Fabrication of InSb(N) thin film by DC magnetron sputtering

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III-V-N alloys have a property called giant band gap bowing, in which the band gap decreases with increasing nitrogen composition in the low nitrogen composition region. This is due to the fact that the electronegativity of N atoms is significantly different from that of group III and group V atoms. $InSb_{1-x}N_x$ alloys can obtain an even smaller band gap by band gap bowing because InSb is a narrow-gap semiconductor. Far-infrared optical devices with wavelengths of 8~14 µm, which is the window of the atmosphere, are expected to have various applications [1]. There have been reports on the growth of InSbN thin films by Molecular beam epitaxial (MBE) and metal-organic chemical vapor deposition (MOCVD) methods, but none by the sputtering method [2-4].

In this study, InSb(N) was grown on GaAs (100) substrate by direct current (DC) magnetron sputtering method and characterized. InSb(N) thin film was grown on semi-insulating GaAs (100) substrate by DC magnetron sputtering method using the InSb (atomic ratio of 1:1) target. All samples were grown at a growth pressure of 5.0×10^{-1} Pa, DC power of 0.10 kW, and growth time of 60 minutes. First, InSb thin films were grown by changing the growth temperatures to room temperature (RT), 150°C, and 300°C. As a result, we were confirmed that the peak intensities of (111), (220), and (311) planes increased as the growth temperature increased. Next, $InSb_{1-x}N_x$ was fixed at 300°C and the flow rates of Ar [sccm]and N_2 [sccm] were varied 50:0 (a), 49:1 (b), 45:5 (c), and 40:10 (d), respectively. As a result, we were confirmed that the peak intensity of $InSb_{1-x}N_x$ became weaker as the N_2 flow rate increased. In sample (c), broad peaks were observed in the (111) and (220) planes of InSb, while no peaks were observed in sample (d). The N compositions of $InSb_{1-x}N_x$ revealed by Secondary Ion Mass Spectrometry (SIMS) analysis were x = 0 for sample (a), x = 0.014 for sample (b), x = 0.07 for sample (c), and x = 0.11 for sample (d). We also confirmed that $InSb_{1-x}N_x$ thin films with a maximum nitrogen composition of x = 0.20 can be grown by changing the flow rate ratio of Ar: N_2 to 0:10. From these results, we found that $InSb_{1-x}N_x$ can be fabricated by sputtering by controlling Ar and N_2 gases.

References

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