13-Defects, Microstructures and Textures

shown that the surface damage layer on polished GaAs wafers is in general 1 to 4 μm deep. The damage layer may result from etching, lapping or polishing. It must be etched out before making a device, because it is very detrimental to the quality and the lifetime of a device.

Table 1. The FWHM of some GaAs wafers before and after etching.

<table>
<thead>
<tr>
<th>Number of the sample</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>FWHM before etching</td>
<td>16.5</td>
<td>17.0</td>
<td>17.0</td>
<td>18.0</td>
<td>19.0</td>
<td>20.0</td>
<td>21.0</td>
</tr>
<tr>
<td>FWHM after etching</td>
<td>15.5</td>
<td>14.5</td>
<td>13.5</td>
<td>17.0</td>
<td>18.0</td>
<td>17.0</td>
<td>18.0</td>
</tr>
</tbody>
</table>

Fig. 1. X-ray double-crystal reflection topograph. 224 reflection Ga, Kα, 40 kV, 100 mA. 1 s at crystal, (113) Si 224 reflection.

Fig. 2. Relationship between etching depth and FWHM of the (204) rocking curve.

PS-13.03.12 A STUDY OF THE SURFACE DAMAGE ON A GaAs Wafer BY X-RAY DOUBLE CRYSTAL DIFFRACTION. By: Gao Zengzheng, Cao Wangde, Li Mei and Zhu Wenlin. Changshu Institute of Physics, Academia Sinica, China.

It is known from X-ray dynamical diffraction theory that the full width at half maximum (FWHM) of the rocking curve of a reflection from a perfect crystal is very small, about a few seconds of arc. But the surface damage and the defects in a crystal lead to a lower crystal perfection. The effects of dynamical and kinematical diffraction overlap, and the rocking curve FWHM increases. Patel suggested (J.R. Patel et al., Acta Met., 1962, 10, 759) that the broadening of the FWHM from the surface damage of the wafer is larger than that due to defects alone. Therefore, the depth of the surface damage layer can be detected by measurement of the FWHM at different depth from the surface of a wafer.

In this work, the surface damage on a GaAs wafer has been studied by measuring the FWHM of an X-ray double-crystal diffraction rocking curve in the non-parallel (+) setting. Seven polished GaAs wafers have been etched in a depth of about 30 μm. The FWHMs before and after etching are shown in Table 1. It is obvious that the differences in FWHM for samples No. 1, 3, 4, 5, are slight, but the decrease in FWHM after etching is of 2 to 6 seconds for samples 2, 6, and 7. From this, we can conclude that there is a damage layer on these seven samples. Fig. 1 shows a double-crystal reflection topograph of a polished (001) GaAs wafer. In the topograph, there is a group of streaks whose curvature and trend are the same to those of the rocking on the back of the wafer. In order to determine the thickness of the surface damage layer of the polished wafer, some steps have been etched on the surface of the tested wafer with the controlled chemical sample-etching technique. The height of the steps is of the order of 1 to 2 μm. Fig. 2 shows the relation between the etching depth and the FWHM for three polished GaAs wafers. The curves 1 and 2 show that the changes in the FWHM tend to steady after the depths much 1.4 and 3.4 μm, respectively. But curve 3 may be considered as a straight line. From the above result, we can conclude that the thicknesses of the damage layer are 1.4 and 3.4 μm, respectively for wafers 1 and 2, but there is no damage layer for wafer 3. From more experimental results it is

PS-13.03.3 DOUBLE CRYSTAL X-RAY Rocking curve analysis of MULTIPLE epitaxial layers. By: Li Mei, Lin Chao Li, Zhihang Shen and Zezhong Liu. Changshu Institute of Physics, Academia Sinica, Changshu, 130001, China.

We have analyzed the characteristics of GaAs/GaAs hetero-epitaxial structures by the X-ray double-crystal rocking curve method. As an example, we have analyzed a three-layer-epitaxial structure grown by LPE on a (001) GaAs substrate, where an active layer is sandwiched between two confining layers of GaAs (top layer and bottom layer, respectively). The active layer can be GaAs or a GaAsAlAs/GaAs (445) superlattice layer. We have measured the rocking curve of a 400 reflection and observed the interference fringes for the above kind of samples. Using kinematical theory, we have calculated the lattice mismatch of the aluminum component. Computer simulation of the experimental curves has been performed with kinematical and dynamical diffraction. Respectively. We have discussed the reasons for the appearance of the interference fringes, and have calculated the thickness of the different layers. We can come to the following conclusions: 1. For sample No 1, we observed the diffraction peaks of the two confining layers and the substrate. There is a shoulder on the left side of the substrate peak. In the simulated curve, two types of interference fringes can be seen. One of them is located between the diffraction peaks, and the fringe period is 15 seconds of arc. It is related to the thickness of the top layer. The other type of fringes is superposed on the left side of the substrate diffraction peak. Its period of 7 seconds of arc corresponds to a thickness of 2.3 μm. This is just the distance between the GaAs active layer and the substrate. This result implies that the interference fringes may be due to the interference between the beams diffracted by the active layer and the substrate.

2. For sample No 2, the experimental and simulated curves are basically identical. There are fringes of period 2641 seconds of arc. From the calculations result, it is determined that the interference fringes are not the Pendellosung fringes of the top layer. The fringe interference is on both sides of the GaAs layers.