Wafer Based Mask Characterization for Double Patterning Lithography

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ABSTRACT

Double Patterning Technology (DPT) is considered the most acceptable solution for 32nm node lithography. Apart from the obvious drawbacks of additional exposure and processing steps and therefore reduced throughput, DPT possesses a number of additional technical challenges. This relates to exposure tool capability, the actual applied process in the wafer fab but also to mask performance. This paper will focus on the latter.

We will report on the performance of a two-reticle set based on a design developed to study the impact of mask global and local placement errors on a DPT dual line process. For 32 nm node lithography using DPT a reticle to reticle overlay contribution target of ≤ 1.5nm has been proposed [1]. Reticle based measurements have shown [2] that this proposed target can be met for standard overlay features and dedicated DPT features. In this paper we will present experimental intra field overlay wafer data resulting from the earlier mentioned reticle set.

The reticles contain a 13x19 array of modules comprising various standard overlay features such as ASML overlay gratings and bar-in-bar overlay targets. Furthermore the modules contain split 40nm half pitch DPT features. The reticles have been exposed on an ASML XT:1700i on several wafers in multiple fields. Reticle to reticle overlay contribution has been studied in resist (double exposure) and using the IMEC dual line process [1] (DPT). We will show that the reticle to reticle overlay contribution on the wafer is smaller than 1.5nm (1x). We will compare the wafer data with the reticle data, study the correlation and show that reticle to reticle overlay contribution based single mask registration measurements can be used to qualify the reticle to reticle overlay contribution on wafer.

Keywords: double patterning, overlay, mask metrology, wafer metrology

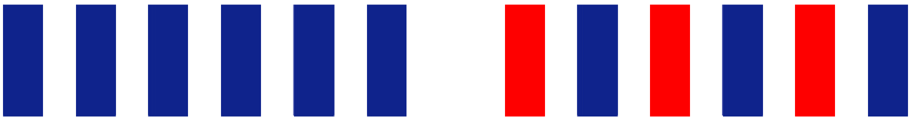
1. INTRODUCTION

Printing 32nm half pitch using a state of the art 193nm exposure tool having an NA of 1.35 requires a k_1 of 0.238 whereas the minimum achievable k_1 value is 0.25. The minimum printable half pitch (line space ratio is 1) can be calculated using the Rayleigh formula and is determined by the process parameter k_1, the wavelength of the exposure light and the NA of the projection lens:

$$HP_{\min} = k_1 \frac{\lambda}{NA}. \tag{1}$$

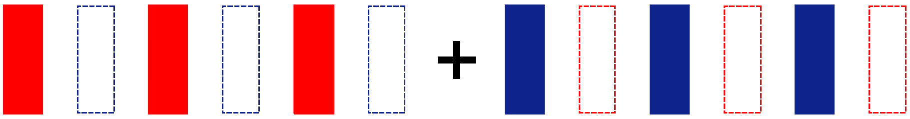
For the mentioned state of the art exposure tool the minimum printable half pitch is ~36nm. There are however several ways that will lead to our lithographic Rome. One can place the burden either on the wavelength by, for example,

switching to EUV (~13nm) or on the NA (high index liquids and lens materials). A third option is to adjust the pitch of the feature on the reticle.
A chip is the result of multiple exposures and process steps and layers. One could divide a difficult or unprintable layer into two or even more printable layers. An example: instead of exposing a dense L/S feature having a line width of 32nm (64nm pitch) one can superimpose two complementary features with a line width of 32nm and a more relaxed pitch of 128nm of which the sum after processing is the earlier mentioned 32nm dense feature.



(a) original feature, 1:1 line space ratio

(b) image split

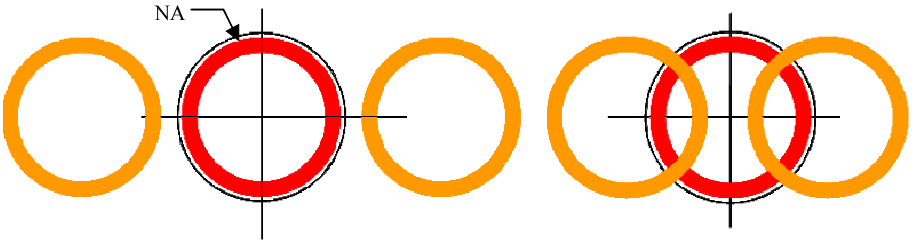


(c) layer 1, 1:3 line space ratio

(d) layer 2, 1:3 line space ratio

Figure 1: Sketch of an image split, resulting in two individual images with a doubled pitch

Instead of aiming at a pitch with a 1:1 line space ratio one now targets a pitch of with a 1:3 line space ratio. The doubling of the pitch results in a reduction of the effective k_1-factor (k_e-factor) of 0.125. Figure 2a shows the top down image of pupil plane of the projection lens with an NA of 1.35 and the zero-ed and first orders of the diffracted light resulting from the exposure of a dense 64nm pitch (1:1 line space ratio) grating. Since no first order light is captured by the lens no imaging will occur at wafer level. Figure 2b shows the diffracted orders when imaging one of the split images with a pitch of 128nm (1:3 line space ratio). Imaging will occur at wafer level since first order light is captured by the lens.



