Highlights from SPIE 2011

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INNOVATIVE SELF-ALIGNED TRIPLE PATTERNING FOR 1X HALF PITCH USING SINGLE “SPACER DEPOSITION-SPACER ETCH” STEP

Basic Process Steps-I

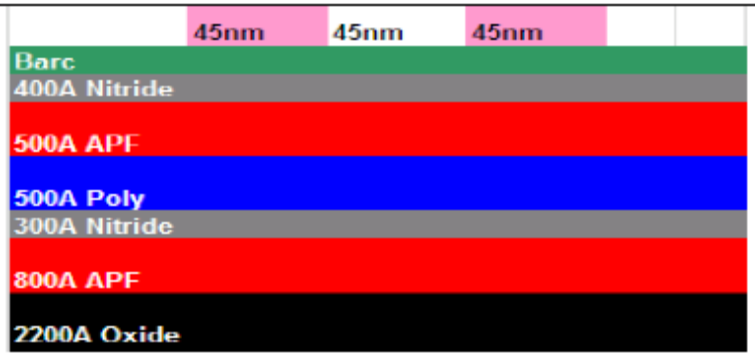


Fig.1: 45nm ½ pitch print at 193i immersion tool

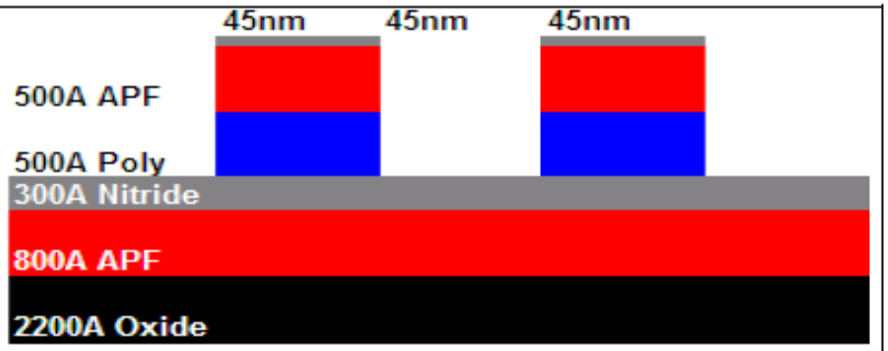


Fig.2: APF™ Core Etch, and Poly HM1 Etch

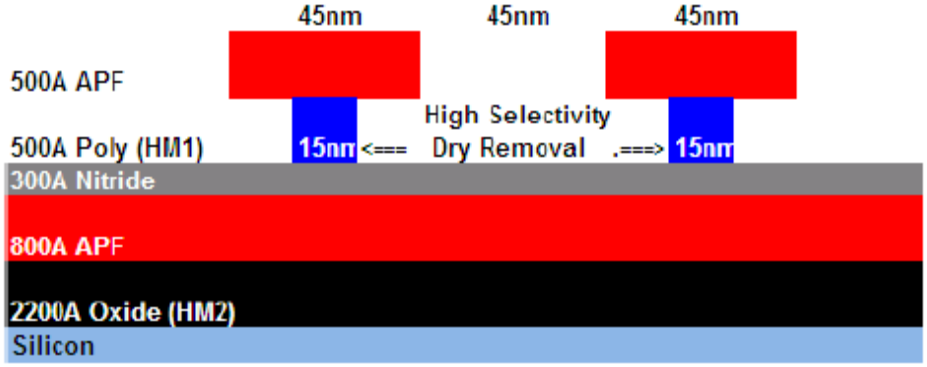


Fig.3: Selective Dry Removal

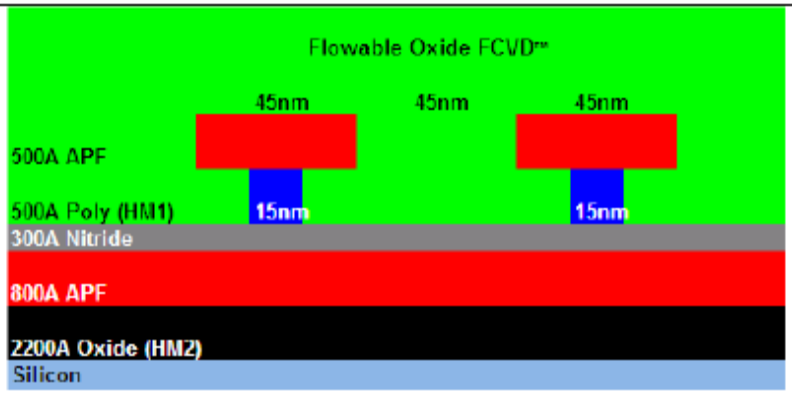


Fig.4: Void-free Flowable Oxide FCVD™ gap fill

Basic Process Steps-II

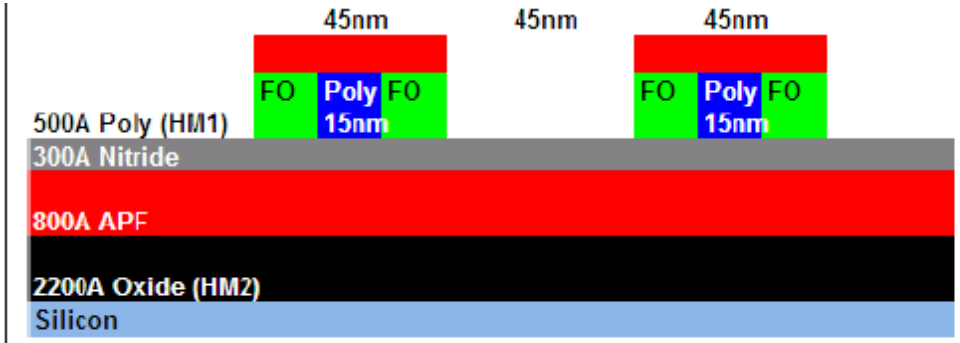


Fig.5: Gap Fill Oxide Etch down to Substrate

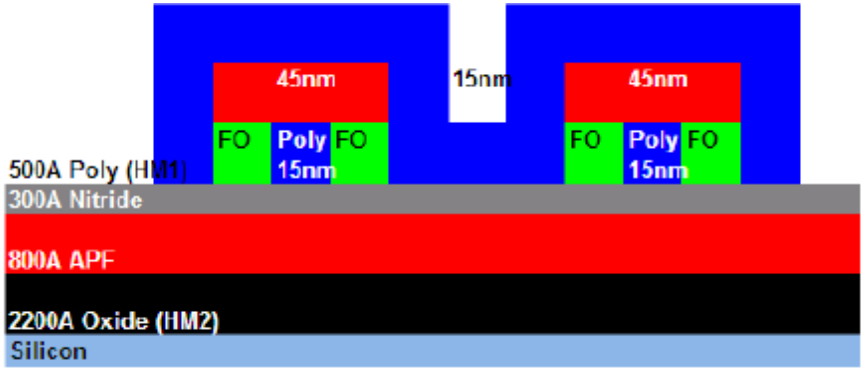


Fig.6: Poly Spacer Deposition

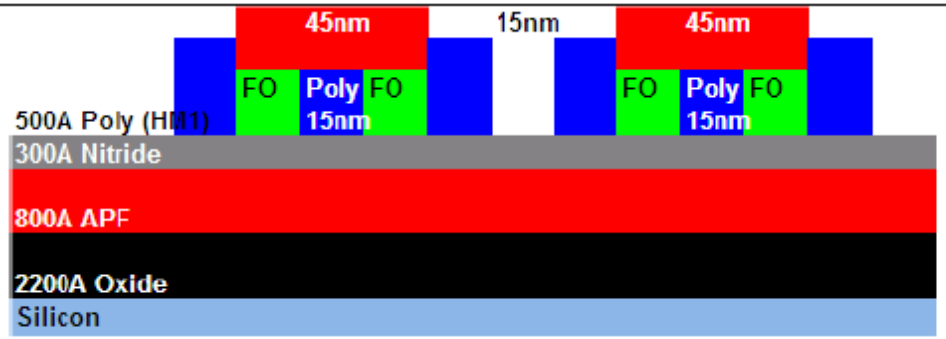


Fig.7: Poly Spacer Etch to expose APF™ and Substrate

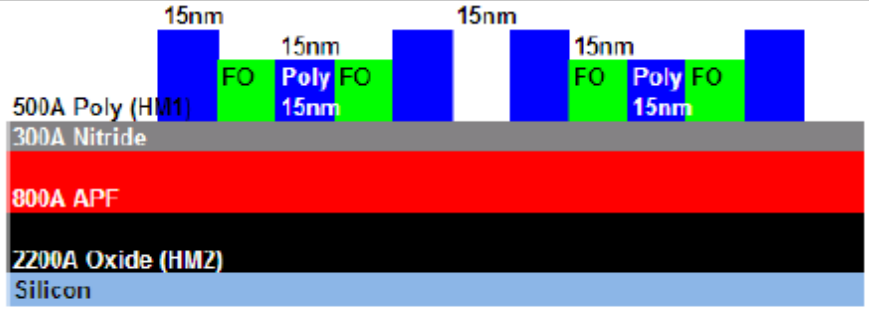


Fig.8: APF™ core Strip

