V-BAND GaAs GUNN DIODE

Chen Xiaojian Deng Yanmao Huang Zhenqi
Nanjing Solid State Devices Research Institute
Nanjing, China

The contradictions between the thermal parameters and microwave parasitic parameters in mm-wave Gunn diodes can be released by reasonable assumption for the thermal-conducting model of devices and practical analysis of microwave parasitic parameters. The corresponding formulas and curves are derived to carefully design the configuration parameters of the V-band device and its package.

The device has N^{++}-N-N^{+}(substrate) structure, using vapor and liquid epitaxial material with nl product being about 1.5 x $10^{12}cm^{-2}$. Both the microwave performance and reliability have been greatly improved by using several technologies in device processing, i.e., growing a cathode-contract layer in $GaAs/AsCl_3/H_2$ system, plating heatsink with lower-stress, substrate thinned by chemical etching, cross-gold ribbon (thermocompression) bonding and edge-free encapsulating by ultrasonic-thermal compression. The devices provide CW output power of 154 mW at 56 GHz and 100 mW at 60 GHz, and the maximum efficiency of 4.4 percent. The chip construction is sketched in Figure 1. The predicted average operating lifetime is over 1.4 x 10^6 hours from the experimental results of long-term accelerated life test. The single-diode cavity-stabilized oscillator, using the device, has been developed with the operating frequency of 55-63 GHz and with the output power of 120 mW. A reflection-type cavity-stabilized circuit with dual coaxial series-arm, shown in Figure 2, is employed that the diode is fully matched and led to high circuit efficiency. By the careful design and adjustment the frequency and power stability are able to be boosted simultaneously. The oscillator can work stably at the temperature of -40~+70°C, with the frequency stability coefficient of 0.02 MHz/°C ($4x10^{-7}$/°C) and power stability coefficient of 0.014 dB/°C and as a pump source or a local oscillator it has found reliable applications in an uncooled 50 K low-noise parametric amplifier and in a microwave radiator, respectively. The oscillator performance at higher frequencies of the device has been observed, and it exhibits the output power of 40 mW at 70 GHz in reflection-type cavity-stabilized oscillator and over 10 mW at 94 GHz in a radial cavity oscillator. The oscillation output at the frequency higher than 100 GHz is also observed in the experiment.

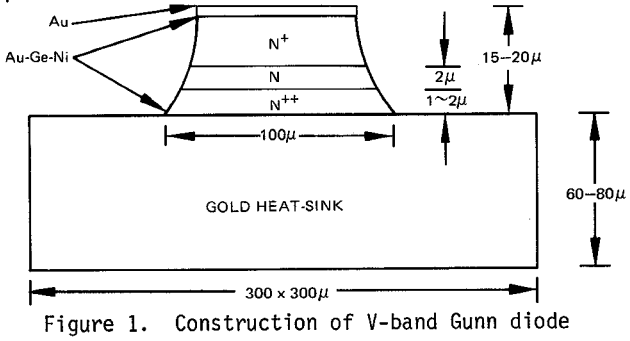

Figure 1. Construction of V-band Gunn diode

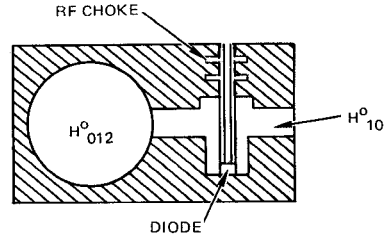

Figure 2. Reflection-type cavity-stabilized circuit