ELECTRICAL PERFORMANCE OF INAS/ALSB/GASB SUPERLATTICE PHOTODETECTOR

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Abstract

Temperature dependent of dark current measurement is an efficient way to verify the quality of an infrared detector. Low dark current density values are needed for high performance detector applications. Identification of dominant current mechanism in each operating temperature with extracted their minority carrier lifetimes are highly important for understanding of carrier transport and improve the detector performance. Here we present electrical as well as optical performance of InAs/AlSb/GaSb based type-II SL N-structure photodiodes

Keywords: Superlattice, dark current, detectivity, GaSb/InAs Infaraed detectors, Introduction

N-Structure GaSb/AlSb/InAs superlattice structure is offered at 2012[1]. Authors Show that if AlSb is placed between InAs and GaSb interface(single site but first interface in one period when structure is growing), e-hh overlap incrase when bias is reversed. AlSb mono layers affects as a electron barier to supress forward difusion current also. In this work we investigated current voltage characteristic an their current components at differen temperatures. Thus, current density-voltage (J-V) characteristics of InAs/AlSb/GaSb based type-II SL N-structure photodiodes are measured as a function of temperature (78-271K). The J-V curves are fitted by using Shockley Formula in order to identify the dominant dark current mechanizm in each operating temperature range. Minority carrier lifetimes are extracted from temperature dependence of current density (J-1000/T) curve quantatively [3]. While Fig.1 shows N –Structure real space band profile Fig.2 shows also band profile but under external applied voltage(reverse bias). Fig.3 a and b Show I-V characteristic obtained different temperature and obtained activation energy which is suitable e-hh optical transition energy. On the other hand, Fig.4 is responsivity calculated by optical response and dark current experiments. Fig.5 also Show current compenents ant their time constants obtained by simulation studies.

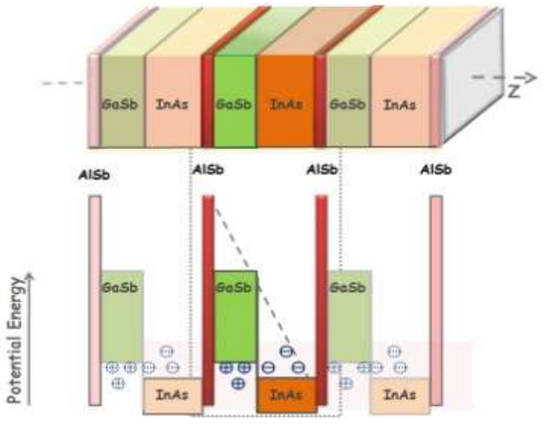

Fig.1 (a) Layer sequence in growth direction, (b) conduction and valence band profiles for asymmetric InAs/AsSb/GaSb based T2SL N-structure

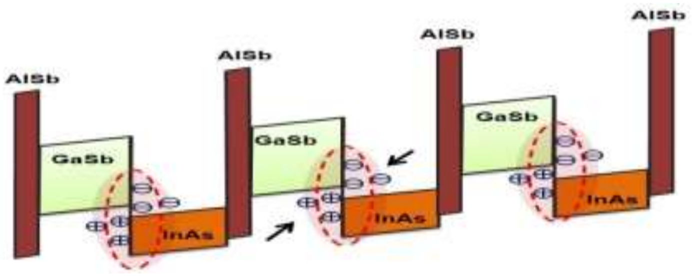

Fig.2 Conduction and valence band profiles for N-structure with electron and hole confinement under reverse bias

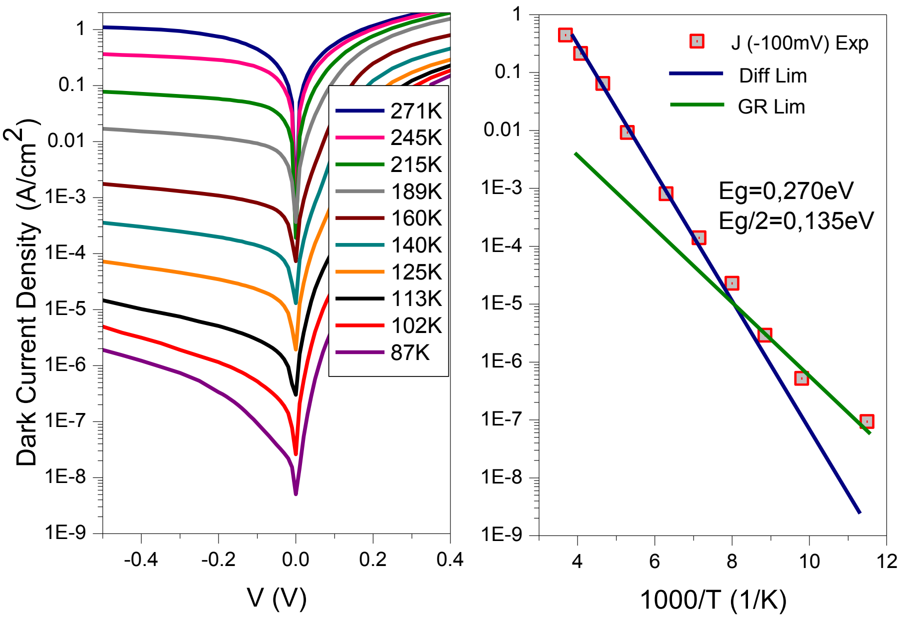

Fig. 3 (a) Temperature dependence of dark current density, (b) Arrhenius plot of dark current density vs inverse temperature (1000/T).

