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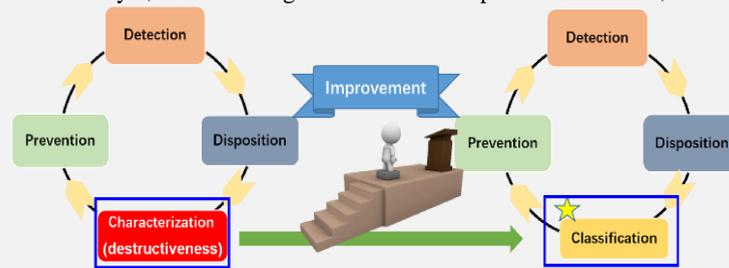
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Introduction

Haze has always been an unavoidable topic in the field of reticle management. The ability of haze control directly determines the lifetime of reticle. Haze is generated from the following aspects: Fab environment, reticle manufacturing, cleaning process, and blank. The energy acts as a catalyst, accumulating under constant exposure conditions, and haze is formed when the threshold is reached.

The Haze map, Grey scale and Size obtained by the advanced detection machine TERON SL670TM were used to replace the traditional elemental analysis. Haze will be classified directly from the results of mask detection, and corresponding actions are taken to control the underlying factors, so as to reduce the haze growth conditions, then improve the mask lifetime. By using this smart haze management mode, CXMT has successfully differentiated four types of haze, and increased the lifetime of mask by two times.



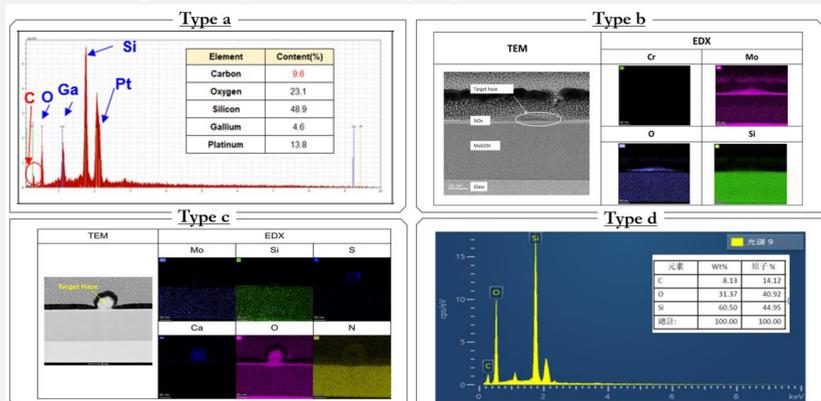
Preliminary classification of haze

At present, haze grows on the surface of both MoSi and glass surface in CXMT, and haze appeared on glass surface grows only on binary mask, haze that appears in shift-layer will only grow in PSM mask. After long-term analysis and observation of the database and online haze mask, CXMT made a preliminary classification of haze from the aspects of mask inspection result, grey scale, haze size and SEM image. As shown in Figure 2, Haze type discovered by CXMT is classified into four types: A, B, C and D.

Haze type	a	b	c	d
CD-SEM Image				
DTD map				
Defect image				
Growth Model	On Glass	On MoSi	On MoSi	On Glass

Classification verification

To verify the primary classification result, FIB, TEM and EDX measurements were used to analyze the haze chemical composition of the randomly selected reticle from preliminary classification groups.

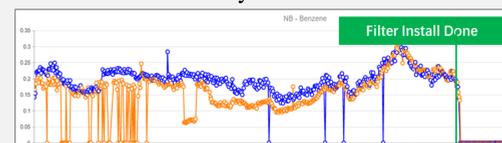


- Type a: Consists of C/O/Si element, the content ratio of carbon and oxygen is 2:5, it is organic haze
- Type b: Main element is Oxygen and Molybdenum, which indicates that the haze is Molybdenum oxide.
- Type c: Contain Ca/O/S three elements, which indicates the haze is calcium sulfate class haze.
- Type d: Consists of C/O/Si element, carbon and oxygen ratio of Type D is 1:4, it is organic haze.

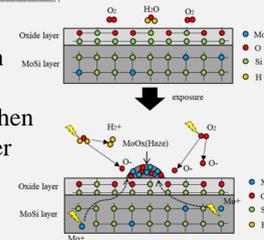
Haze prevention

After classifying haze into four types according to its chemical composition, CXMT investigated corresponding haze prevention and control strategies.

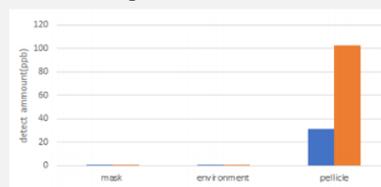
- Type a & d (Organic haze): Organic filter install in mask room, the some organic matter decrease obviously.



- Type b (MoOx haze): Mo ion migrates through the thin silicon oxide layer and combines with oxygen element that either from oxygen gas or from wafer molecule, then forms MoOx haze. The double thickness of oxide layer on the mask surface can prevent this haze efficiently.



- Type c (CaSO4 haze): 1. S in pellicle is very high about 100ppb, far more than mask blank and environment; 2. the frame material of pellicle will flake off after long time using, and new pellicle will not appear this abnormal issue. These prove that S is derived from pellicle. CXMT replaced another pellicle without S to prevention this haze efficiently.



Through these prevention actions, lifetime has been increased nearly twice compared with the previous in CXMT

CXMT Mask Lifetime Status	
Original	X wafers
After development	2X wafers

Conclusion

CXMT classifies the haze in the factory according to haze characteristic differences, and successfully identifies four kinds of haze to form a haze library. Combine the element analysis, the group was correct by classified. In this way, CXMT will gradually increase the number of library, know that Haze can be systematically and automatically classified prevention, directly omit the cumbersome analysis process in the middle, improve work efficiency.

Reference

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