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Interface Properties between Ni and p-GaN Studied by Photoemission Spectroscopy

Y. Hagio, T. Maruyama^a, Y. Nanishi^a, K. Akimoto, T. Miyajima^b and S. Kijima^b

Inst. of Applied Physics, Univ. of Tsukuba,

^aDept. of Photonics, Ritsumeikan Univ.,

^bSony Corporation Research Center

Presenting and contact author: Y. Hagio, E-mail; bk003404@s.bk.tsukuba.ac.jp

Tel.; 0298-53-6177, Fax.; 0298-53-6177

It has been reported that Au/Ni based bilayer structures annealed in oxygen ambient are capable of forming ohmic contacts to *p*-GaN with a low-resistance [1]. It is considered that *p*-type NiO is in direct contact with the *p*-GaN after annealing [2,3]. However, there have been some controversy about the role of NiO layer in the formation of ohmic contact, and the mechanism of the ohmic forming behavior is also unclear now. In this study, we investigated the effect of annealing in an oxygen ambient on the electronic structure at the Ni/*p*-GaN by ultra-violet photoemission spectroscopy (UPS).

The sample was *p*-type GaN, whose hole concentration was $1.2 \times 10^{18} \text{ cm}^{-3}$. After etching with NH_3 at 50°C for 15min, Ni was deposited on it with the thickness of 8 nm under a base pressure of less than 1×10^{-8} Torr. Then, the sample was annealed in an oxygen ambient at 550°C . For each process, the chemical species on the surface was analyzed by Auger electron spectroscopy(AES), and the electronic structure of the sample was investigated by UPS. All AES and UPS measurements were performed at the Photon Factory BL3B and 11C of the Institute of Materials Structure Science (KEK-PF).

Ga 3d photoemission spectra are shown in the Figure. After annealing the Ni/GaN sample for 2min, the peak(a) disappeared and peak(b) appeared, and by further annealing, the peak(c) additionally appeared. Referring to the value of chemical shift of Ga 3d peak, the peak (b) and (c) can be assigned as metallic Ga and oxidized Ga, respectively. The oxidized Ni seems to react with GaN and generates metallic Ga, that is, GaN surface is etched by oxidized Ni. Therefore, it may be possible to propose that the cause of the improvement in ohmic contact may not the formation of NiO but the formation of clean surface of GaN by reactive etching with oxidized Ni.

[1] J-K Ho et al. Appl. Phys. Lett. 74 (1999) 1275.

[2] L-C. Chen et al. J. Appl. Phys. 86 (1999) 3826.

[3] D. Qiao et al. J. Appl. Phys. 88 (2000) 4196.

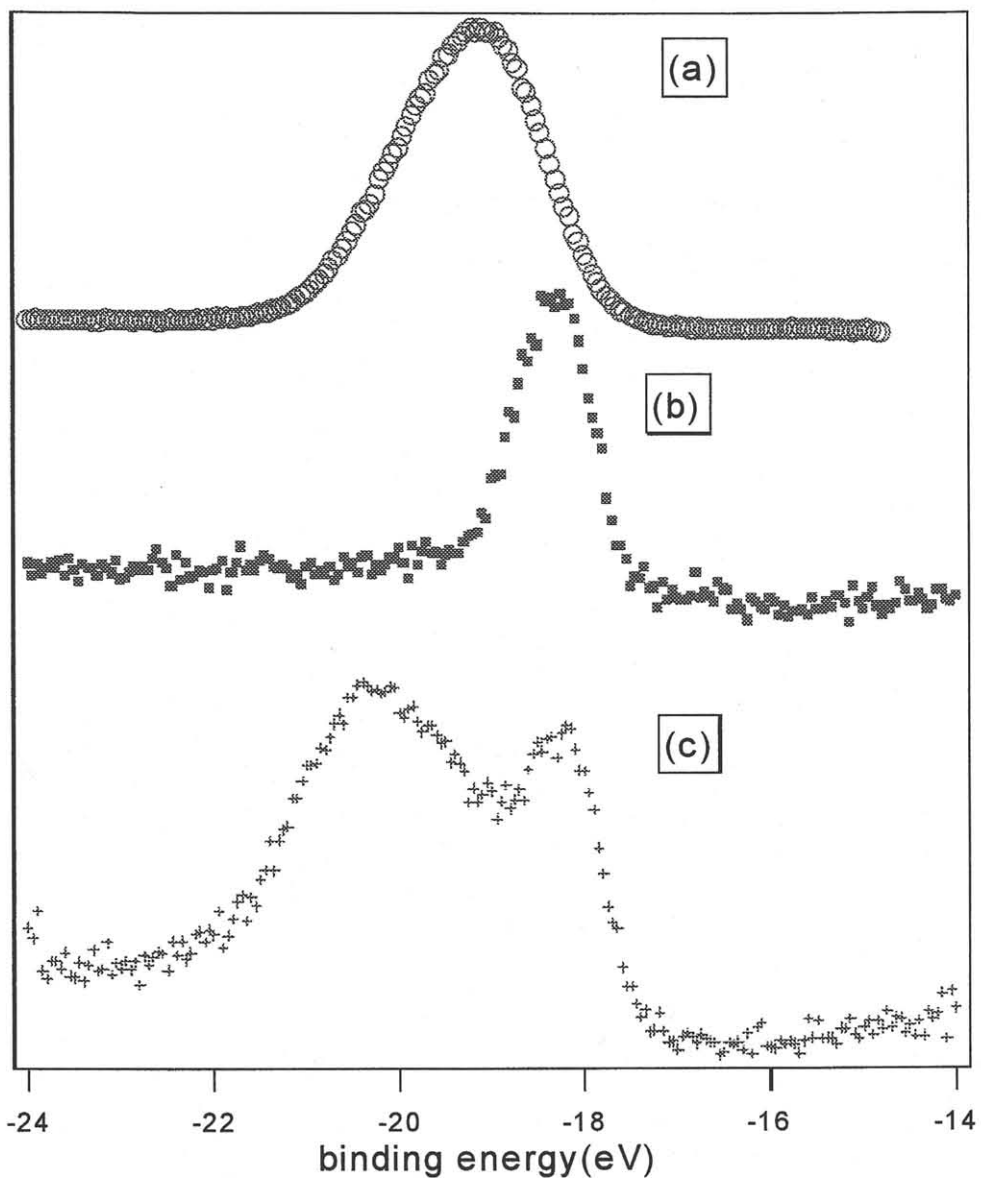


Figure. Photoemission spectra of Ga 3d for chemically etched GaN(upper curve), after annealing at 550°C in O₂ ambient for 2 min of Ni/GaN(middle curve), and after annealing at 550°C in O₂ ambient for 10min of Ni/GaN(bottom curve).