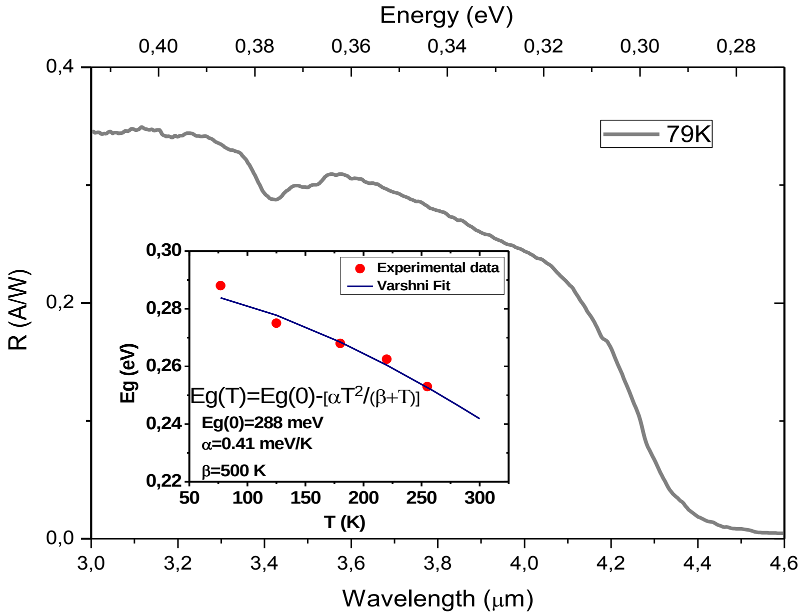

Fig.4: Responsivity spectrum of N-Structure at 79K. Inset shows Varshni fit for band gap energy extracted from optical response spectra for different temperatures.

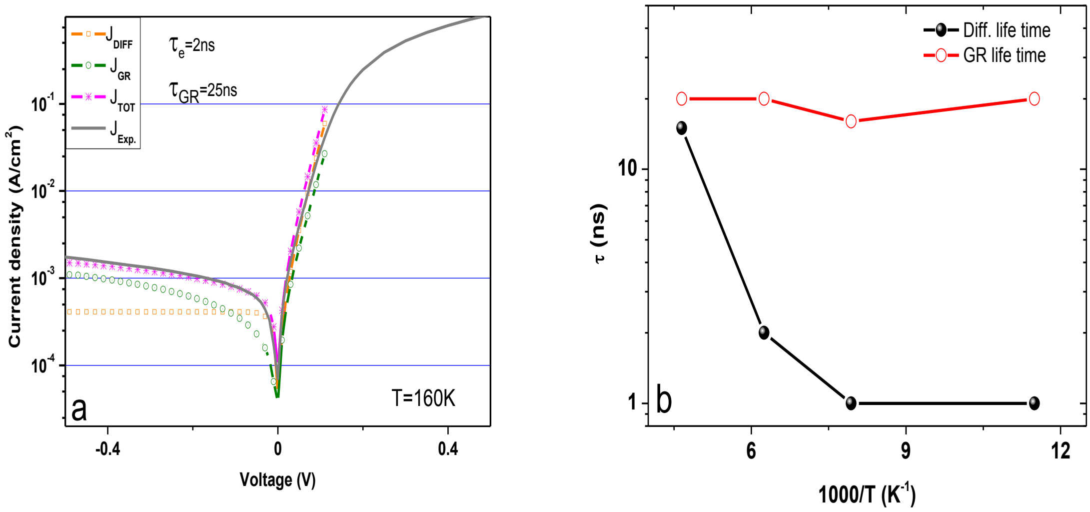

Fig.5 **(a)** -Experimental $J_{Exp.}$ (solid line) and modelled J_{DIFF} (yellow dot), J_{GR} (green dot) and J_{TOT} total dark current densities versus voltage of N-structure SL photodiode at T = 160 K (a) and T = 200 K**.** **(b)** -Calculated diffusion (τ_e) and GR (τ_{GR}) lifetimes at various temperatures.

CONCLUSION

Temperature dependence of J–V characteristics is analysed in InAs/AlSb/GaSb based T2SL N-structure. Deduced from J–V curve-fitting, minority carrier lifetimes have been estimated in the temperature range 87–215 K. At 87K and under -0.1V bias voltage, the dark current density is measured as 9.29x 10^{-8} A/cm^2 and corresponding dynamic resistance area product (RA) is determined as 6.43x10^5Ωcm^2. In the temperature range 271–125 K, the dark current density reveals diffusion-limited behavior (Arrhenius type) with electron lifetime values between 1ns and 15ns. In the lower temperature range (125–87 K), the dominant mechanism starts to become generation recombination (GR) with GR lifetimes varies between 16-20ns.

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