New Processes for FIB backside Approach

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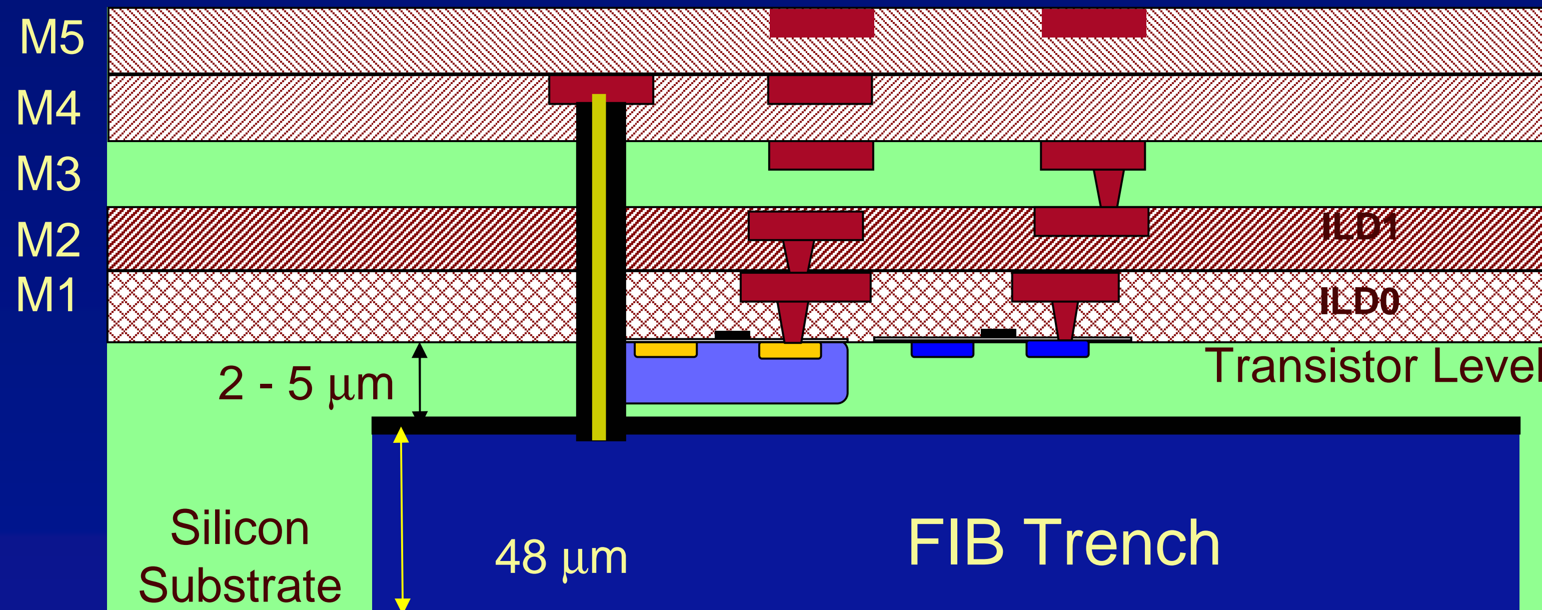
Introduction

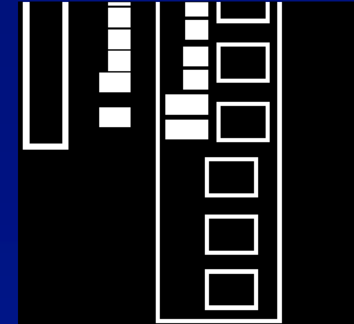


Process Risks of Circuit Edit through Backside:

- **Trench Flatness**
- **Endpoint control of trench for active Silicon volume**
- **Navigation on chip backside**

