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P-N Junctions Formed in Gallium Antimonide

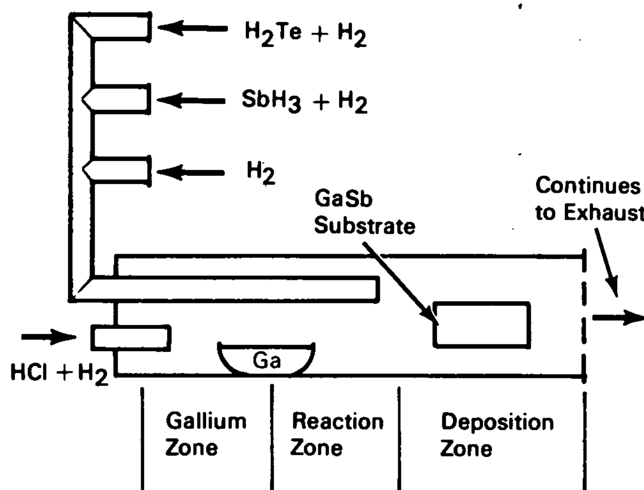

Figure 1. Vapor Deposition Apparatus

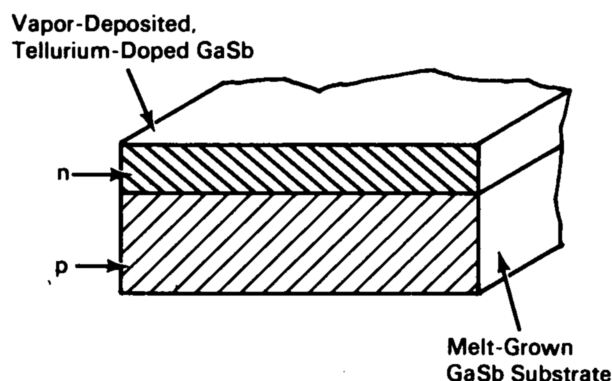

Figure 2. Cross Section of GaSb Device Formed with Vapor Deposited n-Layer

A recent prediction that a Gunn oscillator (source of microwave energy) prepared from gallium antimonide (GaSb) should have desirable properties of lower threshold field and higher efficiency than a device prepared from gallium arsenide, has generated considerable interest in developing new techniques for the preparation of p-n junctions in single crystal GaSb. Undoped GaSb is inherently p-type and would require a suitable n-type dopant, e.g., tellurium or selenium to form the n-region.

A vapor phase deposition process has been developed, using the experimental apparatus shown in Figure 1, to form the heavily doped n-region. A melt-grown p-type GaSb substrate is placed in the deposition zone; HCl is introduced over the gallium boat to transport the gallium (predominately a subchloride) to the reaction zone, where it combines with antimony hydride (SbH_3) and the dopant carrier, hydrogen telluride (H_2Te), to form n-type GaSb on the substrate. Since the growth rate of GaSb is quite low, less than 5 microns/hr, and Te has a high diffusion constant, temperatures as low as 400°C are required to prevent out-diffusion of Te into the substrate.

A cross section of a typical n-p structure is shown in Figure 2. Net electron concentrations of 2×10^{17} e/cm^3 in the n-region have been obtained. Fundamental factors which limit the growth of GaSb from the vapor phase are the low melting point of GaSb (712°C) and the low vapor pressure of antimony (1 mm).

Notes:

1. Further development of the vapor deposition would enable Gunn diodes, electroluminescent devices and transistors to be fabricated from high quality GaSb.

(continued overleaf)

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