# Growth and characterization of low-threshold 1.3μm GaAsSb quantum well laser

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Strained GaAsSb/GaAs quantum wells grown on GaAs substrate, which exhibit a staggered type-II band alignment, are of interest for infrared optoelectronic devices applications, because of its optical interband transitions occur at longer wavelengths than those corresponding to the fundamental band gap energies of each constituent. The quantum wells have been used successfully to fabricate laser diodes, which have emerged to be one of the candidates for 1.3μm laser source on GaAs substrate [1]. In this study, by using Sb monomer to deposit GaAsSb layer, we demonstrate a high quality low-threshold GaAsSb/GaAs double quantum well laser diode.

The samples were grown on $n^+$-GaAs(100) substrates using VG V80MKII solid-source molecular beam epitaxy. Besides the Ga beam used for group-III source, $Sb_1$ and $As_4$ beams were adopted for group-V sources. $Sb_1$ beam was generated from an EPI Model 175 Standard Cracker cell. The cracker zone temperature was 1050°C, while the bulk zone temperature was about 410°C. The improvement on the optical quality of the Sb-containing compound semiconductor by using $Sb_1$ instead of $Sb_4$ has been reported [2]. Fig. 1 shows the structure of the GaAsSb/GaAs double quantum well laser diode. The active region is composed of two $GaAs_{0.66}Sb_{0.34}$ 7nm quantum well separated by a 30nm GaAs barrier. The design of dual quantum wells is to reduce the gain saturation effect [3]. The step-confined $Al_{0.3}Ga_{0.7}As$ layers are used to improve the optical confinement. Finally, the $Al_{0.6}Ga_{0.4}As$ layers serve as the cladding layers of the laser diode.

50μm wide broad area laser diodes with different cavity length were fabricated. In Fig. 2, we show the room temperature light-output versus injection current characteristic of the grown laser diode under pulse operation. A low threshold current density of 210A/cm$^2$ at a 1540μm cavity length is exhibited. The threshold current density is close to the lowest value reported for GaAsSb/GaAs quantum well laser diode [4]. However, our diode has longer lasing wavelength at 1.28μm as can be seen in the inset of Fig. 2. Fig. 3 shows the cavity length dependence of the threshold current density. The threshold current density of the infinite cavity length extrapolated from the data is only 83A/cm$^2$. The dependence of inverse external quantum efficiency versus cavity length is depicted in Fig. 4. The internal quantum efficieny is 62.8% and the internal loss fitted is 3.45cm$^{-1}$. The improvement of the threshold current density is attributed to be the use of $Sb_1$ for Sb source in the growth of GaAsSb layers. Temperature characteristics of the laser were measured from 25°C to 85°C, and the characteristic temperature is 60K. These

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performances indicate that GaAsSb is a promising candidate for the light sources in 1.3μm optical communication.

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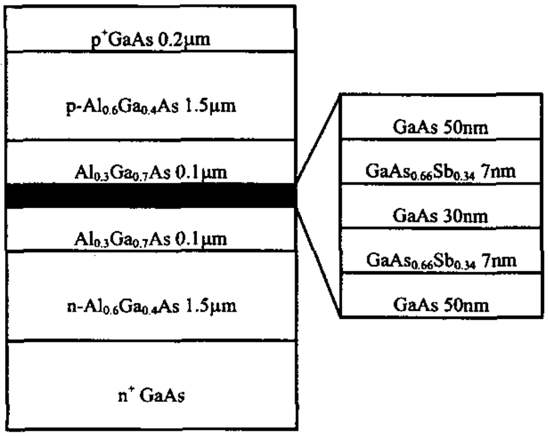

Fig.1 Layer structure of the GaAsSb/GaAs double quantum well laser.

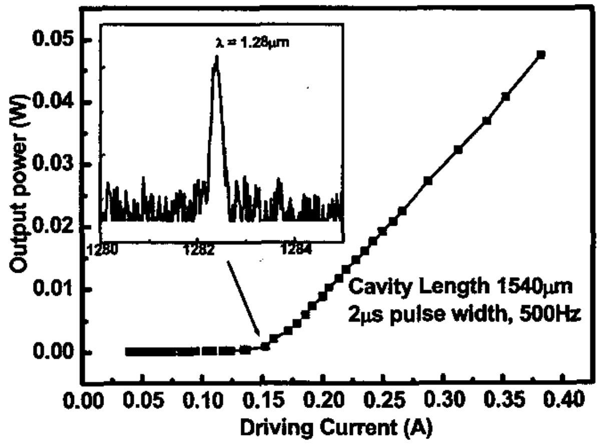

Fig.2 The L-I characteristic of the laser. And the lasing spectrum is shown in the inset.

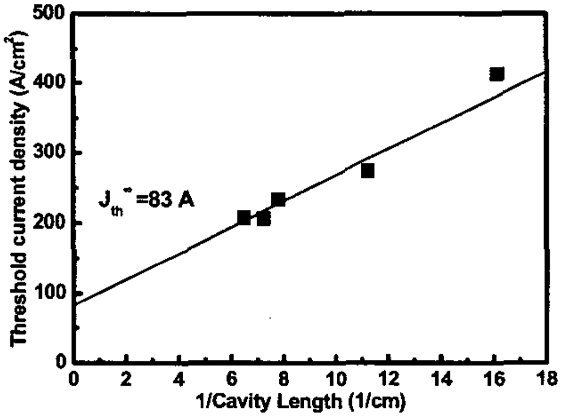

Fig.3 Cavity length dependence of the threshold current density.

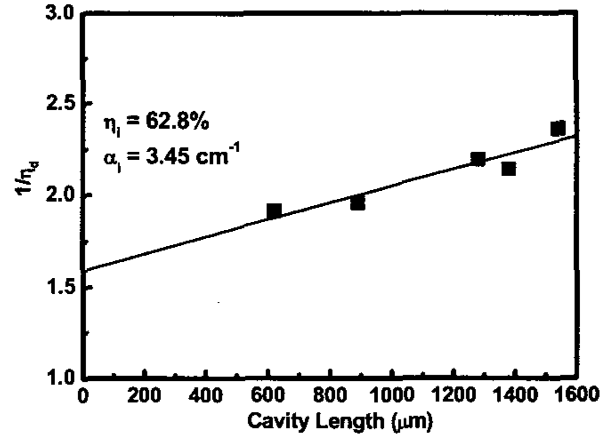

Fig.4 Cavity length dependence of the inverse external quantum efficiency.