Group 10 transition metals with nanoscale dimensions offer significant advantages over their bulk counterparts. Significant work has been devoted toward studying the benefits of their catalytic efficiencies, however, less has been dedicated toward understanding their electronic properties and how such changes influence charge storage and sensor efficiency. This study focuses on designing metallic and bimetallic nanoparticles consisting of nanoscale Group 10 transition metals with well-defined structures, prepared using a facile synthetic procedure. The nanoparticles were characterized by electron microscopy, spectroscopic and x-ray techniques. The efficiency of monometallic and bimetallic nanoparticles toward electron storage was investigated electrochemically and by optical spectroscopy. Novel surface enhanced Raman scattering (SERS) sensors for the detection of heavy metals were also fabricated. Furthermore, the toxicity of the metals was analyzed with a focus on understanding the effects of varied pH. The results show a comprehensive comparative study of the characteristics and potential applications of group 10 transition metals.