(a) 1:1 line space ratio

(b) 1:3 line space ratio

Figure 2: Top down image of the position of the zero-d and first order diffracted light from the reticle in the pupil plane for an NA of 1.35

One could say that with the doubling of the pitch the effective minimum k_1 factor, k_e, has been reduced from 0.25 to 0.125. The k_e is the k_1 times the ratio between the pitch, P, and the new pitch resulting from the split, the NP.

$$LW_{\min} = k_e \frac{\lambda}{NA} \quad \text{and} \quad k_e = k_1\left(\frac{P}{NP}\right), NP = nP \;, n = 1,2,3,\ldots \qquad (2)$$

In theory this opens up a door to a whole new range of feature shrink possibilities since there is no reason why one should limit oneself to double exposure when triple (n=3) or even quadruple (n=4) exposure is possible. One of the challenges of this technique however is the additional overlay error that is introduced by each additional masking layer.

For the 32nm node (32nm half pitch) the 2006 ITRS roadmap mentions an image placement accuracy for double patterning of 2.4nm (reticle level). We would like to introduce an additional relevant figure of merit for double patterning: reticle to reticle overlay. Two reticles can have a pattern placement that surpasses the pattern placement number and still show a good reticle to reticle overlay. Vise versa, good registration values are no guarantee for a good reticle to reticle overlay performance. For 32 nm node lithography using DPT a reticle to reticle overlay contribution target of ≤ 6nm has been proposed [1].

This study is the second phase of a study into the current state of the art of reticle manufacturing for double patterning. In a previous paper [2] we reported on the manufacturing of a complementary reticle set designed for double patterning and showed by means of reticle metrology that these reticles meet the current target of ≤ 1.5nm (wafer level) for the 32nm node. In this second phase we will focus on the wafer results from the reticles bringing the study into the state of the art closer to what is important for our customers, being yield.

2. RETICLE SET

Mask Design

A sketch of the design of the reticle set is shown in Fig. 3. Each mask consists of identical modules arranged in a 13x19 array over an area of around 10cmx13cm. The modules on each mask contain a variety of DPT structures, i.e. complementary parts of split features of the original layout. Furthermore, a number of different metrology targets are included at different locations. The reticle set was provided by TOPPAN Photomasks from the Mask Technology Center in Dresden. For the writing of the reticles an e-beam NuFlare EBM-5000 was used. Position measurements were performed using a VISTEC IPRO3.

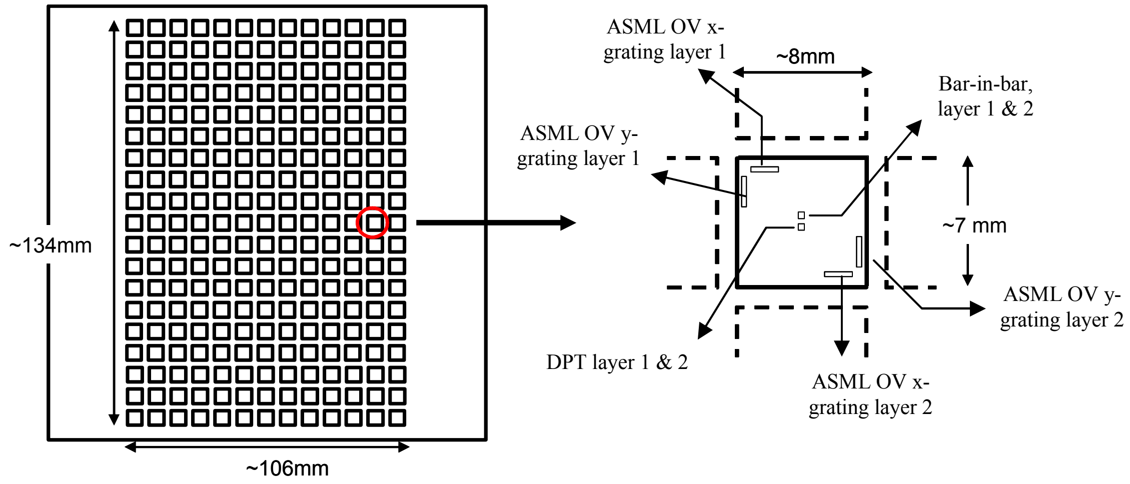


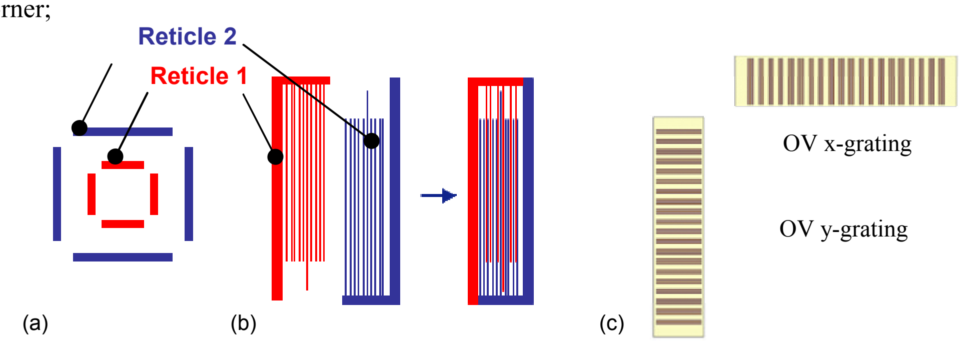
Figure 3: Sketch of the design of reticle set, features in each module are explained in Fig. 4.

