Public Abstract

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Title:Utilizing the size dependent crystallinity, catalytic activity and charge retention characteristics of ultrafine sub-2 nm Pt nanoparticles in electrochemical/electrical systems

Use of nanoparticles (NPs) instead of the bulk material in catalytic/electrical systems is a growing trend, which has resulted in more efficient catalytic systems and low-power operational electrical transduction systems. This dissertation aims to explore and discuss the size dependent application of tilted target sputtered sub-2 nm sized Pt nanoparticles in certain electrochemical/electrical systems. The stability of these Pt NPs, with narrow size distributions and large areal densities, on different supporting surfaces was studied to better understand the role of NP size and surface adhesive forces governing the issue of active surface area loss, a notable concern in systems utilizing Pt NPs as catalysts. From an applications standpoint, with the purpose of analysing the effect of charge transfer characteristics and crystallinity of sub-2 nm Pt NPs in driving reaction kinetics, these Pt NPs were utilized at DSSC counter electrodes order to efficiently realize the triiodide reduction reaction at the counter electrode of DSSCs. While exploring the stability of these sub-2 nm Pt NPs in acidic environments, evidence of size-dependent hydrogen spillover was also observed for these NPs and a correlation between NP size, crystallinity, support characteristics, and hydrogen spillover was explored. While uncapped Pt NPs are utilized for catalytic applications, to take advantage of their size dependent charge trapping characteristics, capped Pt NPs are typically utilized within electronic devices. To study the electronic properties of these Pt NPs for device applications, these Pt NPs were electrically probed while embedded within a dielectric film. These Pt NP embedded dielectrics (Al_2O_3 in this study) were studied with intended application in non-volatile memory devices and the role of defects at the Pt NP/dielectric interface in determining the resultant device characteristics was also explored.