# Mask Bias optimization for NTD lithography process

Liwan Yue [1,2,*], Yanqiu Li [1], Zhibiao Mao [2], Qiang Wu [3], Yanli Li [3]

[1] School of Optics and Photonics, Beijing Institute of Technology, Beijing, China, 100081;
[2] Ningbo Nata Opto-electronic Materials Co. Ltd, 21 Qingshan Road, Beilun District，Ningbo city, Zhejiang Province, China, 315800;
[3] School of Microelectronics, Fudan University, Shanghai, China, 200433;
liwan_yue@natachem.com

## 1. Introduction

In this paper, we studied the Mask Bias effect on NTD lithography process for hole patterns. The key parameters such as MEEF, EL and circularity, have different performance with different Mask Bias. In our experiment, we designed test Hole Patterns with different Mask Critical Dimension (CD)s and same pitch to check the lithography performance for NTD resist with same Wafer CD to get MEEF, EL and circularity.

## 2. Experimental

The photo resist was made by NATA and the resin in this formulation is as shown in Figure 1:

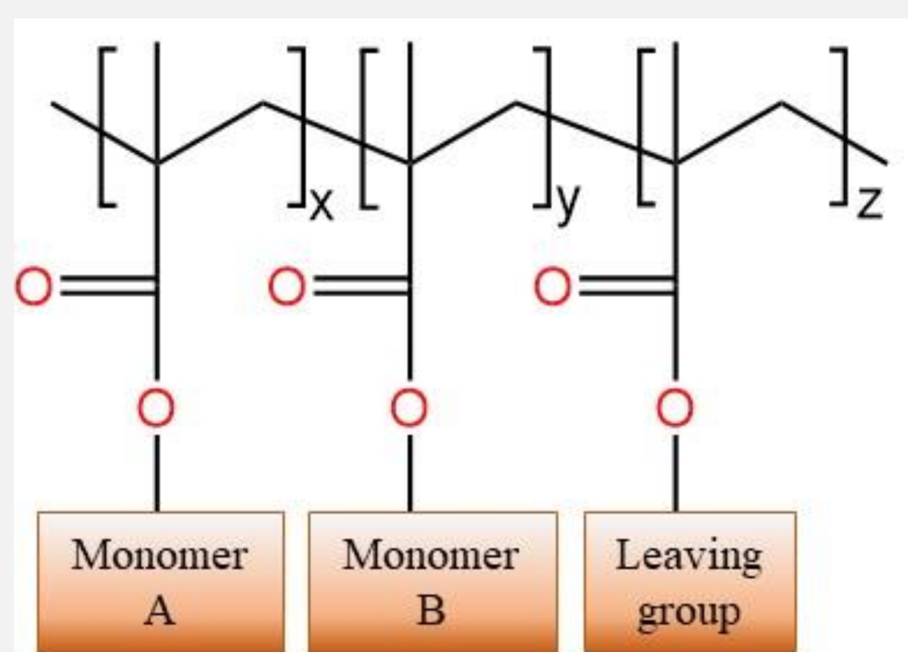


Figure 1. Resin structure of the NTD resist

The test patterns are as shown in Figure 2. We set different anchor point for each Mask Bias experiment test as shown in table 1.

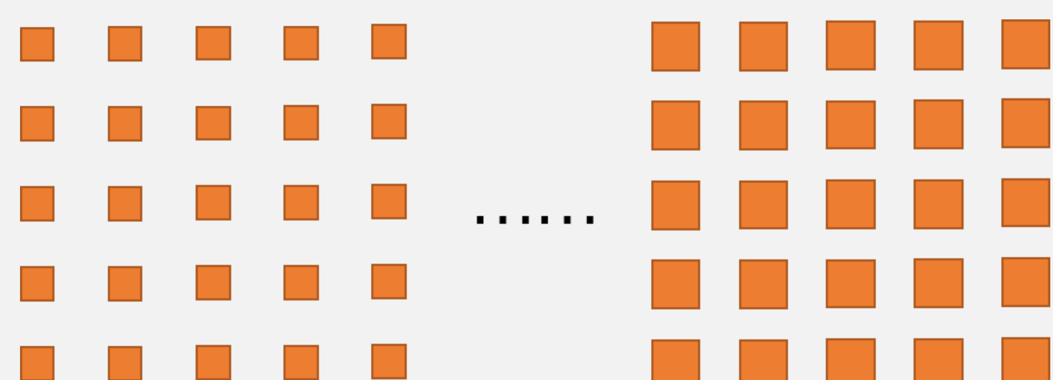

Figure 2. Test Pattern with different Mask CD and same pitch

Table 1. Anchor point setting for each experiment (nm)

| Mask Bias setting | Mask CD | Pitch | Target CD | Mask CD variation |
|---|---|---|---|---|
| Mask Bias 0nm | 70nm | 140nm | 70nm | 66~74nm |
| Mask Bias 2nm | 72nm | 140nm | 70nm | 68~76nm |
| Mask Bias 4nm | 74nm | 140nm | 70nm | 70~78nm |
| Mask Bias 6nm | 76nm | 140nm | 70nm | 72~80nm |
| Mask Bias 8nm | 78nm | 140nm | 70nm | 74~82nm |
| Mask Bias 10nm | 80nm | 140nm | 70nm | 76~84nm |
| Mask Bias 12nm | 82nm | 140nm | 70nm | 78~86nm |

For all the anchor points, Best Energy (BE), Exposure Latitude (EL), Mask Enhancement Effect Factor (MEEF) and circularity have been collected for lithography process performance evaluation.