Of particular interest for this study are three features which are part of each module (see Fig. 4):

- Bar in Bar (BiB) overlay targets (industrial standard) located near the center of each module;
- Split gratings designed to be printed on wafer with a DPT dual line process. A sketch of these features is shown in Fig. 4b. Gratings are located in close proximity (around 100µm in x and y) to the BiB marks near the center of each module. Identical vertically and horizontally (meaning 90° rotated) oriented structures are placed next to each other. The pitch of the structure under investigation is 640nm on mask corresponding to a final half pitch of 40nm (after DPT) on wafer. Each feature contains 10 lines with a specifically designed

surrounding allowing CD and registration measurements of particular lines at particular locations on both mask and wafer. From hereon these features will be referred to as DPT structures;

- Standard ASML overlay (OV) gratings (Fig. 4c), 20 triples of 6.4µm lines for x- and y-orientation. Unlike the DPT and Bar-in-bar are the OV gratings placed at different locations on both reticles. On reticle 1 the marks have been placed in the upper left corner of the cell while on reticle 2 they are placed in the lower right corner;

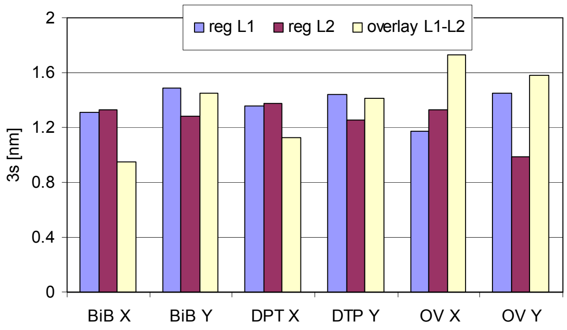


(a) (b) (c)

Figure 4: Studied features: (a) Bar in Bar (BiB) targets, (b) split gratings designed to be printed on wafer with a DPT dual line process – abbreviated "DPT structures", (c) standard ASML overlay (OV) gratings for x- and y-orientation (6.4µm bars)

Mask Characterization by Registration Measurements

In a previous study [2] the mask was characterized by means of extensive registration measurements. Registration measurements on a standard overlay target, a Bar-in-Bar feature, and at resolution DPT features yield comparable values below 1.5nm 3σ, (wafer level). From hereon all values are defined at wafer level. In this study we will also include OV gratings. The position of the OV grating was determined by sampling the horizontal and vertical grating at 4 pre-defined locations. For the position determination of the horizontal and vertical DPT grating the 3 centre lines were sampled whereas for the BiB the positions of both horizontal and vertical bars were measured. The measurement results do include the reticle measurement accuracy. For overlay the impact of the measurement accuracy is increased by a factor of √2. BiB and DPT are placed at the same location in the module on reticle 1 and 2. The results of the measurements can be found in Figure 5:



3ℵ[nm]	reg L1	reg L2	overlay L1-L2
BiB X	1.3	1.3	1.0
BiB Y	1.5	1.3	1.5
DPT X	1.4	1.4	1.1
DTP Y	1.4	1.3	1.4
OV X	1.2	1.3	1.7
OV Y	1.5	1.0	1.6

Figure 5: BiB, DPT and OV grating results (1x) from layer 1 and layer 2

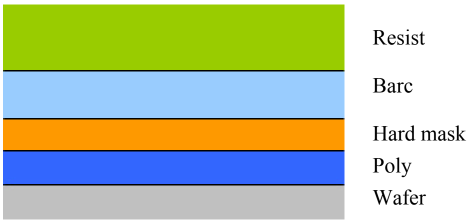
Reticle to reticle overlay measured on the same structures on both masks was found to be smaller or equal to 1.5 nm 3σ. The recently proposed target[1] of a reticle to reticle induced overlay of 1.5nm, 3σ for the 32nm node was met by the reticle set investigated in this paper. The distance between the locations of targets has an impact on the obtained overlay. Therefore a reticle to reticle overlay measurement should be performed on the same locations on both plates. The OV gratings are 4mm (reticle level) apart. As such the OV gratings do not represent double patterning features. The large distance between the marks account for the larger reticle overlay observed for the OV gratings.

3. WAFER EXPERIMENTS

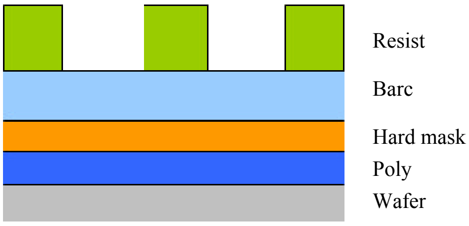
Experimental Conditions

The wafers were exposed on an ASML XT:1700i (immersion, max. NA = 1.2) with an interfaced coating and development track using the following illumination conditions: NA = 1.2, σ_i/σ_o = 0.5/0.8, annular mode, using XY polarized light. For each experiment three wafers were exposed using one and the same wafer chuck. The full imaging field of the reticle was exposed in an 11x9 grid on the wafer. Three experiments were conducted:

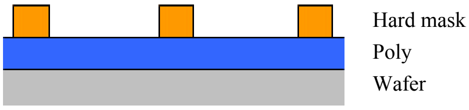
1) Double Patterning (DP) focusing on the bar-in-bar features, the DPT features and the OV gratings on the two double patterning reticles.



