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Dark current generation in a confined and depleted region of silicon JAMES LAVINE, DANIEL MCGRATH, Eastman Kodak Company — Dark current generation degrades the performance of silicon solid-state imagers. The present study examines whether a depleted region with defects supplies dark current to a photodiode when it is separated by a neutral region. Thermally-excited electron-hole pairs appear in the depleted region, which is confined by infinite potential barriers in two dimensions and a triangular potential well in the third. The triangular well has ground states of 0.036 and 0.058 eV for electric fields of 0.1 and 0.2 MV/cm, respectively. Lateral dimensions of 0.1 to 1.0 micrometers lead to high electron densities, which quench further dark current generation before excited states are occupied. As a result, the electrons must diffuse against the strong electric field and are unlikely to reach the photodiode. The same potential barrier accelerates the holes and creates electron-hole pairs by impact ionization. The electron would be generated near the top of the potential barrier. However, the probability that the hole acquires sufficient energy is 0.00001 for 0.2 MV/cm and 0.0028 for 0.3 MV/cm, based on J. S. Marsland in Solid-State Electronics 30, 125 (1987). If the defect is a gold atom at 55 C, this leads to 0.0056 and 1.6 electrons/s.

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