EXPLORING THE CHARGE STORAGE PROPERTIES OF SUB-2 NM METAL NANOPARTICLES - APPLICATIONS IN FIELD EFFECT TRANSISTOR MEMORY AND DETECTION OF TRACE VAPOR MOLECULES

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ABSTRACT

Sub-2 nm size metal nanoparticles are unique compared to their bulk counterparts in semiconductor device and sensor applications due to their size-dependent behaviors, such as Coulomb blockade effect, quantum confinement effect, and the size-dependent work function. In this thesis, the single electron charging behaviors of these nanoparticles are studied through the room temperature operable single charge tunneling devices. Further, by embedding these nanoparticles as discrete charge storage sites in a macroscopic organic field-effect transistor, the electron or hole charging behaviors due to the nanoparticle size-dependent work function are investigated. These memory devices are utilized as sensitive trace vapor detector with the embedded nanoparticles as detection sites. Lastly, the application of these nanoparticles as charge injection hotspots for achieving ideal Ohmic metal-semiconductor contacts, and the doping effects of the nanoparticles to the conduction channel of 2D material-based field effect transistors are studied.