

## Anomalous Electrical Transport at Non-Ideal Au/Epitaxial n-GaAs Schottky Junctions on n<sup>+</sup>-Ge Substrates at Low Temperatures

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### 1. Introduction

When GaAs epitaxial layer is grown on Ge substrate either by metal organic vapour phase epitaxy (MOVPE) or by molecular beam epitaxy (MBE), some problems may arise such as antiphase domains (APDs) surrounded by antiphase boundaries (APBs), misfit dislocations in the grown films and cross-diffusion across the GaAs/Ge hetero-interface. The presence of these defects and dislocations in the grown film poses a major problem. It is, therefore, necessary to understand the electrical activity of these defects and to find ways to control them.

### 2. Main Results

The forward current-voltage characteristics of the Schottky diodes formed by depositing Au contacts on epitaxial n-GaAs films with doping concentrations,  $N_d = 1.6 \times 10^{16} \text{ cm}^{-3}$  (SD1) and  $3 \times 10^{16}$  (SD2) on n<sup>+</sup>-Ge substrates have been studied in the temperature range 51 to 306 K. At room temperature, the I-V characteristics obey the thermionic emission diffusion (TED) model, the barrier heights are 0.81eV and 0.75eV and the ideality factors 1.05 and 1.13 for diodes SD1 and SD2, respectively. A change in the I-V characteristics were observed in SD2 around current value  $10^{-5} \text{ A/cm}^2$  in the temperature 51-275K, while no such phenomenon observed in SD1. Above this current value, the I-V characteristics were also observed to follow the standard thermionic emission (TE) and diffusion phenomenon for SD2. The apparent barrier heights in the diodes SD1 and SD2 decrease, while ideality factors increase with the decreasing temperature. Further, the Richardson plots of saturation current density show a non-linear behaviour. This abnormal behaviour of barrier height, ideality factors and the curved Richardson plots could not be explained on the basis of  $T_0$  effect, flat band barrier height and the recent barrier height inhomogeneities phenomena. This discrepancy in SD2 is more significant than SD1. However, a

close matching of the Schottky barrier parameters: barrier height  $\phi_{bo}$ , Richardson constant  $A^{**}$ , characteristic energy  $E_{00}$  and bias dependence of the barrier heights  $\beta$  with the those reported in the literature has been observed using thermionic field emission (TFE) theory with anomalous high values of characteristics energies  $E_{00}$ . The anomalous factor is more significant in SD2 than SD1.

The excess current at small bias region for diode SD2 in the temperature range 51-275 K below the current value  $10^{-5} \text{ Amp}$  has been explained on the basis of coexistence of some small patches of reduced barrier height embedded in the Schottky area.

### 3. Conclusion

The anomalous behaviour has been found to be due to the effect of Thermionic Field Emission (TFE) with anomalous characteristic energy value  $E_{00}$ . The anomalously high value may be due to electric field enhancement at the periphery of diodes and multi-step tunnelling through deep levels. The difference in the behaviour of the two diodes SD1 and SD2 appears to be associated with the existence of small patches embedded in the Schottky interface area. The double threshold phenomenon observed in SD2 has been found due to small patches of reduced barrier height in the Schottky contact area.