Structural Studies of InGaAS/InP Quantum Well using TEM

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InGaAS/InP quantum well has become an imporant semiconductor materials due to its potential for optoelectronic devices.[1] In InGaAs/InP quantum well, active InGaAs layer is embeded in InP. In such structure, the role of interface between the layers is important because the device quality largely depends on the abruptness of the interface. In order to get high quality of interface, growth interruption (GI) is often used. [2,3] In this work, InGaAs/InP quantum wells were grown by MOCVD with and without AsH3 flow and the effects of AsH3 flow on the quality of interfaces were studied using TEM.

InGaAS/InP quantum well was grown by MOCVD with and without AsH3 flow at 873 K. Cross-section and plane-view TEM samples were prepared by mechanical grinding and subsequent ion milling using argon gas. Ion milling was carried out at liquid nitrogen temperature to reduce damage induced during the milling. Philips CM20 TEM/STEM transmission electron microscope was used to observe the sample.

Fig. 1 is the (220) dark field image of the cross section sample grown with AsH3 flow for 2 min. before and after the growth of InGaAs quantum well. As shown in this figure, the second phase identified as the Moire's fringe is developed at the area where the quantum well is expected to be formed and there is no evidence of the formation of quantum well. Furthermore, the second phase acts as the origin of the dislocations. Typical structure observed in the plane view of this sample consists of a cellular structure as shown in fig. 2. The cell size is approximately 1.0 um. The cell boundary is considered as the second phase. Similar type of structure was observed in the sample grown with 30 s and 40 s AsH3 flow before and after the growth of quantum well, respectively. However, the samples grown without AsH3 flow and 40 s AsH3 flow after the growth of quantum well show fairly well developed quantum well (see fig. 3). We haven't found any structural differences between these two samples however, more study is needed.

Our results imply that AsH3 flow prior to the growth of InGaAs quantum well introduces second phases with defects and develops cellular structure. Furthermore, InGaAs quantum well with good interface is formed by the continuous growth or AsH3 flow after the growth of the InGaAs quantum well.

References

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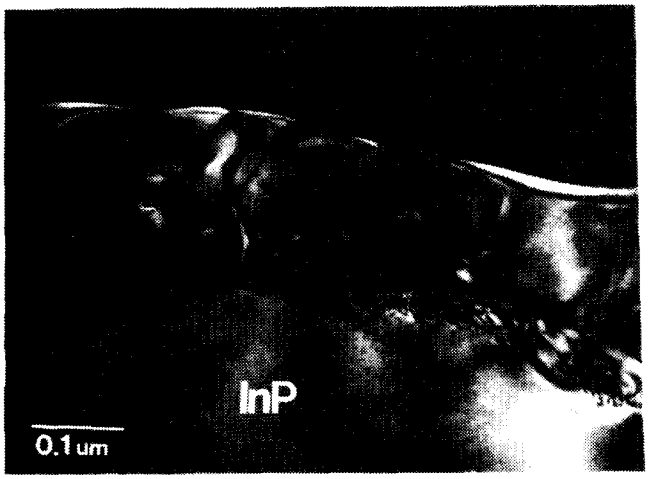

Fig.1 (220) dark field image of sample grown with 2 min. AsH3 flow both 1st and 2nd interruptions.

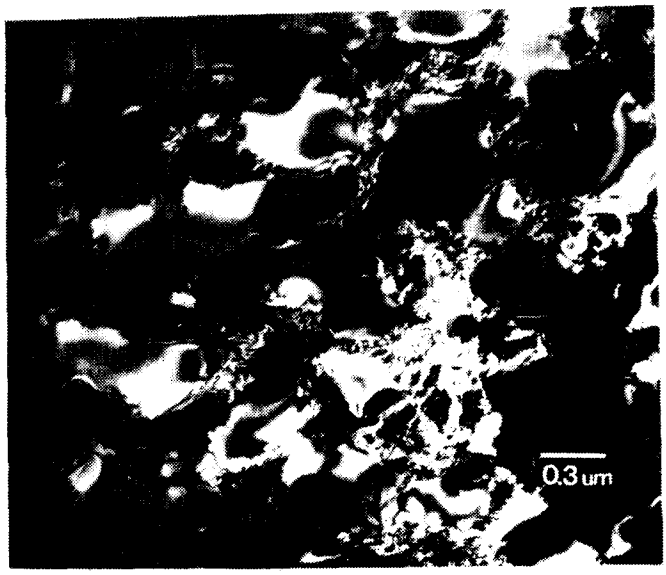

Fig.2 (200) dark field image of plane view sample grown with 2 min. AsH3 flow both 1st and 2nd interruptions.

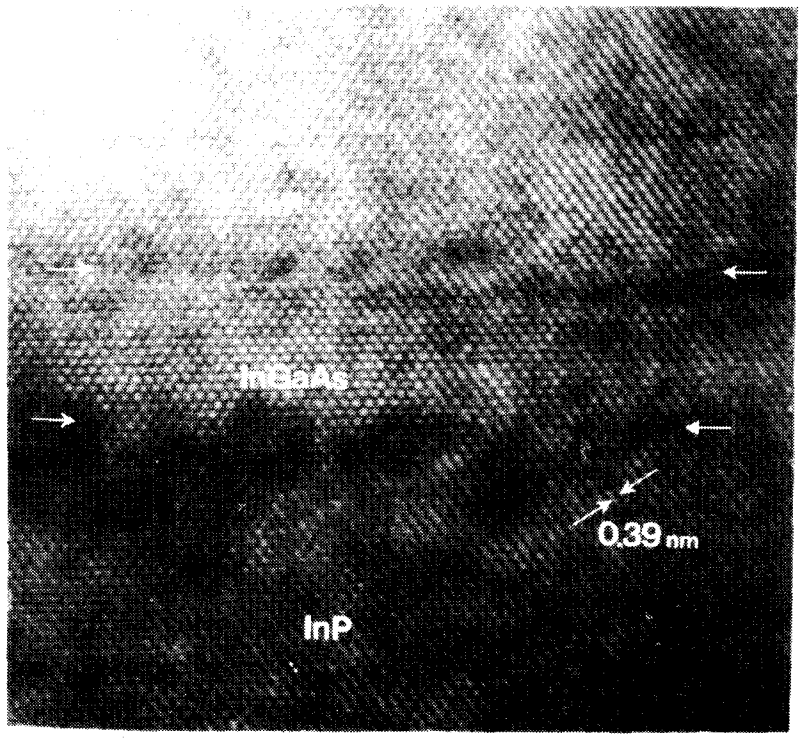

Fig. 2 (110) high resolution lattice image of the sample grown without growth interruption.