PhD Departmental Seminar Abstract

Preparation, Characterization, and Application of Pd and Ni Nanomaterials for Electrochemical Energy Storage and Generation Systems

Sho Fujita

Dr. Gregory Jerkiewicz Research Group

Electrochemical energy storage and generation systems play essential roles in modern civilization. Among various energy storage systems, nickel-metal hydride (Ni-MH) batteries have found different applications because of their safety. Fuel cells are one of the clean energy generation systems producing electricity from hydrogen and oxygen. The anode of the Ni-MH batteries is an intermetallic alloy that undergo pulverization after repetitive H absorption/desorption cycling due to its polycrystalline nature; the process leads to a capacity loss. Our group has recently found that octahedral Pd nanoparticles (Pd NPs) can absorb significantly more hydrogen (H) than bulk Pd materials and do not undergo pulverization after repetitive H absorption/desorption cycling in acidic solution. Thus, if octahedral Pd NPs were applied in Ni-MH batteries, then their cycle-life could be dramatically enhanced. Due to the high cost of Pd, it is more viable to employ octahedral Pd NPs in miniaturized Ni-MH batteries that can be used in microelectronics or other applications, where the cost is secondary to dependability. Because Ni-MH batteries are alkaline batteries, it is necessary to examine the behaviour of the octahedral Pd NPs in alkaline solution. In this study, the electrochemical behaviour and structural changes of Pd NPs during the cycle-performance test in aqueous alkaline solution are discussed. The cathode in the miniaturized Ni-MH batteries also requires a nanomaterial due to limited volume. Thus, the preparation, characterization, and electrochemical behaviour of carbon-supported β-$Ni(OH)_2$ nanosheets are discussed. In general, carbon-supported metallic NPs are employed in fuel cells as electrocatalysts, and it has been widely known that the carbon support undergoes severe corrosion in alkaline condition and makes the metallic NPs agglomerate and detach from the carbon support. Thus, the Pd NPs embedded in the β-$Ni(OH)_2$ nanosheets on the carbon support are prepared and their unique electrochemical property is discussed in this study.