シンクロトロンX線光電子分光法による Al_2O_3/Air/H ダイヤモンドヘテロ界面のエネルギーバンドアライメントの測定

Energy band alignment of Al_2O_3/Air/H-diamond heterointerface determined by synchrotron x-ray photoelectron spectroscopy

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1.Introduction

Diamond is ultimate semiconductor for power electronics devices. Exposure of NO_2, NO, and SO_2 increase the carrier concentration of H-diamond and influence the band alignment of the Al_2O_3/H-diamond heterointerface, where valence band offset of 3.9, 3.7 and 3.5 eV are determined, respectively [1-3]. Normally, air exposed H-diamond is used. In this study, energy band alignment of Al_2O_3/Air/H-diamond heterointerface is determined using x-ray photoelectron spectroscopy (XPS) and compared with NO_2 case.

2. Fabrication and Measurement Process

We used 1-µm-thick (001) H-diamond homoepitaxial layer grown on HPHT diamond. H-diamond sample was exposed to air for 2~3 hours. An 8-nm-thick Al_2O_3 layer was deposited as the oxide layer. XPS and XANES spectra were measured at BL-13 line of the Saga Light Source.

3. Experimental Results

Figure 1 shows the core-level spectra of Al_2O_3/Air/H-diamond heterointerfaces, where core level spectra are fitted by the least-square-fitting technique using a Shirley background and a Voigt line shape. XPS measurements were performed with the photon energy of 700 eV to take O 1*s*, C 1*s*, and Al 2*p* spectra. C 1s and O 2p spectra were decomposed into four and two peaks, respectively. No other peak was at the interface. A valence band offset (ΔE_V) of 4.0±0.1 eV, and a conduction band offset (ΔE_C) of 2.8±0.1 eV are determined from the type II band-alignment of the Al_2O_3/Air/H-diamond structure as shown in Fig. 2. Oxygen derived interfacial states is observed in the XANES measurements. Therefore, ΔE_V value and O-interfacial layer are similar to NO_2 case.

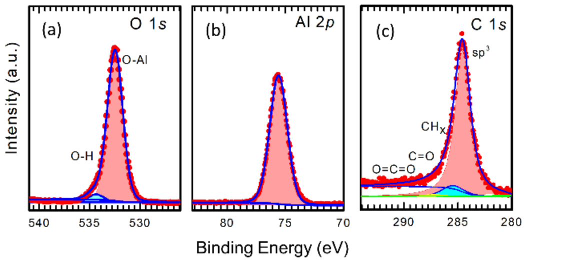

Fig. 1 Core-level spectra of (a) O 1*s*, (b) Al 2*p*, (c) C 1*s* at Al_2O_3/Air/H-diamond interface.

4.Conclusion

Energy band alignment is determined using XPS measurements, where valence band offset of type II band alignments of Al_2O_3/air-exposed H-diamond heterointerface is estimated to be 4.0 eV.

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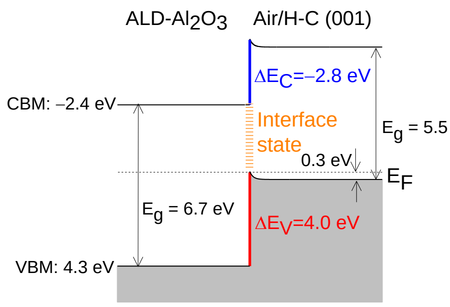

Fig. 2 Schematic energy band alignment diagram of Al_2O_3/Air/H-diamond heterointerface.