Raman and FTIR Spectroscopy of GaSb and $Al_xGa_{1-x}Sb$ Alloys with Nanometric Thickness Grown at Low Temperatures by Liquid Phase Epitaxy

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ABSTRACT

GaSb and $Al_xGa_{1-x}Sb$ thin layers were grown on (001) oriented GaSb substrates by liquid phase epitaxy technique at low temperatures. Until now, there are no previous reports on the growth of this alloy at temperatures lower than 400 °C. The layers were grown from 400 to 250 °C for the ternary layers, and at 200°C for the binary layers using a supercooling process of 10 °C and a cooling rate of 0.5 °C/min. In addition to that, ternary $Al_xGa_{1-x}Sb$ layers were prepared at 250 °C for several contact times 1, 5, 10, 40 and 80 minutes, and something similar was done for binary GaSb layers, with contact times of 7.5, 15, 30, 60 and 120 minutes. Infrared reflectance results show the presence of single mode spectra for GaSb layers and two mode spectra for $Al_xGa_{1-x}Sb$ layers corroborating the growth of the alloys, whereas Raman scattering results show also the single and two mode behaviors of the GaSb and $Al_xGa_{1-x}Sb$ layers respectively. In ternary layers Raman bands, such as LO-GaSb like mode undergo a shift to low energies with growth temperature and with contact time. The results suggest a greater incorporation of Al atoms in the layer for smaller contact times that with greater contact times, and also for high temperatures that with low temperatures.

1. INTRODUCTION

GaSb and $Al_xGa_{1-x}Sb$ alloys are materials with a great importance for the development of optical devices that operate in the region from 1.3 to 6.5 μm [1-2]. This kind of compounds also has been used in manufacturing of avalanche photodiodes of high speed and low noise [3], as well as lasers of AlGaAsSb and GaInAsSb grown on GaSb or InAs substrates which emit in the range of wavelength from 2 to 4 μm [4]. These devices were made firstly from layers grown by molecular beam epitaxy (MBE) and liquid phase epitaxy (LPE), since in the technique of steam phase epitaxy (MOCVD) some problems of contamination by carbon appear. This element enters as type-p impurity and gets up to the precursor materials [5]. Due to the mentioned applications, these semiconducting materials are interesting for the scientific community, originating the necessity to investigate more on their physical properties of this kind of semiconductors III-V; In particular, structural properties can be studied by measuring lattice vibrations of the alloys. In this work, were analyzed the lattice vibrations of GaSb and $Al_xGa_{1-x}Sb$ layers, which were grown on GaSb substrates by liquid phase epitaxy at temperatures that go from 400-250 °C for the ternary layers, up to 200 °C for the binary layers. Until now reports of the growth of this type of films obtained at very low temperature do not exist.

2. EXPERIMENTAL DETAILS

GaSb and $Al_xGa_{1-x}Sb$ alloys were grown on (001) oriented GaSb substrates by liquid phase epitaxy (LPE) at low temperatures. Binary GaSb layers were grown at 200 °C for several contact times (7.5, 15, 30, 60 and 120 minutes), whereas the ternary $Al_xGa_{1-x}Sb$ layers were grown at temperatures that go from 450 to 250 °C with a contact time of 10 minutes. In addition to that, a set of ternary layers were prepared at 250 °C for several contact times (1, 5, 10, 40 and 80 minutes). The growth of the layers was performed applying a supercooling process of 10 °C, with a cooling rate of 0.5 °C/min. Experimentally the composition of the layers was kept near x=0.065, but certainty of the exact value of x is not had. Raman measurements were performed at room temperature employing the 514.5 nm line

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