

Schottky-barrier heights for metal/graphene/ZnO hetero-junctions by direct bonding technique

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Abstract

Schottky-barrier heights have been investigated for metal/graphene/ZnO hetero-junctions by direct bonding technique in atmosphere. Graphene was bonded with either Zn- or O- surface of a ZnO single crystal while metal (Cu and Ni) was also contacted with the graphene.

Two sets of CVD graphene films on Cu or Ni, and (0001) ZnO crystals (10 x 10 x 05 mm)) were purchased. As shown in Fig. 1, metal/graphene/ZnO structures were directly bonded by a pressure (400g/cm²) in atmosphere, and I-V curves were measured at a temperature between 20 and 100 °C. Schottky-barrier heights were experimentally determined based on the Richardson plot using equations (1) and (2).

$$I = I_0 \left\{ \exp \left(\frac{qV}{nk_B T} \right) - 1 \right\} \quad (1)$$

$$I_0 = A^* T^2 e^{-q\phi_{b_0}^j / (kT)} \quad (2)$$

where $\phi_{b_0}^j$: barrier height, A^* : Richardson constant, n: ideality factor.

Figure 2 shows the I-V characteristics of Cu/G/ZnO structures where clear rectifying behaviors were observed. Forward currents were significantly increased as the temperature was increased.

Figure 3 shows the Richardson plot of the samples in Fig. 2. Barrier heights were determined from the slopes of the lines.

Table 1 summarizes Schottky-barrier heights for the two metals (Cu and Ni) and for two ZnO planes (Zn and O surfaces). 1) Barrier heights are larger for Cu than for Ni, 2) Barrier heights are larger for O-surface than for Zn-surface, 3) graphene in the interface increases the barrier heights for O-surfaces while it decreases them for Zn-surfaces. Hetero-junction models can be discussed based on the difference in these barrier heights.

References

- [1] S. Lee et al., Appl. Phys. Lett. **102**, 242114 (2013)
- [2] K. Komatsu et.al, Phys Status Solidi, C **10**, 1280 (2013)

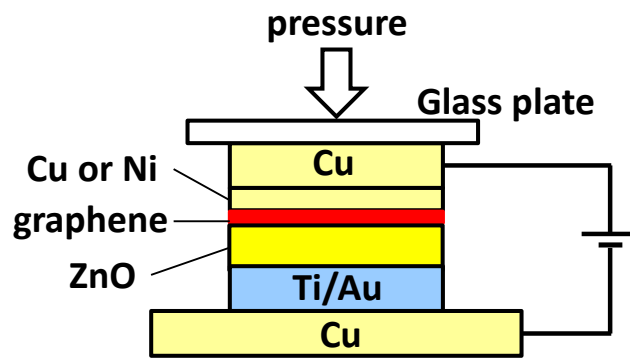


Figure 1 Schematic of direct bonding and I-V measurement.

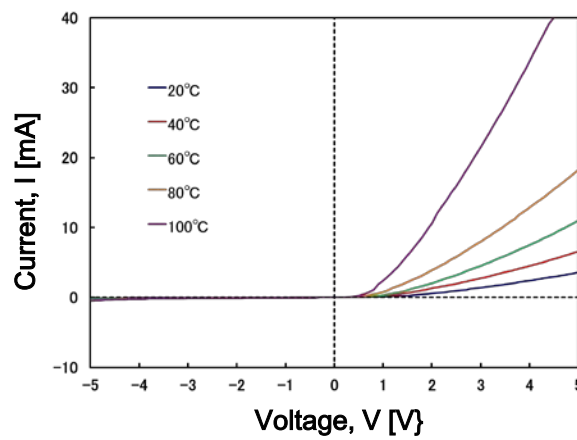


Figure 2 I-V characteristic of Cu/G/ZnO (O-surface) at different temperatures.

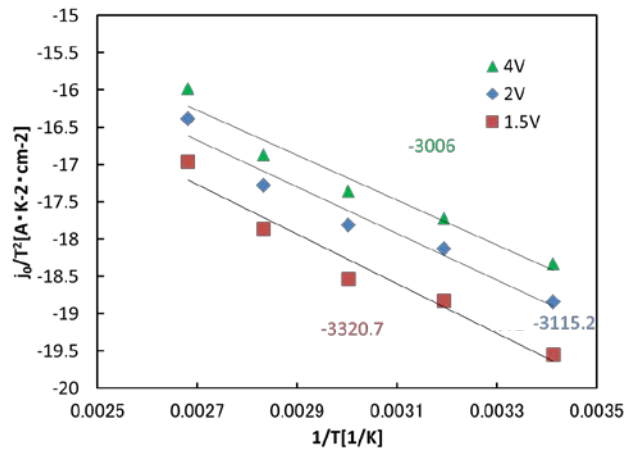


Figure 3 Richardson plots of the I-V curves in Fig. 2.

Table 1 Schottky-barrier heights [eV] for M/G/ZnO

	Cu		Ni	
graphene	with	without	with	without
Zn-surface	0.055	0.092	0.023	0.052
O-surface	0.27	0.22	0.27	0.21