A NEW SMALL ANGLE X-RAY SCATTERING TECHNIQUE FOR DETERMINING NANO-SCALE PORE/PARTICLE SIZE DISTRIBUTIONS IN THIN FILMS

Y. Ito, K. Omote and J. Harada
X-ray Research Laboratory., Rigaku Corportion.,
3-9-12 Matsubara, Akisima, Tokyo 196-8666, Japan

It is well known that small angle X-ray scattering (SAXS) technique can be used to measure nano-scale pore/particle size distributions in thin films. In the conventional SAXS technique, however, the geometry with specimen in transmission is commonly used. X-rays are strongly absorbed by the substrate, and the transmitted X-Rays are very week. This makes it very difficult to use SAXS for determining pore/particle size distributions in thin films deposited on substrates.

Recently, we have developed a new SAXS technique with specimen in reflection for rapid and precise measurements of nano-scale pore/particle size distributions in thin films. The new SAXS technique uses a laboratory X-Ray source and a conventional diffractometer. Experimentally, an offset $2\theta/(\theta + \Delta\theta)$ scanning technique is used to avoid strong specular X-ray reflection from the surface and interfaces so that the true SAXS by pores/particles in a film can be measured with precision.

A new analytical model has been developed for the analysis of experimental SAXS intensities. The model takes into account of absorption, surface and interface effects. The pore/particle size distribution is assumed to follow the Gamma distribution function with two parameters (average pore/particle diameter and distribution coefficient). Values of the two parameters are determined by profile fitting.

In this paper, the results of using the SAXS technique to analyze porous methyl silesesquioxane (MSQ) films on Si substrates are presented. MSQ is a low dielectric material

and has an application as an interlayer insulator. A comparison of the SAXS results with those obtained by gas adsorption, TEM and positron annihilation techniques will be also given.