Application of Pattern Matching on Single Die Photomask for AIMS Reference Image Searching

Fei-Lin Liu, Yi-Min Lin, Po-Sheng Wang, Liang-Chieh Lin
Taiwan Mask Corporation

INTRODUCTION

In the photomask manufacturing industry, accuracy and precision are critical to ensuring the quality of the final product. After utilizing AIMS for defect printing verification, the first challenging task is to figure out reference points on single die photomask. At the back-end process, cycle time is crucial and cannot be wasted. How to find reference with an efficient way is the main objective. In this article, pattern matching was adopted as the major methodology for reference searching. Pattern matching function in **Smart-MRC** provides a reliable solution for finding identical or fuzzy pattern. Combing this methodology with automation would bring significant promotions at back-end process.

Pattern Matching Function in Smart-MRC

Smart-MRC is an MRC (Mask Rule Check) tool which provides various checking function on photomask including pattern match. Pattern matching takes the region, which clip from the mask data as template, searching the identical regions located on the mask. This function could be utilized to search for patterns, which mask shape is interested.

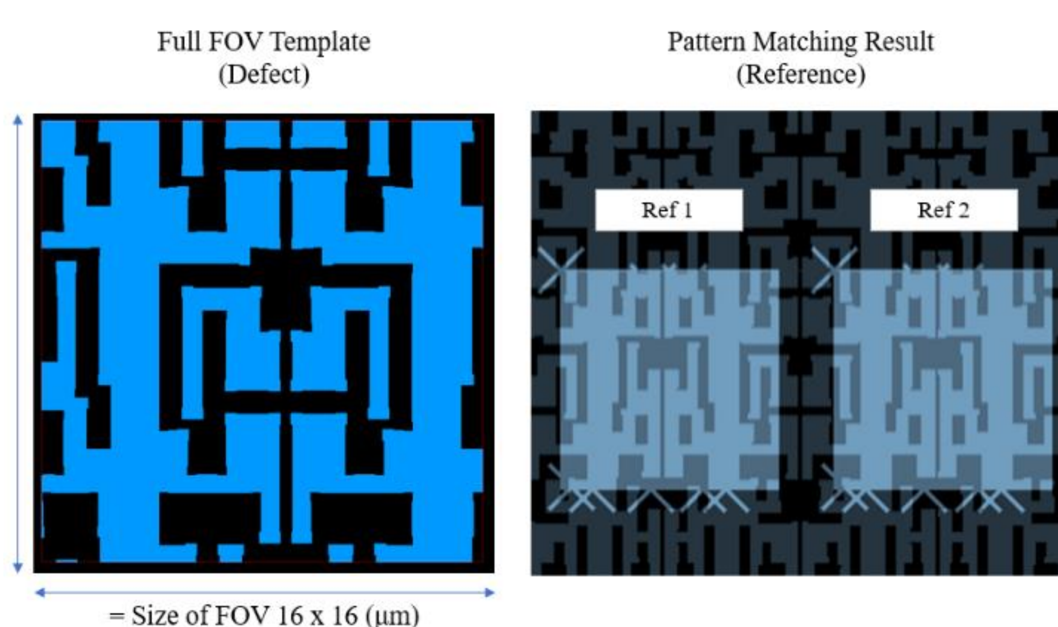
Background

After utilizing AIMS for defect printing verification, the reference searching is the target what we dedicated to accomplished. Kato et al. had introduced the techniques of fuzzy pattern matching in 2013. It would be an efficient way to save much time at the back-end process for searching reference for AIMS or repair tools.

