Initial Growth Stage of Y_2O_3

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Studies on the epitaxial growth of Y_2O_3 films on Si(100) have been carried out for potential applications to silicon-on-insulator (SOI) devices, because SOI devices have been used as a gate insulator or a buffer layer for growing the epitaxial superconducting YBCO on Si. Especially metal-insulator-semiconductor (MIS) devices have attracted considerable attention because their usefulness as high-density storage capacitors in scale-down dynamic random access memory (DRAM) devices. In order to investigate what affects the growing orientation, we observed the initial growth stage of epitaxial Y_2O_3.

The deposition of Y_2O_3 film was performed by using an UHV-ICB system. To see the initial growth modes, we deposited samples of various thickness. And then the film growth process at the initial stage and crystallities were monitored by in-situ reflection of high energy electron diffraction (RHEED). Also we have used X-ray diffraction (XRD) and transmission electron microscopy (TEM) to investigate the crystallographic properties. Surface roughness was investigated by atomic force microscopy(AFM).

From the result of XRD and TEM, the Y_2O_3 films were epitaxially grown at the substrate temperature 700℃ and the acceleration voltage of 5 kV. Also TEM image revealed that the films were composed of two domain structure.

(011)Y_2O_3 // (001)Si, [100]Y_2O_3 // [110]Si

or

(011)Y_2O_3 // (001)Si, [011]Y_2O_3 // [110]Si

The growth process of Y_2O_3 epitaxal films was investigated using a series of RHEED patterns. In case of 1nm film, Bragg reflection didn't appear. At the 2nm film, new streaky line appear faintly. The 3nm film shows a clear diffraction pattern of Y_2O_3 (110) and the growth direction of the films is maintained as deposition proceeds. Also, in our experiment, we found that the preferential orientation was transformed from Y_2O_3(111)//Si(100) to Y_2O_3(110)//Si(100) as the substrate temperature was increased from 500℃ to 700℃. The film roughness was improved up to the thickness of 3nm Y_2O_3 and then increased as the deposition proceeds.

* This work was supported by the Korea Science and Engineering Foundation through the Atomic-Scale Surface Science Research Center(ASSRC) at Yonsei University.