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Study of α-Al_2O_3/Ru(0001) structure by X-ray diffraction

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Introduction

Single-crystal oxide films are important materials from standpoints of fundamental research and application. Those materials are expected to show interesting properties, such as band gap narrowing and metal-insulator transition, when they are grown on metallic crystal surfaces[1]. Since those electronic properties are dependent on the thickness and the quality of the crystal oxide film, characterization of the film by X-rays is required. Synchrotron radiation is necessary for the characterization because the thickness of the film is so thin, about 10 Å, that the expected intensity of X-rays reflected from the film is very weak. In this work, we examine α-Al_2O_3/Ru(0001), which has various potentials for application in thin-film technology[1,2].

Experimental

The combination of α-Al_2O_3 and Ru is very convenient for crystal growth because of the small mismatch between their lattice constants.

Our sample was prepared in an ultrahigh vacuum chamber. A disk of Ru(0001) single crystal was set in the chamber and its surface was cleaned by annealing. Al was deposited on the clean surface from a tungsten basket. After the deposition, a crystalline film of α-Al_2O_3 was grown by heating the surface in O_2 atmosphere. The designed thickness of the α-Al_2O_3 film is 15 Å.

The experiment was performed at BL-9C using a 6-axis diffractometer controlled by SPEC. X-rays of wavelength 1.0 Å were selected by a double-crystal monochromator and focused by a bent-cylindrical mirror. The contamination of the higher harmonics was removed by the mirror. The intensity of reflected x-rays was measured along the 00 rod.

Results and discussion

The result of the measurement is shown in Fig.1. The strong reflection at L=2 is caused by the Bragg reflection of the Ru substrate. It is not clear what weak reflections at L=1 and L=3 are attributable to, since that L is odd is the cancellation condition for not only Ru but also α-Al_2O_3. One remarkable feature of the reflection curve is the fluctuation of intensity around L=1. If this fluctuation is caused by interference of x-rays reflected from the Ru substrate and the α-Al_2O_3 film, it could be a key to evaluate the thickness of the film. Now we are making preparations for the further experiment.

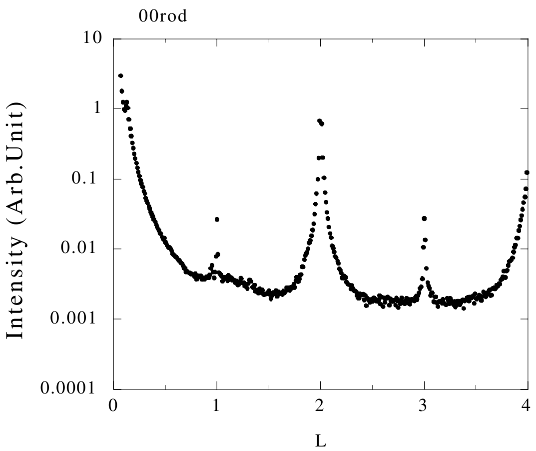

Fig.1. Intensity of reflected x-rays measured along the 00 rod.

References

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