シンクロトロン X 線光電子分光法による Al_2O_3/NO_2/H-ダイヤモンドヘテロ界面での窒素種の観察

Observation of Nitrogen Species at Al_2O_3/NO_2/H-diamond Interfaces Using Synchrotron X-ray Photoemission Spectroscopy

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1.Introduction

Diamond possesses desired properties for the power electronic devices, such as wide bandgap, high breakdown field, and high thermal conductivity. H-diamond exhibits negative electron affinity and the exposure of H-diamond to 2% NO_2 increases the hole sheet concentration up to 2.3 × 10^{14} cm^{-2}. [1] However, whether nitrogen (N) species exist on the NO_2/H-diamond surface or the interface and how the decomposed NO_2 molecule works as an acceptor on the H-diamond surface remained controversial. Geis *et al.*, reported NO_3^- instead of NO_2^- and C-N bonds by FTIR. [2] In this study, synchrotron x-ray photoemission spectroscopy (XPS) was performed to investigate the Al_2O_3/NO_2/H-diamond interfaces.

2. Fabrication and Measurement Process

The measured sample consists of a 2 nm-thick Al_2O_3 layer deposited NO_2-exposed H-diamond on (001) surface orientation. NO_2-exposed H-diamond was not exposed to air before Al_2O_3 layer deposition as well as 2-nm-thick Al_2O_3 layer was adjusted to photoelectron escaping from the interface without sputtering. XPS measurements were carried out at BL-13 line of the Saga Synchrotron Light Source.

3. Experimental Results and discussion

Two N peaks corresponding to C-NH_2 (399.43 eV) and NO_3^- (407.45 eV) were confirmed at the Al_2O_3/NO_2/(001)H-diamond interface as shown in Fig. 1(a). In interface sensitive measurements at the emission angle θ_e of 0°, N 1s/O 1s was 2.26% [Fig. 1(a)], which was higher than of 1.45% for the surface sensitive measurements at θ_e of 60° [Fig. 1(b)]. Thus, the N-species were localized at the interface. C-NH_2 and NO_3^- originated from the decomposition of NO_2 and N_2O_4, respectively, at the interface after accepting electron diamond. The estimated interfacial C-NH_2 bond density is 5.8 × 10^{14} cm^{-2}.

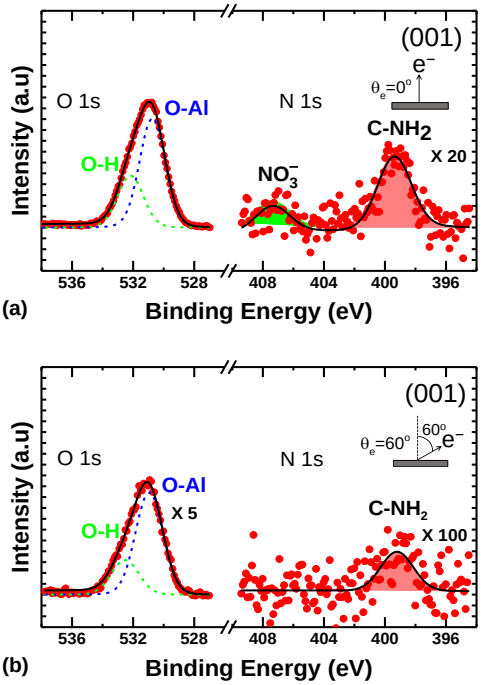

Fig. 1 Core-level photoemission spectra of O 1s and N 1s of the Al_2O_3/NO_2/ (001) H-diamond interface measured at θ_e of (a) 0° and (b) 60°.

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References

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