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Growth of TiO_2 Thin Films on Si(100) and Si(111) Substrates Using Single Molecular Precursor by MOCVD and Comparision of Growth Mechanism and Structural Properties

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We have been deposited titanium dioxide (TiO_2) thin films on Si(100) and Si(111) substrates using a single molecular precursor such as titanium (IV) iso-propoxide ($Ti[OCH(CH_3)_2]_4$, 97%) by metal-organic chemical vapor deposition (MOCVD) method. Highly oriented crack-free, stoichiometric TiO_2 thin films with anatase phase were successfully deposited on both Si(100) and Si(111) substrates at temperature in the range of 400 to 800℃ and at pressure in the range of $3.0\times10^{-7}\sim3.0\times10^{-5}$Torr. XRD data showed highly oriented anatase phase TiO_2 thin films in the [211] direction were obtained on Si(100) at below 500℃, whereas with increasing the deposition temperature to 700℃, the main film growth direction was changed to be [200], signifying a epitaxial thin film growth. Surface morphology showed that quite smooth surface with no cracks and sharp interface between film layer, suggesting good adhesion and uniformity in depth. In the case of TiO_2 films grown under low temperature and high pressure, TED pattern showed a mixed structure with spot and ring patterns, resulting in polycrystalline film formation. With increasing the growth temperature to 700℃, however, a strong spot images with weak ring pattern was observed. This indicates that the film crystallity was strongly affected by deposition temperature and pressure. To compare film's structural properties and a difference of growth mechanism such as growth rate and activation barriers, we also carried out the same experiments on Si(111) substrates under the same deposition condition of Si(100). The growth rate was calculated by the change of films thickness, and a temperature dependence of the growth rate and film quality was also studied.