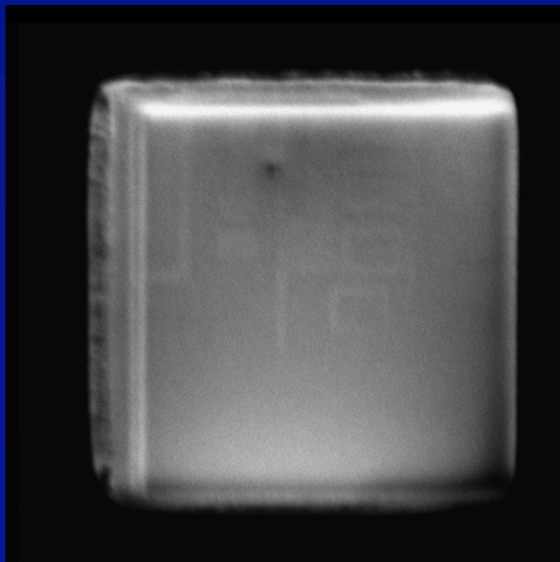
Image Contrast (SE-FIB) of N-Wells Taken from Si-Trench Floor

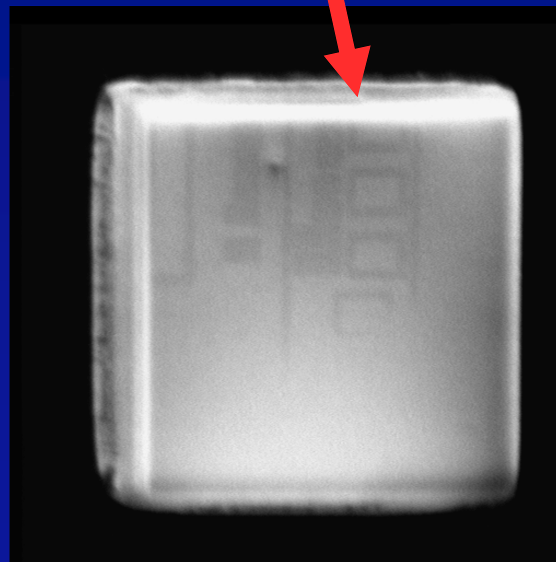
N-well Layout

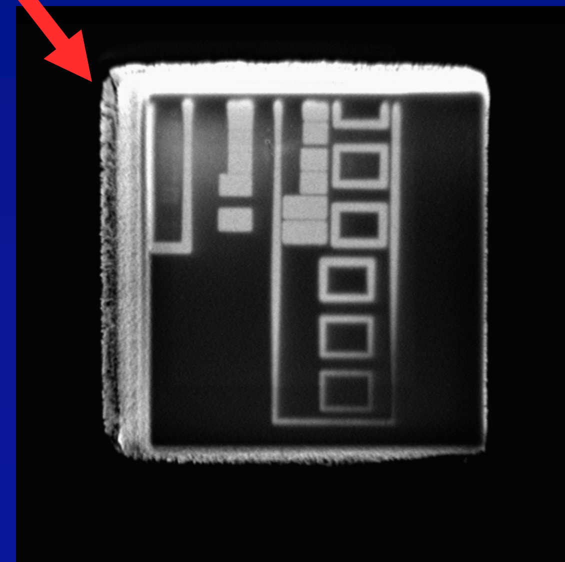


Transient image on Silicon trench floor

Permanent image on SiO2 covered surface
Sio2 thin thick





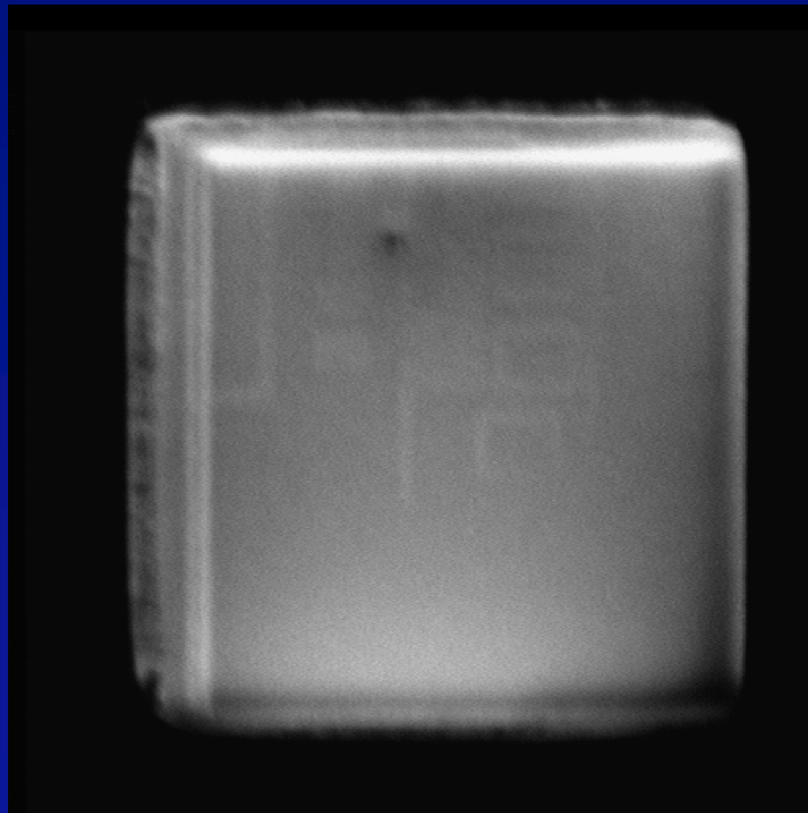


Field of view 182x172mm2