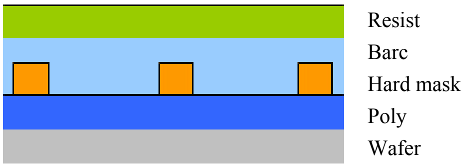
(a) layer stack 1st layer



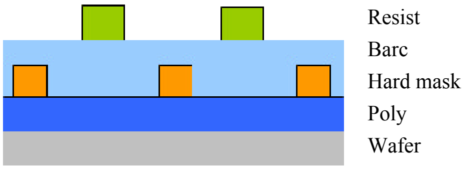
(b) after lihto 1



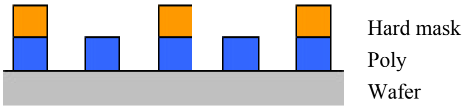
(c) after etch 1



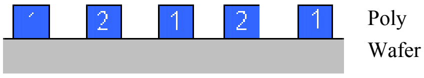
(d) layer stack 2nd layer



(e) after litho 2



(f) after etch 2



(g) layer BARC removal

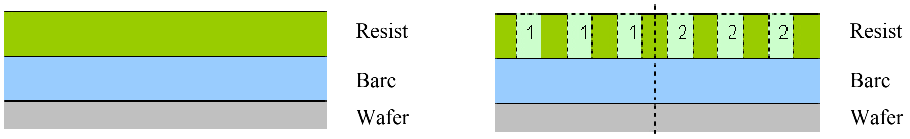
Figure 6: Double Patterning (DP) flow for the dual line process

The flow of the IMEC dual line process [1] consists of 7 steps: Fig. 6(a) shows the stack for layer 1 consisting of a poly layer, followed by a hard mask, a BARC and a resist layer. Fig. 6(b) shows the stack after the pattern has been transferred from the reticle into the resist layer by means of the first exposure and consequent resist development. In the following etch step the pattern is transferred into the underlying hard mask, Fig. 6(c) For the second layer the topology is planarised by means of the BARC and topped with a resist. In the second exposure the pattern is transferred from reticle 2 into the resist, Fig. 6(d) and Fig. 6(e). The pattern is then transferred into the poly (Fig. 6(f)) and the remaining hard mask and BARC is removed (Fig. 6(g)).

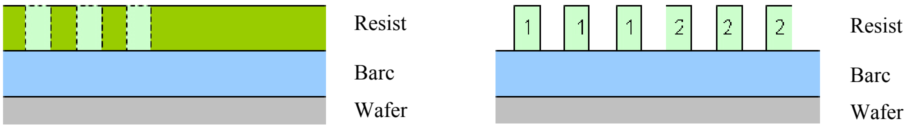
2) Double Exposure (DE), focuses on the OV gratings on the two double patterning reticles. The goal of these experiments is (a) compare resist process with dual line process, (b) second exposure is within seconds of first exposure reducing exposure tool drift to a minimum. The flow, Fig. 7, consists of 4 steps. A wafer is coated with the required resist and BARC. In the second step layer 1 is exposed using reticle 1. In the third step layer 2

is exposed using the second reticle. The wafer remains on the wafer stage. Consequently the wafer is developed.

3) To characterize the exposure tool a DE experiment (DE(1)) is performed using a single standard ASML overlay reticle with the 13x19 OV gratings. In the second and third step layer 1 and layer 2 are exposed using the one and the same overlay reticle. In the second step layer 2 is exposed with a y-shift of 640µm (wafer level). The wafer remains on the wafer stage. Consequently the wafer is developed.



(a) layer stack (c) after exposure layer 2



(b) after exposure layer 1 (d) after development

Figure 7: Double Exposure (DE) flow

Wafer Measurements and Data Handling

The position measurements of the OV gratings on the wafer were performed using the alignment system of the exposure tool by scanning the grating over a large area. The Bar-in-bar features have been measured with a KLA Tencor Archer 10 Overlay. The overlay of the DPT features is determined by measuring the pitches of the DPT feature using an AMAT Verity 2 CD SEM.

