Coverage Dependent Catalytic Activity of Platinum on Gold Nano-octahedra : From Single Atoms to Multiple Layers

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Platinum was deposited on gold octahedral nanoparticles using an electrochemical method. The coverage of platinum on the gold surface was controlled from atomically dispersed sub-monolayer to fully covered multiple layers. CO stripping, oxide formation and reduction and X-ray photoelectron spectroscopy was conducted to evaluate nanostructure of the deposited platinum. Formic acid oxidation and methanol oxidation were conducted to evaluate their catalytic activity and showed completely opposite trend. Catalytic activity of formic acid oxidation greatly increased by two orders of magnitude (0.40 A mg^{-1}_{Pt} for 5 ML and 65.2 A mg^{-1}_{Pt} for 0.05 ML) with decreasing coverage. This high activity resulted from the control toward direct pathway producing no surface-poisoning (CO) species, helped by anti-ensemble effect of isolated Pt atoms and bifunctional effect of neighboring Pt-Au sites. On the other hand, catalytic activity of methanol oxidation was increased with increasing coverage.