METHODS

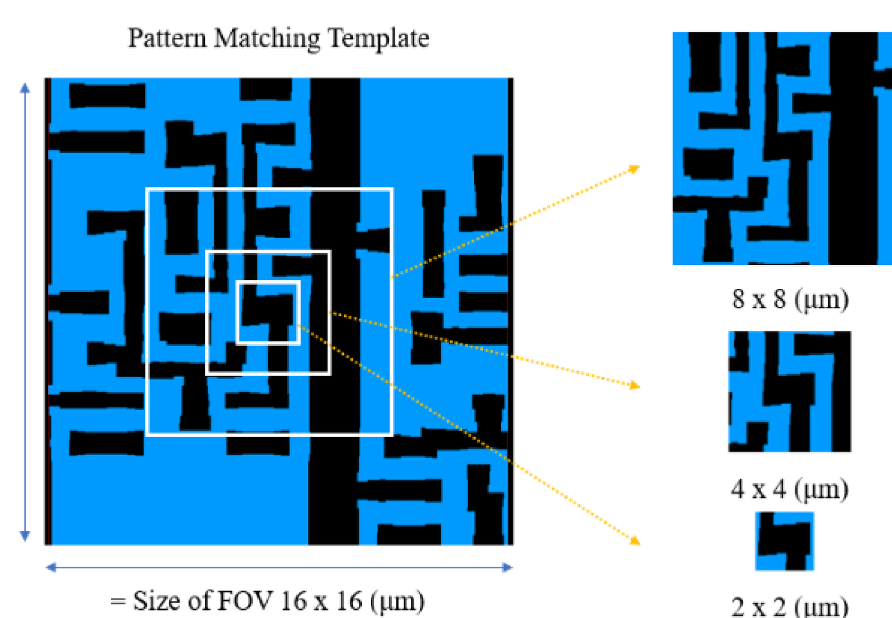
1. FOV Pattern Matching

To find the identical FOV for the reference, the template of pattern matching generated using the size of AIMS FOV. Then, using this template to search the same design region on the whole mask.



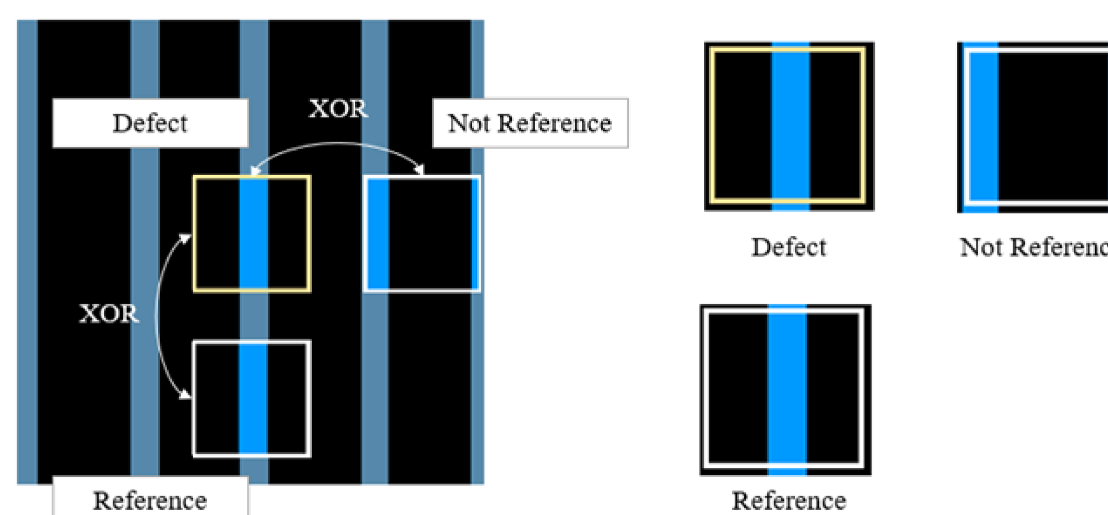
2. Dynamic Pattern Matching

Considering the non-interested patterns, FOV pattern matching might not provide perfect results. Hence, shrinking the region for template would be an alternative way to avoid the consideration on the surrounding pattern. First, creating different size of template files. Then, executing pattern matching from the largest size template until reference location be found.



3. XOR Matching

Although pattern matching brings significant effects on reference searching, some templates are not suitable for this function, such as straight line. In this category, neighboring locations have a high probability of being reference locations. Converting these straight-line and nearby regions to mebes files, then using XOR function in EDA tools. Through comparing these files, reference of straight line would be located.



