Measurement of Electronic Structure of Al_2O_3(0001) Surface

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Al_2O_3 has been widely used as a substrate for GaN thin film. When the GaN film is deposited, the substrate temperature should be raised above 1000 °C. Therefore, the detailed investigation of the Al_2O_3 surface at high temperature is key to improve the quality of GaN and other semiconductor films. The stable surface structure of Al_2O_3(0001) is the 1×1 structure. However the surface structure is reconstructed to the √31×√31±R9° structure (hereafter √31 structure) by annealing at about 1000 °C in the vacuum [1-3]. It is theoretically predicted that the√31 reconstruction occurs by removing oxygen layers from the surface and forming Al layers[4]. Therefore the change of the electronic structure from the 1×1 structure to the √31 structure is very interesting.

We use well-oriented Al_2O_3 (0001) samples, which were supplied by Namiki Precision Jewel Co. Ltd. The samples were cut parallel to the (0001) plane with off angle being 0.15° ±0.02° off for <10T0> direction and annealed at 1000°C or 1400°C annealing in air. The air-annealed surface shows a clear 1×1 Reflection High Energy Electron Diffraction (RHEED) pattern without any treatment in the vacuum as shown in Fig. 1.

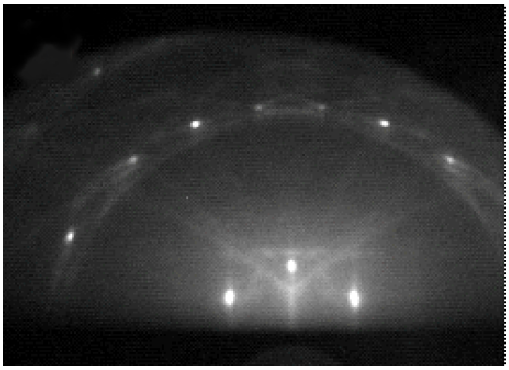

Fig. 1. RHEED pattern of an air-annealed Al_2O_3 (0001) surface.

We tried to measure the photoelectron spectra (PES) from the Al_2O_3 (0001) surface. Figure 2 shows a typical example

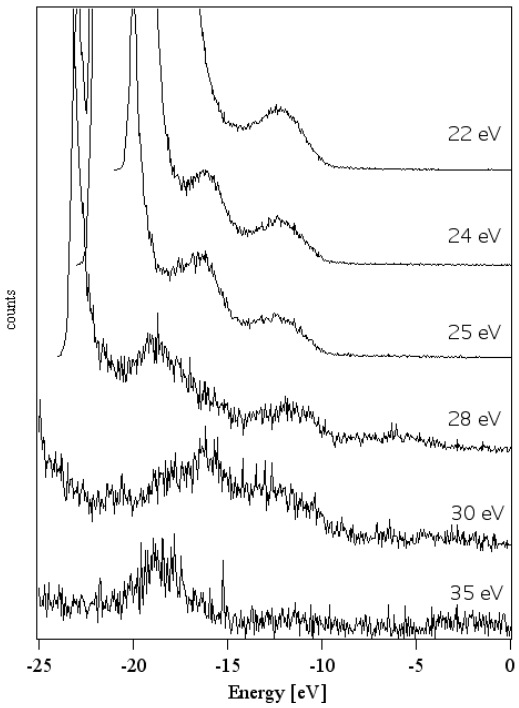

Fig. 1. PES from Al_2O_3 (0001) surface at photon energies (E_p) from 22 eV to 35 eV

of the PES, where the photo-electrons emitted to the normal direction are measured at photon energies (E_p) from 22 eV to 35 eV. The PES at E_p below 25 eV show two clear states originate from the *Al-O* bonding state and the O-*2p* state [5]. On the other hand, the PES at E_p over 28 eV become noisy and each peak is shifted to unsystematic directions. The random shifts will be caused by a charging up on the insulator surface.

Therefore, PES have measured at E_p below 25 eV. From the PES from 1x1 and √31 structure, we have obtained some experimental evidences that the √31 structure is formed by Al layers by leaving O layer on top of the Al_2O_3 (0001) surface from the results of the PES and RHEED. Detailed structure model will be published in elsewhere in the near future.

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