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A Novel Multiple Layers Overlay Run-to-Run Control Using New Algorithm Metrics for Logic Process

Xiaosong Yang, Hai Zhang, Dekun Huang, Duo Yu
Semiconductor Manufacturing South China Corporation, Inc. Shanghai, China

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Agenda

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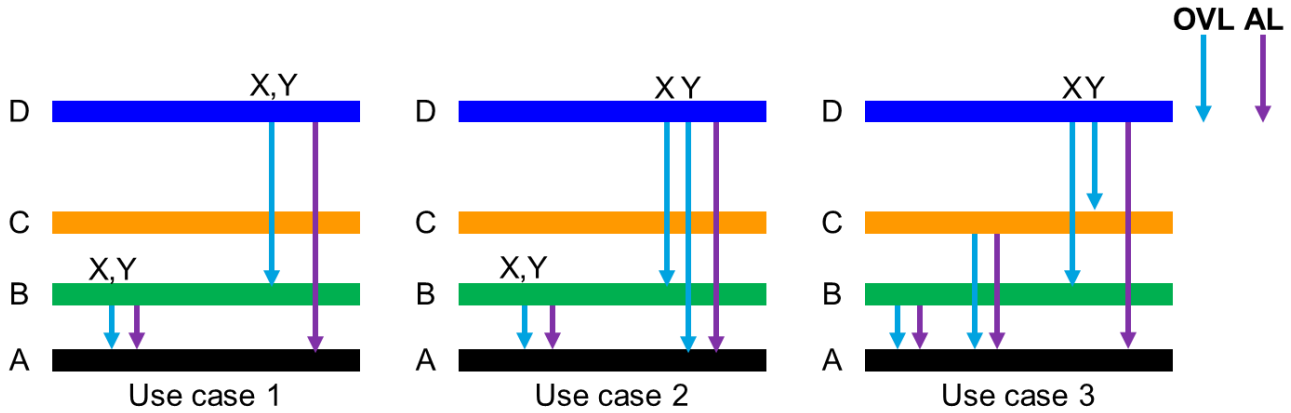
Introduction

- Feedforward method has already been proved as an effective way to prevent overlay variation from propagating
- Here we extend the application of FF control to uses cases in which X and Y directions shares different bottom layers in alignment tree and overlay tree. (use case 2 &3)



Layer M

Use case 2 – simulation for X direction

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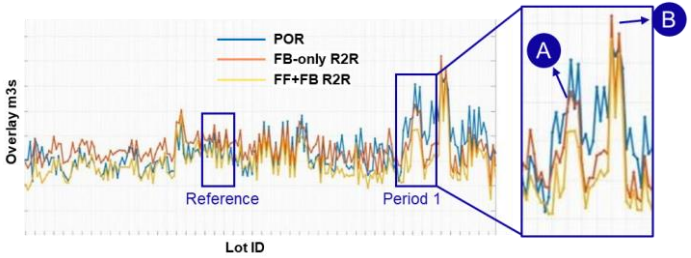
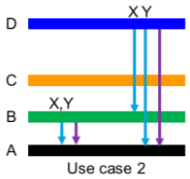
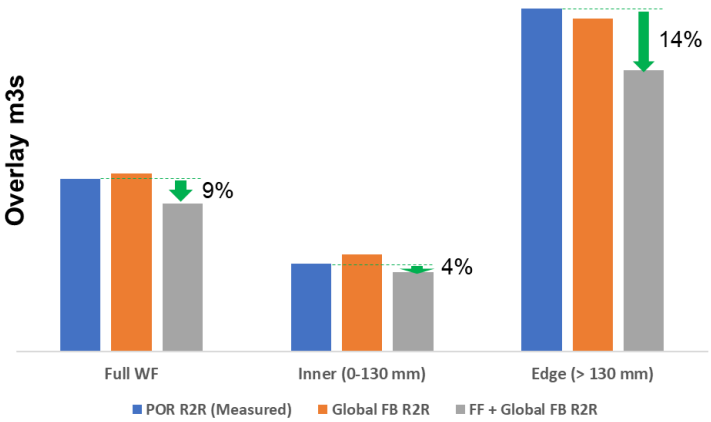
- Layer M X direction overlay trend plots (50 lots, with over 200 wafers)
- Wafers and lots in periods 1 showed jumped overlay







- FB only optimization does not bring benefit, but is comparable
- FF brings 4% and 14%, X direction of the correction set of the bottom layer is extracted and feedforwarded to Layer M for a combined FF and FB R2R simulation using the same global model.

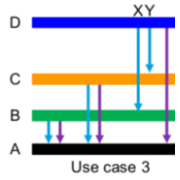
Remark: in this study, an expected ‘offset reduction’ is in period1-A, which caused by lot-based update feedforward w.r.t. period1-B

