Room temperature lasing operation of 1.5µm GaInAsP LD on InP/Si substrate

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1. Introduction
The monolithic integration of optical III-V Laser Diode (LD) especially InP based LD is a predominant factor in the actualization of light sources on the silicon platform. We have proposed the monolithic integration of III-V LD epitaxial layers on the wafer-bonded InP/Si substrate via MOVPE. Our unique approach is that we do the adhesion of thin film InP and Si substrate before the MOVPE growth. We have already shown the successful demonstration of GaInAsP LD on InP/Si substrate. [1-2] In this paper, we report the room temperature lasing operation of 1.5µm GaInAsP LD on InP/Si substrate resulting in the lowest threshold current density at the room temperature.

2. MOVPE Growth design
The epitaxial growth was performed on the directly bonded InP/Si substrate in the low-pressure MOVPE in vertical flow rotating disk reactor using hydrogen as carrier gas. The growth temperature was set to be 650°C and the pressure was 60 Torr. The precursors namely TBA, TBP, TEG, TMI, DTBSi and DEZn were employed and the growth structure consists of: n-InP (1000nm)/n-Si (250µm), n-InP (330 nm), i-GaInAsP (150 nm, active layer), p-InP (1500nm), p-GaInAs (25 nm, contact layer). The ratio of GaInAsP was maintained at Ga0.39In0.61As0.75P0.16. Fig.1 shows the epitaxial III-V layer structure grown on the InP/Si substrate by MOVPE.

![Fig.1 Layer structure design](image)

Fig.1 Layer structure design

After the MOVPE growth process, electrodes were formed using Au-Zn for p-InP layer and Au-Al for n-Si by evaporation technique. Both the facets of the laser chip were manually cleaved for the fabrication of Fabry-Perot LDs.

3. Experimental Results
Fig.2 shows the lasing spectrum of InP/Si subs. obtained at 10°C using the optical spectrum analyzer. The chip size is found to be 312µm*91µm. The peak wavelength of the lasing spectrum at the maximum injection current 4.22 kA/cm² is 1500 nm. Fig.3 shows the IL characteristics of another LD of InP/Si substrate from 0°C to 20°C. The chip size is 256µm*70µm. The threshold current density of InP/Si LD subs. increases as the temperature is increased.

![Fig.2 Lasing spectrum of InP/Si subs.](image)

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![Fig.3 IL Characteristics of InP/Si subs.](image)

Fig.3 IL Characteristics of InP/Si subs.

4. Conclusions
From the experimental results of IL, we find that the Jth is 1.70 kA/cm² at 0°C and 2.2 kA/cm² at 20°C confirming the temperature dependence of Jth and successful demonstration of room temperature lasing operation on the InP/Si subs. with the lowest threshold current density.

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References