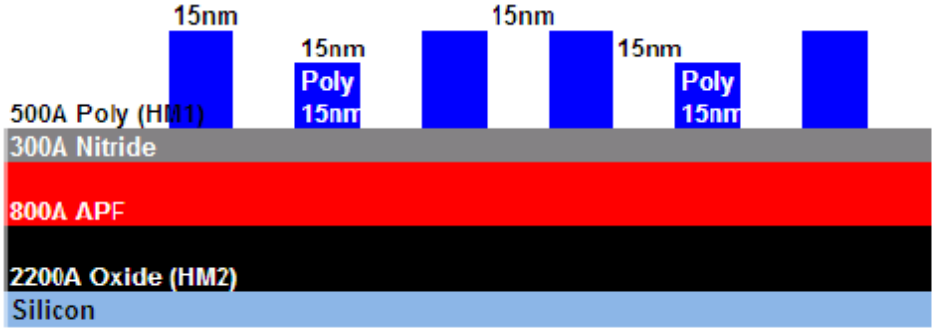


Fig.9: Flowable Oxide Removal. 15nm ½ pitch Structure

Fig.10: Pattern Transfer to Silicon STI

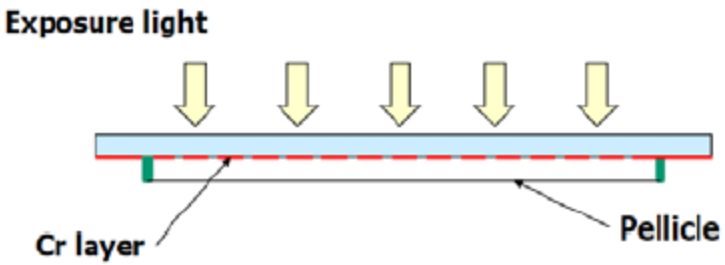
Some Key features

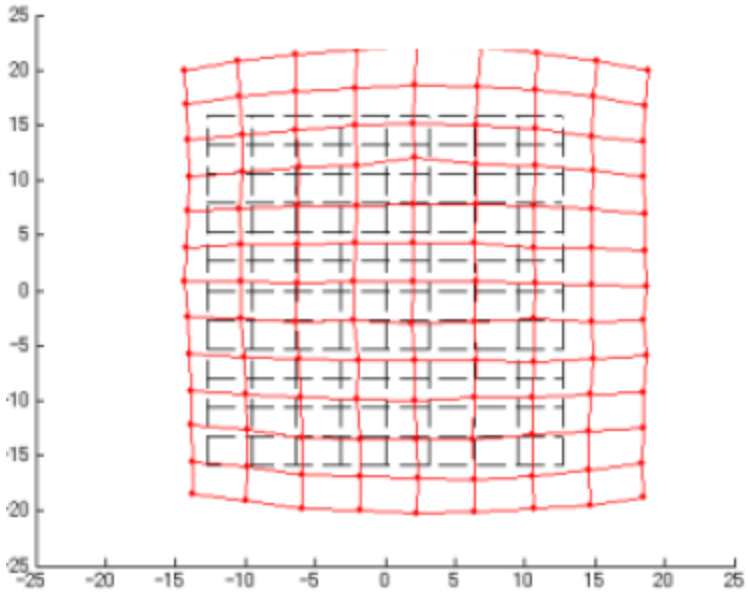
- 15nm pitch created with this method
- Fewer process steps compared (9 steps) compared to self-aligned quadruple patterning (12 steps)
  - Potentially less CD control and process window
- Method proved only for poly layer so far
- LER/LWR characteristics not yet demonstrated

THE COMPARISON OF NGLS FROM A TOOL VENDOR'S VIEW

Double Patterning

- Key concern is overlay control
- Simultaneous wafer/reticle stage control and lens magnification
- Time dependent Reticle heating: Can cause up to 3nm overlay with 200wph throughput





EUV Lithography

- Key issues: sources, resist and mask
- NA likely to stay below 0.40 for next 4-5 yrs (1.35 for DUV)
- DoF 200nm for 16nm lines with NILS 1.2
- Even 2nm MSD can cause 10% contrast change
- Will require SMO to improve contrast

Nanoimprint Lithography

	Mask	Tool	Wafer/ Process
Defects	Defects by EB writing Manufacturing Process Release agent adhesion	Particle Control Imprint/Separation control	Particle control Resist improvement
Overlay	EB writing accuracy Flatness	Global alignment concept Exposure Heat control Imprint/Separation control	Separation force reduction Temperature control
CoO	Surface control for imprint/separation	Imprint/Separation control Environment control	Environment control Easy filling
	EB writing time Mask lifetime	Imprint/separation control Particle control	Separation force reduction
Miscella-neous	Mask Cleaning Inspection/Repair	Defect control Process Matching	Inspection

- Overlay main concern for tool vendors (1X masks)
- Separation control for defect reduction