Auger Depth Profiling Analysis Using Inclined Holder

Toshiya Ogiwara and Shigeo Tanuma
National Institute for Materials Science, 1-2-1 Sengen, Tsukuba, Ibaraki 305-0047, Japan
OGIWARA.Toshiya@nims.go.jp

(Received: November 17, 2008; Accepted: February 12, 2009)

We have investigated the high depth resolution Auger depth profiling using an inclined holder. The developed inclined holder enables the very shallow incident angle of argon ion for sputtering to be used. In consequence, depth profiles of Ga LMM and Al KLL from a GaAs/AlAs multilayer specimen showed a much better depth resolution compared to those obtained by the conventional method. We also measured the Auger depth profiles of a Si/Ge multiple delta-layer specimen using the inclined holder and confirmed. A Ge mono-layer can be profiled.

1. Introduction

Auger electron spectroscopy (AES) combined with argon ion sputtering is widely used for the depth profiling of multilayer structures. In this method, it is very important to measure the depth profile of a specimen with high depth resolution to evaluate the structure of materials precisely. In this work, we have carried out the high depth resolution Auger depth profiling analysis with a very shallow incident angle of argon ion for sputtering using an inclined holder.

2. Experimental

A schematic view of the shallow angle argon ion sputtering method using an inclined holder is shown in Fig.1. The sample is mounted on a slanted sample holder. The sample surface is inclined over an angle 45° with respect to the base plane. In consequence, the angle between the sample surface normal and the electron beam direction is 45° with independence of the azimuthal rotation [1]. At the same time, the incidence angle of argon ions can be varied from 38.9° to 83.3° by rotating the sample. In this way, the inclined holder enables the very shallow incident angle of argon ion for sputtering to be used. In order to examine efficiency of this method, we have performed Auger depth profiling of a GaAs/AlAs multilayer specimen [2] using the inclined holder.

3. Results

The measured Auger depth profiles of the GaAs/AlAs multilayer specimen using the inclined holder are shown in Fig. 2(a). The incidence angle of argon ions was 83.3°. For comparison, the Auger depth profile measured by the conventional method at the incidence angle of 38.9° is shown in Fig. 2(b). The depth resolutions of Ga LMM and Al KLL obtained from Figs. 2(a) and (b) versus the depth from the surfaces are summarized in Fig. 3. The depth resolution is defined by the distance between 16% and 84% (or 84% and 16%) of the intensity change at an interface. The depth profile of Ga-LMM and Al-KLL in Fig. 2(a) showed much better the depth resolution compared to that of the conventional method as shown in Fig. 2(b). We applied the inclined holder to the measurement of a Si/Ge multiple delta-layer specimen [3]. The measured Auger depth profile of the Si/Ge multiple delta-layer specimen using the inclined holder is shown in Fig. 3(a). Fig. 3(b) shows an enlarged profile of the Ge. We can observe the Ge mono-layer of the Si/Ge multiple delta-layer specimen using an inclined holder. This method is the practical measurement method utilizing the characteristic of the hemisphere type AES device.

4. Summary

We have carried out the high depth resolution Auger depth profiling using the inclined holder. The obtained results are summarized as follows:

(i) The depth profiles of Ga-LMM and Al-KLL from the GaAs/AlAs multilayer specimen showed a much better depth resolution compared to those obtained by the conventional method.

(ii) The depth resolution obtained from the inclined holder method is almost constant and independent on the depth. The highest depth resolution was about 3 nm.

(iii) The Ge mono-layer can be profiled by the inclined holder.

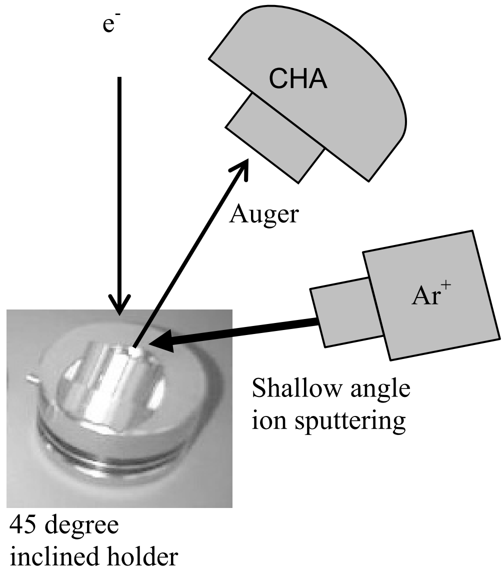

Fig. 1 Schematic view of the shallow incident angle ion sputtering method using the inclined holder.

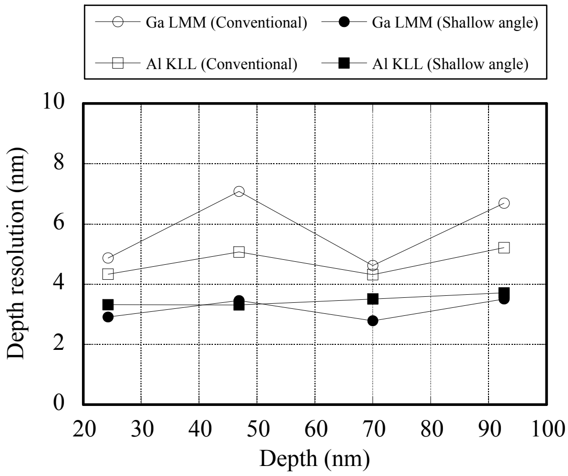

Fig. 3 Dependence of the depth resolution of the GaAs/AlAs multilayer specimen on the depth from the surface.

