond interface, cross-sections of the samples were analyzed via Scanning Electron Microscopy (SEM) and the presence of germanium and aluminum and their distribution was investigated via Auger Electron Spectroscopy (AES).

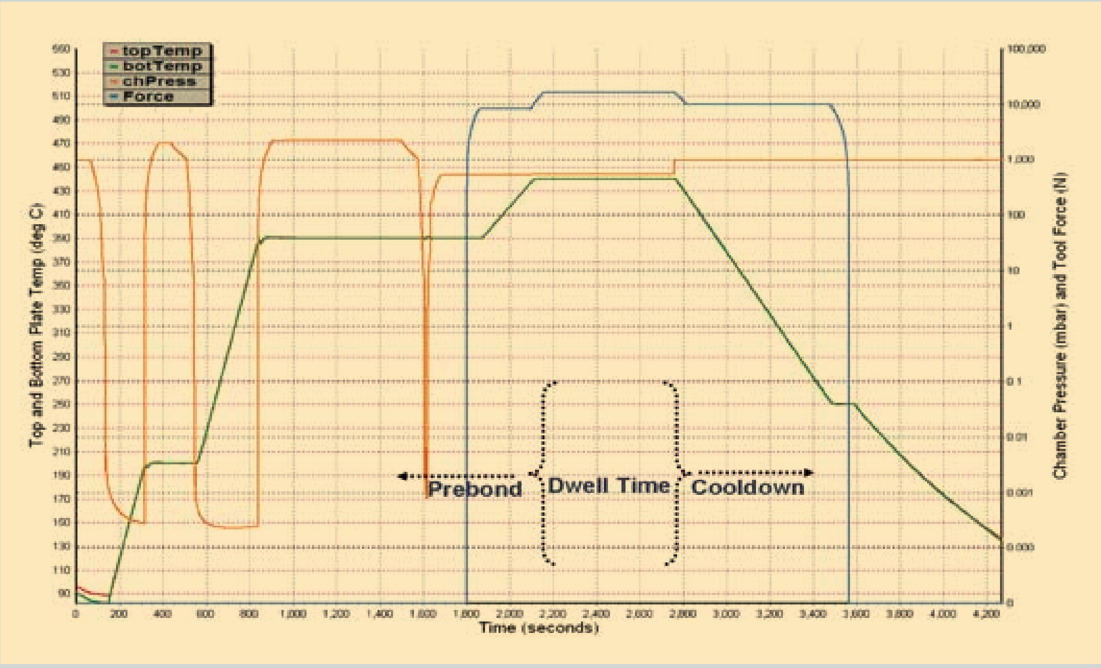

Figure 3:
CB200 Process curve showing Al-Ge bond parameters: top and bottom chucks temperature are plotted on left axis while chamber pressure and tool force are plotted on the right axis (log scale).

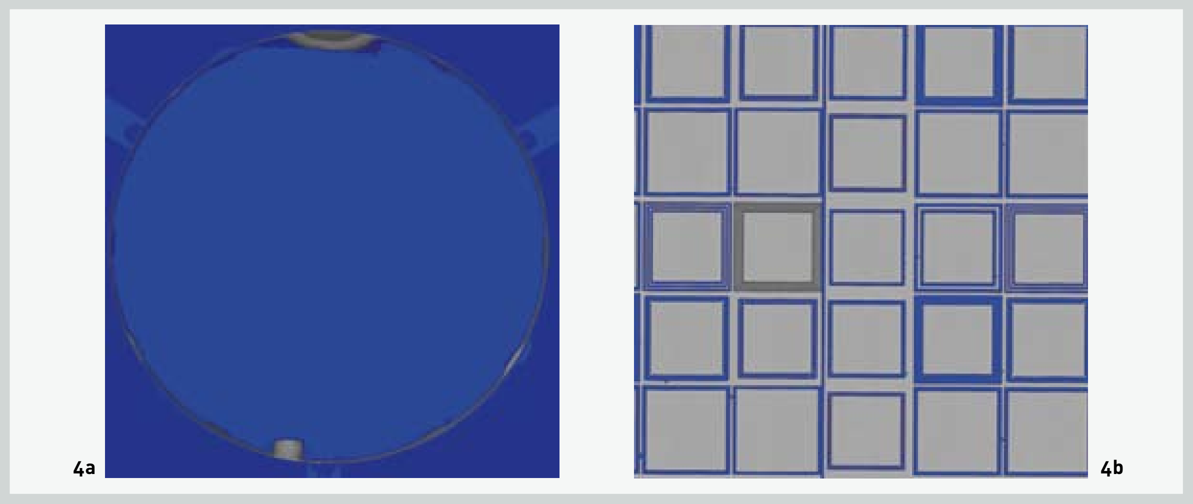

Figure 4: (a)
SAM image of a blanket Al-Ge bonded pair showing a void-bond at 440°C/ 40kN/30 minutes. The two artifacts at 6 o'clock and 12 o'clock position are from wafer clamping during upstream processes (b) High-resolution SAM Image of patterned bonded Al-Ge pair section showing well-bonded seal rings. The variation in seal rings colors is due to varying seal ring widths

