## L.7: Development of usable GaAs *p-i-n* photodetectors and γ-ray irradiation effect on its characteristics :

GaAs based *p-i-n* photodetectors are of high importance due to the high radiation resistant properties compared to Si based *p-i-n* photodetectors [*Nuclear Instruments and Methods in Physics Research Section B, 269, 272 (2011)*]. At SCLS, we are in the process of developing GaAs based *p-i-n* photodetectors. Here, we report the development of usable GaAs *p-i-n* photodetectors and effect of γ-ray irradiation on their performance. GaAs based *p-i-n* photodetector structures are grown by MOVPE (AIX-200) and processed using the shadow mask technique. Two sets of metal masks are used for defining the electrode area (~36 mm²) and surface passivation area (~38 mm²) of the photodetector. These masks are fabricated using laser cutting facilities at SSLD. The metals (Ti/Pt/Au) electrode (ring type) is fabricated in the deposition unit using one set of mask. The current spreading area from the top of the device region is removed by chemical etching process using $H_3PO_4$:$CH_3OH$:$H_2O_2$ solution. Thereafter, the surface area of the detector is passivated by e-beam deposited $SiO_2$ dielectric using second set of mask. Gold wire of 1 mil diameter (~25μm) is used for ball bonding on the p-side electrode (Ti/Pt/Au). Silver paste is used for n-side electrode (Au-Ge/Ni/Au) formation. The photograph of the fabricated detector along with its schematic is shown in Fig. L.7.1.

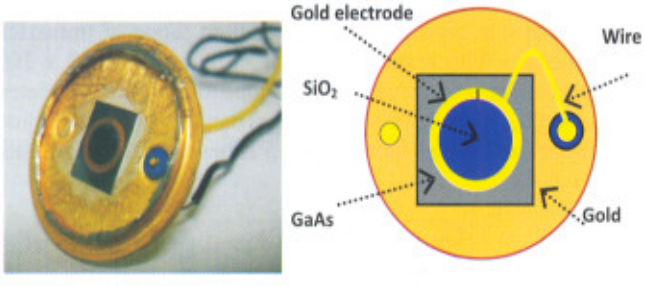


*Fig.L.7.1:GaAs photdetector a) Photograph b) Schematic*

Spectral response of these detectors is in the range of 300 to 860 nm with peak response at 690 nm (Fig. L.7.2). Furthermore, the photoluminescence of $Al_xGa_{1-x}As$/GaAs quantum well structure is recorded using this detector with the device geometry shown in the inset of Fig L.7.2 The excitonic transitions ($e_1$-$hh_1$, $e_1$-$lh_1$) are observed and the positions of these transitions are matching with those recorded using a commercial Si photodetector (Fig. L.7.2). Further, the photodetectors are irradiated with $^{60}$Co γ-ray radiation (upto100 kGy). The radiation effects on photodetectors characteristics are evaluated using temperature dependent current voltage and capacitance voltage measurements [*Nuclear Instruments and Methods in Physics Research Section B, 269, 272 (2011), Nuclear Instruments and Methods in Physics Research A, 685, 41 (2012)*]. From these results it is concluded that these photodetectors can be used for several applications even in very high radiation zones, particularly below 100 kGy of γ-rays. The typical photodetector parameters are also furnished in Fig. L.7.3, where a low dark current (4 nA) and capacitance (250 pF) are observed even at 15V.

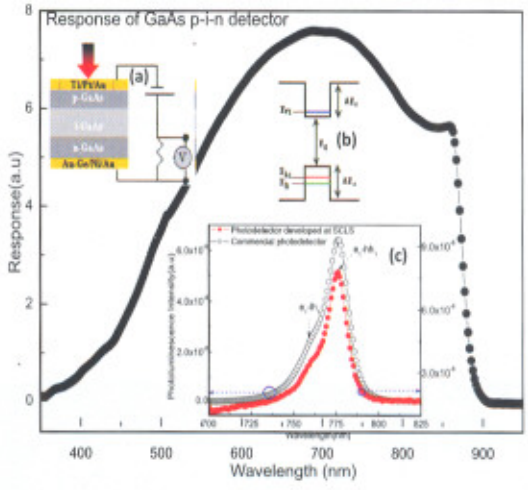


*Fig.L.7.2: Spectral response of GaAs p-i-n photodetector, inset shows a) Schematic of operating condition of photodetector b) Schematic of electronic levels of quantum well c)Electronic transitions observed in photoluminescence of AlGaAs/GaAs QWs*

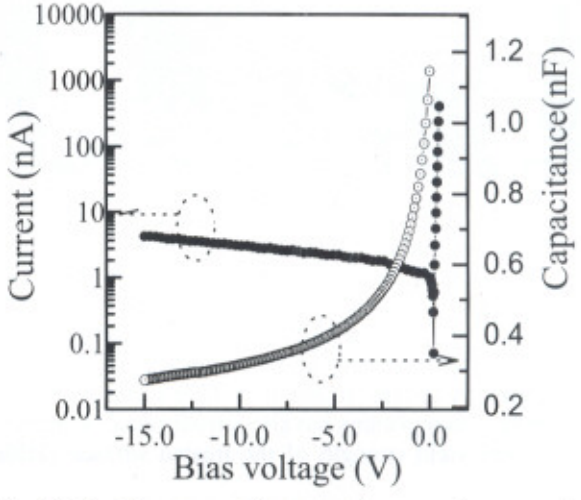


*Fig.L.2.3: Current volatge and capacitance voltage characteristics of GaAs p-i-n photodetector*

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