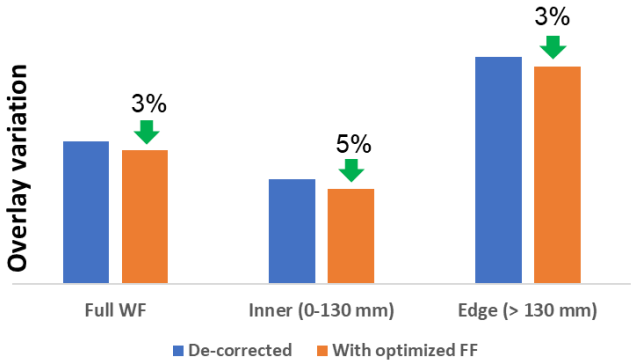
Layer N

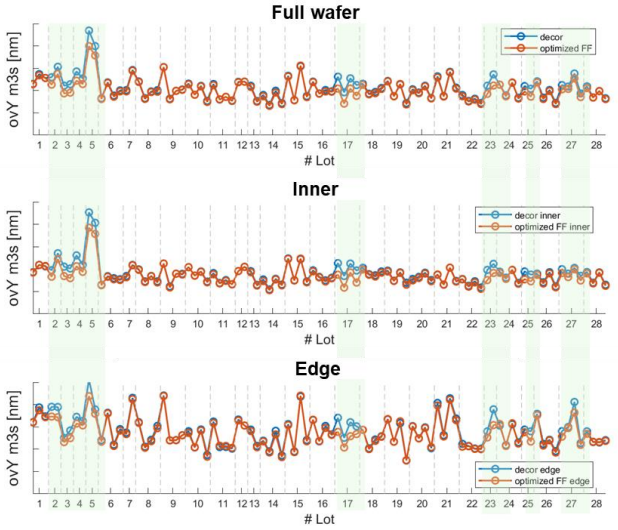
Use case 3 – simulation for Y direction

Using Feedforward only to the Y direction.

- The optimized feedforward can reduce overlay variation of Layer N by a small number of about 3% for this specific layer when putting all lots together.



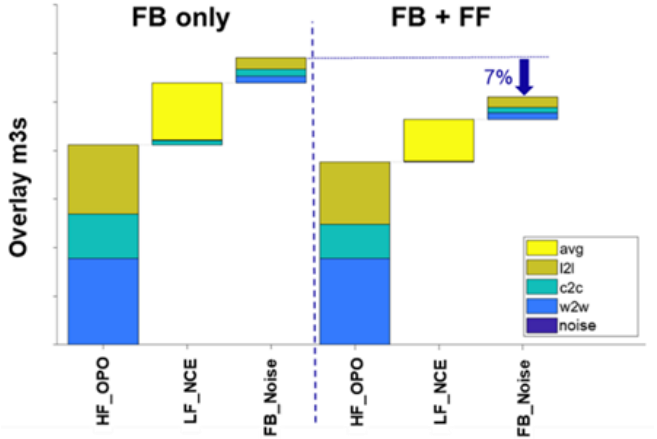




- The lots highlighted by light green background are those lots having their (high order) corrections of the FF layer changed, while the rest use the same one for this layer (it is also the overlay bottom layer of Layer N).
- From these trend charts, it is clear that FF reduces overlay variation mainly for those lots when their bottom layer uses a different correction.

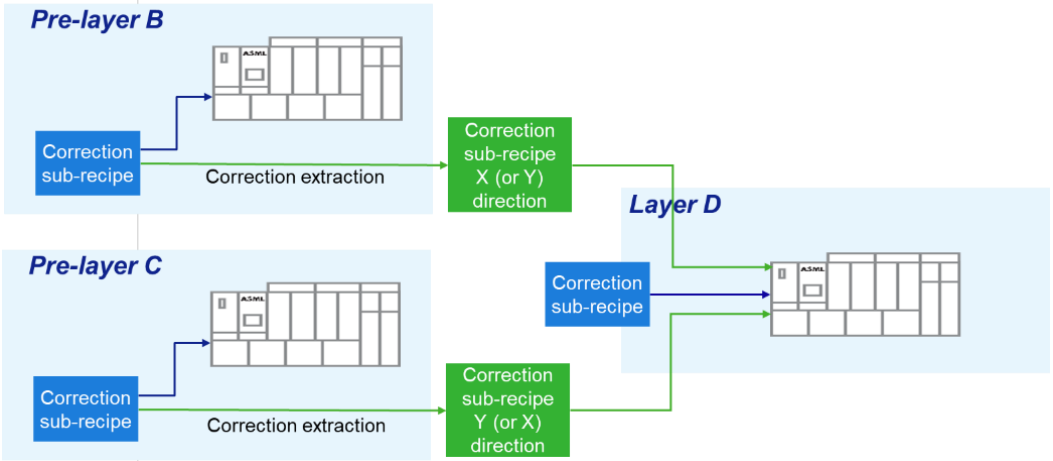
Overlay contributors analysis

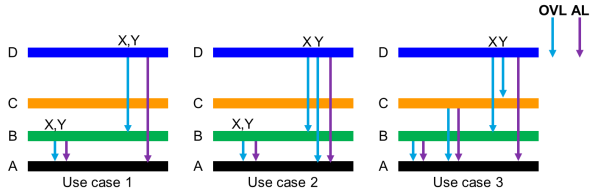
- To look into the effect of control on overlay components with and without FF, we used a new control budget breakdown method to analyze the total contributors to overlay performance.
- In this method, the overlay is separated into fast (high frequency) and slow (low frequency) varying components. Slow variation is a drift and the correctable part (which is APC model dependent) is expected to be corrected by R2R control together with the average part. Fast variation part then has to be handled by variation reduction solutions such as e.g., alignment, FF or re-work, etc.



Automation in HVM environment

Realization of FF in wafer fab





- Single direction overlay correction information (either X or Y) is extracted from Layer B and Layer C sub-recipes respectively.
- The two extracted sub-recipes are used together with the FB sub-recipe for the overlay control of Layer D.
- Sub-recipes are generated following Litho InSight (ASML) run-to-run control as designed.

Conclusions

Two use cases with different alignment and overlay tree configurations are investigated by simulation. OPO reduction by including FF in a R2R control loop is observed . Moreover, by using a new budget breakdown analysis methods, it is shown that overlay improvement is mainly from variation reduction as well as from reduction of non-correctable part in the average and slow drift. The automation scheme is successfully integrated in fab automation system and has been used in production. Split X and Y Feedforward control enables users to control X and Y overlay more precisely by better taking advantage of scanner lens actuators control ranges.