Analysis of Auger depth profiles with a resolution function

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Auger depth profiling analysis is widely used for the evaluation of multilayers structures. In practical case, we find the broader interfaces of the Auger depth profiles rather than those of true ones due to atomic mixing, surface roughness caused by the ion sputtering and the effects of inelastic mean free path. Usually the depth resolution is expressed as the distance between 16 and 84% (or 84 and 16%) of intensity change at an interface. This definition , however, could not describe the shape of the depth resolution clearly.

Although the depth resolution function obtained from Auger depth profile is very useful, it is scarcely applied to describe the resolution of the interface. We have, then, applied to the analysis of GaAs/AlGaAs sample contained Al graded-layers in order to know the effectiveness of the depth resolution function.

Experimental

The sample used for the analyses; 1) graded-layer sample and 2) reference sample ; were shown in Fig.1. The samples were prepared by MOCVD. The x in the graded layer was changed from 0 to 0.22.

Auger depth profiling using 1 kV Ar+ sputtering was carried out. The measurements were made with JEOL JAMP-30 scanning Auger Microprobe. The primary electron accelerating voltage was 5kV. The measurement range 25 - 85 eV.

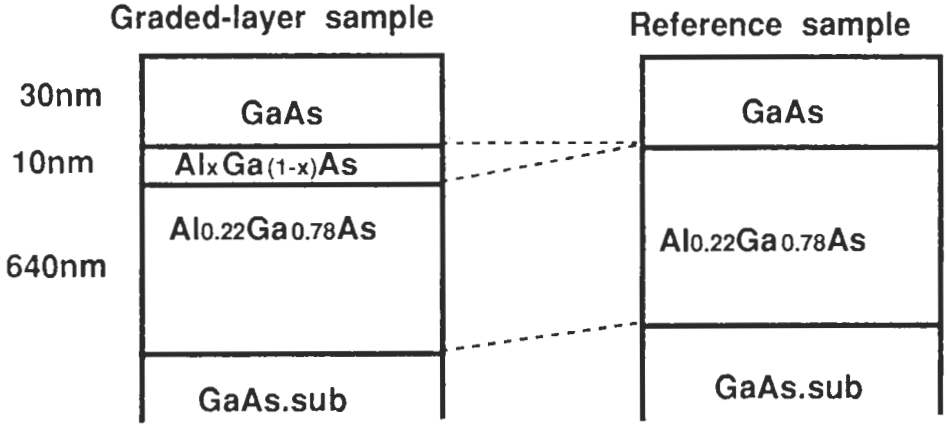

Fig.1. The samples of Al graded-layer and the reference of GaAS/Al0.22Ga0.78As

Results and Discussion

The Auger depth profiles were shown in Fig.2. However, the Al and Ga Auger profile were overlapped each other. Then we carried out the peak separation to the components of GaAs and AlGaAs with non-negative least square curve fitting method. Therefore, Fig 2 shows the Auger depth profiles of the GaAs component and AlGaAs one. From this figures, we could find the difference between reference and graded-layer samples. However, it is hard to know the thickness of the Al graded-layers. From the Auger depth profile of the reference sample, we could obtain the resolution function of GaAs component as shown in Fig. 3