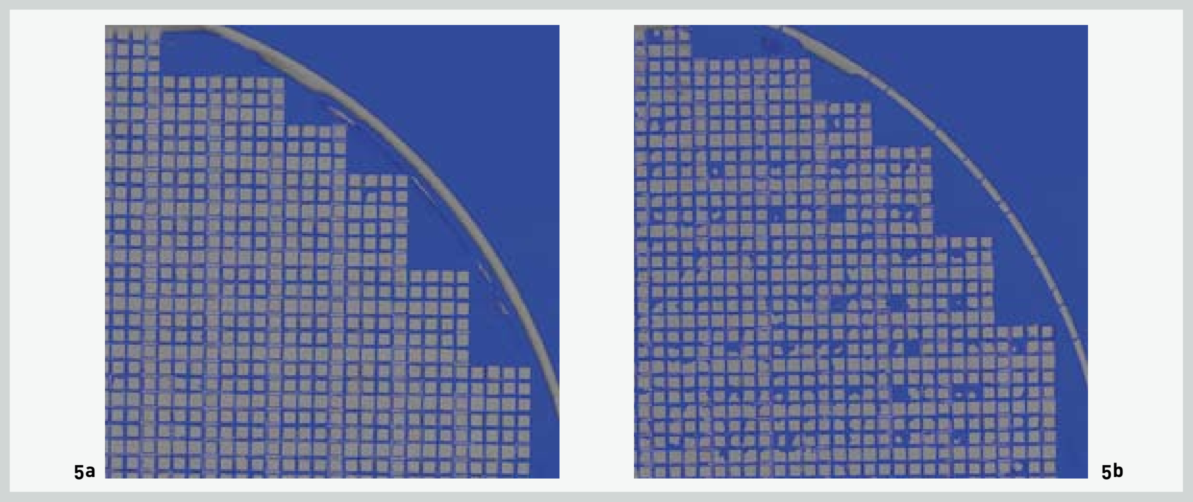

Figure 5:
SAM Images of patterned bonded Al-Ge pairs showing bonded seal rings with (a) no eutectic squeeze-out at 440°C/ 30kN (b) excessive eutectic squeeze-out into the cavities at 455°C/40kN

SAM & IR ANALYSIS:

Void-free bonding (SAM) for both blanket as well as patterned substrates with good post bond alignment (<3um post bond) was observed in the temperature range 435°C-445°C and tool force range of 20kN-40kN. Figure 4(a) shows a SAM image of a void-free bond for a blanket Al-Ge bonded pair while Figure 4(b) shows the high resolution SAM image of a section of from a patterned Al-Ge pair showing bonded seal rings with varying seal widths. Figure 5 compares the squeeze-out of the eutectic alloy from two Al-Ge runs processed at 440°C and 455°C respectively. At temperatures above 445°C, eutectic squeeze-out was observed irrespective of the tool force used owing to excessive melting as shown in Figure 5(b) while minimal squeeze-out was observed at temperatures up to 440°C. In addition, at temperature >445°C, post bond misalignment >5um was observed which is attributed to the molten eutectic state and therefore slippage at the bond interface. Mixed bonding was observed in the 425-440°C range with moderate tool force (20kN-30kN) while poor bonding was observed below 425°C irrespective to tool force up to 40kN. Figure 6 shows the transmission IR images of seal rings taken with an offline microscope and depict void free bonding and no eutectic squeeze-out with post bond alignment < 3um.

CONCLUSION

In conclusion, this paper described a practical AlGe based bonding process that can be used for both CMOS and MEMS friendly wafer level packaging and can be easily integrated into the wafer level packaging line without huge investment. Using the above discussed wafer stack, the process window for Al-Ge bond process was found to be 435°C-445°C, 10-15 minutes at 20-40kN force. With optimization of precleaning techniques, it is hoped that the process temperature and forces can be further reduced.

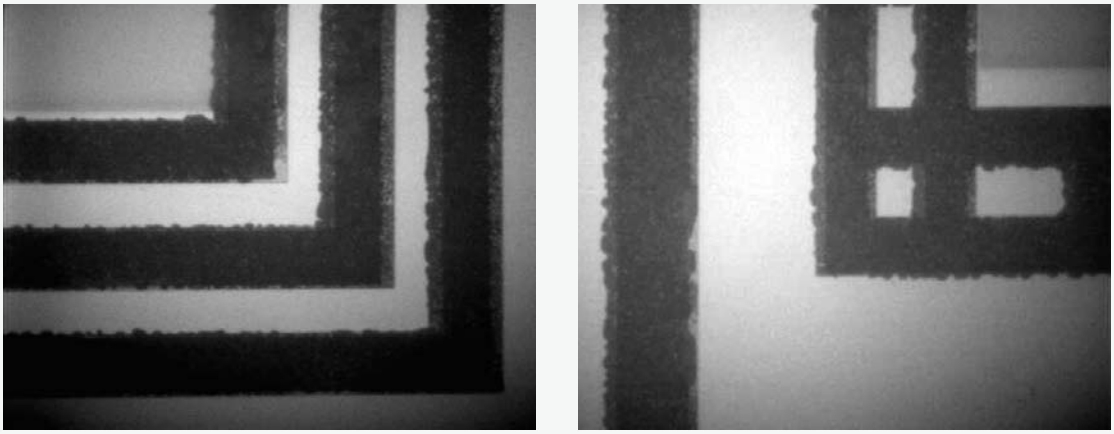

Figure 6: Transmission IR images (20x) from an offline IR microscope shows seal-rings from aligned and bonded AlGe substrates bonded at 440C/30kN/15 minutes

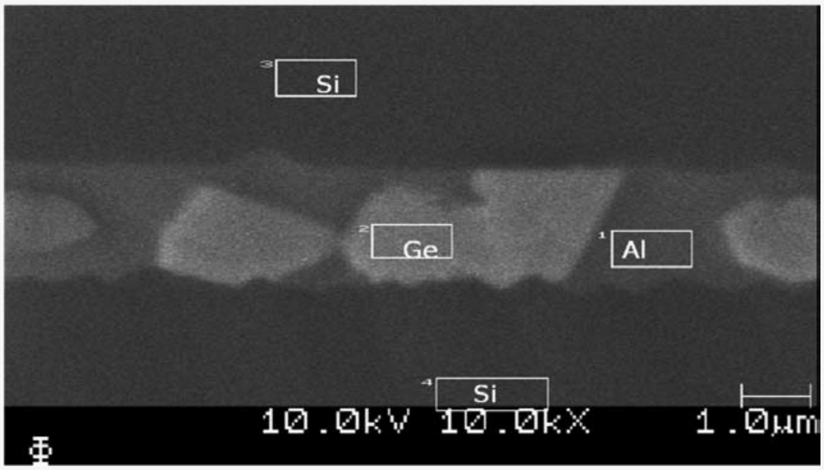

Figure 7: Cross-section SEM of the bonded pair section with void-free eutectic AlGe alloy at the bond interface. The bond interface is not visible with the Al/Ge grains completely diffused across the interface.

