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MBE에 의해 성장된 SiGe/Si의 DCXRD와 TEM을 이용한 구조분석 연구

(Structural studies on SiGe/Si grown by MBE using DCXRD and TEM)

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Recently there has been a lots of interest in SiGe/Si hetero-epitaxial layer for the application in both optical and electronic devices. In particular, its application to high performance hetero-junction bipolar transistor is important because such devices can be integrated into VLSI silicon technology. In such materials, electronic properties depend on strain and composition, therefore accurate measurement of these factors is important to control device properties. In this work, SiGe films were grown on Si substrate at various temperature using molecular beam epitaxy (MBE) and variation of strain and crystalline quality was investigated using double crystal X-ray diffractometry (DCXRD), and transmission electron microscopy (TEM).

$Si_{1-x}Ge_x$ (x=0.2) films were grown on Si using MBE at various growth temperatures (250 C -850 C) with the thickness of 150 nm. The strain and crystalline quality were investigated using both symmetric (004) and asymmetric (224) reflections by Bede 300 double crystal X-ray diffractometer. TEM was used to observe the microstructure and RBS was also used to measure the thickness and composition of the SiGe film.

For the SiGe film grown at 250 C, peaks from both film and sustrate were found but the value of full width at half maximum (FWHM) of the peak from the film was large. As the temperature increases, peak from the SiGe film becomes sharp indicating good crystalline quality. However, the SiGe film grown above 550 C, the value of FWHM of peak from film becomes large implying the degradation of crystalline quality of film. In addition, the amount of strain in SiGe film increases as the growth temperature increases. However, for the film grown above 550 C, it decreases as the growth temperature increases.

In order to understand the above results, TEM study was carried out. According to the TEM results, for SiGe film grown below 550 C, SiGe single crystal was developed a few tens of nanometers from the interface and amorphous SiGe film was also developed above SiGe single crystal layer. For SiGe film grown above 550 C, SiGe with good single crystallinity was formed, but for the samples grown above 750 C, dislocations were developed. Therefore large value of FWHM of peak from film layer (films grown at both below and above 550 C) can be explained in terms of the presence of amorphous SiGe layer and dislocations. In this work, variation of strain according to the growth temperature and the structural properties of the system were also studied.