The Interface Study of Epitaxy Hexagonal Perovskite $YAlO_3$ Grown on GaAs (111)

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Aberration corrected scanning transmission electron microscopy (AC-TEM) is a widely used tool for materials characterization in the sub-nano scale because of its ultra-high resolution and it can simultaneously acquire image and X-ray/electron spectrum for physical and chemical properties mapping[1]. The simple interpretational Z contrast annular dark field imaging in AC-STEM is also a powerful technique due to its simple incoherent nature; therefore, it has been a routine procedure to investigate the atomic structure, quantitative analysis and interface studies [1-3].
In the present study, the ternary compound of hexagonal perovskite $YAlO_3$ epi-layer grown on GaAs(111) substrate was synthesized via atomic layer deposition (ALD). The procedure of the $YAlO_3$ layer grew by the following step. The nano-laminated a-Al_2O_3/a-Y_2O_3/a-Al_2O_3/a-Y_2O_3/a-Al_2O_3/c-Y_2O_3 (a denote as amorphous, c denote as crystalline) multilayer was deposited on GaAs (111)A-2x2 wafers firstly. Then the as-deposited films were undergone rapid thermal annealing at 900℃ in He atmosphere. The amorphous nano-laminated layers were formed an excellent-quality hexagonal $YAlO_3$ epi-layer even the large lattice misfit [4].
The heterostructure of the $YAlO_3$/GaAs interface was studied utilizing probe-forming Cs-corrected scanning transmission electron microscopy (JEOL ARM-200F, cold field mission gun), and the images were acquired via annular dark field detector, and the collection angle was 30-120 mrad. The sharp interface of the epitaxial layer as shown in Figure 1, only the Y atoms were revealed in the $YAlO_3$ layer. It is very difficult to identify the bonding at the interfaces. The crystallographic relationship between the epitaxial layer and substrate is $YAlO_3$ $(0001)[2\bar{1}\bar{1}0]$// GaAs $(111)[1\bar{1}0]$, which was determined from the fast Fourier transform (FFT) of each layers and confirmed by simulated diffraction patterns. In order to get the better understanding of the $YAlO_3$ growth mechanism, the detailed structure will be investigated by annular bright field (ABF) imaging, which can reveal the light elements and the interface structure could be reconstructed from the result. The detailed study will be shown during the conference.

References

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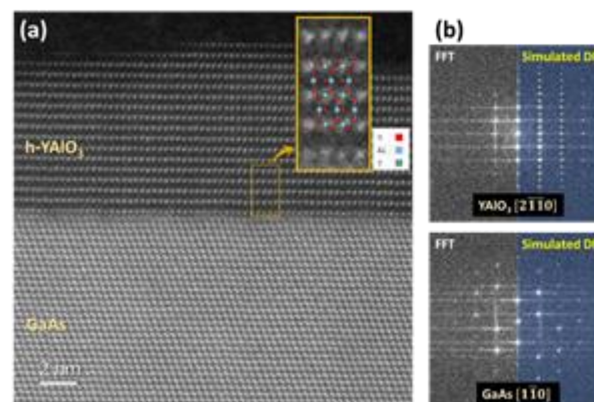

Figure 1. (a) The interface structure of the epitaxial $YAlO_3$ film on GaAs. (b) the FFT and simulated diffraction patterns of $YAlO_3$ and GaAs layers.