ACKNOWLDEGEMENTS

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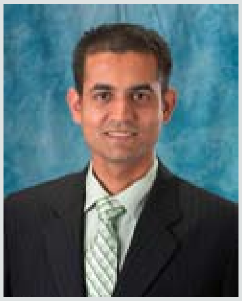
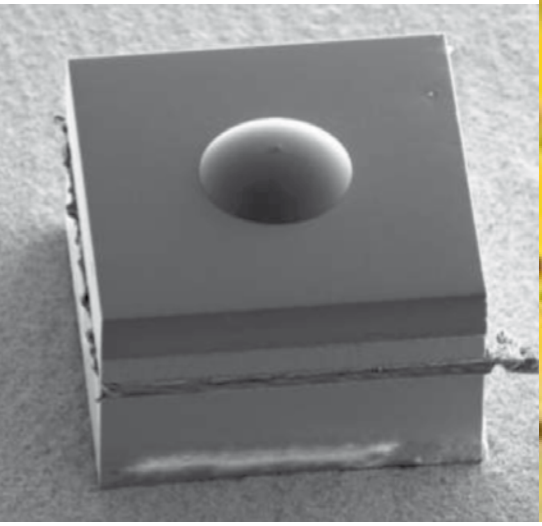
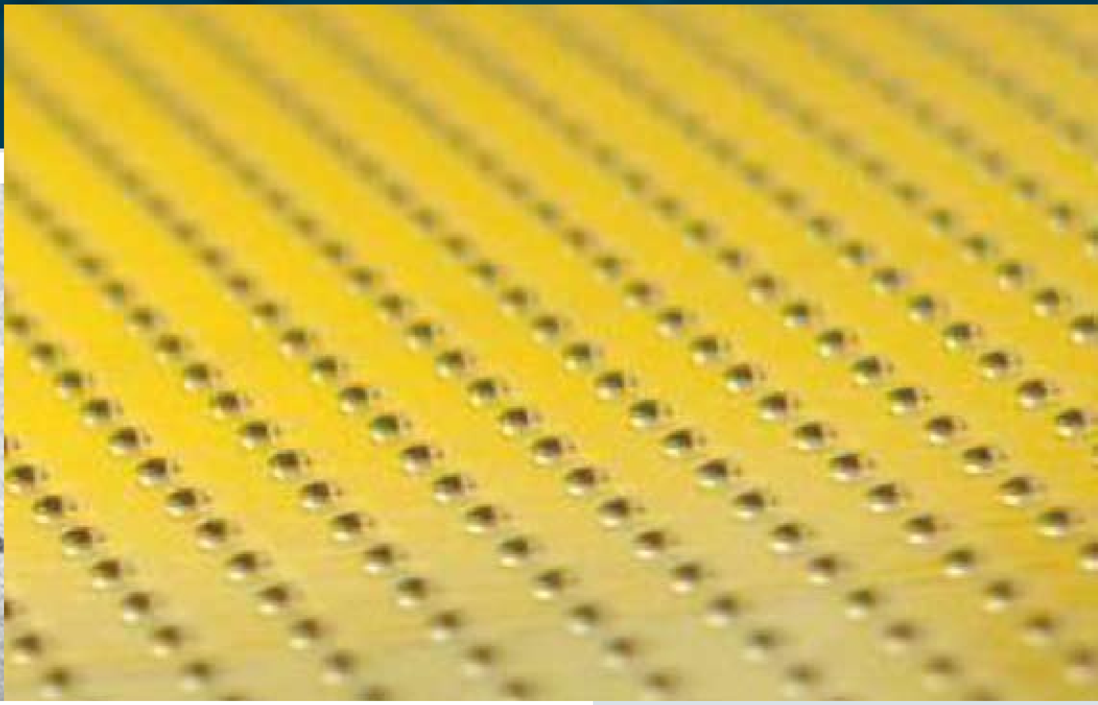


SUMANT SOOD

is Senior Applications Engineer for Wafer Bonders at SUSS MicroTec. His recent experience includes development of plasma enhanced wafer bonding processes for SOI and strained silicon on insulator (sSOI) applications. Sumant has authored and co-authored more than 15 papers in wafer bonding, SOI, strained silicon and related areas. He received his B.Tech in Electrical Engineering from Punjab Technical University, India and his MS in Microelectronics from University of Central Florida.

Soft Imprinting for Micro Lens Replication





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Application Scientist at SUSS MicroTec Lithography

He works on coaters and mask aligners with lens imprinting as his main focus. Marc graduated in Physics at Munich University where he also received his PhD working on micro fluidic systems for biological applications. He authored and coauthored several papers on various topics, including micro imprinting and lithography.

With ongoing miniaturization of optical components for mobile equipment new production technologies became necessary. In contrast to the traditional approach of assembling individual micro cameras from solitarily produced lenses the wafer level camera (WLC) process produces and assembles the optical components on wafer level, thus producing thousands of modules at a time. Micro imprinting of transparent optical

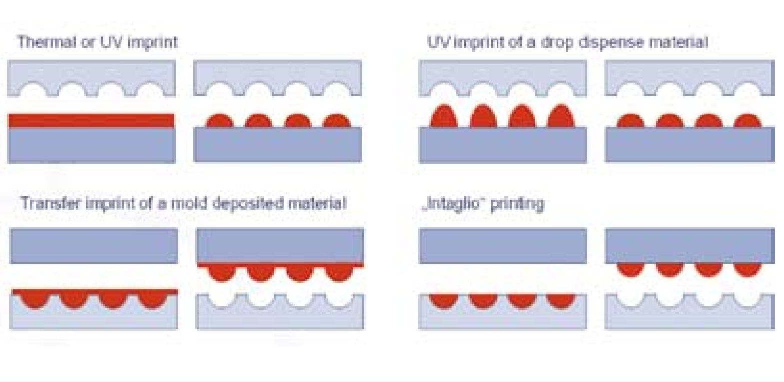


Figure 1: most common replication methods. While imprinting and transfer of mold deposited material lead to residual layers, the transfer processes can produce solitary material areas.

components is one of the most critical process steps of the whole WLC process. The quality of the imprint does not only define the quality of the final optical system but is also the crucial parameter for the final yield.

