Characteristics of InGaP/GaAs Single-Heterojunction Bipolar Transistor with Zero Potential-Spike by δ–Doped Sheet

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Abstract

We report the fabrication and characterization of the InGaP/GaAs single heterojunction bipolar transistor (SHBT). The cross sectional structure of the studied device is shown in Fig.1. The SHBT with a delta-doped sheet located at the E–B heterointerface (δ–SHBT) exhibits a common-emitter current gain as high as 410 and an extremely low offset voltage of only 55 mV. Figure 2(a) and (b) illustrate the I-V characteristics and the expanded view near the near of the same device. The higher current gain of δ–SHBT can be attributed to the increase of the hole barrier resulting from the δ-doped sheet and to the reduction of charge storage because of the existence of thin spacer (50-$\AA$). The low offset voltage is due to the elimination of the potential spike of E–B junction. The calculated conduction band-edge diagrams near the E–B junction of δ–SHBT, conventional SHBT and HEBT at various biased conditions are plotted in Fig.3. At equilibrium, no potential spike exists for all the three structures. As V_{BE}=+1.0 V forward biased, a potential spike about 60 meV existed in an SHBT while no potential spike existed in both δ–SHBT and HEBT. Also notice that the width of neutral region in narrow energy-gap emitter for an HEBT is also increased with biased voltage. It is evident that the potential spike do be eliminated by utilizing δ–doped sheet. On the other hand, calculated increase of the E–B capacitance for our δ–SHBT is very small due to the thin enough δ–doped sheet.

Cap.	0.3 μm	3×10^{18} cm^{-3}
Emitter	0.1 μm	5×10^{17} cm^{-3}
Spacer	5 nm	undope
Base	0.1 μm	1×10^{19} cm^{-3}
Collector	0.5 μm	2×10^{16} cm^{-3}
Buffer	0.3 μm	3×10^{18} cm^{-3}

$\delta(n^+)$

n^+–Substrate

Fig.1. Schematic cross section of the studid InGaP/GaAs δ–SHBT.

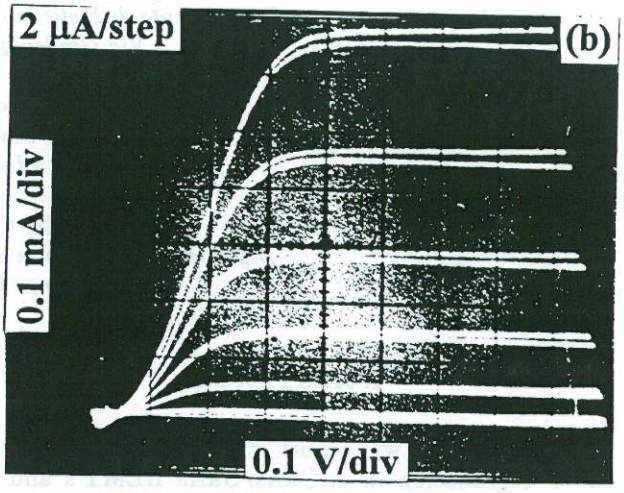
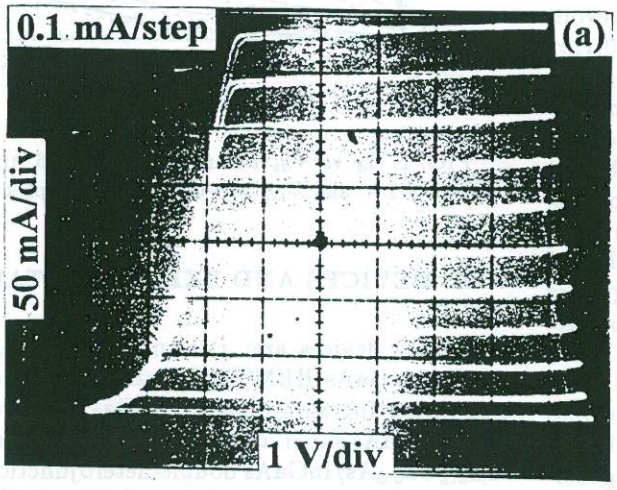


Fig.2 (a) Typical common–emitter characteristics of a δ–SHBT with emitter area of 1×10^{-4} cm^2. (b) The common– emitter configuration of the same device in the offset region on an expanded scale.



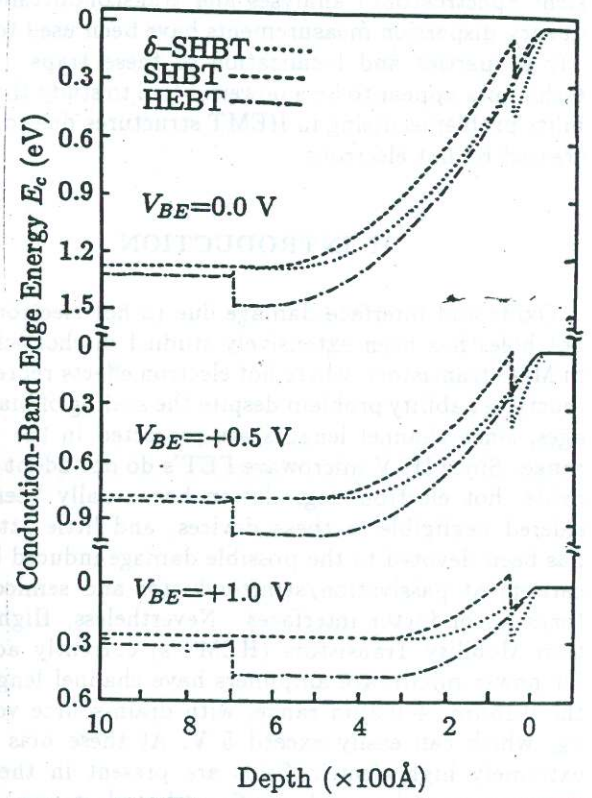


Fig.3. Calculated conduction–band edge diagrams near E–B junction of δ–SHBT, SHBT, and HEBT at thermal equilibrium, V_{be}=+0.5 and +1.0 V forward biased, respectively.