Ion beam irradiation effects of oxide thin films formed by oxygen cluster ion beam assisted deposition

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Introduction

The thin films metal oxides, for example TiO_2 will be used for multi-layer thin film for optical devices combined with SiO_2 thin films. It is necessary for the improvement of the optical properties to control accurately the refractive index and the optical transparency of the TiO_2 layer, i.e. high stoichiometry and so-called 'amorphous' structure.

The fluorescence XAFS analysis is one of powerful tools to analyses the valence state and the structure of the 'amorphous' thin films at the atomic level instead of the conventional X-ray diffraction technique. In this study we made the fluorescence XAFS measurement of Ti oxide thin films, which were obtained by the oxygen gas cluster ion beam assisted deposition techniques.

Experimental

The Ti K-XAFS of Ti oxide thin films with 200nm thickness, which were formed by both the oxygen gas cluster ion beam assisted deposition and an electron beam deposition, were measured in fluorescence XAFS mode by a Lytle type ionization chamber using incident X-ray beam monochromatized by double Si(111) crystals at beam line 7C and 9A. Also the Ti K-XAFS of Ti metal, two polymorphs of TiO_2, rutile and anatase, were measured as reference spectra.

Results and Discussion

Fig. 1 shows the comparison of the Ti K-XANES of the samples. The significant difference of the spectral features is observed between the films under electron beam and 3keV accelerated cluster ion beam deposition conditions, and two polymorphs of TiO_2.

Fig. 2 shows the comparison of the Ti K-EXAFS of the samples. Also the significant loss of long-range-order in high *k* region is found for both the films deposited with assistance of 3keV accelerated cluster ion beam and electron beam deposition. This suggests that these Ti oxide thin films have the amorphous-like structure.

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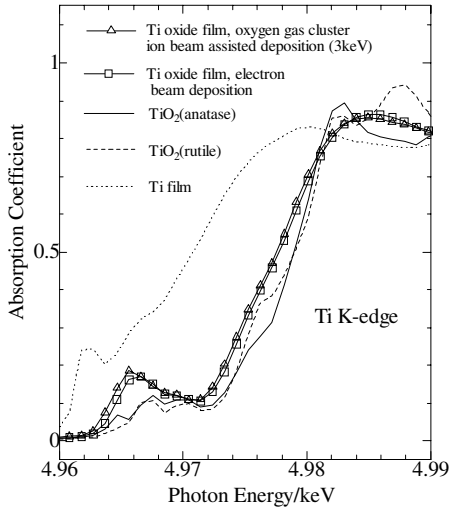

Fig. 1. Ti K-XANES of Ti oxide thin films, which were formed by the oxygen gas cluster ion beam assisted deposition (3keV) and electron beam deposition together with those of Ti metal, TiO_2 (rutile) and TiO_2 (anatase).

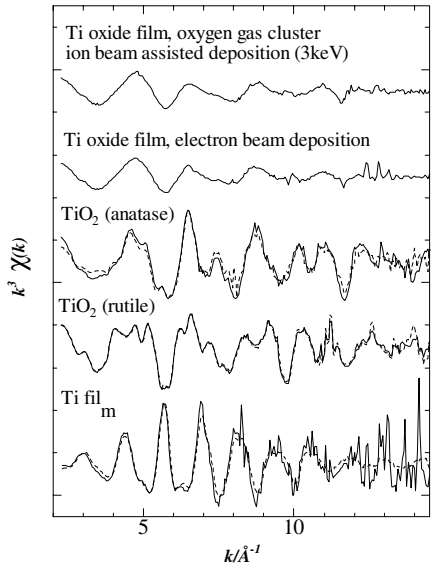

Fig. 2. Ti K-EXAFS of Ti oxide thin films, which were formed by the oxygen gas cluster ion beam assisted deposition (3keV) and electron beam deposition together with those of Ti metal, TiO_2 (rutile) and TiO_2 (anatase).

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