Artifacts in the imprint are caused by several factors, ranging from the general process selection over dynamic parameters like imprinting speed to material properties. In the following several of these parameters will be discussed.

Replication process: Very important to the result of the replication is the selection of the replication type, that fits best to the requirements of the component to be produced. From the bunch of different imprinting types that can be found in literature1 two processes became the de facto standard for the micro lens replication. While the micro imprint uses a process where the stamp is pressed into a puddle or a previously spin coated film, the micro transfer process uses micro dispensed material that specifically fills the structures which will be replicated. Both processes have their individual advantages and drawbacks. A specific feature of the imprinting process is that everywhere on the wafer a residual layer of material remains after completion of the replication. Even under highest pressure this residual layer can just be thinned, but never completely removed. As almost all polymers are prone to material shrinkage during cross linking, the ready processed wafers will present a reasonable warpage, complicating the following process steps. On the other hand, the residual layer will permit higher alignment precision, as due to the lubricating effect of the lens material realignment at the final process step is possible.

In contrast, the transfer process tends to be problematic when aiming at highest alignment accuracies, especially when the ratio between the area of the replicated lenses and the space between the lenses is small, as this is leading to a higher risk of contact between dry areas of the stamp and the wafer surface. Due to the high stickiness of the stamp material polydimethylsiloxane (PDMS), any contact between stamp and wafer will avoid further alignment.

To get the highest benefit out of the solitary lenses produced by the transfer process the size of the footing created by excess material has to be controlled. However, to control the back focal length of the optical system, also the thickness of the footing created by the residual layer has to be controlled precisely. Due to the restricted accuracy of the dispense machines (typically jetting dispensers with about 1% accuracy) this can impose substantial problems. This effect is the greater, the thinner the footings are designed. Caused by the small enclosed volume within the footing a change of 1% of the dispensed volume can easily cause an overflow of material into exclusion areas. Therefore, whenever possible the design of the imprint process should include thick footings making footing size control easier. Alternatively, the design of the single lens cavities may include an

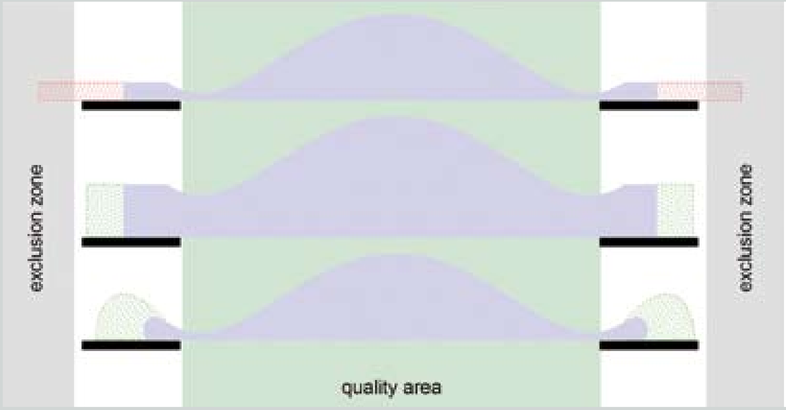


Figure 2: replication processes with varying footing thickness and their effect on the footing size. While thin footings need large lateral space to compensate volume variations (green area) thicker footings allow to confine the lateral extent outside of the exclusion zones. Where thick footings can not be accepted, overflow cavities can do the same job.

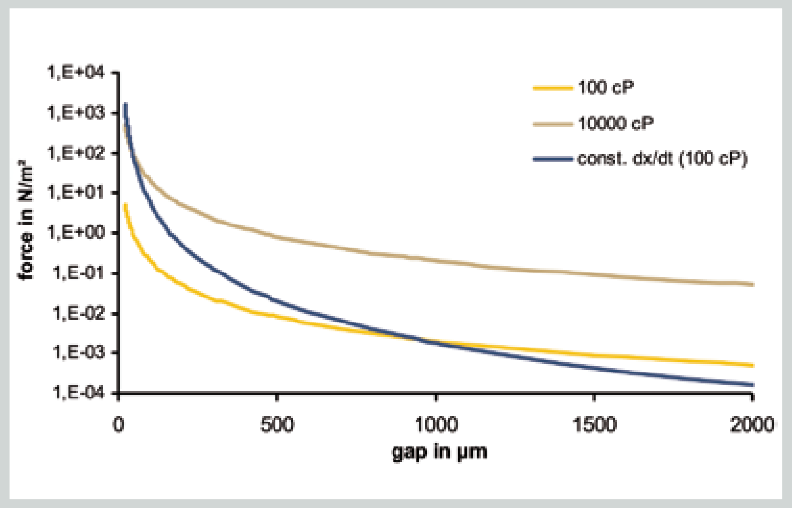
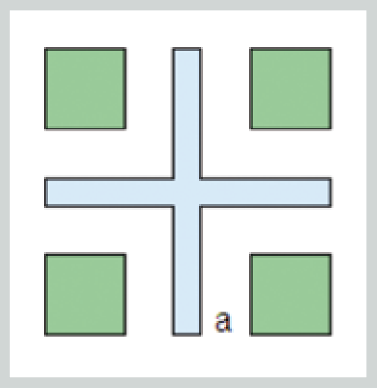


Figure 3: dependence of the sheer force from the remaining gap for different viscosities. The yellow and brown line represent the force when keeping the speed of the material front constant, i.e. when constantly reducing the z-axis speed. The dark blue line shows the conditions when keeping the imprint speed constant. The force is proportional to the viscosity of the material.

overflow cavity outside of the lens quality area, when thick footings can not be integrated (see figure 2) due to design demands.

