Materials Science & Engineering Doctoral Defense

The study of Ohmic contacts to nitrogen-doped nanocarbon layers and diamond surfaces

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Abstract

Over the past few years, research into the use of doped diamond in electronics has seen an exponential growth. In the course of finding ways to reduce the contact resistivity, nanocarbon materials have been an interesting focus. In this work, the transfer length method (TLM) was used to investigate Ohmic contact properties using the tri-layer stack Ti/Pt/Au on nitrogen-doped n-type conducting nano-carbon (nanoC) layers grown on (100) diamond substrates. The nanocarbon material was characterized using Secondary Ion Mass Spectrometry (SIMS), Scanning electron Microscopy (SEM) X-ray diffraction (XRD), Raman scattering and Hall effect measurements to probe the materials characteristics. Room temperature electrical measurements were taken, and samples were annealed to observe changes in electrical conductivity. Low specific contact resistivity values of 8 x 10^-5 Ωcm^2 were achieved, which was almost two orders of magnitude lower than previously reported values. The results were attributed to the increased nitrogen incorporation, and the presence of electrically active defects which leads to an increase in conduction in the nanocarbon. Further a study of light phosphorus doped layers using similar methods with Ti/Pt/Au contacts again yielded a low contact resistivity of about 9.88 x 10^-2 Ωcm^2 which is an interesting prospect among lightly doped diamond films for applications in devices such as transistors. In addition, for the first time, hafnium was substituted for Ti in the contact stack (Hf/Pt/Au) and studied on nitrogen doped nanocarbon films, which resulted in low contact resistivity values on the order of 10^-2 Ωcm^2. Lastly, a method for the selective area growth of nanocarbon was developed and studied and the results provided an insight into how different characterizations can be used to confirm the presence of the nanocrystalline diamond material, the limitations due to the film thickness was explored and ideas for future study was proposed.

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