[III-27]

Theoretical Study of Electron Field Emission from Diamond Surfaces

Moon Sung Chung, and Ji Mo Park
Department of Physics, University of Ulsan, Ulsan, 680-749

The electron field emission from diamond surfaces is theoretically investigated using both a conventional theory and a model consisting of an imaginary conduction subband in the bandgap. It is found that the conventional theory of electron emission from the crystalline p-type diamond cannot explain the measured high-current emission at low fields. For the external field F=0.1V/Å, the electron affinity x=0.1 eV, and carrier concentration $p=1x10^{19}/cm^3$, we obtained the electron emission current $j=1.4x10^{-31}A/cm^2$. This value is too small compared to the experimentally observed value $j=1.0x10^{-3}A/cm^2$ at F=0.004 V/Å. The tunneling from the bulk conduction and valence bands is negligible in the p-type diamond semiconductor. While there is no clear mechanism to transport electrons to states evacuated by field emission, emission from surface states is shown to be capable of producing the current density comparable to the observed value. For same p and x, we have $j=1.0x10^{-6}A/cm^2$ at F=0.004 V/Å. For better theoretical description of the low-field emission in diamond, we introduce one imaginary subband which can be generated by impurities or defects. As shown in Figure 1, the obtained j are in good agreement with experiment. The Fowler-Nordheim plot is far from the typical shape due to tunneling.

Figure 1. Emission from Surface States

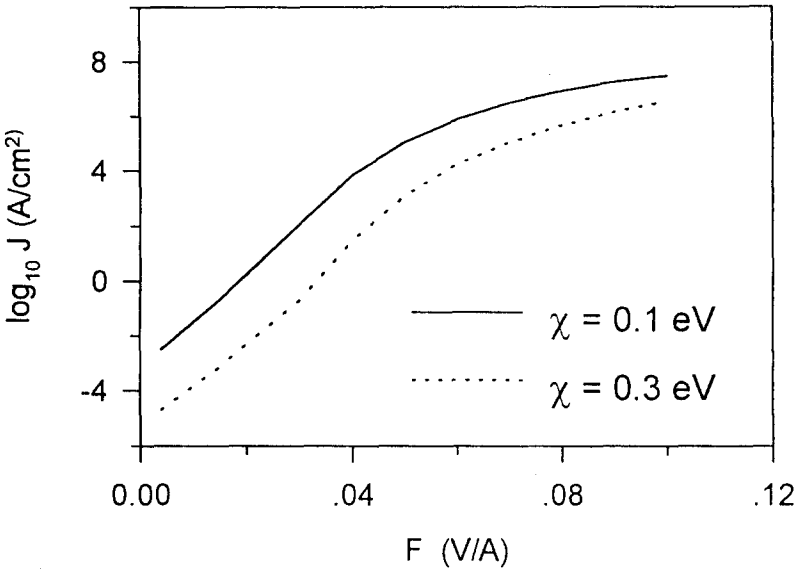

Figure 2. Fowler-Nordheim Plot