Quantum Devices, Inc.

"Improving the Quality of Life through the Power in Light"

Quantum Facts

Series: QF1-02

CUSTOM PHOTODIODE

Silicon Photodiodes are essentially solid state quantum detectors having the ability to convert photon energy (light) into electrical current. When properly designed a silicon photodiode can have the ability to convert energy in the electromagnetic spectrum from UV through the visible to near infrared. Due to their solid state construction silicon photodiodes offer the most rugged and versatile large area light sensor with the best cost per sensor area on the market today.

Quantum Devices offers the ability to customize planar photodiodes with either single or multiple diode structures on a single chip. This configuration is a p-on-n structure and can be used to detect the presence and absence of minute quantities of light. The linearity of this response can range over several orders of magnitude, from 10 picowatt/cm^2 to several hundred MW/cm^2.

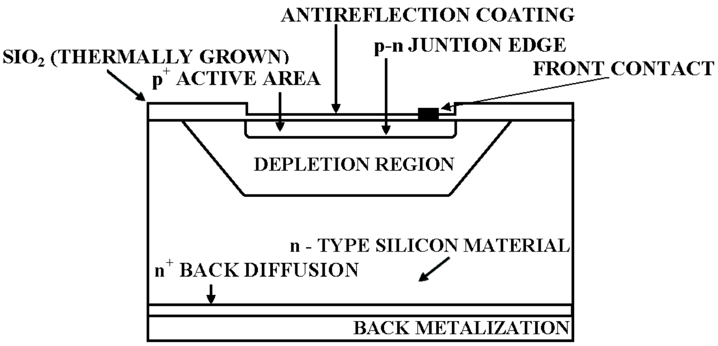

Figure 1 Planar Silicon Photodiode

Figure 1 indicates a cross sectional view of a planar diffused PIN diode. A depletion region is created when the p-type silicon doped with acceptor impurities (excess holes) comes into contact with the n-type silicon with donor impurities (excess electrons). The holes and electrons flow across the junction as a result of experiencing a lower potential on opposite sides of the junction. When photons of energy greater than the band gap of silicon (1.12eV) fall onto the photodiode, they are absorbed and electron-hole pairs are created. The intrinsic electric field of the pn junction prevents recombination of the pair and the anode becomes positive with the accumulation of holes, and the cathode becomes negative with electrons. This potential causes current to flow in an external circuit from anode to cathode. This is the generation of current from a pn junction when exposed to light.

For a planar device, the active area is defined photolithographically after the pattern is etched through the initial oxide passivation layer (SiO2). A subsequent doping to a P+ level is controlled by the active area opening of the initial oxide passivation layer forming the anode. Multiple and/or separate active areas can be developed within a single device. Likewise the entire backside of the wafer is doped to a N+ level and becomes the common cathode for the topside junctions. An additional oxide passivation layer is grown over the active area of the photodiodes to form a anti-reflection coating. The spectral response can be enhanced 10-20% by adjusting the anti-reflection coating to a particular wavelength. Photolithography is used to pattern the top side metallurgy and contact to the active areas through the anti-reflection coating.

Topside metallurgy is either thin film aluminum for wire bonding applications, or a nickel/gold plated contact for solderable applications. The topside metallurgy can be patterned over the anti-reflection coating to perform an additional optical masking of the active area. The backside metallurgy is either a thin film gold for silver epoxy applications, or a nickel/gold plated contact for solderable applications.

…THE QDI WAY…

Typically, the photolithography is initially designed on a CAD system for the desired application. The design of the light sensitive area is determined by the customer. During chip fabrication, the p-n junction, or anode-cathode configurations, are defined by the photolithography of the different layers. These patterns are repeated across the silicon wafer in a square or rectangular pattern to form an array of chips. Processing of the silicon wafer can generate from 10 to several thousand chips depending on the final design of the art work.

After the wafer is fabricated, every diode on the wafer is tested to desired specifications by a QDI developed automated probe station. This test station is programmed to test illuminated as well as dark parameters and will identify and mark any non-conforming devices. The accepted chips are cut from the wafer using a diamond saw.

Packaging of photodiodes provides the designer with multiple options. Wire bonding and solderable contacts allow unlimited assembly options to printed circuit boards, ceramic substrates, flex circuits and lead frames. The most common method of attaching the photodiode chip is to use silver conductive epoxy to bond the backside chip contact (cathode) to the board or substrate and wire bond the substrate contacts to the light sensitive anodes on the chip surface. For applications that do not demand ultra-low leakage characteristics, solderable contacts can be used for typical relfow applications. In addition, the common cathode contact can also be routed to a topside contact for applications that require all anode and cathode contacts to be on the front surface.

Quantum Device's knowledgeable and friendly staff are available to support the design of photodiodes from concept through the final application of the product in manufacturing. Design flexibility has made photodiodes a component of choice for many applications as low-cost silicon wafer fabrication technologies continue to provide high reliability and long-term performance.

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