Stamp properties: Together with the basic process selection the properties of the stamp have a crucial impact on the imprinting result. Besides the design aspects discussed in the section above obviously the total thickness variation (TTV) of the stamp has an essential influence on the uniformity of the replication results. As current imprinting machines like the MA8Gen3 can only control thickness variations in form of wedges, the stamp should show as little curvature and waviness as possible. While glass stamps are unmatched regarding the thickness variation itself, polymeric stamps can catch up due to their elasticity. This holds especially true when the used stamps have a thickness that is significantly bigger than the height of the structures being imprinted. Especially when using composite stamps that have a very soft intermediate layer between the supporting glass and a more rigid structured layer, deformations of the imprinted structures can be kept at bay while using increased forces to improve the contact uniformity. For example, using a 3 mm thick monolithic stamp with lens structures of 100 µm height and a waviness imposed TTV of the stamp of 30 µm will create a lens deformation of 1 µm. By using composite stamps made of polymers with different elastic moduli this can be reduced further.



Material: Obviously also the selection of the replication material has an important influence on the replication result. Diffractive index, Abbe number and absorption are important for the performance of the optical system but are no critical parameters for the development of the replication process. Photo sensitivity, relaxation times and viscosity of the material on the other hand are just three examples for material properties that influence the replication process directly. The viscosity of the lens material has a major influence on the throughput of the process as it defines the forces created during imprint and thereby the maximum imprinting speed. Especially at the end of the imprinting process, when the residual layers are becoming very thin (down to a few µm) the forces created during the imprint are rising fast. Figure 3 shows the theoretical dependence of the sheer forces from the gap that is remaining between the surfaces of the stamp and of the substrate. When keeping the axis speed constant during the imprint, due to the increasing spreading speed and the decreasing layer thickness the created forces are inversely proportional to the gap to the power of 3.5. Even when continuously reducing the axis speeds to keep the spreading speed constant (i.e. a reduction of the z-axis speed that goes with the square root of the gap cubed) the forces are still inversely proportional to the gap squared. To provide the user with the possibility of reducing speeds during the process, machines designed for the replication process allow to define several process steps with individual axis speed and other process settings.

The increasing force requires to slow down the replication process considerably at the final steps to keep stamp deformations under control. Especially for the imprint process with soft stamps, where centre puddle dispensed material is dispersed over the wafer area during the replication, too high imprint speeds will cause a severe super elevation at the wafer center and additional deformations of the lens molds. Using as low viscosity materials as possible and allowing thicker residual layers are two main possibilities to improve throughput and reduce artifacts due to force induced stamp deformation.

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Another important factor for the throughput is the sensitivity of the photoactive compound. For the time being all lens materials known to the author to be used in the replication process are based either on epoxies or acrylates or compounds of both. While the epoxides traditionally seem to be favorable over the acrylates for their optical properties, the advantage of acrylates lies in the low UV doses needed for the cross linking. The typical difference between the doses can even exceed one order of magnitude, resulting in exposure times of several seconds for acrylates and some minutes for epoxies.

Another, not less challenging part of the process is the alignment of the replicated lenses to other lithographic layers like apertures, or to lenses on the other side of the substrate. Alignment accuracy often suffers from insufficient image contrast and deformed target geometry, two challenges that have to be addressed by the machine. The main problem is the visibility of the alignment fiducials. Primarily when aligning lens layer to lens layer, both targets, on stamp as well as on the wafer consist of transparent polymers. The common designs of the fiducials in combination with standard reflected light microscopy often cannot deliver images with sufficient contrast for pattern recognition (see figure 4b). The biggest improvement can be achieved by tailoring the fiducials similar to what was patented by Geffken and Leidy of IBM in 1993. They increased the target contrast by embedding a grid like structure to roughen the surface and therefore either reducing the reflectivity of the target surface or using thin film effects. Besides this, the targets should of course follow the standard design rules for SUSS DirectAlignment targets, i.e. adjustment of the target size to the field of view and resolution of the alignment microscope, no or only minor overlap between the different target layers (especially when using pattern recognition) and unambiguous geometrical design (e.g. rectangular targets when the main replicated structures are circular and vice versa).

Additionally to the optimized target design visibility can be enhanced by use of advanced optical techniques. Often already the change from reflected light microscopy to transmitted light microscopy can improve the target visibility enough to allow manual alignment. Contrast enhancement by reducing the aperture of the incident light can be done easily on almost all microscopes used in imprinting machines, but will reduce the resolution of the microscopic system and thus reduce the alignment accuracy. Where those easy methods cannot improve the contrast sufficiently, phase contrast or differential interference contrast are two micro optical methods that might help. Both methods are transferring information about the material thickness into a contrast signal in the microscopic image. However, their use is restricted to thin material layers and they are intricate to be integrated into the small alignment microscopes of imprinting machines.

High accuracy recognition of fiducials is still challenging currently and will be subject of an ongoing improvement process.

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In the Spotlight

The Need for a New Paradigm in Mask Aligner System Design

MA/BA8 Gen3

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Ulrike Schoembs is responsible for product management of the manual mask aligners at SUSS MicroTec. Having set off a practical career in mechanical engineering Ulrike joined SUSS MicroTec in 2003 and started off in various positions in Applications and Product Engineering. In 2006 she received an academic degree in precision and micro engineering. Since 2006 she is also holding a teaching position in microsystems engineering at the Fachhochschule München.

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Brigitte Wehrmann is responsible for the international marketing of mask aligners and coat/develop systems. She has been working with Suss MicroTec in Germany on various marketing positions for more than 15 years.

