Electron affinity of cubic boron nitride terminated with vanadium-oxide YU YANG, TIANYIN SUN, JOSEPH SHAMMAS, MAN-PUNEET KAUR, MEI HAO, ROBERT NEMANICH, Arizona State University — H-terminated cubic boron nitride (c-BN) has been shown to exhibit a negative electron affinity (NEA) surface, which may enable applications in thermionic and photon-enhanced energy conversion devices. The ability to withstand high temperature operation is an important factor in the thermionic emission applications. Theoretical and experimental studies have indicated that transition metal oxides can significantly influence the electronic properties of diamond. In this study, a thermally stable NEA for a c-BN surface with vanadium-oxide-termination is achieved, and its electronic structure was analyzed with in-situ photoelectron spectroscopy. Thin vanadium layers of ~0.1 and 0.5 nm were deposited on the c-BN surface in an electron beam deposition system. Oxidation of the metal layer was achieved by an oxygen plasma treatment. After 650 °C thermal annealing, the vanadium oxide on the c-BN surface was determined to be VO$_2$, and the surfaces were found to be thermally stable, exhibiting an NEA. In comparison, the oxygen-terminated c-BN surface, where B$_2$O$_3$ was detected, showed a positive electron affinity (PEA) of ~1.2 eV. The B$_2$O$_3$ evidently acts as a negatively charged layer introducing a surface dipole directed into the c-BN. Through the interaction of VO$_2$ with the B$_2$O$_3$ layer, a B-O-V layer structure would contribute a dipole between the O and V layers with the positive side facing vacuum. The lower enthalpy of formation for B$_2$O$_3$ is favorable for the formation of the B-O-V layer structure, which provides a thermally stable surface dipole and a NEA surface.

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