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# $TiO_2$ Thin Film Patterning on Modified Silicon Surfaces by MOCVD and Microcontact Printing Method

강병창, 이종현, 정덕영, 이순보, 부진효
성균관대학교 화학과

Titanium oxide ($TiO_2$) thin films have valuable properties such as a high refractive index, excellent transmittance in the visible and near-IR frequency, and high chemical stability. Therefore it is extensively used in anti-reflection coating, sensors, and photocatalysis as electrical and optical applications. Specially, $TiO_2$ have a high dielectric constant of 180 along the *c* axis and 90 along the *a* axis, so it is highlighted in fabricating dielectric capacitors in micro electronic devices. A variety of methods have been used to produce patterned self-assembled monolayers (SAMs), including microcontact printing ($\mu$CP), UV-photolithography, e-beam lithography, scanned-probe based micro-machining, and atom-lithography. Above all, thin film fabrication on $\mu$CP modified surface is a potentially low-cost, high-throughput method, because it does not require expensive photolithographic equipment, and it produce micrometer scale patterns in thin film materials. The patterned SAMs were used as thin resists, to transfer patterns onto thin films, either by chemical etching or by selective deposition.

In this study, we deposited $TiO_2$ thin films on Si (100) substrates using titanium (IV) isopropoxide ([$Ti(O(C_3H_7)_4)$] ; TIP) as a single molecular precursor at deposition temperature in the range of 300 - 700 ℃ without any carrier and bubbler gas. Crack-free, highly oriented $TiO_2$ polycrystalline thin films with anatase phase and stoichiometric ratio of Ti and O were successfully deposited on Si(100) at temperature as low as 500 ℃. XRD and TED data showed that below 500 ℃, the $TiO_2$ thin films were dominantly grown on Si(100) surfaces in the [211] direction, whereas with increasing the deposition temperature to 700 ℃, the main film growth direction was changed to be [200]. Two distinct growth behaviors were observed from the Arrhenius plots.

In addition to deposition of the $TiO_2$ thin films on Si(100) substrates, patterning of $TiO_2$ thin films was also performed at grown temperature in the range of 300 - 500 ℃ by MOCVD onto the Si(100) substrates of which surface was modified by organic thin film template. The organic thin film of SAM is obtained by the $\mu$CP method. Alpha-step profile and optical microscope images showed that the boundaries between SAMs areas and selectively deposited $TiO_2$ thin film areas are very definite and sharp. Capacitance - Voltage measurements made on $TiO_2$ films gave a dielectric constant of 29, suggesting a possibility of electronic material applications.