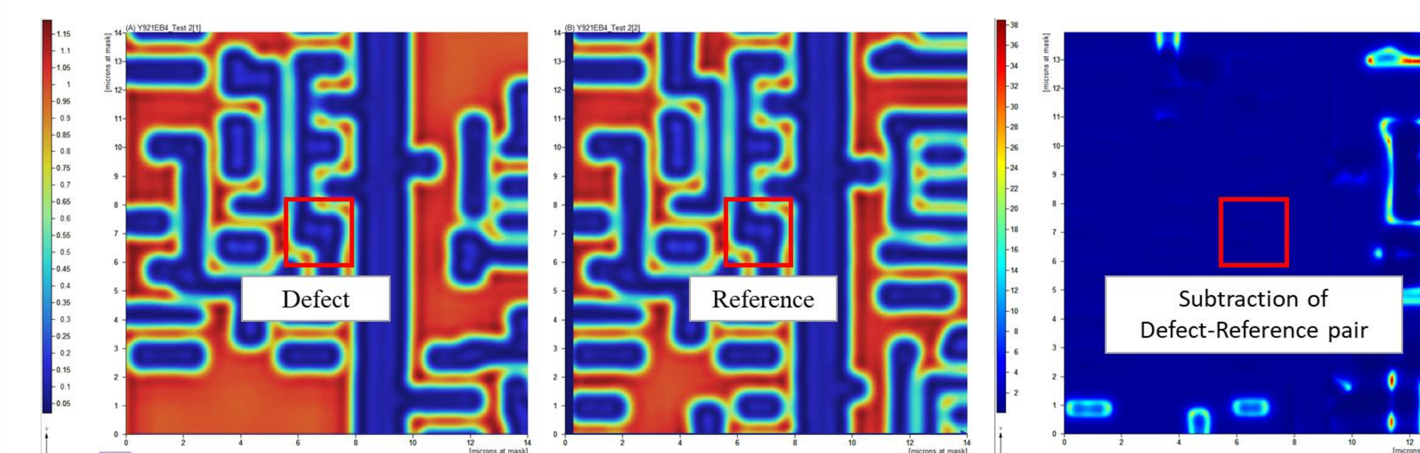
4. Method Summary

Despite dynamic pattern matching could handle most situations, AAA auto analysis needs to set up the region of profile comparison manually. The efficiency are advantages of FOV pattern matching and XOR matching approaches. If there is no overlay region needs to be considered, the calculation of the intensity could be automatically.

Method	FOV Pattern Matching	Dynamic Pattern Matching	XOR Matching
Strategy	FOV's Template Pattern Matching	Different Size Template Pattern Matching Until Successful	XOR with Nearby Regions
Scope	Identical Design of Wide Area	Identical Design of Small Area	Less Vertex Regions
Auto Analysis	O	X	O

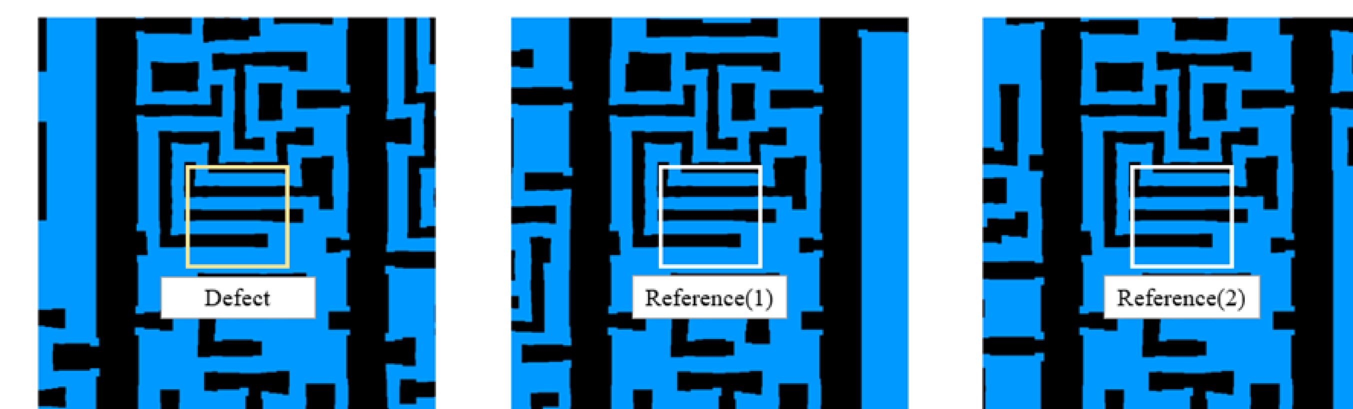
RESULTS

The light intensity chart of defect and reference in the following picture can be provided from AIMS. The subtraction of defect-reference pair demonstrates that the intensity difference almost none in the area affected by the defect. After applying the dynamic pattern matching, the reference was identified, and the suspicion of this defect could be waived.



CONCLUSIONS

With the developing progress in computer science, the performance of pattern matching in Smart-MRC and other operation was significantly improved. As a result, combing pattern matching with automation could not only greatly improving the cycle time at back-end process but also providing reference locations precisely. However, not each defect could find the identical FOV for AIMS reviewing. Without considering the conditions surrounding the location of interest, the analysis results might differ according to the selection of reference. Therefore, the choice of appropriate reference point is a topic need for further investigation.



Which reference is more suitable?

REFERENCES

[1] Kokoro Kato, Yoshiyuki Taniguchi, and Kuninori Nishizawa "Fuzzy pattern matching techniques for photomask layout data", Proc. SPIE 8701, Photomask and Next-Generation Lithography Mask Technology XX, 87010C (28 June 2013)

[2] Kokoro Kato, Yoshiyuki Taniguchi, Kuninori Nishizawa, and Tadao Inoue "Applications of MRC software for efficient mask manufacturing", Proc. SPIE 8441, Photomask and Next-Generation Lithography Mask Technology XIX, 84411D (29 June 2012)