Thin Films and Coatings

LBP.MS.P10
Characterisation of MBE grown type-II superlattices with electron microscopy

Y.E. Suyolcu[1], B. Aslan[2], U. Serincan[2], S. Turan[3]

[1]Anadolu University, Nanotechnology, Eskisehir, Turkey
[2]Anadolu University, Physics, Eskisehir, Turkey
[3]Anadolu University, Materials Science and Engineering, Eskisehir, Turkey

yesuyolcu@anadolu.edu.tr
Keywords: MBE, type-II superlattice, SEM, TEM

The uses of infrared photodetectors in different areas are increasing rapidly. In recent infrared photodetector technologies, group III-V compounds have been widely used [1]. Especially, type-II InAs/GaSb superlattice (SL) structures have been proposed and heavily studied as an alternative candidate for the third generation systems [2]. It is important to study the individual InAs and GaSb layers and their interfaces of the order of 1-2 monolayers by using transmission electron microscopy (TEM) techniques since the defects in the crystal, layer thicknesses, and intermixing at the interfaces are crucial for the device performance. The most appropriate TEM techniques to investigate the layer thicknesses and to examine the packing of atoms at the interfaces are high resolution transmission electron microscopy (HRTEM) and scanning transmission electron microscopy (STEM) techniques.

Epitaxial growth of high quality electronic and optoelectronic devices require the use of high quality substrates with low defect and etch pit densities as well as the growth of atomically smooth, ideally defect-free buffer layers. The surface quality of the GaSb layer is especially critical in the detector performance; because, any roughness in the InAs/GaSb superlattices leads to inferior lateral transport and in-homogeneity of the band gap [3]. Therefore, the effect of the growth parameters such as growth temperature, V/III beam flux ratio and cooling steps for a high quality material growth was studied and the surfaces have been investigated by the SEM.

In electron microscopy the reliability of the analyses are directly related to the samples and also to the sample preparation procedures. Successful electron microscopy with all of the possible techniques depends on the quality of the specimens' examined. Preparation of TEM samples can be identified as an art more than a science. The necessity of the samples being electron transparent makes the sample preparation procedures challenging. The samples for TEM analyses are prepared in many different ways depending on the production types and/or application areas.

In this study, due to the soft and very brittle characteristics of the aforementioned structures, it was first aimed to prepare very thin (<100 nm) damage free samples for TEM analyses. After a cross-sectional TEM sample preparation recipe was improved, the TEM-BF, HRTEM and STEM techniques were used to investigate the structural properties of the MBE grown type-II SL structures. The microstructures of the SL structures were examined by the TEM-BF imaging technique after the SLs were grown. Then the layer thicknesses obtained via STEM investigations. Finally, the interfaces were examined with HRTEM technique to show the abruptness of the layers and the packing of atoms. In the SEM and TEM analyses, Zeiss Supra 50VP and JEOL™ JEM-2100F were used respectively.

1. Rogalski, A., Opto-Electron. Rev., 14**,** (2006), p. 98-84.
2. Razeghi, M., Nguyen, B.M., Hoffman, D., Huang, E.K., Delaunay, P.Y., Proc. of SPIE, 7298 (2009), p. 72981T-13-72981T-1,
3. Razeghi, M., Mohseni, H., Tahraoui, A., Wojkowski, J., Brown, G.J., Mitchel, W.C., Park, Y.S., Appl. Phys. Lett., 77 (2000), p. 1572-1574.
4. Authors would like to thank Bulent Arikan for providing MBE grown superlattice structures. This work was supported in part by TUBITAK under the Grant No. 111T335 and by Anadolu University under the project BAP-1205F083.

