Materials Science

4A/2005C016

Characterization of nanometer-sized metal particles embedded in thin film by microbeam grazing incidence small angle x-ray scattering (μGISAXS)technique

Kazuhiro TAKADA[1], Taihei MUKAIDE[1], Takashi Noma[1], Atsuo IIDA[2]
[1]CANON Research Center, Shimomaruko, Tokyo 146-8501, Japan
[2]KEK-PF, Tsukuba, Ibaraki 305-0801, Japan

Introduction

Recently nanometer-sized metals are interested because of their characters. By controlling the characters (size, size distribution etc.) of particles embedded in thin films, we can obtain the thin films which have various physical properties. To produce such a thin film, it is important to know the detail structures of the films.

Grazing incidence small angle X-ray scattering (GISAXS) technique [1-2] is effective method to evaluate the structure and morphology of the nanometer-sized particles or the nanostructures. So it is ideal to know the metal particles characters. By controlling the incident angles, we can evaluate the depth-controlled information of the nanostructures. However under the grazing incidence condition, the irradiated areas of x-rays become large. Using GISAXS combined with X-ray micro-beam (μGISAXS), it is possible to restrict the irradiated areas about few micrometer size in lateral direction even under the grazing incidence condition. So μGISAXS is suitable to evaluate the structures of practical devices. In this study, we have investigated mainly the distribution of the metal particles embedded in thin film.

Experiment

The experiment was done using standard micro-beam setup at BL-4A. The X-ray energy was 8keV. The X-ray micro-beam size was set to 4μm×5μm by Kirkpatric-Baez system. The scattered intensity was measured by an image intensified X-ray CCD camera (C4880-80 Hamamatsu photonics K.K.) or Imaging Plate. The vacuum path was inserted to reduce air scattering between the sample stage and detector. The sample to detector distance was set about 1400mm. The half transmitted specular beam stop was set in front of the detector.

We confirmed beforehand that μSAXS optics have a resolution about 60nm in transmission mode. The measurement was done by changing the incident angles. The incident angles were changing from 0.2°(lower than the total external reflection angle; α_c) to 0.6° (higher than α_c), so we measured the depth information of the metal particles. The sample was thin film in which nano-meter sized metal(= gold, silver) embedded.

Results and Discussion

Typical μGISAXS patterns are shown in Fig1. At the small angle region, the scattering from the metal particles, the specular beam which intensity was attenuated and Yoneda wing are observed. The X-ray scattered pattern of Fig1(a) shows that the metal particles are uniformly distributed. The pattern of Fig1(b) shows the interference reflections of the film thickness. From these data, it is possible to estimate of information about the metal by using the technique of local monodisperse approximation (LMA)[3].

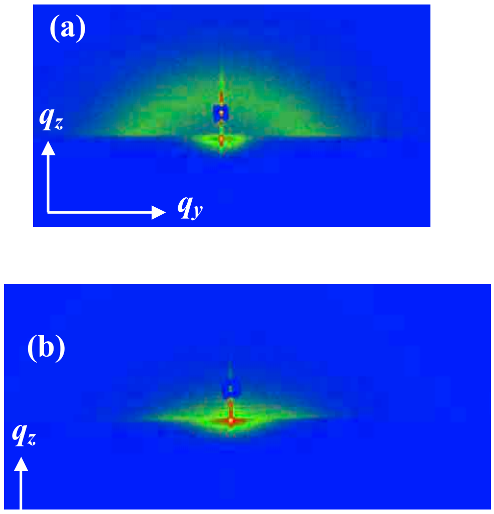

Fig.1 Typical μGISAXS patterns of the (a) gold embedded film obtained with an incident angle α=0.3°. (b) silver embedded film obtaioned with an incident angle α=0.3°.

References

[1] D.Babonneau et.al., Appl. Phys. Lett. 76,2892(2000).
[2] H.Okuda et.al., Appl.Phys.Lett. 81,2358(2002).
[3] J.S.Pedersen, J.Appl.Cryst. 27,595(1994).

* takada.kazuhiro@canon.co.jp