ADVANCED MASK TECHNOLOGY CENTER

Repair of EUV Masks using a Nanomachining Tool

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RAVE

Introduction

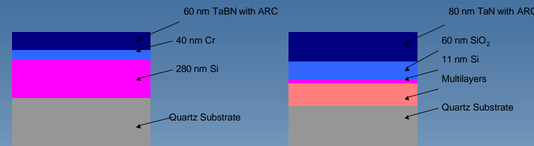
- Materials and sizes of EUV mask layers are chosen according to their function
- Absorber structures need to be repaired to achieve defect free masks
- Buffer layer protects multi-layer against repair damage
- Capping layer protects multi-layer during operations and may not be damaged

Goals

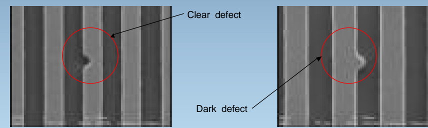
- Development of a repair process for EUV absorber binary masks
- Dark defect removal by nano-maching
- Defect sizes down to 30 nm
- Applicable to material stacks of different commercial vendors
- Determination of minimum buffer thickness
- Determination of repair quality impact
- Verification by printing experiments

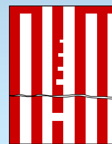
Masks with programmed defects

- Two masks with structures between 150 nm to 450 nm

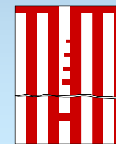


- Programmed defects from 30 nm to 450 nm
- Clear and dark defects
- Extensions and bridges





Programmed defects
Design layout



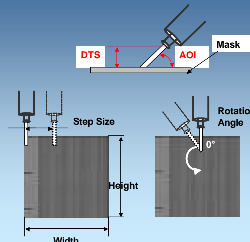
Defect size, nm	Half Pitch 150 nm	300 nm	450 nm
	30	30	30
	40	40	40
	50	50	50
	60	60	60
	70	70	70
	80	80	80
	90	90	90
	100	100	100
	120	120	120
	140	140	140
	bridging	160	160
	bridging	180	180
	bridging	200	200
	bridging	225	225
	bridging	250	250
	bridging	275	275
	bridging	300	300
	bridging	bridging	350
	bridging	bridging	375
	bridging	bridging	400
	bridging	bridging	425
	bridging	bridging	450

Repair Requirements for 45 nm node

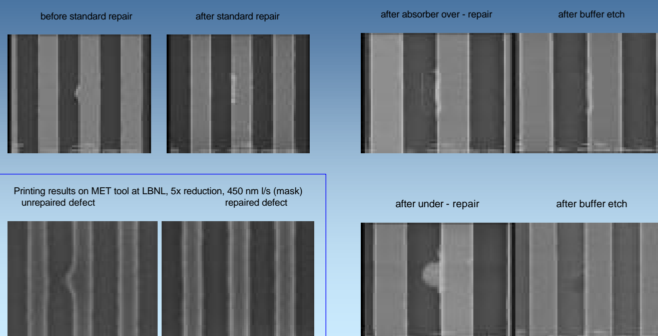
- The absorber removal must be confined within the minimum space of 180 nm
- The deposition must be confined within the minimum line width of 90 nm;
- The edge placement precision of 10 nm (3 sigma) must be ensured
- Defects >32 nm must be resolvable and repairable;
- The reflectivity loss after repair must be <5%

Repair Principle

- Dark defect is scraped off with NanoBit™
- Debris is cleaned off using CO_2 snow (Eco-Snow™)

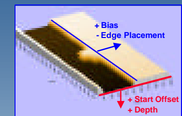


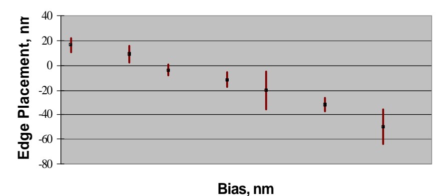
Repair Examples



Edge Placement Accuracy

- Determination of optimal process parameters, e.g. bias value for minimum edge placement





Conclusions

- Dark defects can reproducibly be removed with nano-machining
- Almost no differences found in settings for absorber materials from different vendors
- Repair method allows to minimize the buffer thickness

Acknowledgements

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