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Wavelength Extension in GaSbBi Quantum Wells Using Delta-Doping

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Delta doped GaSbBi quantum wells (QWs) grown by molecular beam epitaxy was investigated to extend light emission wavelength at room temperature with the Bi content of 7.0 %. The delta-doped GaSbBi QWs transition energy shifts up to 47.0 meV with increasing the Te dopant concentration from 0 to 4.56x10^{12} cm^{-2}, resulting in maximum light emission of 2.42 μm, without obvious degradation of optical quality. The temperature coefficient of the band-gap for the delta-doped QW is only 0.099 meV/K compared with 0.265 meV/K from the undoped GaSbBi reference QW.

Keywords: Molecular Beam Epitaxy, Delta-Doping, GaSbBi, Photoluminescence

I. INTRODUCTION

Incorporating a dilute amount of bismuth (Bi) in Ⅲ-Ⅴ semiconductors has drawn much attention in recent years, due to that such formed dilute bismides show a number of unique physical properties like giant band-gap bowing effect [1, 2], a larger spin-orbit splitting energy [3] and surfactant effect [4] etc. For GaSbBi, several optical measurements have shown that the band-gap reduction is about 30-36 meV/%Bi [5-8], making GaSbBi compounds suitable for mid-infrared optoelectronics device applications.

However, growth of high quality GaSbBi is a challenge because bismuth element itself is difficult to be incorporated due to its large atomic size and easily segregates to surface forming droplets. High growth temperature prevents Bi incorporation because of the low bonding energy between Bi and group-III elements [9]. Bismuth content is sensitive to the V/III flux ratio, too high or too low Sb flux will lead no Bi incorporation or forming Ga or GaBi droplets [9]. Therefore, achieving a high content Bi needs low growth temperature, a near stoichiometric V/III flux ratio, a low growth rate and relatively low Bi flux [6, 10, 11].