# Size Effects of Core-Shell $CoO_x$-$Co(OH)_2$ Nanocatalysts in Oxygen Electrocatalysis

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Recently, unitized regenerative fuel cell (URFC), which is combined system of electrolyzer and fuel cell, has attracted much attention. URFC can maximize the usage of renewable energy sources by saving the leftover chemical fuels through electrolyzer, which can be later used when the renewable energy sources are unavailable. The key element for improvement of URFC performance is dictated by the development of bifunctional catalysts which promote both oxygen reduction reaction (ORR) and oxygen evolution reaction (OER). As bifunctional catalysts, cobalt nanoparticles (Co NPs) with controlled particle sizes (3.0, 6.2, 7.7, and 9.1 nm) were synthesized and supported on highly conductive carbon nanotubes, affording Co/CNTs. High-resolution TEM as well as extended X-ray absorption fine structure spectra over Co/CNTs revealed that crystal phase of 6.2, 7.7 and 9.1 nm Co NPs is predominantly composed of CoO core and $Co(OH)_2$ shell whereas the smallest 3.0 nm Co NPs consists of $Co_3O_4$ core and $Co(OH)_2$ shell. With the core-shell structured nanoparticles on CNTs, size dependent electrocatalytic activities toward ORR and OER in alkaline solution were investigated.