Mist chemical vapor deposition of α-Ga_2O_3 and α-Fe_2O_3 thin films on corundum-structured rh-ITO electrode

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Corundum-structured oxides have gained significant attention for their various attractive properties. Among them, we featured α-Ga_2O_3, α-Fe_2O_3, and rh-In_2O_3. α-Ga_2O_3 exhibits an ultra-wide bandgap (5.3 eV); therefore, this has been widely studied for power electronics and optoelectronics [1]. α-Fe_2O_3 is widely investigated as a photocatalyst for hydrogen production by water splitting using solar energy because the bandgap (2.2 eV) is suitable to use visible light, and it is composed of abundant minerals [2]. For many device applications of these corundum-structured oxides, it is essential to prepare an electrode. We proposed to utilize low-resistivity tin-doped rh-In_2O_3 (rh-ITO) for the under electrode of α-Ga_2O_3 and α-Fe_2O_3. There are few reports on the heteroepitaxial growth of α-Ga_2O_3 and α-Fe_2O_3 thin films on rh-ITO for the under electrode. In this study, the heteroepitaxial growth of these heterostructures was demonstrated by mist chemical vapor deposition, which is often used for the crystal growth of these oxides.

Figure 1(a) shows a schematic of the α-Ga_2O_3/rh-ITO heterostructure. α-Ga_2O_3 and α-Fe_2O_3 buffer layers were used for decreasing lattice mismatch with rh-ITO and α-Ga_2O_3, respectively. XRD result of α-Ga_2O_3/rh-ITO heterostructure revealed that these buffer layers allowed the growth of rh-ITO and α-Ga_2O_3 epitaxial thin films, as shown in Figure 1(b). A schematic of the α-Fe_2O_3/rh-ITO heterostructure is shown in Figure 2(a). α-Fe_2O_3 buffer layer was used for decreasing lattice mismatch with rh-ITO. XRD result of α-Fe_2O_3/rh-ITO heterostructure revealed that α-Fe_2O_3 thin films were grown epitaxially on rh-ITO under electrode (Figure 2(b)). Next, device applications of these heterostructures were investigated. The photodetector of α-Ga_2O_3/rh-ITO heterostructure was measured by the spectral photoresponse. This measurement revealed that this photodetector was sensitive to UV-C region and operated self-powered. Cyclic voltammetry measurement was performed to observe the reaction of the photoelectrode for α-Fe_2O_3/rh-ITO heterostructure. The photocurrent was increased by the illumination of the Xe lamp, indicating that photo-excited hole-electron pairs contributed to the reaction on the surface. From these analyses, the growth and device operation of α-Ga_2O_3/rh-ITO and α-Fe_2O_3/rh-ITO heterostructure were demonstrated.

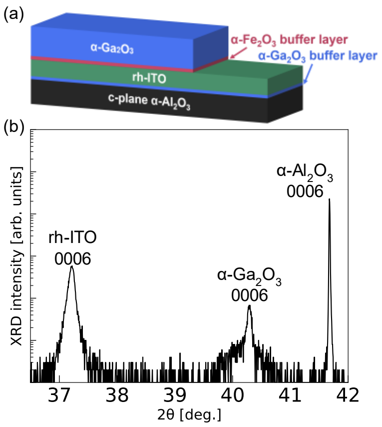

Figure 1 (a) Schematic and (b) XRD 2θ-ω scan result of α-Ga_2O_3/rh-ITO heterostructure.

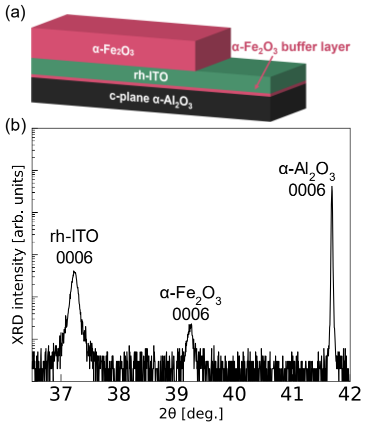

Figure 2 (a) Schematic and (b) XRD 2θ-ω scan result of α-Fe_2O_3/rh-ITO heterostructure.

References
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