Electrical Properties of Al-Foil/4H-SiC Schottky Junctions Fabricated by Surface-Activated Bonding

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***Abstract*—17-µm Al-foil/n-4H-SiC Schottky junctions with the foils as contacts are fabricated in order to investigate the impacts of annealing on their electrical characteristics. By measuring their current-voltage and capacitance-voltage characteristics, the ideality factor and Schottky barrier height (SBH) are estimated to be 1.31 and 1.37 eV for junctions after annealing at 673 K, respectively.**

I. Introduction And Background

Aluminum (Al) is widely used for contacts and interconnects in semiconductor devices and circuits due to its low resistivity. Noting that Al foils are much thicker (>10µm) than evaporated or sputtered Al films in the standard device process, we previously demonstrated Al foil/Si junctions fabricated using the surface-activated bonding (SAB) method and investigated the possibility of the bonded Al foils as constituents for ultra-thick low-resistance contacts and interconnects[1]. Such thick metal layers are likely to be useful in power devices because high electrical powers are required to be handled with low losses in power devices. In this work, 4H-SiC Schottky junctions with bonded Al foils as Schottky contacts are fabricated and their ideality factor and Schottky barrier height (SBH) are evaluated at room temperature.

II. Results

17-µm Al foils were bonded to 4H-SiC epitaxial substrates, which were made of 6-µm-thick n-doped (1×10^{16} cm^{-3}) epitaxial layers and 0.3-µm-thick n-doped (1×10^{18} cm^{-3}) buffer layers grown on n^+-doped substrates. The contacts on the backsides of SiC substrates were formed by the annealing of evaporated Al/Ni/Au multilayers. Circular contacts with a diameter of 400 µm were formed by the wet etching of the Al foils. We measured the current-voltage (I-V) and capacitance-voltage (C-V) characteristics of the Schottky junctions before and after annealing at 673 K.

The I-V characteristics of the Schottky junctions are shown in Fig. 1. The ideality factor, which was 1.67 without annealing, decreased to 1.31 after annealing the contacts at 673 K. This indicates that the interface properties of Al-foil/4H-SiC junctions were improved by the annealing.

Figure 2 show the $1/C^2$-V characteristics at 100 kHz after the annealing. The flat-band voltage was found to be 1.16 V by linearly extrapolating $1/C^2$ to zero, which indicates that the SBH was 1.37 eV.

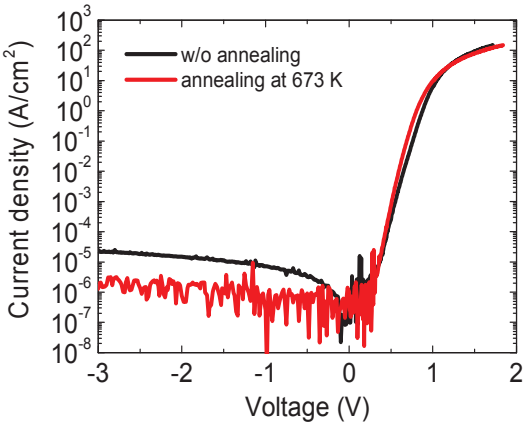

Fig. 1. I-V characteristics of Al-foil/4H-SiC Schottky junctions at room temperature before and after annealing at 673 K.

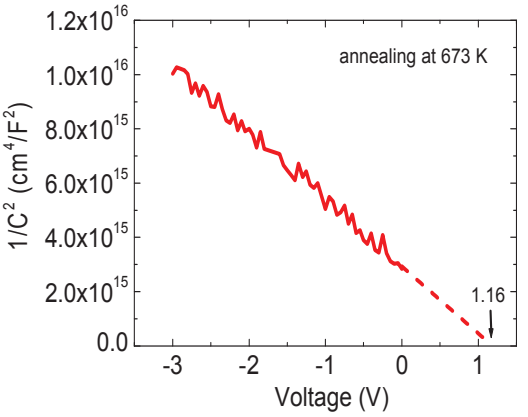

Fig. 2. 100-kHz $1/C^2$-V characteristics of Al-foil/4H-SiC Schottky junctions after annealing at 673 K.

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References

[1] J. Liang, K. Furuna, M. Matsubara, M. Dhamrin, Y. Nishio, and N. Shigekawa, "Ultra-thick metal ohmic contact fabrication using surface activated bonding" ECS Trans. vol. 75, pp. 25-32, 2016.