혼합 이온빔을 이용한 주석산화물 박막의 성장
(Growth of Tin Oxide Thin Film deposited by a Hybrid Ion Beam)

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A hybrid ion beam system consisted of an ionized cluster beam(ICB) source and a broad gas ion gun was adopted to grow tin oxide thin film(SnO_2) on Si(100) and BK7 glass substrates. A ICB source was used for Sn metal evaporation and a cold hollow cathode ion gun was applied to irradiate oxygen ion during metal deposition. In this experiment, a reactive ICB(R-ICB) deposition technique in which Sn metal was evaporated with various acceleration voltages of 0-4 kV in O_2 environment and a ractive ion assisted deposition(R-IAD) where oxygen ion were irradiated during Sn metal evaporation without acceleration were carried out for the formation of tin oxide thin film.

In R-ICB, composition of deposited tin oxide film were turned out mainly Sn metal and SnO, and Sn metal became dominant as accelaration voltage increased. Surface roughness of tin oxide film deposited by R-ICB increased from 47 to 212 Å as acceleration voltage increased from 0 to 4 kV.

In R-IAD, however, tin oxide film showed highly preferred orientaion along SnO_2(200) axis were grown on Si(100) and glass at room temperature when only discharged oxygen ions were introduced during Sn metal evaporation. The composition of quite transparent SnO_2(200) film was identified as stoichiometric by x-ray photoelectron spectroscopy(XPS) and Auger electron spectroscopy(AES).

Moreover, the relative arrival ratio of oxygen ion to Sn metal particle were changed in R-IAD, where Sn metal is evaporated without acceleration and oxygen ion flux were changed at constant ion-beam-supply potential of 500 eV, i.e., the average energy of incident oxygen ions from 10 to 100 eV during tin oxide thin film growth. From Rutherford backscattering spectroscopy(RBS) analysis, oxygen contents increased and composition of deposited film became stoichiometric as average energy or oxygen ion flux increased. In particular, by comparison of Sn metal and SnO_2 powder with deposited tin oxide film by XPS and AES analysis, chemical shift bewteen stannous tin($SnO:Sn^{2+}$) and stannic tin($SnO_2:Sn^{4+}$) were observed 1.0 eV[1], and which results reveal more accurately the binding energy difference between two states than previously reported value of 0.65-0.7 eV[2].

1) W.K. Choi, H.-J. Jung, and S.K. Koh, J. Vac. Sci. Technol.(accepted, Oct. 1995)
2) J.M. Themlin, M. Chtaib, L. Henrard, P. Lambin, J. Darville, and J. M. Gills, Phys. Rev. **B** 46(4), 2460 (1992).