

Ultraviolet and Visible Response of Delta-Doped CCDs

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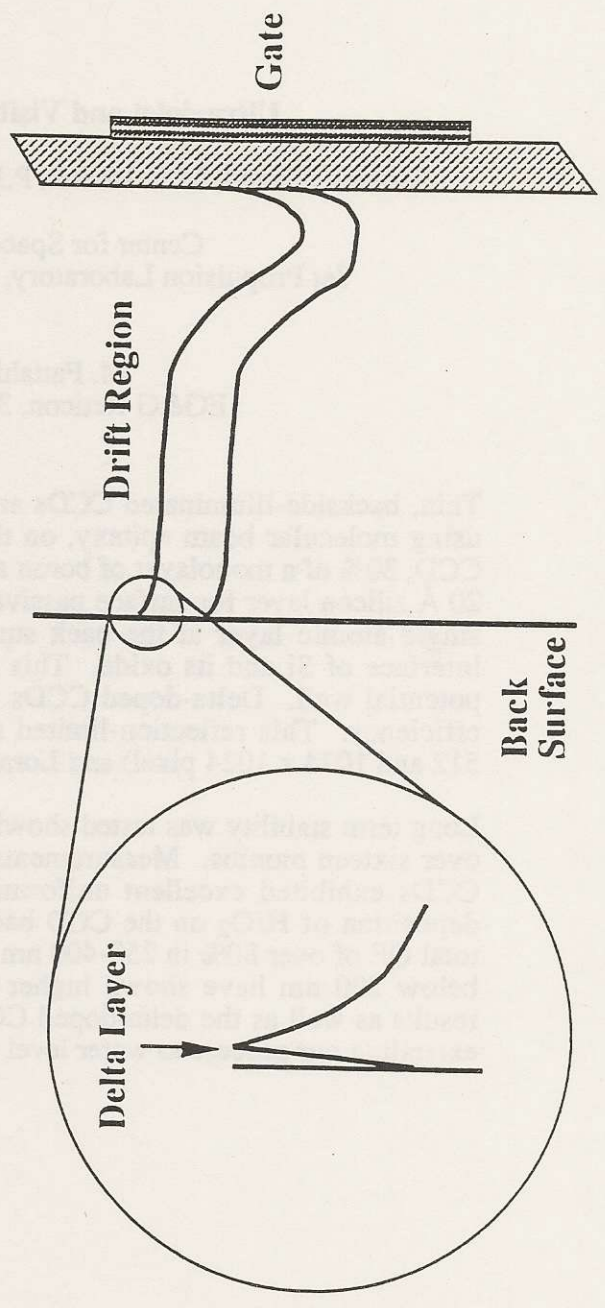
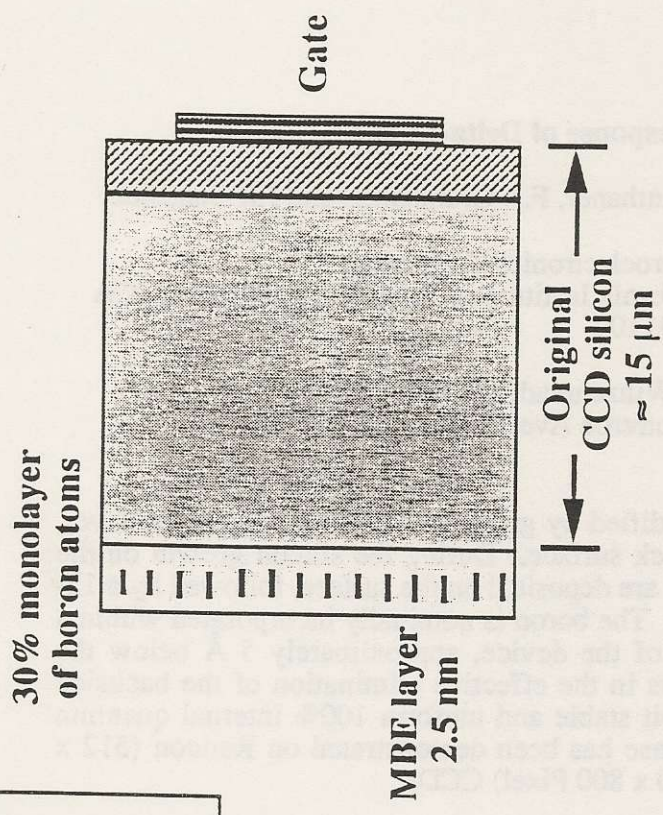
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Thin, backside-illuminated CCDs are modified by growing a delta-doped silicon layer, using molecular beam epitaxy, on the back surface. During the silicon growth on the CCD, 30% of a monolayer of boron atoms are deposited on the surface, followed by a 15-20 Å silicon layer for surface passivation. The boron is nominally incorporated within a single atomic layer at the back surface of the device, approximately 5 Å below the interface of Si and its oxide. This results in the effective elimination of the backside potential well. Delta-doped CCDs exhibit stable and uniform 100% internal quantum efficiency. This reflection-limited response has been demonstrated on Reticon (512 x 512 and 1024 x 1024 pixel) and Loral (800 x 800 Pixel) CCDs.

