Characteristics of Electronic States at the Interface of Aluminum on cubic Boron Nitride

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Cubic boron nitride (c-BN) is an ultra-wide band gap semiconductor making it a good candidate for high power switching, radio frequency, and optoelectronic devices in the deep UV range. BN has a high electron mobility, breakdown field, and a dielectric constant similar to diamond. Cubic BN is second only to diamond in its hardness, strength, and thermal conductivity. Moreover, c-BN has higher oxidation and graphitization temperatures than diamond, and therefore, is more thermally and chemically stable. Cubic BN has a larger band gap (6.4 eV) than diamond (5.5 eV) as well as suitable n and p type dopants, increasing its potential to be a superlative semiconductor for high temperature and high power operation. Such impressive properties motivate the search for Schottky contacts towards the production of practical devices.

There is limited literature on the deposition of metal contacts to cubic boron nitride. Depositing aluminum metal contacts onto BN is the starting place of our approach toward demonstrating BN as practical material for transistors and other electronic devices. Aluminum metal has a high electrical conductivity only behind silver, copper and gold. However, Al has a lower density and is cheaper making it a common choice for wires and power transmission lines.

Since large substrates of c-BN are not available, epitaxial c-BN layers may be grown on diamond substrates, which have a small lattice mismatch of 1.4%. In this study, ~100 nm thick epitaxial c-BN layers were grown on poly-crystalline boron doped diamond substrates via electron cyclotron resonance plasma enhanced CVD. X-ray photoemission Spectroscopy (XPS) measurements indicated the presence of some sp^2 bonded BN at the surface.

Ultra thin layers of aluminum were then deposited onto the mixed phase BN sample. The sample was transferred in ultra high vacuum to the XPS system and spectrally recorded. The deposition of 24 Å of Al onto the sample revealed a Schottky barrier height of 3.1 ± 0.43 eV at the Al / BN interface.

The research will be extended to establish the Schottky barrier height on hexagonal and c-BN. Deposition of other metals onto c-BN in future work can follow the example given by this study.

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