The semiconductor industry has experienced exceptional double-digit growth over the past 25 years. Its future, however, depends on the ability of semiconductor manufacturers and equipment suppliers alike to lower cost while pushing the technological limits of lithography, materials, science and further development of new manufacturing techniques. This means that semiconductor manufacturers must overcome specific technology challenges, while equipment suppliers need to identify those areas where the productivity of their equipment has added, and can continue to add value to the growth of the industry.

For instance the push to integrate greater functionality into smaller packages has leveraged new manufacturing methods such as 3D or MEMS packaging, which are promising technologies for extending Moore's momentum in the next decennium, offering higher transistor density, faster interconnects, heterogeneous technology integration, and potentially lower cost and time-to-market. But before these new device types can be produced, new capabilities are needed: process technology, architectures, design methods and system solutions. In order to fulfill these new requirements existing equipment platforms have to be modified.

With the third generation of its MA/BA8 SUSS MicroTec has decided to completely reinvent its manual aligner platform and integrate new technologies in a well thought-out system design. The system was not planned as an off-the-shelf mask aligner solution, but rather as a kind of state-of-the-art 'tool set' that can be configured according to specific process needs. Based on the proven mask aligner technology from SUSS MicroTec (photo 1), which stands for superior quality, high alignment accuracy and sophisticated exposure optics, the new generation of the MA/BA8 is a highly effective single system solution that embraces many aspects of modern manufacturing from MEMS, Advanced Packaging, 3D-Integration up to Optoelectronics. Besides standard photolithography the MA/BA8 Gen3 supports nano and micro lens imprinting, UV-bonding, standard bond alignment and plasma treatment for surface activation and fusion bond processes. A great number of these technologies are commonly used in semiconductor manufacturing, which opens the process window for MA/BA8 Gen3 to a variety of new applications, that can be seen as forerunners for new, creative manufacturing methodologies, where maximum functionality can be packaged on minimal space.

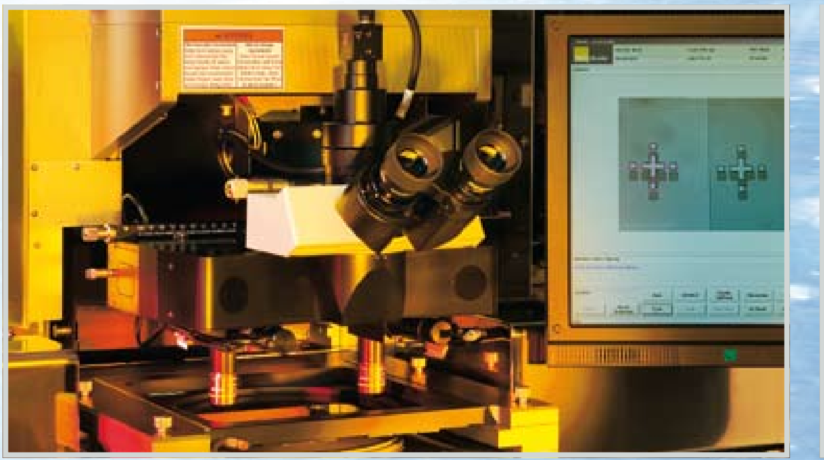

Photo 1: The MA/BA8 Gen3 stands for superior quality, high alignment accuracy, and sophisticated exposure optics

Photo 2: The SCIL nanoimprint toolkit offers a straightforward upgrade path to the world of large area nanoimprinting

For the MA/BA8 Gen3 several enabling upgrades are available, that are able to push the limits of standard mask aligner technology:

Nanoimprinting: The MA/BA8 Gen3 supports imprinting techniques for nanotechnology, that can be integrated into the system as an option. All techniques are based on the principle of mechanically modifying a thin polymer film with a stamp containing pattern at the nanoscale level.

UV-NIL is a production technology that enables imprinting of sub 50nm geometries on substrates up to 1x1 inch using a rigid quartz stamp.

The Substrate Conformal Imprint Lithography (SCIL) technique (photo 2) enables low-cost imprinting across substrates up to 6 inch and combines the advantages of a soft composite working stamp for large area patterning with a rigid glass carrier for low pattern deformation and best resolution reaching down to sub 50nm on a the full wafer area (photo 3). SCIL was developed by Philips Research, Eindhoven and transferred to SUSS MicroTec in a license agreement. Its excellent performance in respect to substrate conformity and pattern fidelity over large areas makes SCIL a powerful tool for manufacturing patterned media, HB-LEDs, MEMS or optical elements.

Microlens Imprinting;

Microlens Imprinting or SMILE (SUSS Microlens Imprint Lithography) has been developed by SUSS Micro Optics on a MA/BA Gen3 (photo 4) and is regarded as a key enabling technology for wafer level cameras as used in mobile phones or miniaturized image sensors. SMILE is a cost-efficient manufacturing technology for wafers up to 8 inch, where a liquid polymer is dispensed on or transferred to the wafer, while the lenses are imprinted by using a UV-transparent stamp or mold and UV-light for curing. SMILE allows the manufacture of lens arrays with a submicron lateral accuracy in a mask aligner (photo 5). Active Wedge Error Compensation (WEC) guarantees uniform imprint results.