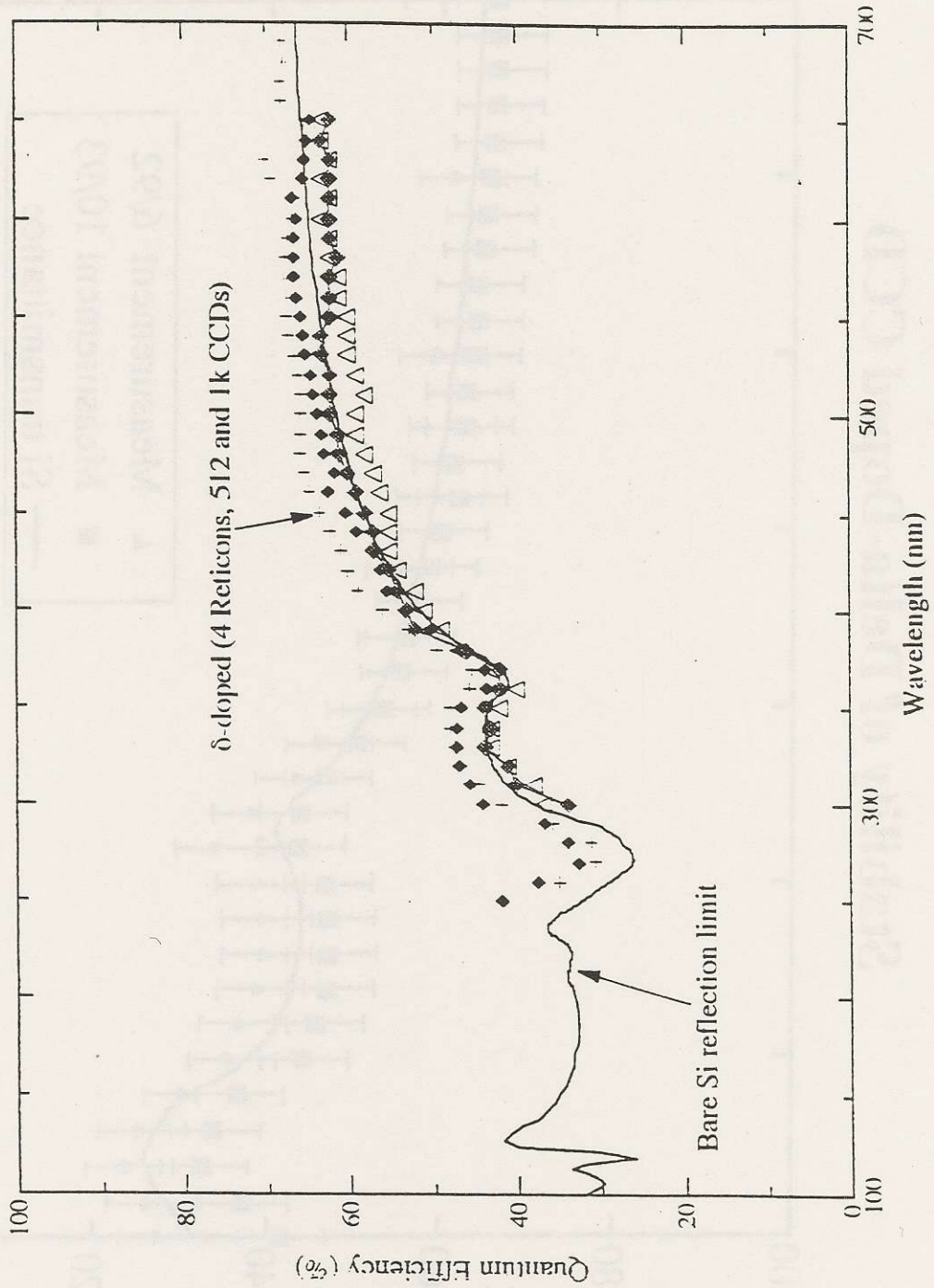
Long term stability was tested showing no degradation of the device quantum efficiency over sixteen months. Measurements of the spectral and lateral response of delta-doped CCDs exhibited excellent uniformity of the device. Reduction of the reflection by deposition of HfO₂ on the CCD back surface further increased the QE, with measured total QE of over 80% in 250-400 nm region of the spectrum. Measurements in the region below 200 nm have shown higher than unity quantum yield. We will discuss these results as well as the delta-doped CCD concept and process and recent developments in extending our process to wafer level for manufacturability.

