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In Situ Monitoring of the MBE Growth of AlSb by Spectroscopic Ellipsometry

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AlSb is a promising material for optical devices, particularly for high-frequency and nonlinear-optical applications. And AlSb offers significant potential for devices such as quantum-well lasers, laser diodes, and heterojunction bipolar transistors. In this work we study molecular beam epitaxy (MBE) growth of an unstrained AISb film on a GaAs substrate and identify the real-time monitoring capabilities of in situ spectroscopic ellipsometry (SE). The samples were fabricated on semi-insulating (0 0 1) GaAs substrates using MBE system. A rotating sample stage ensured uniform film growth. The substrate was first heated to 620°C under As2 to remove surface oxides. A GaAs buffer layer approximately 200 nm- thick was then grown at 580°C. During the temperature changing process from 580°C to 530°C, As2 flux is maintained with the shutter for Ga being closed and the reflection high-energy electron diffraction (RHEED) pattern remaining at (2×4). Upon reaching the preset temperature of 530°C, As shutter was promptly closed with Sb shutter open, resulting in the change of RHEED pattern from (2×4) to (1×3). This was followed by the growth of AlSb while using a rotating-compensator SE with a charge-coupled-device (CCD) detector to obtain real-time SE spectra from 0.74 to 6.48 eV. Fig. 1 shows the real time measured SE spectra of AlSb on GaAs in growth process. In the Fig. 1 (a), a change of ellipsometric parameter Δ is observed. The Δ is the parameter which contains thickness information of the sample, and it changes in a periodic from 0 to 180° with growth. The significant change of Δ at～0.4 min means that the growth of AlSb on GaAs has been started. Fig. 1b shows the changes of dielectric function with time over the range 0.74～6.48 eV. These changes mean phase transition from pseudodielectric function of GaAs to AlSb at～0.44 min. Fig. 2 shows the observed RHEED patterns in the growth process. The observed RHEED pattern of GaAs is (2×4), and the pattern changes into (1×3) with starting the growth of AlSb. This means that the RHEED pattern is in agreement with the result of SE measurements. These data show the importance and sensitivity of SE for real-time monitoring for materials growth by MBE. We performed the real-time monitoring of AlSb growth by using SE measurements, and it is good agreement with the results of RHEED pattern. This fact proves the importance and the sensitivity of SE technique for the real-time monitoring of film growth by using

ellipsometry. We believe that these results will be useful in a number of contexts including more accurate optical properties for high speed device engineering.

Keywords: 타원편광분석법(Ellipsometry), AlSb, 유전함수, 실시간 성장 모니터링

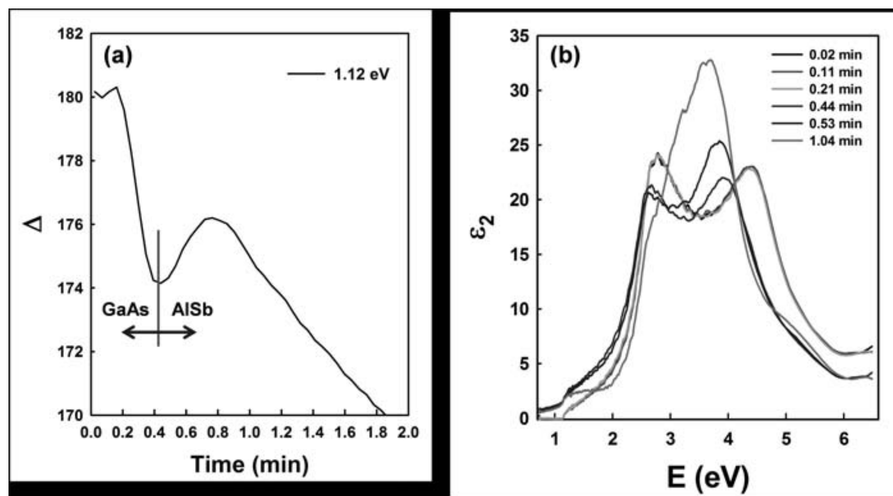

Fig. 1.

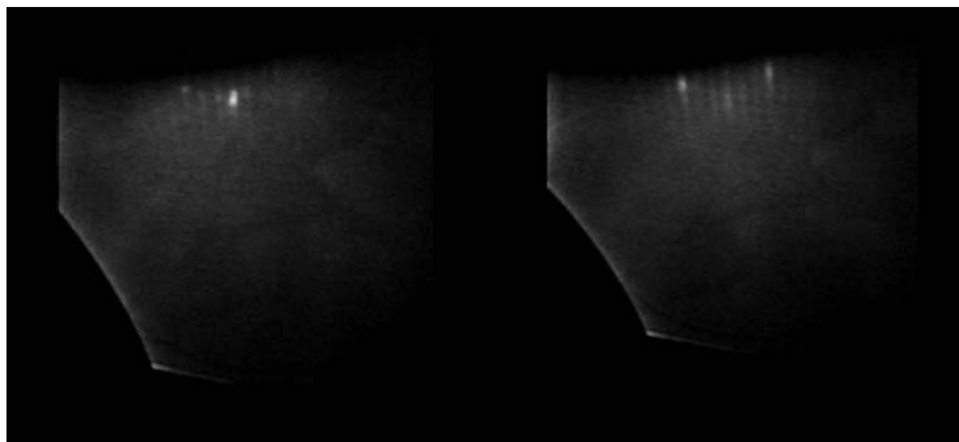

Fig. 2.