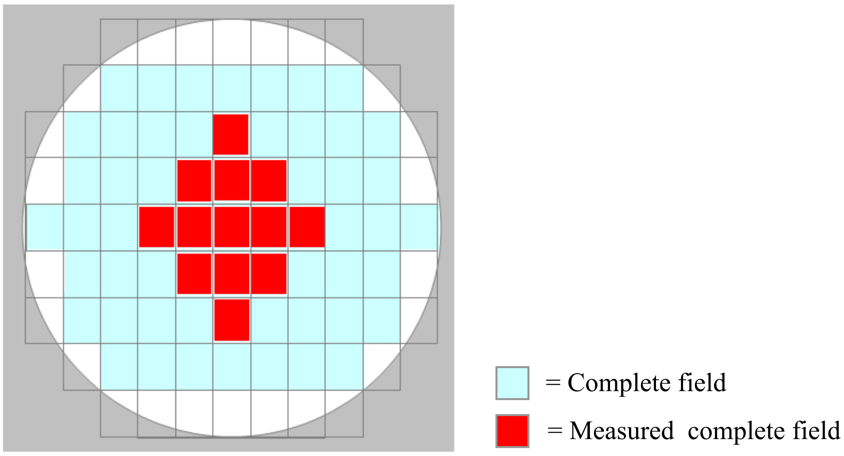


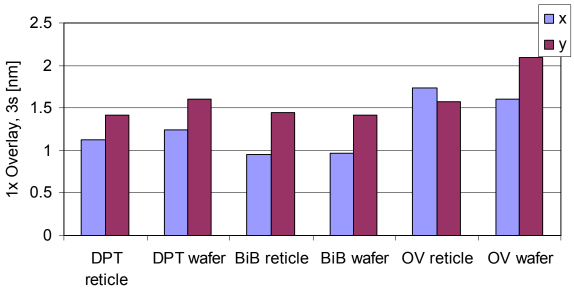
Figure 8: Wafer lay-out showing the location of the 13 fields

On each wafer the features have been measured in the thirteen fields centered around the middle of the wafer. The wafer data is corrected for deviations between reticle grid and wafer grid (intra field effects) and wafer field to field grid variations (inter field effects). Consequently the data was averaged over the 13 fields and 3 wafers to reduce the impact of e.g. wafer processing effects and measurement noise.

4. WAFER RESULTS

Double Patterning Wafer Results

Figure 9 shows the double patterning overlay results of the DPT features, the BiB features and the OV gratings collected from both the reticle and the DP wafers.



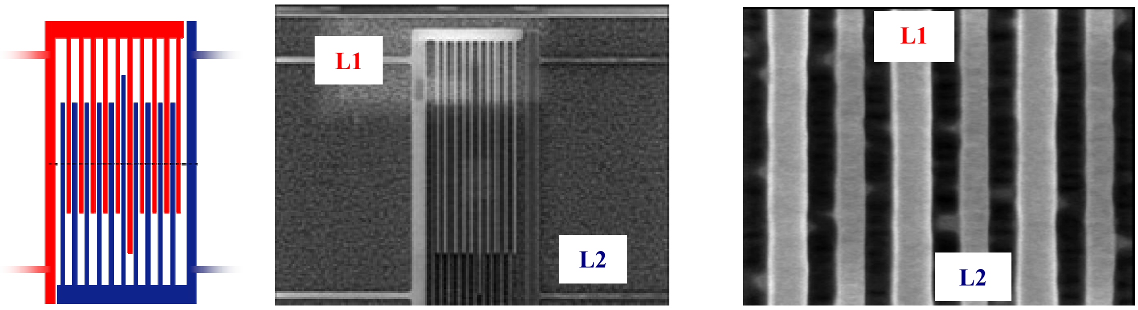
dx, 3s, 1x [nm]			
feature	**Ret**	**Waf**	**Rx**
DPT	1.13	1.24	0.79
BiB	0.95	0.97	0.71
OV	1.73	1.60	0.81

dy, 3s, 1x [nm]			
feature	**Ret**	**Waf**	**Ry**
DPT	1.42	1.61	0.89
BiB	1.45	1.41	0.89
OV	1.58	2.10	0.81

Figure 9. Double Patterning overlay results of the BiB, OV and DPT features and the correlation coefficients between the reticle and wafer overlay

The data was tested for skewness and kurtosis to determine whether it could be considered a normal distribution. The DPT data shows a slight skew (appendix). This is within the errors of the limits defined as twice the standard error of the skewness. The distribution is considered normal. This also holds for the wafer data from the other features.

The wafer results show overlay values for the BiB and DPT of close to 1.5nm, 3σ. The wafer values are also equal or close to the reticle values. This is confirmed by the correlation coefficients that have been calculated. The overlay values found for the OV gratings are larger due to the fact that the gratings printed as layer 1 and layer 2 are not located on the same location of the reticle (shown in Fig. 3) and the wafer but several 100μm apart.



(a) (b) (c)

Figure 10. (a) DPT schematic showing the two layers, (b) SEM photo of the DPT feature on wafer, (c) 3 lines from layer one and layer 2 that have been used to determine the overlay

Fig. 10 shows the DPT feature: (a) schematic representation of the two split layers that together constitute the DPT feature and (b) the SEM photo of the DPT feature after double patterning of the two split layers on the wafer.(c) zooms in on the 6 lines that were used for the overlay determination. The SEM photos reveal a slight CD difference between the two layers. This difference is the result of an etching process that is sub-optimal for this specific reticle set. The CD difference between the two layers does not have an impact on the calculated overlay of the DPT feature. The overlay is determined by measuring the spaces between the lines.