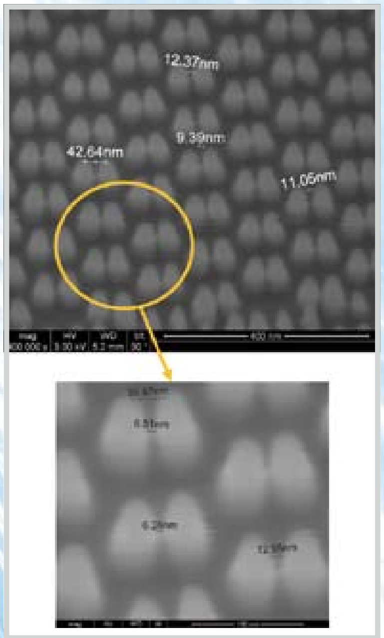

Photo 3: High resolution structures imprinted with SCIL in sol-gel. Gap between two posts ~ 9.4nm (6.5nm demonstrated)

UV-Bonding:

For the final assembly of the wafer level camera (photo 6) the lens imprinted wafers are stacked, aligned and bonded, before the wafers are diced into individual optics modules and get connected to an image sensor to build a camera system. The superior submicron alignment capability of the MA/BA8 Gen3 enables the system to accurately align and bond the opto wafers via UV-bonding. Along with the enhanced Cognex® based pattern recognition software it is possible to perform an ultra precise alignment of the wafer planes with a large axial distance of up to several millimeters. High intensity optics guarantee high throughput in dose intensive UV-bonding applications.

Photo 4: The MA/BA8 Gen3 equipped with a toolkit for microlens imprinting

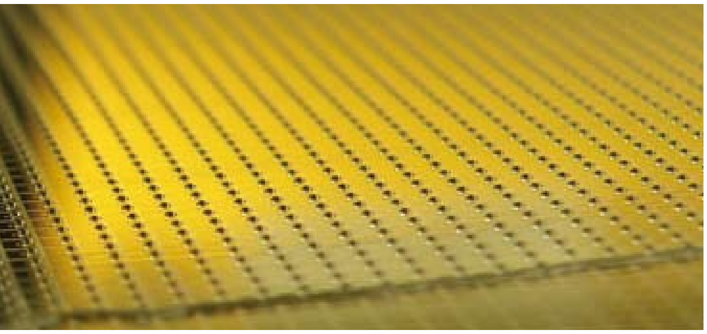

Photo 5: Microlens replication on 200mm wafer performed on a MA/BA8 Gen3. Material: Delo Katiobond 18499

Photo 6: Wafer level camera in mobile phone; By courtesy of Carl Zeiss AG

Photo 7: The MA/BA8 Gen3 can be configured as mask and bond aligner combination or as bond aligner only.

Bond Alignment:
Besides its basic mask aligner configuration the MA/BA8 Gen3 can be configured as a mask/bond aligner combination or as a bond aligner only (photo 7). In bond aligner mode it aligns and clamps wafers in fixtures to maintain the position during manual transfer to a wafer bonder. In case of direct bonding processes, the wafers can be bonded in the aligner as well. The highly rigid and stable alignment stage of the MA/BA8 Gen3 ensures reliable and accurate alignment of substrates. The proven, patented SUSS MicroTec wedge error compensation system guarantees highest possible planarity between wafers. In bond aligner mode the MA/BA8 Gen3 accommodates even most demanding alignment processes in MEMS production and growth markets like 3D integration.

Selective Plasma Activation (SELECT): Fraunhofer IST and SUSS MicroTec have developed a new method of plasma treatment that enables a local activation of specific, preselected wafer areas and functional layer deposition. The new patent pending technology reduces process temperatures in wafer bonding applications and allows plasma treatment of selected wafer areas for certain MEMS, optical or solar applications that incorporate wafers, which contain plasma sensitive micro components or electronics (photo 8, 9). Local treatment can be used for the creation of micro mirror arrays, micro valves, sensors or microfluidic channels using direct wafer bonding or surface activation. Selective plasma treatment allows to replace some of the standard lithography process steps, which enables to further streamline device production processes and reduce cost per wafer. The process enhancement is available as SELECT toolkit for the MA/BA8 Gen3.

Photo 8: The MA/BA8 Gen3 SELECT enhancement enables selective surface activation using direct wafer bonding or surface modification

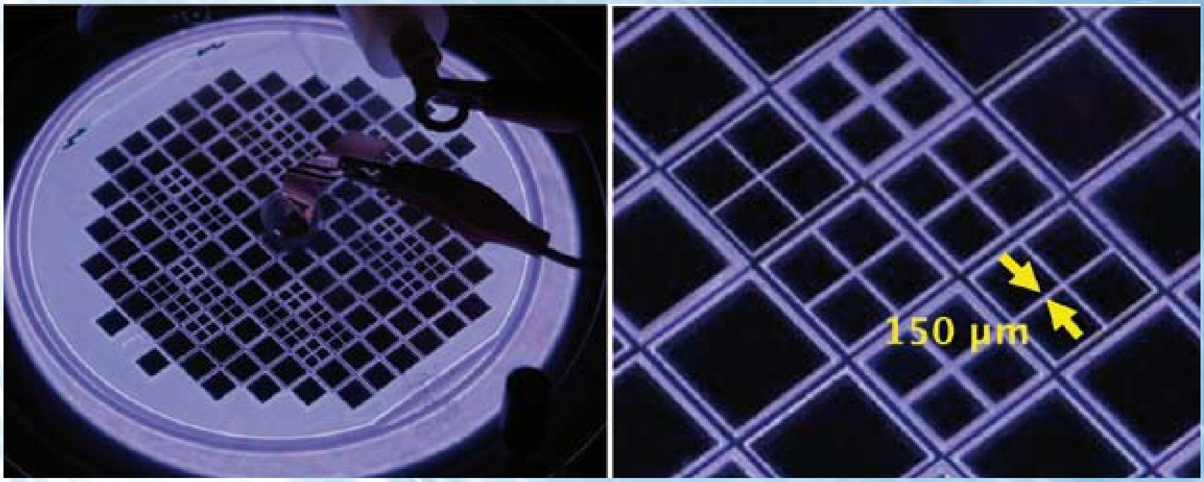

Photo 9: With selective activation of the wafer surface plasma is generated in the cavities; By courtesy of Fraunhofer IST

SUSS MicroTec in the News

**Here is a summary of our recent press releases.
To read the entire press release, please visit
http://www.suss.com/company/news**

June 8, 2010

SUSS MicroTec Cooperates with Research Institute ITRI on Technology Development in 3D Integration

SUSS MicroTec today introduced the next generation of its MA100e mask aligner, a dedicated lithography solution for manufacturing high-brightness light emitting diodes (HB-LEDs). Based on SUSS MicroTec's production proven mask aligner design the automatic MA100e Gen2 processes wafers up to 4 inches and enables an industry leading throughput of 145 wafers per hour with reduced cycle times.