A silicon epitaxial layer is grown on the CCD backside by molecular-beam epitaxy

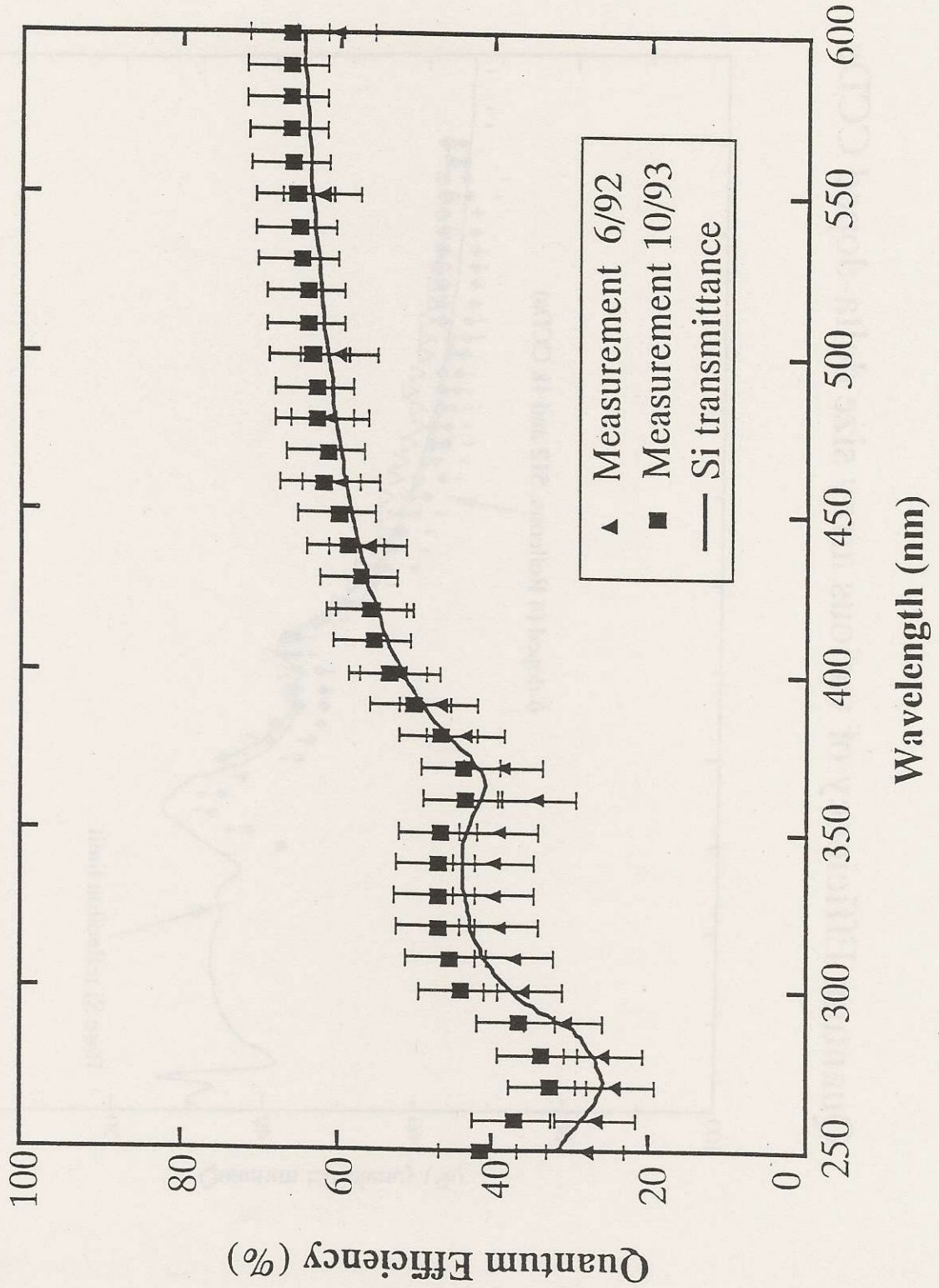
- MBE is used to extend crystal lattice 2.5 nm
- 30% ML of boron atoms within single monolayer
- Produces ideal termination potential



