Methane (CH4), a major compound of natural gas, has been suggested as a future energy carrier. However, it is also known to be a strong greenhouse gas. The use of CH4 obtained from crude oil as an associated gas is often uneconomical, and it is thus burned off. Avoiding flaring and making the energy stored in the molecule available, is a major research challenge. In this PhD thesis, CH4 oxidation on nanoparticular gold is studied both experimentally and theoretically. In the course of this PhD project, CH4 oxidation was experimentally found more likely to form CO2 and H2O than other low index hydrocarbon oxygenates, even at mild conditions (p = 1 bar, # B250XC). This has been taken as an indication that CH4 oxidation proceeds along a pathway of full combustion. Thus, it was decided to study the tail of the CH4 oxidation pathway, which is given by CO and H2 oxidation, in more detailed. Extensive steady-state activity measurements were performed to obtain the reaction rates for CO and H2 oxidation. These reactions were studied on three different gold particle sizes using either O2 or N2O as oxidation agents. Using particle size distributions obtained from TEM analysis, it was found that the CO oxidation rates follow the d−3 relationship proposed in [Nano Today 2, 14 (2007)]. To corroborate the experimental findings, density functional theory (DFT) calculations on the Auf532g surface and a Au12 cluster, which model corner sites, were used in a microkinetic model. This model reproduced the apparent activation energies for CO oxidation by both O2 and N2O. Interestingly, the apparent activation energy for small particles (