CHAPTER V
CONCLUSIONS

Titanium oxide mixed-phase thin films were successfully fabricated via RF magnetron sputtering and reactive gas timing (RGT) sputtering. For RF magnetron sputter deposition, the prepared TiO_2 films are ultra-thin (less than 5 nm). In the visible and near-IR spectrum, all samples exhibit a high transmittance (> 85 %T). Except for the 2.2 Pa sample, the transmittance tended to decrease as the working pressure increased. Refractive index depends on preparation condition (working pressure). Mixing phase of Rutile and Anatase were found in all films corresponding to XANES results. The fitted plots of EXAFS data in the R-space show that the bond length of the lower working pressure sample is greater than that of higher.

By using reactive gas timing (RGT) sputtering technique, TiO_2 thin films were fabricated on a silicon and glass substrates at fixed working pressure and power. The oxygen flow timing was varied between 3 and 57 s and the stop timing was kept at 3 s. Cross-sectional SEM images reveal that the morphology of prepared TiO_2 thin films have noticeably nano-column shape. The transmittance spectra from UV-vis measurement of the RGT samples are obviously different from the spectrum of uncoated glass slide. The maximum transmittance spectra of the shorter oxygen flow timing show a longer wavelength. Conventional, RGT 57:3, RGT 27:3, and RGT 3:3 films have maximum transmittance peaks at about 475, 530, 560, and 596 nm, respectively, and the maximal light transmittance value is 96%. All of the investigated metal oxides lowered the optical transmittance of undeposited glass when applied as a single layer of TiO_2. The GIXRD diffraction pattern and Raman spectra of all films exhibits mixed anatase and rutile structure. The XRD results also show that the intensity of the anatase and rutile peaks varies on the preparation conditions.

Considering with the UV-vis result, the transmittance of TiO_2 thin films is sensitive to slight variation in the film structure. The normalized Ti K-edge XANES result in fluorescence mode at different oxygen timing sequence including the spectra of reference samples are report. The characteristics of pre-edge and white line regions of all films reveal the rutile-anatase phase mixture. Linear combination fitting of XANES data exhibits that weight of TiO_2 Anatase and Rutile in TiO_2 thin films depend on the oxygen flow timing which is good agreement between XANES and XRD results. Bond length between Ti – O and Ti - Ti were shown by EXAFS results.

TiO_2+SiO_2 multilayer thin films were fabricated. Transmittance of TiO_2+SiO_2 multilayer is different from SiO_2 single layer. XANES and EXAFS results are analyzed. In the visible area, the light transmittance of SiO_2-TiO_2 multilayer films was larger than that of a single layer TiO_2 film. The shorter oxygen flow duration results in a larger wavelength shift in the spectrum of maximum transmittance. These multilayer thin films are suitable to be used for anti-reflection coating and filter applications.