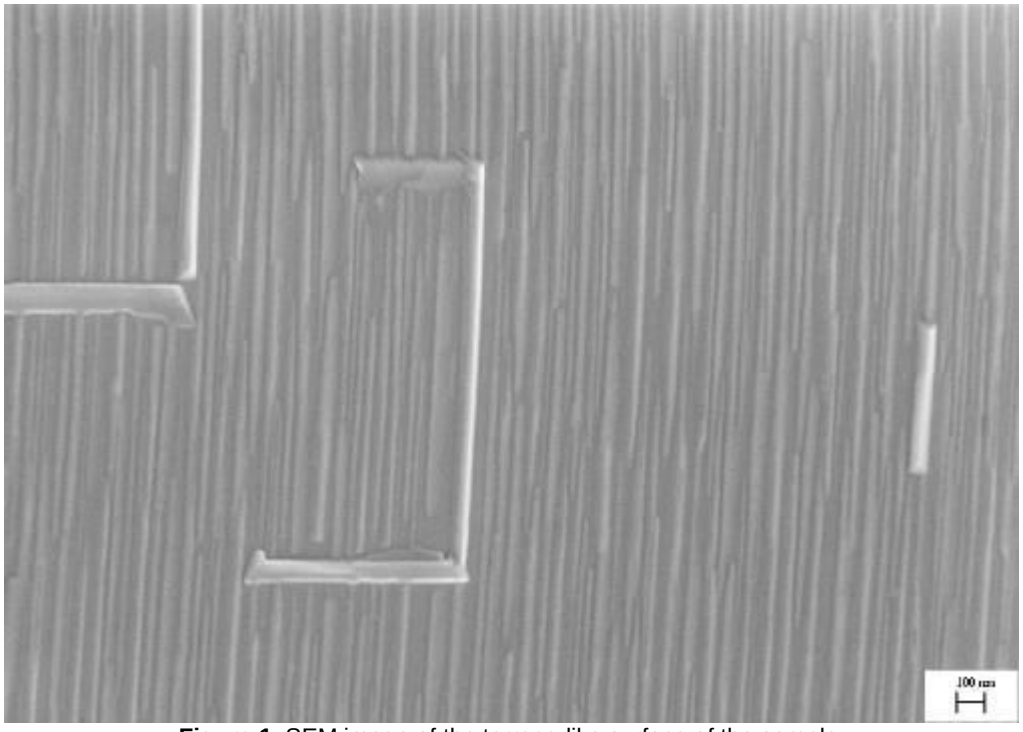

Figure 1. SEM image of the terrace-like surface of the sample.

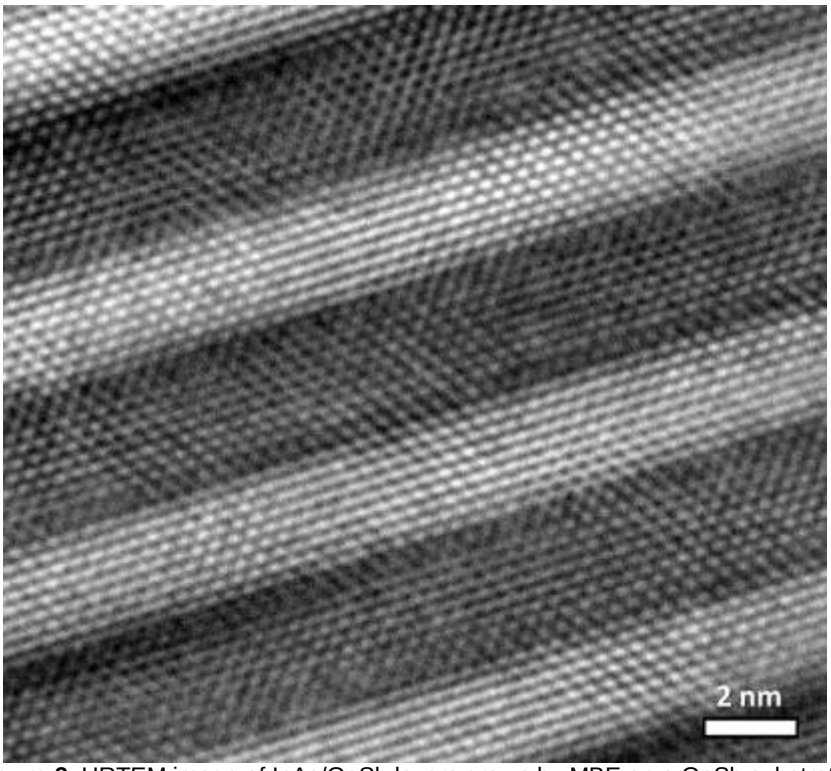

Figure 2. HRTEM image of InAs/GaSb layers grown by MBE on a GaSb substrate.