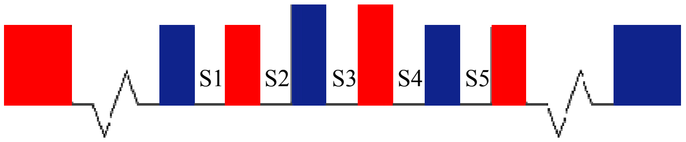
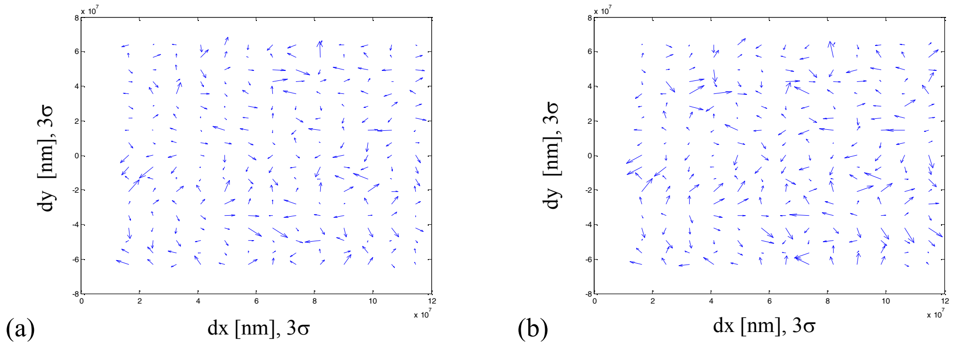


Figure 11. Definition of the spaces between the lines from layer 1 (🟥) and layer 2 (🟦)

The overlay has been calculated from the measured spaces using the following formula (also see the Appendix):

$$OVL = \left(\frac{1}{8}\right)\left[\left(S_1 - S_2\right) + \left(S_3 - S_2\right) + \left(S_3 - S_4\right) + \left(S_5 - S_4\right)\right] \tag{A.9}$$

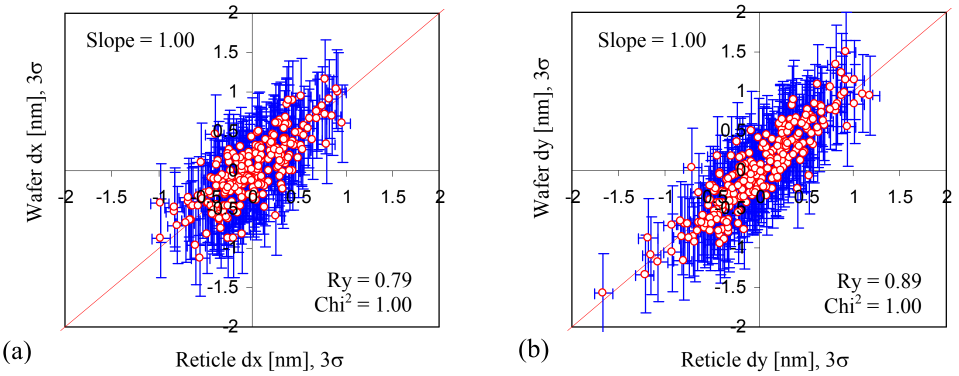
The resulting overlay errors are shown in the table of Fig. 9 and in the arrow plots of Fig. 12. The DPT reticle data (Fig. 12a) and wafer data (Fig. 12b) yield comparable results. The reticle fingerprint is clearly visible in the wafer plot.



(a) (b)

Figure 12. DPT reticle to reticle overlay based on (a) reticle measurements and on (b) DP wafer measurements

The correlation between reticle and wafer data is confirmed by the calculated correlation coefficients (Rx = 0.79, Ry = 0.89). The correlation scatter plots are shown below.



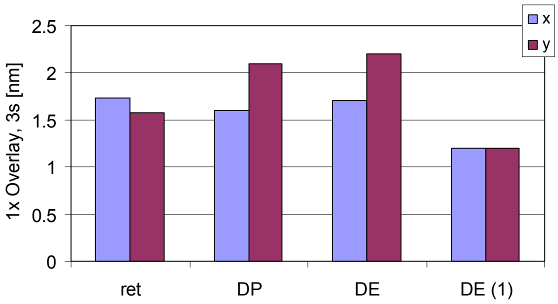
(a) (b)

Figure 13. DPT scatter plots showing the correlation between reticle (x) and wafer (y) data for (a) dx and (b) dy

The BiB and OV reticle and wafer data yield comparable results. One should bare in mind that the wafer data does include overlay contributions from the exposure tool. Furthermore the etching of the individual layer will introduce a time delay between the exposures of the consecutive layers allowing for a drift in the exposure tool. Furthermore the double patterning process might introduce additional overlay (process overlay). Finally the measurement methods used for the reticle and the wafer differ. To get a feel for the impact of these contributors Double Exposure (DE) experiments have been performed using the OV-gratings.

Double Exposure Wafer Results

Fig. 14 shows the overlay measurement results from the OV gratings measured on the reticle, the DP experiments, the DE experiments and the DE(1) experiment using the single standard overlay reticle.



dx, 3s, 1x [nm]		
feature	**Ret**	**Waf**
OV DP	1.73	1.61
OV DE	1.73	1.71
OV DE(1)	0.00	1.22

dy, 3s, 1x [nm]		
feature	**Ret**	**Waf**
OV DP	1.58	2.14
OV DE	1.58	2.23
OV DE (1)	0.00	1.22

Figure 14. The DP and DE wafer results of the OV gratings

For the DE and the DE(1) experiments the wafer remained on the wafer stage while for the DP experiment the wafer left the stage. The impact of these differences on the reticle to reticle overlay has been eliminated by the intrafield and interfield corrections of the data. The reticle to reticle overlay of the OV gratings using the DE process is found to be 2.2nm, 3σ. The value includes the contributions from the exposure tool such as noise, stage repeatability, reticle clamping etc. The OV gratings yield comparable registration and overlay results for both DE and DP (Figure 14). The impact of processing and a delay between the DP exposures is negligible.