Transient N-well Image Contrast on Silicon Surface

Endpointing contrast variation in FIB-SE image of the trench floor. Parameters for trenching and imaging are 15keV beam energy and 4nA beam current.

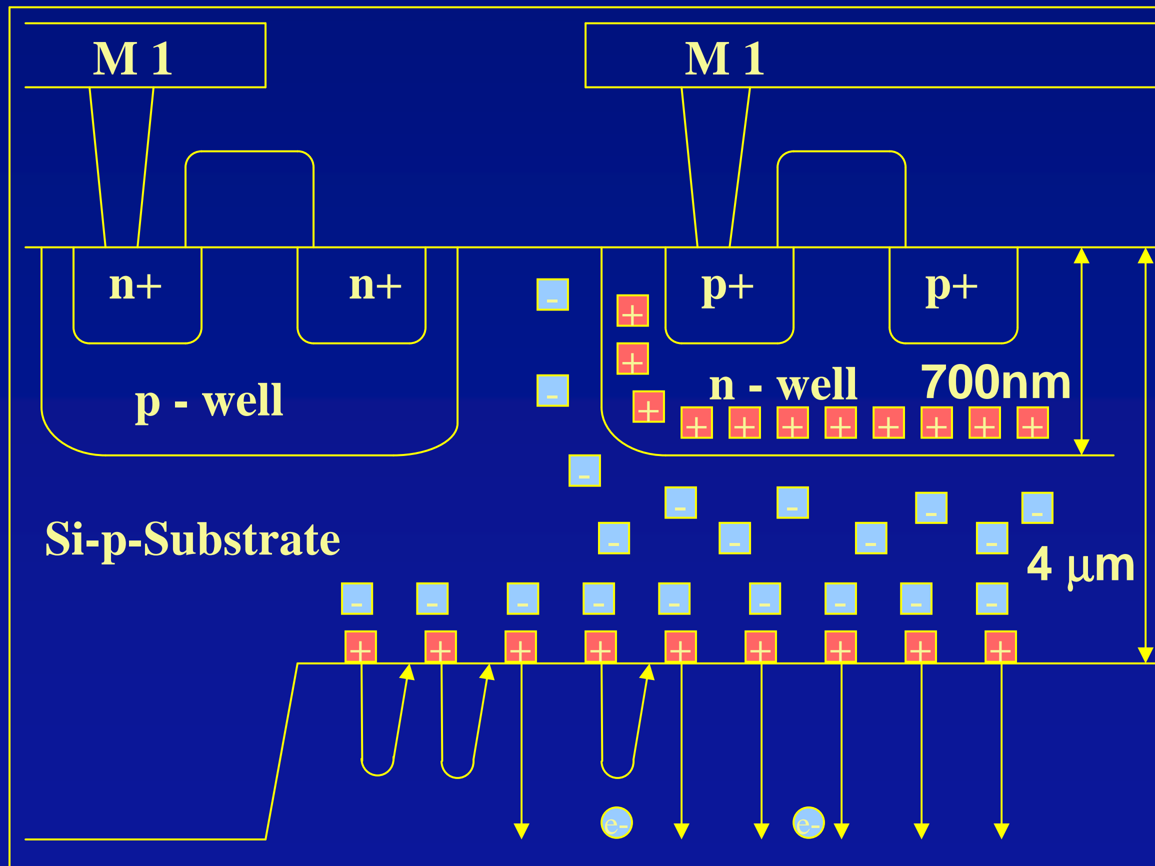
The n-wells appear slightly brighter than the p-substrate. Transient image due to XeF_2 trench floor cleanup