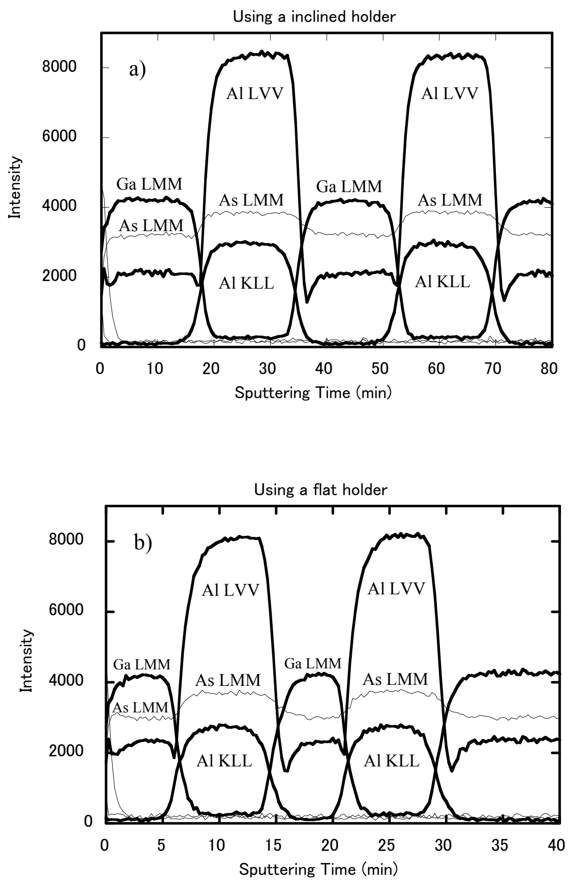

Fig. 2 AES depth profiles of the GaAs/AlAs multilayer specimen obtained using (a) the inclined holder and (b) conventional method.

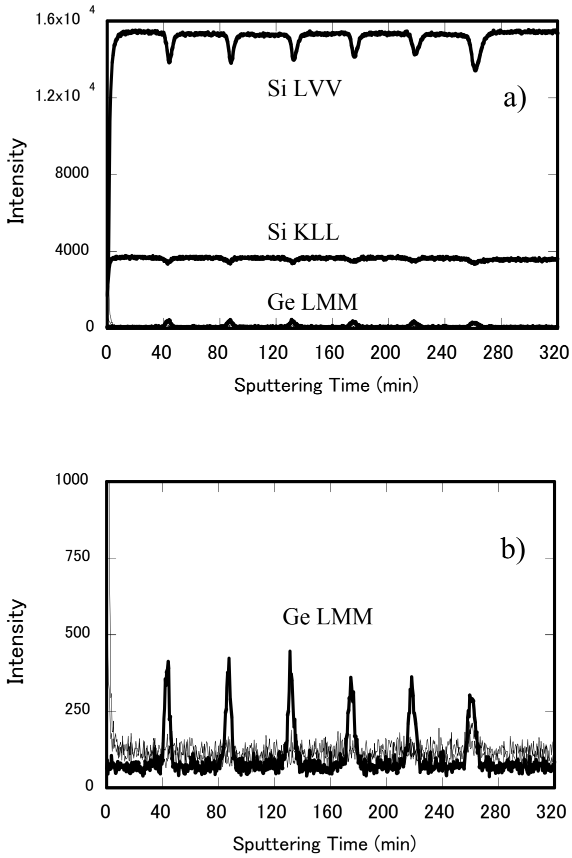

Fig. 4 AES depth profiles of the Si/Ge multiple delta-layer specimen using an inclined holder. (a) Depth profiles of Si LVV, Si KLL and Ge LMM. (b) The enlarged Ge LMM depth profile.

5. Acknowledgements

The authors are grateful to Dr. K. J. KIM of KRISS for preparing the Si/Ge multiple delta-layer specimen.

6. References

[1] W. S. M. Werner, W. Smekal and H. Stori, Surf. Interface Anal. **31**, 475 (2001).
[2] NIMC CRM 5201-a, GaAs/AlAs superlattice reference material, GaAs:24nm/ AlAs:22nm/ GaAs:23nm/ AlAs:22nm/ GaAs(substrate).
[3] KRISS RM, Si(39.45nm)/ Ge(delta-layer)/ Si(39.59nm)/ Ge(delta-layer)/ Si(39.14nm)/ Ge(delta-layer)/ Si(39.04nm)/ Ge(delta-layer)/ Si(39.07nm)/ Ge(delta-layer)/ Si(37.83nm)/ Ge(delta-layer)/ Si (substrate).