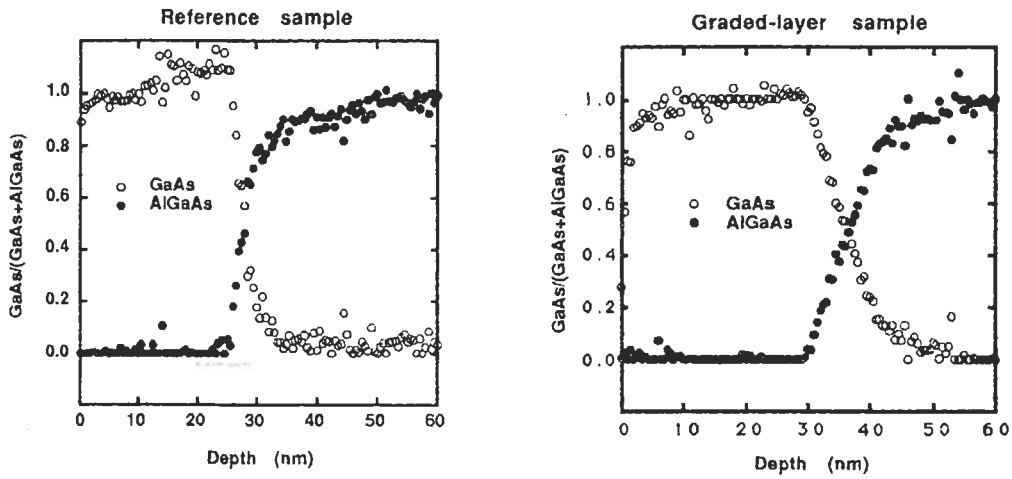

Fig. 2 The depth profiles of the component GaAs and AlGaAs.

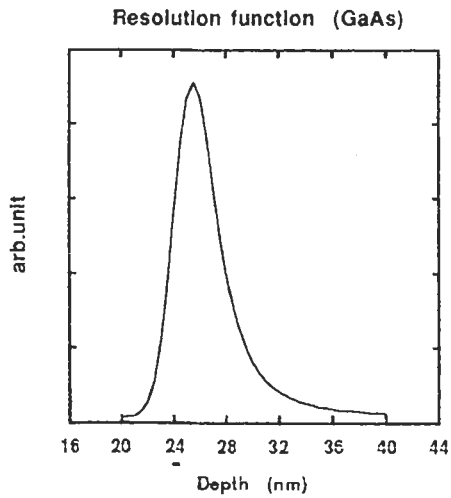

Fig. 3 The depth resolution function of GaAs obtained from the reference sample.

Using this resolution function, we calculated the Auger depth profile of the GaAs component in the graded-layer with the convolution method. The resulting profiles were shown in Fig.4.
In this figure, the solid line expressed as the convolution results of 14 nm-layer-thickness coincide well with the observed Auger depth profile as shown in open circles. The resulting thickness is also in good agreement with the one estimated from the growth rate of the thin films at preparing the sample with MOCVD.

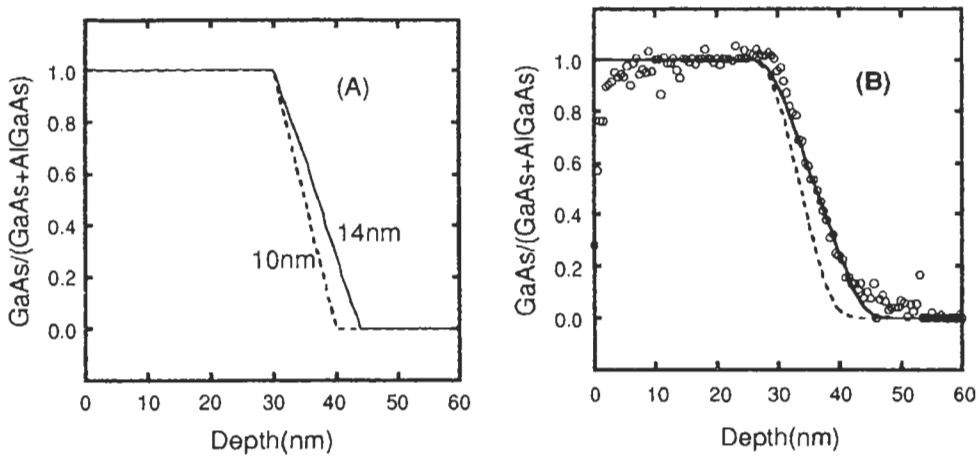

Fig. 4 Calculated Auger depth profile of GaAs component and the model of the graded-layer sample.