The tool contribution from the double exposure of the OV gratings has been determined using the DE(1) experiment and is 1.2nm, 3σ. Since the DP and DE experiments yield the same results the tool contribution obtained from the DE(1) experiment also represents the tool contribution in the DP experiments. The overlay, σ_{waf}, on the wafer was determined in the DE experiment and is shown Fig. 14. The overlay is given by:

$$\sigma_{waf}^{2} = \sigma_{ret}^{2} + \sigma_{sys}^{2} + 2\sigma_{meas}^{2}, \qquad (3)$$

where σ_{ret} is the reticle contribution, σ_{sys} the system contribution and σ_{meas} the system measurement contribution. With the single reticle DE experiment, ED(1), we determined the overall tool contribution $\sigma_{sys}^{2} + 2\sigma_{meas}^{2}$ to be 1.22nm. From the results we can determine the reticle to reticle overlay based on wafer data for the OV gratings which are shown in Fig. 15:

Reticle to reticle overlay OV, 3s, 1x [nm]		
Feature	**dx**	**dy**
Ret	1.73	1.58
DP	1.05	1.76
DE	1.13	1.82

Figure 15. reticle to reticle overlay based on wafer data

The difference between the wafer based values and the values based on reticle measurements is mainly thought to be the result of the applied reticle measurement scheme (the position of the 2mm long OV grating in the reticle was determined by sampling the horizontal and vertical grating at 4 pre-defined locations whereas the wafer measurement was performed by scanning the grating over a large area using the alignment system of the exposure tool) but also reticle measurement accuracy. Furthermore we can not exclude a possible remainder of the contribution to the overlay by the exposure tool.
Because the OV gratings are not 'real' double patterning features (the OV gratings from layer 1 and two are several 100µm apart on the reticle and wafer) the actual tool contribution to the overlay of the DPT and BiB results is thought to be somewhat less.

5. SUMMARY AND CONCLUSIONS

We investigated the overlay performance of a reticle set and used the IMEC double patterning dual line process [1] by exposing wafers and process them using the mentioned process.

Reticle data has shown a reticle to reticle overlay for the BiB of 1.45nm, 3σ, and 1.42nm for DPT features. The target value of the reticle to reticle induced overlay is ≤ 1.5nm. Based on the reticle data this target is met.

Wafer data show comparable overlay results: 1.41nm, 3σ, for the BiB features while the DPT features show 1.61nm. When taking into account that these values include the contribution of the exposure tool, the measurement tool errors, the different measurement techniques and the dual line process to overlay, the data imply that the overlay data on the wafer confirm the reticle to reticle data obtained by reticle metrology and the target value of the reticle to reticle induced overlay is ≤ 1.5nm.

Mask to mask overlay obtained by standard reticle metrology is a suitable measure for the qualification of the mask to mask overlay that one will find on the wafer. The correlation between the DPT and BiB overlay show that standard targets (BiB) represent the mask to mask overlay quality of other features and can be used as an overall indicator of the mask to mask overlay

In order to estimate the contribution of the exposure tool and the process additional experiments (DE) were performed. The negligible difference between the OV registration and overlay values using the DE and DP processes show that the impact of the process and the time delay due to the etching of the individual layers is negligible excluding exposure tool drift.

In the case of the OV marks we determined the contribution from the exposure tool to the overlay error allowing us the calculation of the position reticle to reticle overlay error. The wafer results deviate from the reticle measurements. This difference can be attributed to the reticle measurement scheme, the reticle measurement accuracy and a possible remainder of the contribution of the exposure tool to the overlay.

APPENDIX

Registration, Overlay and Correlation Coefficient

Registration is defined as the difference (dx,dy) between the actual position of a feature and its nominal design position. Overlay is a measure for the discrepancy between two registration maps and is simply defined as the difference (dx1-dx2,dy1-dy2) between registration at particular positions. Specifications on registration are usually given in terms of the standard deviation defined as,

$$\sigma_{\mathrm{dx}} = \sqrt{\frac{1}{N-1}\sum_i \left(\mathrm{dx}_i - \overline{\mathrm{dx}}\right)^2}\ , \tag{A.1}$$

where dx_i denotes the registration error at a particular position and dx the average of all measured values. The standard deviation of overlay between two reticle sets can be expressed in terms of the registration as,

$$\sigma_{\mathrm{OVLx}} = \sqrt{\sigma^2_{\mathrm{dx1}} + \sigma^2_{\mathrm{dx2}} - 2R_x \sigma_{\mathrm{dx1}} \sigma_{\mathrm{dx2}}}\ , \tag{A.2}$$

where (Pearson's) correlation coefficient R_x is defined as ,

$$R_x = \frac{\sigma_{\mathrm{dx1dx2}}}{\sigma_{\mathrm{dx1}}\sigma_{\mathrm{dx2}}}, \text{ with the covariance given by } \sigma_{\mathrm{dx1dx2}} = \frac{1}{N-1}\sum_i \left(\mathrm{dx1} - \overline{\mathrm{dx1}}\right)\left(\mathrm{dx2} - \overline{\mathrm{dx2}}\right). \tag{A.3}$$

