TiC films formed by multi-stacking process for diamond contact metal electrodes


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TiC films have been formed by stacking multiple thin Ti and C layers with subsequent annealing on diamond substrates. Thermally stable contact characteristics have been obtained with TiC electrodes, owing to the suppression of reaction between TiC and diamond.

Diamond has drawing significant attention as a novel semiconductor for future power electronics with high voltage operation. One of the issues for diamond electron devices is high contact resistance at metal and diamond interface. Ti has been commonly used as a contact metal as it forms TiC at the interface, however, the carbide formation strongly depends on annealing conditions. In this work, we propose a multi-stacking process to form TiC as a stable contact material for diamond substrates.

Diamond substrates used in this work were heavily doped n-type with P concentration of 8×10¹⁹ cm⁻³. Ti and C films with thicknesses of 0.83 and 0.45 nm, respectively, were cyclically sputter deposited on substrates for 18 times (fig. 1). These thicknesses were set to achieve an atomic ratio of 1 to 1. Formation of TiC was confirmed by GIXD measurement when the sample is annealed at over 500°C (fig. 2). Current-voltage characteristics were measured by the circular TLM method. Ti metal contact with a thickness of 50 nm was also fabricated as a reference.

Figure 3 shows the current voltage characteristics of TiC and Ti electrodes with the circular TLM patterns annealed at various temperatures. Samples with Ti electrodes showed relatively low current. Moreover, further reduction was observed when the sample was annealed at higher temperature. On the other hand, almost identical characteristics were obtained with TiC electrode from as-deposited condition up to 750°C annealing, indicating high thermal stability of the electrodes.

In summary, the Ti/C multi-stacking process to form TiC has been used as a contact metal electrodes on diamond. Owing to suppressed reaction at the metal/substrate interface, thermally stable current-voltage characteristics have been obtained.

References