## 3. Results and Discussion

The ADI CD trend for each anchor point with different Mask CD variation is as shown in Figure 3. Figure 4 is the BE for each anchor point on target (70 nm) energy.

Based on FEM result, EL for each anchor point has been calculated as shown in Figure 5. From the trend chart, we can see that the EL trend is up as Mask Bias became larger and get the extreme value at Mask bias 6 ~ 10 nm. Circularity result as shown in Figure 6 showed that the Mask Bias 10 nm can get minimum Circularity value. The MEEF result as shown in Figure 7 showed that MEEF is stable with different Mask Bias.

## 4. Conclusion

Therefore, concluding with EL, MEEF, circularity and BE, 10 nm Mask bias is a best choice for this NTD resist system. The lithography performance can be most optimized with this anchor point.

## 5. Acknowledgement

The author would like to thank all the members of Ningbo Nata team with the project supported by the National Natural Science Foundation of China (Nos. 20472062, 20672079), the Natural Science Foundation of Jiangsu Province (No. BK2006048), the Natural Science Key Basic Research of Jiangsu Province for Higher Education (No. 06KJA15007) and a Research Grant from the Innovation Project for Graduate Student of Jiangsu Province.

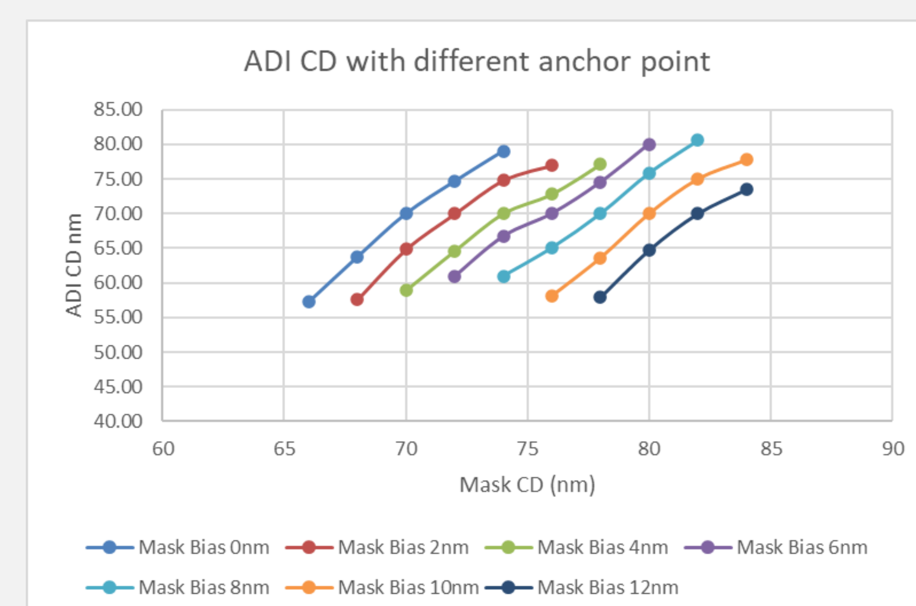


Figure 3. ADI CD trend for each anchor point with different Mask CD

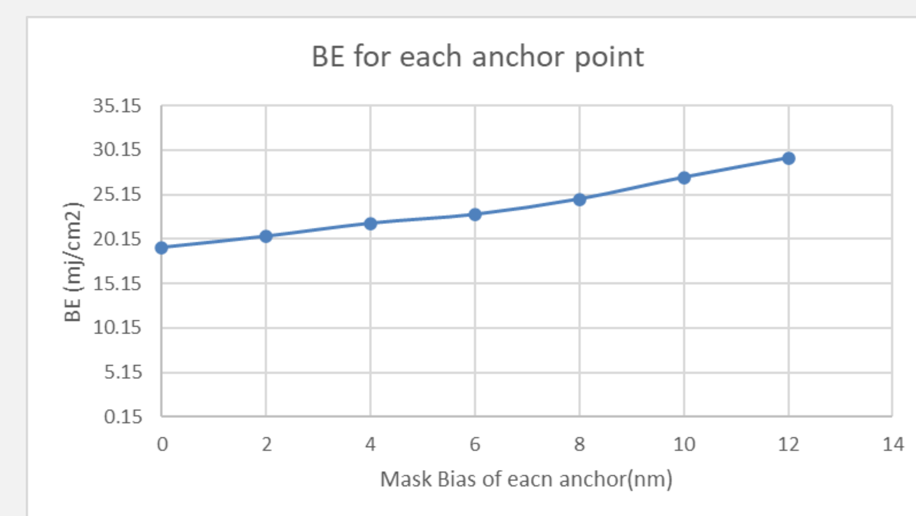


Figure 4. BE for each anchor point with different Mask CD

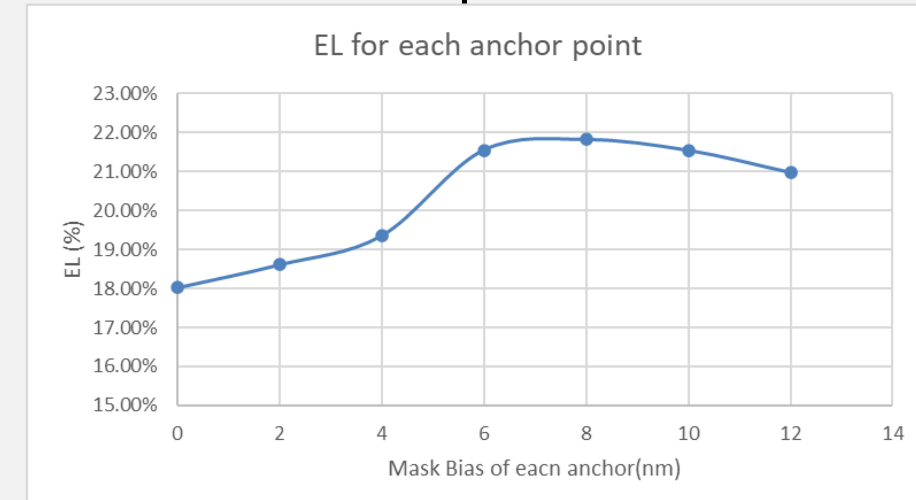


Figure 5. EL for each anchor point with different Mask CD

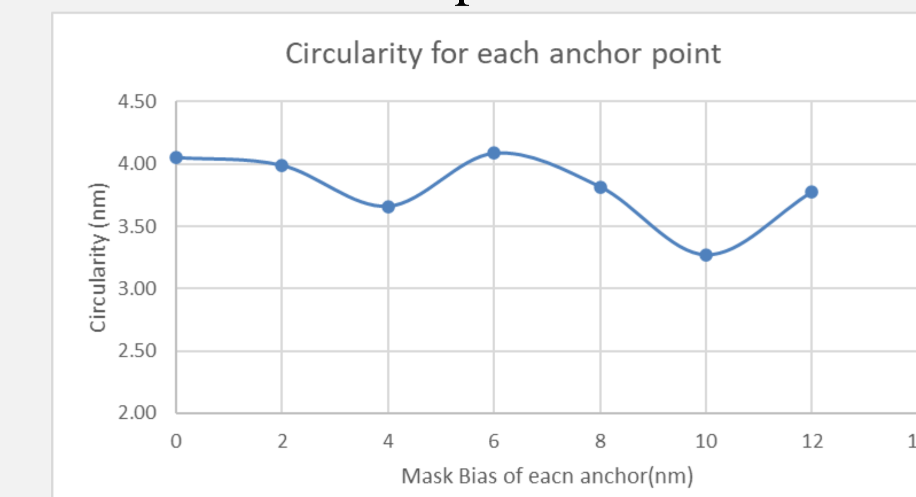


Figure 6. Circularity for each anchor point with different Mask CD

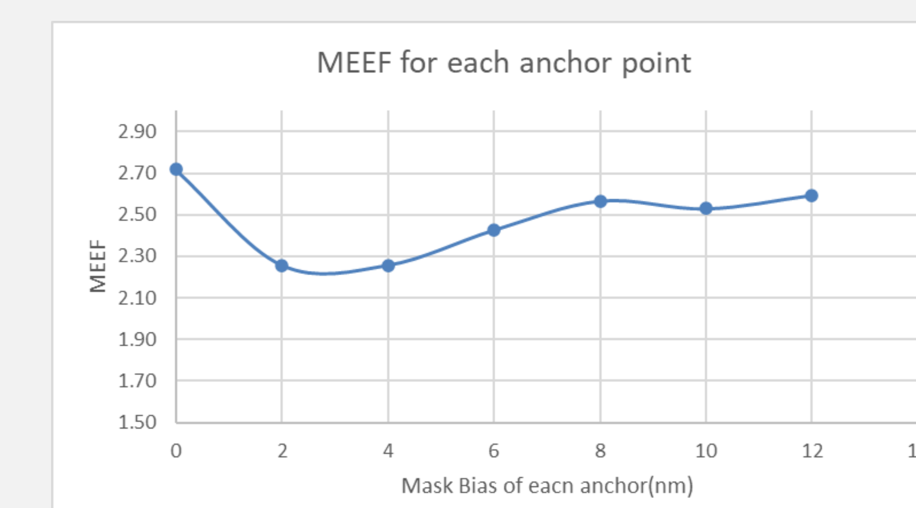


Figure 7. MEEF for each anchor point with different Mask CD