Overlay determination DPT Feature

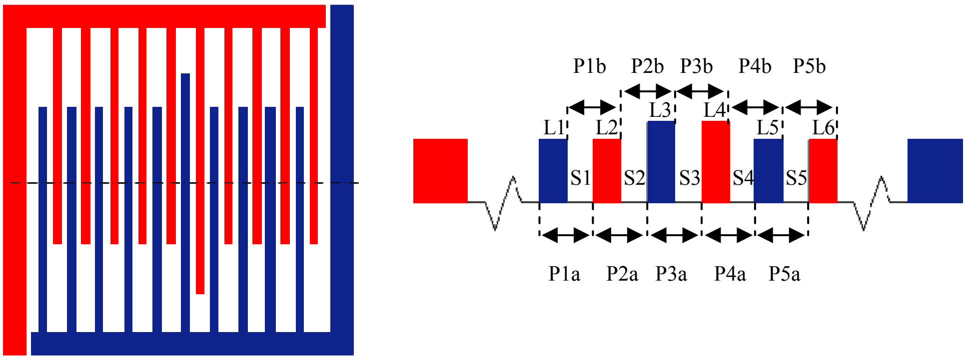


Figure A.1. Reticle to reticle overlay determination on OV grating

Each pitch is measured twice, once using the left flanks of the lines (Pa) and a second time measuring the right flanks of the lines (Pb). Thus if one wants to determine the pitch between L1 and L2, one has to calculate 4 pitches:

$$P_{1a} = L_1 + S_1,\ P_{1b} = L_2 + S_1,\ P_{2a} = L_2 + S_2 \text{ and } P_{2b} = L_3 + S_2\,, \tag{A.4}$$

$$P_1 = \tfrac{1}{2}\left(P_{1a} + P_{1b}\right) = \tfrac{1}{2}\left(L_1 + L_2\right) + S_1\,, \tag{A.5}$$

$$P_2 = \tfrac{1}{2}\left(P_{2a} + P_{2b}\right) = \tfrac{1}{2}\left(L_2 + L_3\right) + S_2\,, \tag{A.6}$$

$$OVL = \tfrac{1}{2}\left(P_1 - P_2\right) \text{ or } OVL = \tfrac{1}{2}\left(\left(\tfrac{1}{2}\left(L_1 + L_2\right) + S_1\right) - \left(\tfrac{1}{2}\left(L_2 + L_3\right) + S_2\right)\right). \tag{A.7}$$

Since $(L_1 + L_2) \approx (L_2 + L_3)$ (A.12) (CD uniformity impact) thus

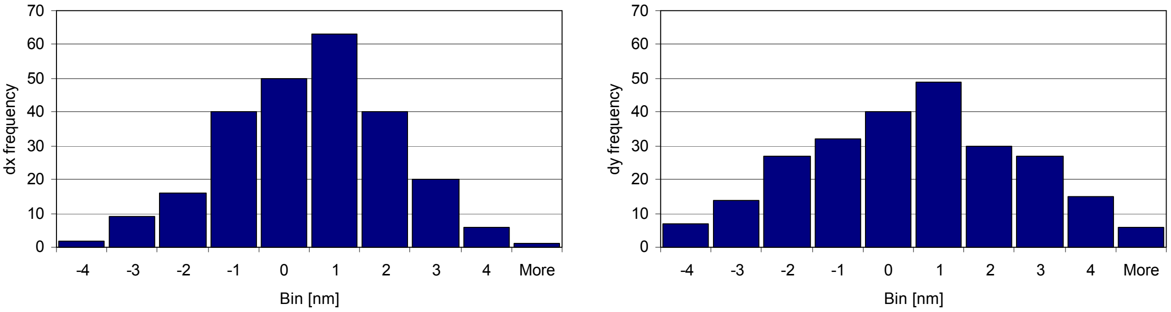
$$OVL = \tfrac{1}{2}\left(S_1 - S_2\right). \tag{A.8}$$

Applying this for all lines and pitches results in

$$OVL = \left(\frac{1}{8}\right)\left[\left(S_1 - S_2\right) + \left(S_3 - S_2\right) + \left(S_3 - S_4\right) + \left(S_5 - S_4\right)\right]. \tag{A.9}$$

Skewnesss and Kurtosis

The data was tested for skewness and kurtosis to determine whether it could be considered a normal distribution.



Parameter	x	y	2*SE
Skewness	-0.142	-0.017	0.312
Kurtosis	-0.115	-0.198	0.623

Figure A.2. Histograms of the resulting dx and dy after grid corrections

The graphs show a moderate positive skew. The skewness is within the errors of the limits defined as twice the standard error (SE) of the skewness. The standard error of skewness or variance of the skewness is $\sqrt{6/n}$ and for kurtosis $\sqrt{24/n}$ where n is the size of the data population. The distribution is considered normal. This also holds for the wafer data from the other features.

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