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CMOS compatible PureB technology for robust UV/VUV/EUV photodiode detectors and imagers

With PureB technology, Si photodiode detectors have been fabricated and commercialized with outstanding optical and electrical performance for low penetration-depth beams such as vacuum-/extreme-ultraviolet (VUV/EUV) light and low-energy electrons of which the minimum penetration depth in Si is only ~5 nm. The PureB layer is formed by a pure-boron chemical- vapor deposition (CVD) in a manner that allows integration of nanometer thin boron layers as light-entrance windows. At the same time the PureB layer provides an effective p+ doping of the semiconductor surface to form a nm-thin p+n junction. The basic PureB photodiode process is quite straightforward and has high compatibility with CMOS technology. Moreover, ideal diodes can also be fabricated with deposition temperatures from 700℃ down to 400℃ meaning that the process is compatible with back-end CMOS. Photodiodes made with PureB-only light-entrance windows have been optically characterized in the UV/VUV/EUV spectral ranges for a number of deposition conditions and post-deposition treatments. Most of the characterization is performed on mm-large photodiodes showing near-theoretical responsitivity and high-stability even for high-dose EUV exposures. Moreover, for integration in high-sensitivity imaging arrays, micron-sized photodiode pixels have been fabricated and operated in Geiger-mode with a low dark-count rate of 5 Hz at room-temperature for Φ4-μm devices. In all cases, it is shown that keeping the PureB layer intact is essential for maintaining the superior responsivity and stability performance. To enable this, special processing techniques have been developed. Particularly challenging is the case when pixel integration demands high-temperature post-PureB-deposition treatments and/or removal of extra layers deposited on the PureB.

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