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Ultra-low temperature transport property measurement of nanocrystalline diamond films

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We aim to establish the electronic transport properties of ultra-nanocrystalline diamond (UNCD) films at extremely low temperatures (specifically in the millikelvin regime) and under high magnetic fields up to 6 T in the z-axis. A dilution refrigerator was utilized to conduct the experiment in the millikelvin regime. UNCD, unlike its single-crystalline counterpart, is formed as small crystallites typically in the range of 3-10 nm. Their interaction is mediated by grain boundaries, which determine the transport properties of UNCD films. The electrical transport across two proximate grains can be tuned through p- or n-type doping with Boron or Nitrogen respectively. Unlike Boron, Nitrogen doping usually occurs at the grain boundaries. We performed low temperature resistance measurements to probe the mechanisms of electrical transport such as weak localization (WL), or spin orbit coupling under high magnetic fields. Nitrogen doped UNCD thin films were fabricated using plasma enhanced chemical vapour deposition (PECVD) technique. Electrical transport measurements on nitrogen doped UNCD thin films were analyzed using thermally activated transport, variable range hopping (VRH), and the WL models (with VRH and WL taking into account the dimensionality of the system). From our results, it is noted that the 3D WL best explains the experimental data.

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