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2-in-1 Diodes with a Contact-Sidewall Structure for Small Pixel Pitch in Silicon-on-Insulator (SOI) Uncooled Infrared (IR) Focal Plane Arrays

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Interest continues to grow in the development of uncooled infrared (IR) focal plane arrays (IRFPAs) for high-resolution imaging using pixel pitch reduction technology. However, this approach causes two serious problems. The first is the reduction of IR responsivity that is caused by decreasing the incident IR ray intensity per pixel area. The second is the nonuniformity of the output DC level in the pixels caused by the increase in the production tolerance influence. Since pixel pitch and sensor performance exhibit an inverse relationship, we need two methods to improve these characteristics. The first is an increase in the conversion efficiencies from IR ray to electric signal. The second is a decrease in the production tolerance influence by improving the sensor structure. We investigated silicon-on-insulator (SOI) diode structures to address this challenge, and proposed a 2-in-1 diode with a contact-sidewall structure, whose key feature is a self-aligning fabrication process that reduces the temperature sensor size without degrading the responsivity and uniformity in the pixels. We fabricated a 17-μm-pixel pitch IRFPA to measure the performance of 2-in-1 diodes with a contact-sidewall structure. This new structure, which reduces the temperature sensor size in the 17-μm-pixel pitch by more than 14% compared with the 2-in-1 diodes used in previous studies, also enables pixel pitch reduction. Under a forward bias constant current of 6 μA, the temperature coefficient of V_f (dV_f/dT) increased to 4.1%, and the standard deviation of the diode forward voltage of the IRFPAs was reduced from 0.123 to 0.057 mV compared with 2-in-1 diodes without a contact-sidewall structure. Our proposed diode structure realizes pixel pitch reduction with increasing IR responsivity, which also improves the pixel uniformity.

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