

Variation of electronic and chemical properties of Au nanoparticles with decreasing particle size

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Size-dependent variation of electronic and adsorption properties of Au nanoparticles formed on native Si oxide surfaces were investigated using synchrotron radiation photoemission spectroscopy (SRPES) and ultraviolet photoelectron spectroscopy (UPS). The Au 4f level undergoes a positive shift with decreasing particle size, and the size-dependent positive shift is more pronounced for the valence edge. This result is interpreted in terms of strong contribution of the initial state effect on the shift of the valence edge due to the quantum confinement effect. Adsorption reactivity of oxygen and butanethiol first increases with decreasing particle size; however, below certain particle sizes, Au gradually becomes resistant toward adsorption of both reagents. The mean particle sizes for the maximum adsorption reactivity of oxygen and butanethiol are different, which are 2.5 and 0.8 nm for oxygen and butanethiol, respectively. This result is in contrast to previous studies on Au₅₅ clusters, which addressed a non-monotonous size-dependence in chemical activity with pronounced inertness of a certain particle size.