Field of view 182x172mm^2

Imaging Contrast for Endpoint Control

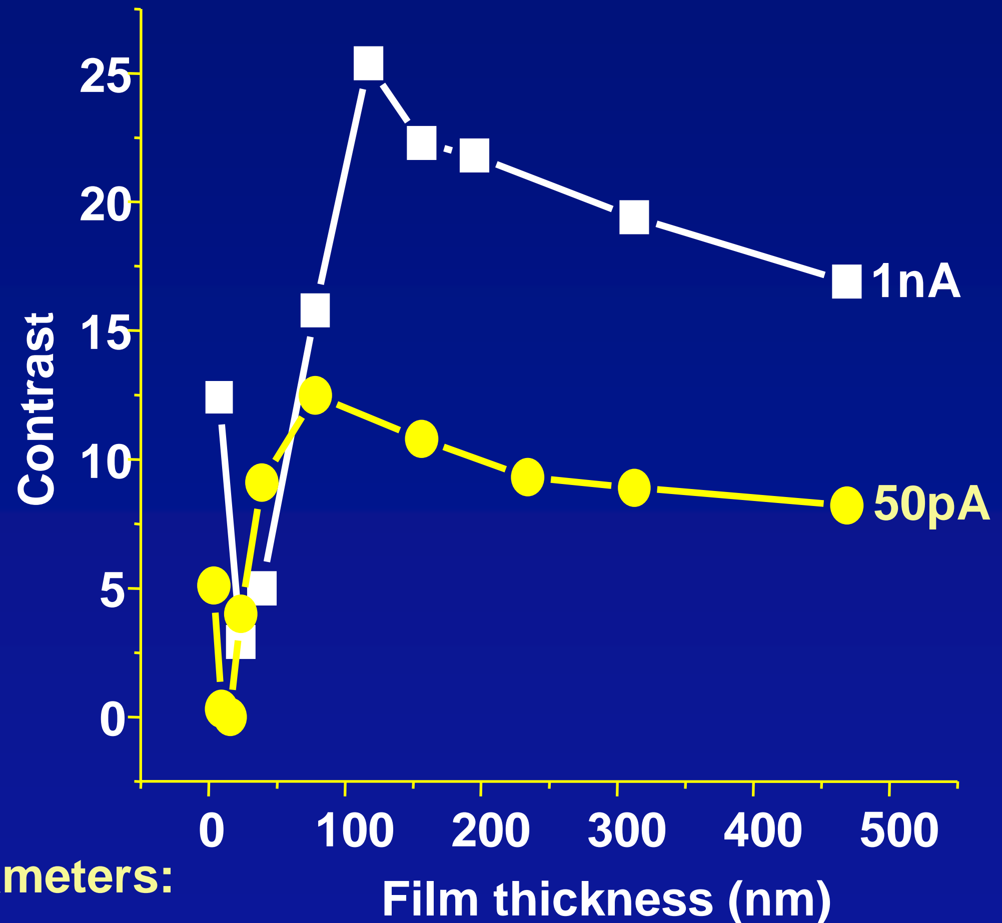
when n-well space charge overlaps Ga-related space charge and helps compensate positve surface charge



- Ion Beam removes material
- and implants Ga ions into the back surface.
- Influence of SCR causes contrast of secondary particle emission rate

Image Contrast on SiO_x Film Surface

- Contrast variation on the trench floor as a function of SiOx film thickness for two imaging beam currents.
- At film thicknesses below the contrast minimum, the n-wells appeared dark, while they appeared bright for thicker films.



