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AlGaAs계 DBR에서의 Al 조성이 VCSEL의 표면에 미치는 영향

(Influence of Al composition in AlGaAs based in DBR on surface roughness of VCSEL)

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1. Introduction

Smooth surface morphology is an important property of semiconductor epitaxial layers for device performance. Vertical cavity surface emitting laser (VCSEL) is one of the promising optical devices due to a lot of advantages and especially 850 nm VCSEL using AlGaAs material is recently commercialized. It has been thought that AlGaAs is an ideal epitaxial material for distributed Bragg reflector (DBR) because of its lattice match on GaAs, low electrical resistivity, and large variation in refractive index as the Al composition for high reflectance mirror. AlGaAs DBR has been widely used in GaAs-based optoelectronic devices, such as reflection modulators, photonic switching devices and vertical cavity surface emitting laser (VCSEL). In this study, we investigated the influence of Al composition of AlGaAs VCSEL grown MOCVD on surface morphology.

2. Experiment

The VCSEL structure consists of a 1-λ cavity containing three GaAs quantum wells sandwiched by two distributed Bragg reflectors (DBRs). The upper carbon doped mirror is composed of 18~25 periods of low and high Al content AlGaAs layer pairs, while the lower Si-doped DBR is composed of 20~39 periods. The VCSEL epitaxial films were grown on Si-doped GaAs (100) substrate with a miscut angle of 2 degree toward <111>A by MOCVD in a vertical rotating reactor Quantitative analysis on surface morphology was investigated by atomic force microscope.

3. Summary

We investigated surface roughness of AlGaAs VCSEL grown by MOCVD, as a function of Al composition at low and high Al content layers. The surface roughness was strongly dependent on Al composition of low Al content layer. Besides the epi thickness was also one of the parameter that affected morphology.

In accordance, we believe if we use as lower Al composition for low Al content layer in DBR as the tuned wavelength is not absorbed, surface morphology would be improved under specified design.