Line Edge Roughness Reduction at the 90nm Technology Node for Contact and Trench Etched Features

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Outline

- 1. Contact Overview/Problem
- 2. Contact Solution
- 3. Contact LER Result / Algorithm
- 4. Trench Overview/Problem
- 5. Trench Solution
- 6. Trench LER Result / Algorithm
- 7. Conclusion



Contact Overview/Problem

Photo

Shorting PFA



193 nm Resist w/conductive coat



248nm Resist w/conductive coat

LER Reduces Alignment Margin





Etch





Mechanism of the Problem

1. The problem originates in 193nm photoresist and is maintained in the pattern transfer process (etch)



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Contact Solution Etch Profiles







OE Slope 87-88 in Square Hole

OE Slope 88-89 in Square Hole

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CT LER Results

CD IN Etch

CD OUT Etch







CT Parametric Results





CT Photoresist LER Algorithm





CT Etch CD IN LER Algorithm



100

150

50

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CT Etch CD OUT LER Algorithm



$$\label{eq:rms_dr} \begin{split} rms_{\delta r} &= 2.5 \ nm \\ \rho_{\delta r} &= 13.9 \ nm \\ max_{LER} &= 6.7 \ nm \end{split}$$







CT Quantative LER Comparison

Image	RMS Delta from	LER Range	Max LER
	Ideal Circle	(nm)	(nm)
	(nm)		
Photoresist	3.9	18.8	8.8
CD IN	6.6	37.1	19.2
CD OUT	2.5	13.9	6.7
CD OUT to CD IN	62 1	62 5	65 1
Improvement %	02.1	02:0	0011



Trench Overview/Problem

Photolithograph

Pre Etch

Post Etch



Photoresist	
BARC	
Сар	
OSG	
 SiC	

Post Etch

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Trench Solution









Trench Photoresist - LER Algorithm $rms_{\delta l} = 3.7 \text{ nm}$ $\rho_{\delta l} = 20.2 \text{ nm}$ $max_{LER} = 10.3 \text{ nm}$













Trench Etch CD OUT BARC and Cap Etch Only - LER Algorithm

 $rms_{\delta l} = 2.4 \text{ nm}$ $\rho_{\delta l} = 17.2 \text{ nm}$ $max_{LER} = 6.2 \text{nm}$









Trench Quantitative LER Comparison

Image	RMS Delta from	LER Range	Max LER
	Ideal Circle	(nm)	(nm)
	(nm)		
Photoresist	3.7	20.2	10.3
CD IN	6	41.6	19.4
BARC & Nitride Only	2.4	17.2	6.2
CD OUT	2.8	16.2	7.1
CD OUT to CD IN	52.2	61 1	62.4
Improvement %	55.5	01.1	03.4



Conclusion

- Line Edge Roughness (LER) can be reduced by an etch process for the 90nm node
- Key to reducing LER was a quick taper away from the 193nm photoresist (LER source)
- LER was reduced by >63% with the <u>CD OUT</u> etch profile approach on holes and lines
- Reduction in LER increased CT to poly alignment margin by 12.5nm for CT holes
- A quantitative method of evaluating LER was developed and used for process transfer

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