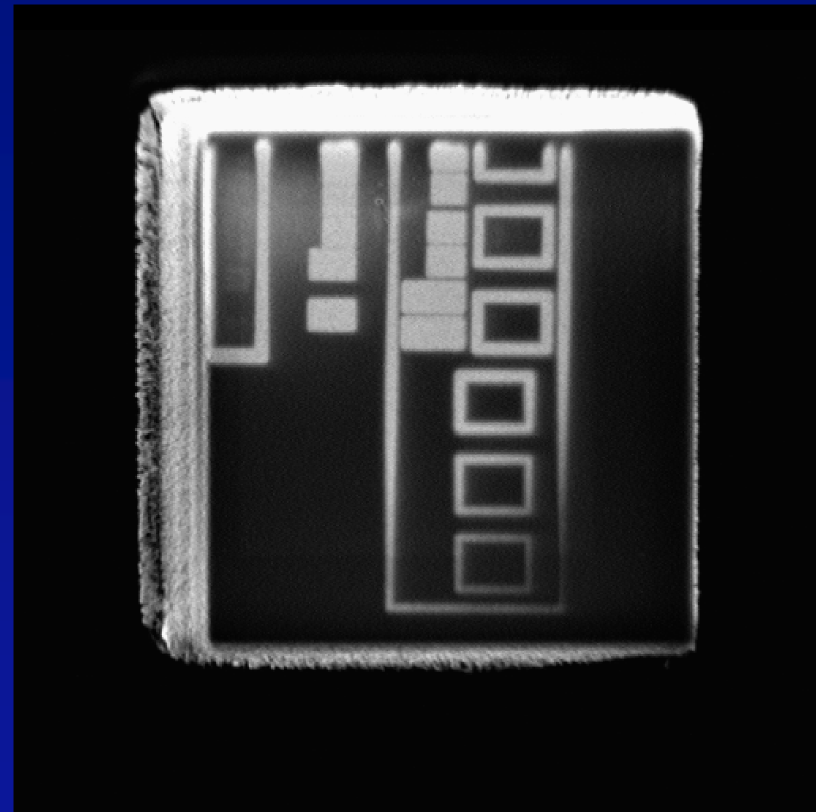
SiOx deposition parameters: 15keV, 4nA

Imaging parameters: : 30 keV

Permanent Image contrast on Insulator Surface

Image Contrast after 19min of SiOx deposition on the trench floor (thickness 130nm, 15keV and 4nA deposition parameters)

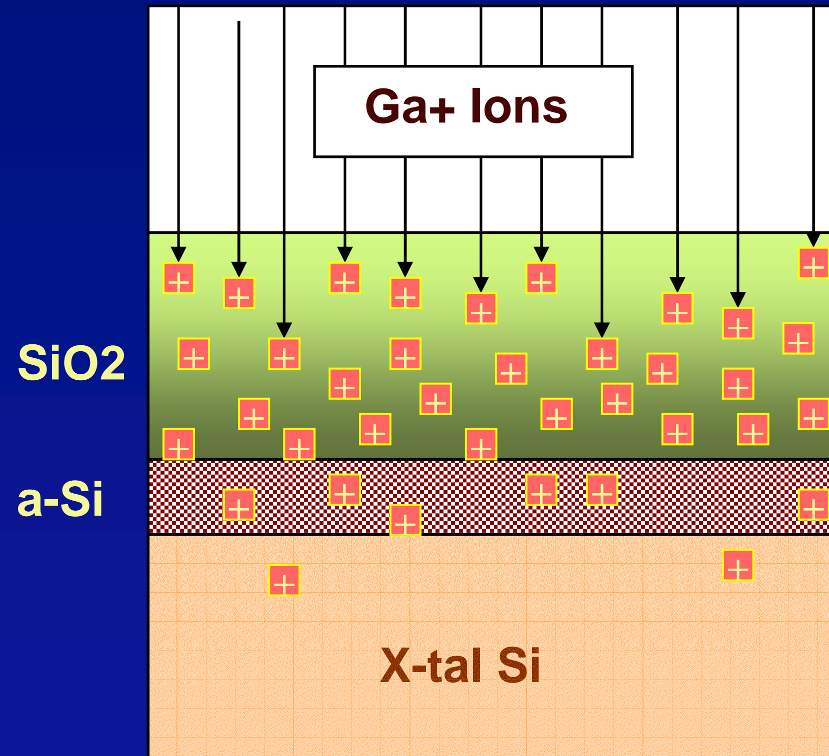
The n-wells appear much brighter than the p-substrate.