"With the next generation of the MA100e SUSS MicroTec has developed a highly efficient automatic mask aligner solution for LED production that helps our customers to cut down cost per lumen and increase their production efficiency."
Frank Averdung, President and CEO, SUSS MicroTec

June 10, 2010

Strategic Restructuring of the SUSS MicroTec Group

SUSS MicroTec today announced its decision to relocate its Substrate Bonder division to Germany this year. The division is currently based in Waterbury, Vermont, USA. In the course of the planned restructuring, the research and development, production and product management functions of the Bonder product lines will be moved to the production site in Sternenfels, Germany. At the same time, the North American service and sales activities as well as the applications center will be moved from Waterbury, VT, to Silicon Valley in California.

"By combining the product lines in Sternenfels we will be much more responsive to our customers and will be able to provide them with state-of-the-art solutions to meet the challenges of 3D integration."
Frank Averdung, President and CEO, SUSS MicroTec

July 13, 2010

SUSS MicroTec Launches MaskTrack Pro® Bake/Develop for Next Generation Lithography

Today, HamaTech APE GmbH & Co. KG, a wholly owned subsidiary of SÜSS MicroTec AG, introduced the latest addition to its Next Generation Lithography line of mask integrity platforms, the MaskTrack Pro Bake/Develop (BD). The product addresses the challenges of mask manufacturing of advanced 193i Optical Immersion and Extreme Ultraviolet Lithography (EUVL).

"With the complementation of the photomask processing product line, SUSS MicroTec extends its market leadership in Next Generation Lithography equipment."
Frank Averdung, President and CEO, SUSS MicroTec

September 31, 2010

SUSS MicroTec Appoints New VP R&D

SUSS MicroTec has appointed Dr. Rainer Knippelmeyer as Vice President R&D and CTO. In this function Dr. Rainer Knippelmeyer will oversee research and development and innovation management for all products. His main focus will be on the creation of a cross-product technology roadmap within the SUSS MicroTec group.

"With his wealth of experience Dr. Rainer Knippelmeyer will be able to further emphasize the clear focus on development activities in the strategic markets for the SUSS MicroTec group. Our customers all over the world will benefit from the close linking of our development departments." says Frank P. Averdung, President and CEO, SUSS MicroTec

November 11, 2010

SUSS MicroTec and Fraunhofer IST Introduce New Technology for Selective Surface Treatment

SUSS MicroTec and Fraunhofer for Surface Engineering and Thin Films IST today announced the launch of SELECT, a technology for bond aligner and mask aligner that selectively activates parts of wafer surfaces through plasma. Selective plasma activation can be applied to a variety of MEMS, optical and solar applications using direct wafer bonding or surface modification for the creation of micro mirror arrays, micro valves, sensors or micro fluidic channels. The SELECT toolkit is an upgrade option of SUSS MicroTec's MA/BA8 Gen3.

"The new technology has the potential to completely change the cost-of-ownership model for a large variety of applications. This creates an interesting opportunity for the customers of our latest manual mask aligner generation."
Frank Averdung, President and CEO, SUSS MicroTec

November 30, 2010

SUSS MicroTec Extends Technological and Market Leadership of its Photomask Equipment Division

Today, HamaTech APE GmbH & Co. KG, a wholly owned subsidiary of SÜSS MicroTec AG, announced that it has received a double-digit number of orders for MaskTrack Pro, the mask integrity platform for Next Generation Lithography, since its launch in July 2009.

"Mask integrity is the cornerstone of the MaskTrack Pro platform design and plays an important role in the successful adoption of advanced lithography."
Frank Averdung, President and CEO, SUSS MicroTec

December 2, 2010

SUSS MicroTec and Rolith Cooperate on Development of New Nanolithography Technology

SUSS MicroTec today announced that it has entered into a joint development and exclusive license agreement with Rolith, Inc. to develop and build nanostructuring equipment employing a disruptive nanolithography method developed by Rolith. Availability of a high throughput cost effective technique for nanostructuring over large areas of substrate materials brings new possibilities to renewable energy and green building markets.

"Combined with our flexible equipment solutions the novel optical nanolithography technology by Rolith has the potential to bring high volume nanoimprint technology to market by fundamentally changing the cost structure compared to current technologies."
Frank P. Averdung, President and CEO, SUSS MicroTec

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Some of the opportunities to meet with SUSS MicroTec in the upcoming months:

January

Photonics West - San Francisco, CA, USA	Jan 22 – 27
EMLC – Dresden, Germany	Jan 18 – 19
SEMICON Korea – Seoul, Korea	Jan 26 – 28

February

Strategies in Light – Santa Clara, CA, USA	Feb 22 – 24
SPIE Advanced Lithography – San Jose, CA, USA	Feb 27 – Mar 4

March

Semicon China – Shanghai, China	Mar 15 - 17
Smart Systems Integration – Dresden, Germany	Mar 22 - 23
IMAPS Device Packaging – Scottsdale, AZ, USA	Mar 8 - 10

May

The ConFab – Las Vegas, NV, USA	May 15 - 18
Laser World of Photonics – Munich, Germany	May 23 - 26

June

EIPBN - Las Vegas, NV, USA	May 31 - Jun 3
ECTC – Lake Buena Vista, FL, USA	May 31 - Jun 3
Opto Taiwan – Taipei, Taiwan	Jun 14 - 16

Please check our website for any updates: www.suss.com/events

We hope you found this edition of the SUSS Report interesting and informative.
For more information about SUSS and our products, please visit

www.suss.com

or write to **info@suss.com** with your comments and suggestions.

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SÜSS MicroTec
Our Solutions Set Standards