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Progress and Prospects of Delta-doped Back-Illuminated CMOS Imagers

In this paper, we report recent results of our development of delta-doped, thinned, back-illuminated CMOS imaging arrays. Recent advances in CMOS imager design and low noise performance has brought great interest in higher QE and higher fill factor through back illumination. Problems with back surface passivation have emerged as critical to the prospects for incorporating CMOS imaging arrays into high performance scientific instruments, just as they did for CCDs over twenty years ago. In the early 1990's, JPL developed delta-doped CCDs, in which low temperature molecular beam epitaxy was used to form an ideal passivation layer on the silicon back surface. Comprising only a few nanometers of highly-doped epitaxial silicon, delta-doping achieves the stability and uniformity that are essential for high performance imaging and spectroscopy. Delta-doped CCDs were shown to have high, stable, and uniform quantum efficiency across the entire spectral range from the extreme ultraviolet through the near infrared. Delta-doped CMOS devices exhibit the high quantum efficiency that has become the standard for scientific-grade CCDs. We have demonstrated both thinned, monolithic delta doped CMOS imagers as well as bump-bonded thinned, delta-doped CMOS imaging arrays to a CMOS readout. We will present the latest results of this work.