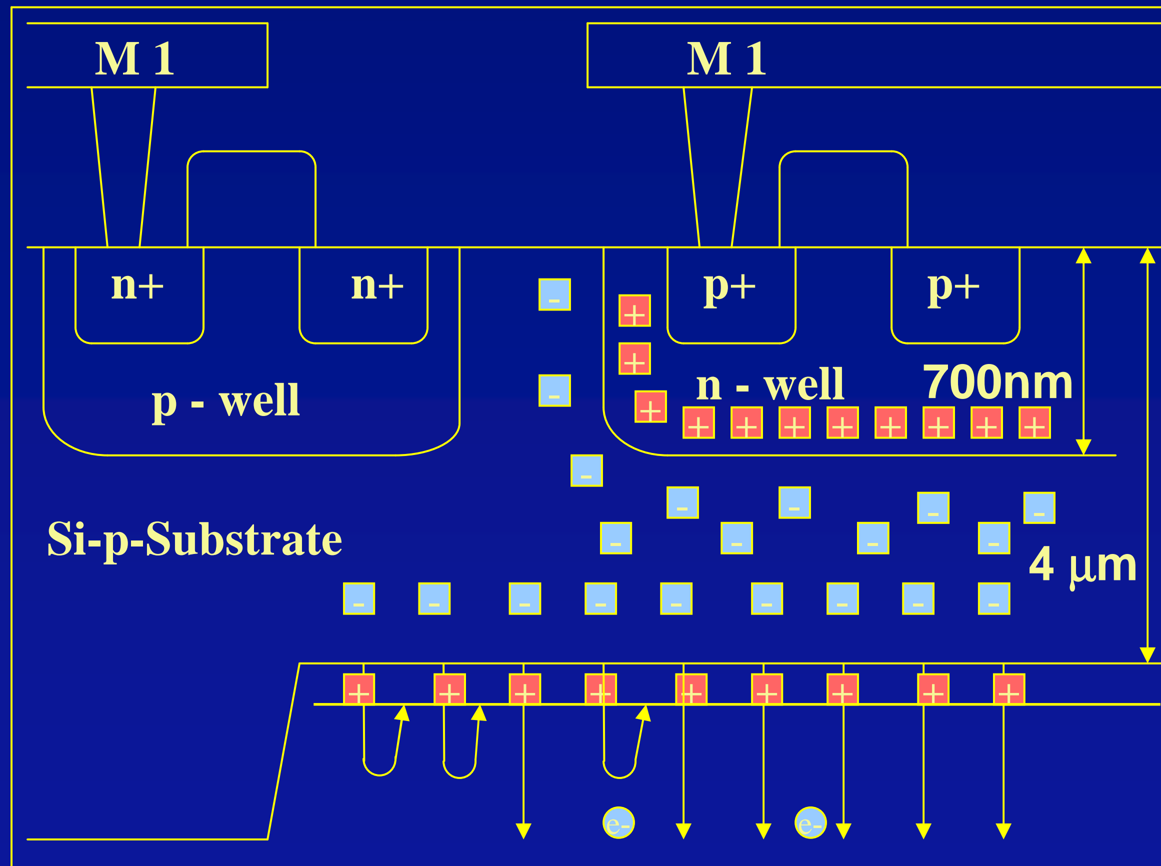
Imaging parameters are 30keV and 6nA. Field of view 182x172mm2.

Ga ion Implant at tox > 30nm

When tox>30nm, the Ga ions of the sweep are implanted in oxide layer, creating a space charge similar to the silicon surface case
- but more intense and permanent
(no removal by XeF_2)



Model for Image Contrast on Insulator Deposition > 30nm



When insulator exceeds thickness of amorphized layer, charges that are built into the oxide permanently create contrast stronger than in transient case

Conclusion

- At a remaining Silicon thickness of 3-5 µm, a FIB-SE image contrast of the wells occurs
- This contrast, although transient, can be used for endpoint detection of the Silicon trench in a circuit edit process through chip backside
- The contrast can be made permanent by SiO_x deposition on the trench floor, visualizing the wells for CAD-FIB alignment or analysis purposes
- The effects can be understood quantitatively with common semiconductor device models

Further Projects

- Parametric Investigation of deposited interconnects on backside topography
- Reliability Issues
- Edit options on silicon