[III-17]

XPS study of RuO_2 films deposited by reactive sputtering

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The conductive metallic oxide, RuO_2, has been recently the subject of numerous studies as a bottom electrode for ferroelectric thin film capacitors because of its excellent electrical and diffusion barrier characteristics. The sputter-deposited RuO_2 film may be amorphous or polycrystalline according to the deposition conditions. Electrical properties vary as the phase of RuO_2 film. The resistivity of the polycrystalline film is lower than that of the amorphous film. In transition metal compounds, the valence d-electrons play an important role in the electrical properties. In case of RuO_2 single crystal, the resistivity is associated mainly with electron-phonon scattering.

In the present work, the relationship between the electrical properties and the electronic structures of the RuO_2 films has been investigated using a monochromatic X-ray photoelectron spectroscopy (XPS). Core level spectra of XPS did not show any distinctive difference between the observed phases. The valence band spectra, however revealed a characteristic relationship between them. A sharp valence d-band near the Fermi edge, which is closely related to the film conductivity, has been observed in the polycrystalline film while a broad valence d-band has been observed in the amorphous film. The valence band structure and its contribution to the electrical properties of RuO_2 films will be further discussed.