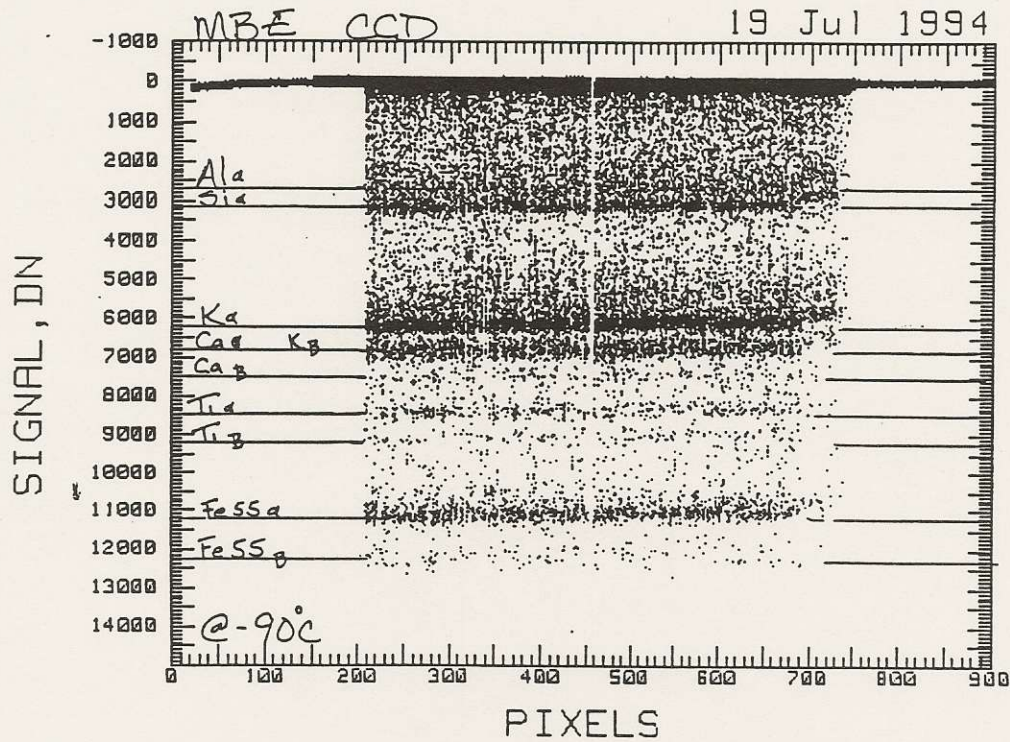
Quantum Efficiency of various array size delta-doped CCDs



Stability of Delta-Doped CCD



X-ray measurements to evaluate CTE



Direct deposition of anti reflection coatings

