Preventing Metallic Contamination in Image Sensors

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Image sensors are among the fastest growing category of integrated circuits, due to the increasing proliferation of smartphones, industrial sensors, and security equipment. Because they involve both photodetection and signal processing, both CMOS image sensors and charged coupled devices (CCDs) are considerably more complex than many other integrated circuits. This results in

ole pairs are generated in

valence band. This minimizes the highest energy gap that must be crossed for the electron to transition to the conduction band, leading to maximum tunneling. Since tunneling processes increase exponentially as the energy gap is reduced, trap T_2 will cause the highest tunneling, usually referred to as the *generation current*. This generation current cannot be distinguished from photon-induced current and will be misinterpreted by the pixel readout circuit as light impacting the photodiode.

Dark current issues can be divided into two cases. The first is the low-level dark current that affects many or most of the pixels in an image sensor. The result is poor low-light sensitivity, but the image sensor is still usable. The other case is where one or a handful of pixels has a dark current equivalent to the photon-induced current from a bright light on the pixels due to a high localized concentration of metals or defects (or both). Such pixels will appear bright white on all outputs of the image sensor, ruining the image quality and making the sensor unusable.

Successful image sensor fabrication therefore requires minimizing contamination of the silicon by elements that cause traps in the silicon bandgap, especially those with traps near the midpoint of the bandgap. Table 1 lists trap energies for metals commonly encountered in silicon processing. Equipment

Element Trap Energy (eV above the Valence Band)



Figure 2: SIMS data from a very high dose boron implant on the Optima XEx. Despite the 20% natural abundance of ¹⁰B in the source, it is undetectable in the wafer due to the velocity/mass filtering effect of the linac.